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Technical Report

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Broadband satellite multimedia;
Part 2: Scenario for standardization

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES), STF126.

The present document contains much supportive material that leads up the conclusions in clauses 11 and 12. These are considered the main clauses. The supportive material can be basically categorized as on-going standardization activities outside and inside ETSI, trends in multimedia networking and satellite networks, as well as current research.

The present document is part 2 of a multi-part TR covering the Satellite Earth Stations and Systems (SES); Broadband satellite multimedia, as identified below:

Part 1: "Survey on standardization objectives";

Part 2: "Scenario for standardization".

Introduction

The terms of reference for the present document report state that the output shall be based upon the Phase 1 report TR 101 374-1 [2], as well as the GMM Report [19] and the GMM companion document [20]. Further, the terms of reference underline the topics of:

- Fixed-Mobile Convergence (FMC);
- Virtual Home Environment (VHE); and
- Number Portability.

Considering those aspects, but not excluding others as well, the present document will address requirements for both harmonized and voluntary standards. A non-exclusive list of considerations will include focus on:

- Radio air interfaces;
- Gateway interfaces;
- Terminal I/F interface;
- User application interface.

The GMM standardization framework refers to an Information Infrastructure in ETSI with four domains, which are closely related to the business roles in the EII/GII enterprise model. The framework includes terminals and networks that support both personal and terminal roaming. In the present document we will relate to these domains, which are:

- User Domain: user terminal equipment (fixed, mobile, consumer etc.);
- Access Domain: access networks;

- Core Network Domain: core transport networks; and
- Content Domain: applications services.

The GMM report further describes the trend of a shift from separate industries for communications, IT and broadcasting to convergence through the integration of services and operations. *This implies that a long-term discrimination between these types of services should not be made*.

The ITU-R considers that fixed-satellite systems must be part of the global information infrastructure (GII) (ITU-R Working Party 4B, and a logical consequence of that based on the fixed-mobile convergence is that also mobile systems will eventually be considered as part of the GII.

The quality-of-service (QoS) is a fundamental concept in networked multimedia communications, and is a key differentiator from traditional communication architectures. The multimedia application used by a user (or an entity) defines the abstraction of QoS parameters and the level of abstraction of the "quality level" has to be mapped at different architectural elements that are encountered between the source and destination entities in a distributed environment.

The Phase-1 report from 1998 provided a snapshot survey of the status at the time of the information gathering for BSM systems. Some significant events have occurred since then. It is worth mentioning here that several European BSM systems tend to announce compliance with a forthcoming DVB return channel specification (DVB-RCS). There also are signs of stronger interest now in standardization, and ETSI has been contacted by several American companies interested in the work and in participation in future standardization work.

Focusing specifically on the title Broadband Satellite *Multimedia* (BSM), the present document will interpret BSM as satellite systems that are used for broadband *multimedia* communications over satellite, as opposed to general broadband satellite systems. The underlying assumption is that such systems have sufficient bandwidth for communications originating audio-visual sources in combination with computer data.

Distribution based systems contain interactive broadcast systems, where a user accesses and is accessed by a predefined service provider. DVB based systems typically belong to this class.

Communication class systems include evolutions of S-PCN systems, where any user can contact any other user directly. Solutions may or may not involve a gateway, and routing through terrestrial networks. With the emergence of Internet, there is also a need for networks that support efficient Multicasting.

Broadband multimedia communication can be characterized by:

- In its most general form, having the ability to be used for any combination of sources with any set of QoS requirements. (In practice technology and regulations will set some limits).
- Having the ability to jointly transfer data from a combination of sources, where at least one of them is audio/video and another is text or computer data.
- Having the ability to transfer audio and video with high fidelity.
- Involving a multimedia application on at least one side.
- Applications may or may not have some form of QoS mechanism.
- Exhibiting bursty traffic patterns and variable bit-rates.
- Having some real-time requirement.

From the Phase 1 report, it was accepted that for fixed multimedia terminals a capability of approximately 2 Mbit/s or more in at least one direction would be required. We will therefore keep that assumption here.

It is assumed that:

- BSM systems will be used for broadband access to the GII.
- Some satellite systems may be used to complement other networks.
- Some satellite systems may compete with other access networks.
- Satellite based access should be similar to other GII access.

- VHE involves nomadic users, with or without terminals
- Fixed mobile convergence implies in some cases long-term similar services for FSS and MSS.
- Location management concepts developed for GSM could be applicable also for BSM satellite systems.
- Different BSM users are not generally on the same system.
- IP dominates as a protocol for multimedia applications.

Satellite communications is both for a regional and for a global market. The satellite communications market as a whole may benefit from users not having to worry that an investment in a terminal will tie them to one system and service provider.

With the requirement for a multi-megabit communications capacity some further assumptions can be made with respect to for instance the frequency band for such satellite systems. In practice they will use frequencies from the Ku-band and up in at least one direction. In general, return channels at low rate at frequencies below the Ku band should not be excluded. Currently, most filings focus on the Ka-band, at 20/30 GHz. However, there are also filings at the V-band and Ku-band. Standards should therefore be made as independent of the frequency band as possible. Frequency dependent specifications should in general be separated into dedicated documents.

With respect to the transmission formats there are a few different classes of systems that seem to emerge, being able to carry IP traffic, and being able to carry traffic from the other classes. The classes are:

- ATM-based systems; and
- DVB-based systems;

However, even if there is work in progress for both interactive DVB and ATM based communications, there is no universal and complete standard for satellite systems yet that ensures an efficient use of the resources.

Visions for this work include the following issues:

- That there is a need for efficient inter-system interoperability (between both BSM systems and terrestrial systems).
- That there is room for proprietary Intra-system solutions.
- That there is an opportunity to develop standards that could increase the use of satellites for broadband satellite multimedia communication.
- Satellite standards would benefit from being global.

Such a vision will be beneficial to the whole satellite community, independently of systems.

A high market segment for BSM systems is a goal for the general industry. This could be achieved by:

- Attracting a large number of customers by offering attractive services and equipment;
- Placing the satellite systems at the market early enough to capture market opportunities from competing technologies and take advantage of market windows. Other major competing technologies include ADSL, which may come to define some of the market expectations for broadband communications systems;
- Inviting service providers to offer the satellite capabilities to end users. With a similar subscriber management as for other access technologies, the threshold for a SP to offer satellite access as a service is lower than if BSM are designed and have to be treated specially;
- Establishing standards and integration with "the rest of the world".

Low entry level for consumers requires reasonable low cost, as well as other factors like availability of equipment, ease of installation, etc. It should also be recognized that:

- Different service providers may be associated with the same satellite system;
- The same service provider may be associated with different satellite systems;

- Users may have several service providers.

Some service providers will probably offer broadband access via satellite in addition to other means, like ADSL.

Standards that allow open competition in the terminal market will be important. So will standards that encourage competition in the service provider market.

The present document is structured as follows:

- The first clause covers Trends in Telecommunications, followed by Trends in Satellite Networks;
- The next two clauses cover other relevant Standardization activities, first external and then within ETSI;
- The following clause treats Regulatory Issues;
- Then relevant Research activities are mentioned. This clause is an update from the phase-1 report;
- Several relevant Reference Models are presented in clause 10. These define the interfaces that may be considered for standardization;
- The Standardization Scenario is discussed in the following clause, and finally the Summary Recommendations for ETSI are listed in clause 12.

Following this, there are several annexes, providing detailed information on selected topics.

The abbreviations GEO and GSO are commonly used in various reference documents, both referring to the geo-stationary earth orbit. In this report, GEO is normally preferred. However, when there is reference to work where GSO is used, that abbreviation has been kept for consistency.

Executive Summary

The present document has been produced to consider standardization scenarios for broadband satellite multimedia, BSM. The phase–1 report TR 101 374-1 [2] included a survey of different proponents for BSM, and through a questionnaire asked different proponents to give their views on issues to be standardized. A special task force, STF126, Phase 2 prepared the present phase 2 report TR 101 374-2.

The **Fixed and Mobile convergence** (subclause 4.2) is a market driver for e.g. UMTS, and the service capabilities developed for fixed network multimedia users will be candidate services for mobile multimedia. It is argued that this should be taken into account when specifying UMTS systems e.g. specific source coding or compression techniques should be considered. Common Service Provision for different networks will need to be specified by ETSI. In the same respect, this is a valid argument for BSM systems.

The **GMM report** (subclause 4.4) stated that globalization of information brings an additional dimension to the convergence issues. From a user perspective those issues remain the same - access (real or apparent) to the same services and features as "at home". For operators and service providers, however, the matter becomes more complex with globalization. Not only are there technical aspects to be addressed, but issues of a commercial and regulatory nature may also have to be accommodated (roaming agreements and the like).

Virtual Home Environment (subclause 4.5.1) is a system concept for service portability in the IMT-2000 across network borders. In this concept a foreign network emulates for a particular user the behaviour of his home environment. For the user, adaptation of his service handling is therefore unnecessary.

Number portability (subclause 4.5.2) is a facility provided by one operator to another that enables customers to keep their telephone numbers when switching their business between those operators. Changing number can be a major inconvenience for customers and a barrier that prevents them from exercising choice and taking advantage of growing competition in the telecommunication markets. Number portability means that customers can change to a new operator without the trouble of having to change their number.

The Internet and the **Internet Protocol** (IP)(subclause 4.6) are already dominating multimedia communications, and will continue to do so in the foreseeable future. For future BSM systems, it is quite obvious that IP must be supported, and preferably as efficiently as possible. For mobile multimedia networks there seems to be a trend towards pure IP networks, with ATM as an intermediate technology to support QoS. For fixed networks the trend is the same.

Asynchronous transfer mode (ATM) (subclause 4.7) is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic. ATM is a technology that enables carriers to capitalize on a number of revenue opportunities through multiple ATM classes of services, high-speed local area network (LAN) interconnection, voice, video, and future multimedia applications in business markets in the short term and in community and residential markets in a longer term. ATM has evolved as a major technology for core networks over the last decade.

UMTS/IMT2000/3GPP (subclause 4.8) is the future universal system for mobile communications. It will evolve smoothly from the GSM basis. With respect to the fixed-mobile convergence, UMTS may form a framework within which BSM systems may fit.

The trends in satellite networks (subclause 5) indicate that satellite communications has a bright future. This is due not only to advances in satellite technology, but also because of satellites' ability to provide broad coverage, fixed, nomadic and mobile services, and broadband multimedia services direct to the consumer. Satellite systems can also supply cost-effective broadcasting services, together with the ability to provide instantaneous re-deployment of capacity, instantly provide communications infrastructure, and avoid costly, time-consuming terrestrial system deployment, and provide overall flexibility and reliability.

There is a significant amount of work being carried out world-wide, both in official standardization bodies and in ad hoc groups of interested parties. As ETSI activity on BSM can not take place in isolation of global developments, it is essential to know what other work is being carried out elsewhere. In subclause 6 the most important relevant activities are outlined.

The ITU (subclause 6.1) is arguably the single most important standardization body in global telecommunications. National and regional standardization activities, including ETSI work, can generally be considered as input to the ITU work and therefore a solid understanding of ITU study areas is essential. In subclause 6.1, the relevant work within both ITU-T and ITU-R is presented.

The TIA (subclause 6.2) is accredited by the American National Standards Institute (ANSI) to develop voluntary industry standards for a wide variety of telecommunications products. TIA's Standards and Technology Department is composed of five divisions that sponsor over 70 standards-setting formulating groups. The committees and subcommittees that formulate the standards are sponsored by five divisions - Fiber Optics, User Premises Equipment, Network Equipment, Wireless Communications and Satellite Communications.

The ATM Forum (subclause 6.3) is an international non-profit organization formed with the objective of accelerating the use of ATM products and services through a rapid convergence of interoperability specifications. In addition, the Forum promotes industry co-operation and awareness. Currently the Forum is developing IP over ATM, voice over ATM, real-time multimedia over ATM (based on ITU-T Recommendation H.323 [69]), and a performance-testing specification as it seeks to secure the technology's future. The organization is using its expertise in the ATM market to transform itself into a multiprotocol forum. A newly established working group has been charged with intensifying ATM's support of IP-based services. The Forum also formed another working group to encourage the development of VoDSL technology, along with voice and data convergence.

The Internet Engineering Task Force (IETF) (subclause 6.4) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual.

ESA/ESTEC (subclause 6.9) is initiating work toward the development of a set of common air interface standards for regenerative satellites. This work will be carried out by a group called the "Ad-hoc Group to promote standardization of terminals for regenerative satellite multimedia systems (RSAT)".

The Digital Video Broadcasting Project (DVB) (subclause 6.10) includes more than 220 well-known organizations in more than 30 countries world-wide. Members include broadcasters, manufacturers, network operators and regulatory bodies, committed to designing a global family of standards for the delivery of digital television.

DVB-compliant digital broadcasting and reception equipment for professional, commercial and consumer applications is widely available on the market, and numerous broadcast services using DVB standards are now operational, in Europe, North and South America, Africa, Asia, and Australasia. The DVB-RCS group is finalizing a first version of a return channel standard for interactive satellite communications.

In 1995 a group of telecommunication network operators and equipment suppliers established an international initiative called "**Full Services Access Networks (FSAN)**" (subclause 6.12). The objective was to create the conditions for the development and introduction of access systems supporting a full range of narrow-band and broadband services through the definition of a basic set of common requirements. These networks should be able to deliver existing and future services, in some cases not yet completely identified

FSAN consists of 20 Telcos who are working with their strategic equipment suppliers to agree upon a common broadband access system for the provision of both broadband and narrowband services. This common broadband access system is documented in the FSAN requirements specification and is a public document, with the contents available to relevant standardization bodies.

Related standardization activities in **ETSI** are presented in subclause 7, starting with TC SES, TC SPAN, EP TIPHON, TC SEC on security, EP BRAN, EP UMTS, TC TMN, TC HF Human Factors, TC ERM, TC SMG and EP EASI.

The overall regulatory environment is presented in subclause 8, and the impact of the new R&TTE Directive is described, together with indication of the Lawful Interception required by Legal Authorities.

The research activities, in particular the 5^{th} Framework Programme is presented in subclause 9.

For the purpose of discussion and standardization there is a requirement to decide which reference models to use (subclause 10). Different models are used for different purposes by different bodies. There is no one single correct reference model. This clause aims to present some of the reference models considered most relevant for this work, and suggests a few generated by the STF.

Subclause 11 concludes with Recommendations for standardization. The topics are grouped into different categories. Each topic is introduced briefly, also mentioning benefits of standardization, before a suggested working method is listed.

All the recommendations for standards, except one, are for voluntary standards. Organizations that see benefits in having a standard can thus support it, while those not interested need not comply.

Subclause 12 summarizes the recommendations in tabular form.

1 Scope

The scope of this work is to consider a standardization scenario for Broadband Satellite Multimedia:

- Phase 2: TR 101 374-2, "Standardization Objectives for Broadband Satellite Multimedia: The Standardization Scenario";

based upon the report:

- Phase 1: TR 101 374-1 [2], "Survey on Standardization Objectives for Broadband Satellite Multimedia".

The standardization approach, relevant issues, actions and further work that should be undertaken within ETSI is analysed and presented.

This Phase 2 analyses the various possibilities of harmonized and voluntary standardization, based on among other issues, the GMM report [19] and the GMM companion document [20], and taking into account the R&TTE directive 1999/05/EC [22].

The standardization scenario also addresses issues mentioned in the Phase 1 report, as: Fixed Mobile Convergence, Virtual Home Environment, Number Portability, Radio Air Interface, I-F Interface, Application, User Interface, and Gateway Interface.

The conclusions define the Standardization scenario, including identification of standards proposed to be produced by ETSI.

2 References

The following documents contain provisions, which through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETSI, TR 101 118: "Network Aspects (NA); High level network architecture and solutions to support number portability".

[2] ETSI, TR 101 374-1: "Satellite Earth Stations and Systems (SES); Broadband satellite multimedia; Part 1: Survey on standardization objectives".

[3] ETSI, TR 101 458: "Universal Mobile Telecommunications Services (UMTS); Future direction of standards work on UMTS / IMT-2000 (TR 101 458 v1.0.0)".

[4] ETSI, TS 122 121: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); Service aspects; The Virtual Home Environment (3G TS 22.121 version 3.1.0 Release 1999)".

[5] ETSI, ETR 154: "Digital Video Broadcasting (DVB); Implementation guidelines for the use of MPEG-2 Systems, Video and Audio in satellite, cable and terrestrial broadcasting applications".

[6] ETSI, ES 201 158: "Telecommunications Security; Lawful Interception (LI); Requirements for network functions".

[7] ETSI, ES 201 671: "Telecommunications security; Lawful Interception (LI); Handover interface for the lawful interception of telecommunications traffic".

[8] ETSI, EG 202 306: "Transmission and Multiplexing (TM); Access networks for residential customers".

[9] ETSI, EN 300 421: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services".

[10] ETSI, ETS 300 802: "Digital Video Broadcasting (DVB); Network-independent protocols for DVB interactive services".

[11] ETSI, ETS 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

[12] ETSI, EN 301 005 (all parts): "V interfaces at the digital Service Node (SN); Interfaces at the VB5.1 reference point for the support of broadband or combined narrowband and broadband Access Networks (ANs)".

NOTE 1: Parts 3 and 4 are not yet published.

[13] ETSI, EN 301 192: "Digital Video Broadcasting (DVB); DVB specification for data broadcasting".

[14] ETSI, EN 301 217 (all parts): "V interfaces at the digital Service Node (SN); Interfaces at the VB5.2 reference point for the support of broadband or combined narrowband and broadband Access Networks (ANs)".

NOTE 2: Parts 3 and 4 are not yet published.

[15] ETSI, EN 301 358: "Satellite Earth Stations and Systems (SES); Satellite User Terminals (SUT) using satellites in geostationary orbit operating in the 19,7 GHz to 20,2 GHz (space-to-earth) and 29,5 GHz to 30 GHz (earth-to-space) frequency bands".

[16] ETSI, EN 301 359: "Satellite Earth Stations and Systems (SES); Satellite Interactive Terminals (SIT) using satellites in geostationary orbit operating in the 11 GHz to 12 GHz (space-to-earth) and 29,5 GHz to 30,0 GHz (earth-to-space) frequency bands".

[17] ETSI, EN 301 459: "Satellite Earth Stations and Systems (SES); Harmonized EN for Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit in the 29,5 to 30,0 GHz frequency bands covering essential requirements under article 3.2 of the R&TTE Directive".

NOTE 3: Not yet published.

[18] ETSI, ETR 331: "Security Techniques Advisory Group (STAG); Definition of user requirements for lawful interception of telecommunications; Requirements of the law enforcement agencies".

[19] ETSI GMM Report: "Global Multimedia Mobility: A standardization framework for multimedia mobility in the information society". 1996.

[20] ETSI GMM Companion Document (V.3.0.1, 17 June 1999): "GMM: Seamless Service Offering, Giving users consistent access to Application/Service Portfolios independent of Access Network and Core Network".

[21] Squire Sanders & Dempsey and Analysys (1998): "Adapting The EU Telecoms Regulatory Framework To The Developing Multimedia Environment. A Study for the European Commission (Directorate-General XIII)".

NOTE 4: The above reference can be found at http://193.118.248.19/products/internet/ecreport/default.htm.

[22] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications equipment and the mutual recognition of their conformity.

[23] ITU-T Recommendation G.826 (1999): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[24] ITU-T Recommendation G.902: "Framework Recommendation on functional access networks (AN) - Architecture and functions, access types, management and service node aspects".

[25] ITU-T Recommendation G.967.1 (1998): "V-interfaces at the service node (SN): VB5.1 reference point specification".

[26] ITU-T Recommendation G.967.2 (1999): "V-interfaces at the service node (SN): VB5.2 reference point specification".

[27] ITU-T Recommendation I.356 (1996): "B-ISDN ATM layer cell transfer performance".

[28] ITU-T Recommendation I.357 (1996): "B-ISDN semi-permanent connection availability".

[29] ITU-T Recommendation M.3010 (1996): "Principles for a Telecommunications management network".

[30] ITU-T Recommendation Q.708 (1999): "Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)".

[31] ITU-T Recommendation Y.100: "General overview of the Global Information Infrastructure standards development".

[32] ITU-T Recommendation Y.110: "Global Information Infrastructure principles and framework architecture".

[33] ITU-T Recommendation Y.120: "Global Information Infrastructure scenario methodology".

[34] ITU-R Recommendation M.1167 (1995): "Framework for the satellite component of International Mobile Telecommunications-2000 (IMT-2000)".

[35] IETF RFC 2760: "Ongoing TCP Research Related to Satellites", February 2000.

[36] IETF RFC 2488 (1999): "Enhancing TCP Over Satellite Channels using Standard Mechanisms".

[37] ATM Forum UNI 3.1: "ATM User-Network Interface Specification V3.1", 1994.

[38] ATM Forum AF-RBB-0099.000: "Residential Broadband Architectural Framework", July 1998.

[39] ATM Forum/98-0828: "A Progress Report on the Standards Development for Satellite ATM Networks", November 1998.

[40] ATM Forum/98-0735: "Infrastructure Mobility and Satellite Access Sub Group Work Plans", October 1998.

[41] TIA/EIA TELECOMMUNICATIONS SYSTEMS BULLETIN: "High Level Requirements for Common Air Interface for GEO-mobile (Super-GEO) Satellite Communications Featuring Interoperation with Terrestrial GSM, TIA/EIA/TSB 90", August 1998.

[42] TIA/EIA TELECOMMUNICATIONS SYSTEMS BULLETIN Satellite ATM Networks: Architectures and Guidelines, TIA/EIA/TSB-91, April 1998.

[43] NASA (1998): WTEC Panel Report on Global Satellite Communications Technology and Systems.

NOTE 5: The above reference can be found at http://www.itri.loyola.edu/satcom2/toc.htm.

[44] I. Mertzanis et al, "Protocol architectures for satellite ATM broadband networks", IEEE Communications Magazine, March 1999.

[45] ITU-R Recommendation S.1062: "Allowable error performance for a hypothetical reference digital path operating at or above the primary rate".

[46] ITU-R Recommendation M.1343: "Essential technical requirements of mobile Earth stations for global non-geostationary mobile-satellite service systems in the band 1 GHz to 3 GHz".

[47] ISO/IEC 16500 (all parts): "Information technology - Generic digital audio-visual systems".

[48] EN 300 652: "Broadband Radio Access Networks (BRAN); HIgh PErformance Radio Local Area Network (HIPERLAN) Type 1; Functional specification".

[49] I-ETS 300 819: "Telecommunications Management Network (TMN); Functional specification of usage metering information management on the Operations System/Network Element (OS/NE) interface".

[50] EN 300 292: "Telecommunications Management Network (TMN); Functional specification of call routeing information management on the Operations System/Network Element (OS/NE) interface".

[51] EN 300 291 (all parts): "Telecommunications Management Network (TMN); Functional specification of Customer Administration (CA) on the Operations System/Network Element (OS/NE) interface".

NOTE 6: Part 2 is not yet published.

[52] ETS 300 673: "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for 4/6 GHz and 11/12/14 GHz Very Small Aperture Terminal (VSAT) equipment and 11/12/13/14 GHz Satellite News Gathering (SNG) Transportable Earth Station (TES) equipment".

[53] EN 301 261-3: "Telecommunications Management Network (TMN); Security; Part 3: Security services; Authentication of users and entities in a TMN environment".

[54] ES 201 386: "Telecommunications Management Network (TMN); Service Switching Function (SSF) management information model".

[55] TR 101 648: "Telecommunications Management Network (TMN); Managed object modelling guidelines".

[56] ES 200 653: "Telecommunications Management Network (TMN); Network level generic class library".

[57] EN 301 271: "Telecommunications Management Network (TMN); Management interfaces associated with the VB5.1 reference point".

[58] ES 201 654: "Telecommunications Management Network (TMN); X interface; SDH path provisioning and fault management".

[59] EN 300 820 (all parts): "Telecommunications Management Network (TMN); Asynchronous Transfer Mode (ATM) management information model for X interface between Operation Systems (OSs) of a Virtual Path (VP)/Virtual Channel (VC) cross connected networks".

NOTE 7: All parts are not yet published.

[60] Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility.

[61] TR 101 673: "Technical Framework for the Provision of Interoperable ATM Services; Overview".

[62] EG 201 399: "A guide to the production of Harmonized standards for application under the R&TTE Directive".

[63] Directive 98/13/EC of the European Parliament and of the Council of 12 February 1998 relating to telecommunications terminal equipment and satellite earth station equipment, including the mutual recognition of their conformity.

[64] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.

[65] CEPT/ERC/REC 01-07: "Harmonized regime for exemption from individual licensing of radio equipment".

[66] IEEE 1394: "IEEE Standard for a High Performance Serial Bus".

[67] ITU-T Recommendation G.982: "Optical access networks to support services up to the ISDN primary rate or equivalent bit rates".

[68] ITU-T Recommendation G.783: "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".

[69] ITU-T Recommendation H.323: "Packet based multimedia communications systems".

[70] ITU-T Recommendation Z.130: "ITU object definition language".

[71] ITU-T Recommendation E.164: "The international public telecommunication numbering plan".

[72] ITU-T Recommendation X.25: "Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit".

[73] ITU-T Recommendation Q.2931: "Digital Subscriber Signalling System No. 2 (DSS 2) – User-Network Interface (UNI) layer 3 specification for basic call/connection control".

[74] ITU-T Recommendation X.509: "Information technology – Open Systems Interconnection – The Directory: authentication framework".

[75] ITU-T Recommendation I.371: "Traffic control and congestion control in B-ISDN".

[76] ITU-T Recommendation I.610: "B-ISDN operation and maintenance principles and functions".

[77] ITU-T Recommendation M.3100: "Generic network information model".

[78] ITU-R Recommendation M.817: "International Mobile Telecommunications-2000 (IMT-2000). Network architectures".

[79] ITU-R Recommendation M.818: "Satellite operation within International Mobile Telecommunications-2000 (IMT-2000)".

[80] EN 301 005-1: "V interfaces at the digital Service Node (SN); Interfaces at the VB5.1 reference point for the support of broadband or combined narrowband and broadband Access Networks (ANs); Part 1: Interface specification".

[81] IEEE 802.3: "CSMA/CD Access Method".

[82] EN 301 217-1: "V interfaces at the digital Service Node (SN); Interfaces at the VB5.2 reference point for the support of broadband or combined narrowband and broadband Access Networks (ANs); Part 1: Interface specification".

[83] ETSI, EN 301 360: "Satellite Earth Stations and Systems (SES); Satellite earth station User Terminals (SUT) using satellites in geostationary orbit operating in the 17,7 to 19,7 GHz (space-to-earth) and 27,5 to 29,5 GHz frequency bands".

[84] IEEE 802.1G: "Remote Media Access Control (MAC) bridging".

[85] EN 301 754: "Telecommunications Management Network (TMN); Management interfaces associated with the VB5.2 reference point".

NOTE 8: Not yet published.

[86] TS 101 674-1: "Technical Framework for the provision of interoperable ATM services; Part 1: NNI-Interface User and Control plane specification (including network functions and service aspects) Phase 1".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
ACTS	EU Advanced Communications Technologies and Services Programme
ADSL	Asymmetric Digital Subscriber Loop
AN	Access Network
ANI	Access Network Interface
ANSI	American National Standards Institute
API	Application Program Interfaces
ARP	Address Resolution Protocol
ATM	Asynchronous Transfer Mode
B-BCC	Broadband Bearer Connection Control
BER	Bit Error Rate
BGP	Border Gateway Protocol
BRAN	ETSI Project: Broadband Radio Access Networks
BSM	Broadband Satellite Multimedia
BSS	Broadcast Satellite Service
CAC	Call Admission Control
CASI	Common ATM Satellite Interface (TIA)
CATV	Cable Television
CBR	Constant Bit Rate
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications administrations
CER	Cell Error Ratio
CLR	Cell Loss Ratio
CORBA	Common Object Request Broker Architecture
CPE	Customer Premises Equipment
CPG	CEPT Conference Preparatory Group
DAMA	Demand Assigned Multiple Access
DAVIC	Digital Audio Visual Council
DBS	Direct Broadcast System
DECT	Digitally Enhanced Cordless Telecommunications
DHCP	Dynamic Host Configuration Protocol
DIFFSERV	Differentiated Services
DSL	Digital Subscriber Loop
DSM-CC	Digital Storage Media - Command and Control
DVB-MHP	Digital Video Broadcasting - Multimedia Home Platform
DVB-RC	Digital Video Broadcasting - Return Channel
DVB-RCS	Digital Video Broadcasting - Return Channel over Satellite
DVB	Digital Video Broadcasting
DVB-C	Digital Video Broadcasting - Cable
DVB-CA	Digital Video Broadcasting - Conditional Access
DVB-CI	Digital Video Broadcasting - Common Interface
DVB-MC/S	Digital Video Broadcasting - Microwave Multipoint Video Distribution
DVB-S	Digital Video Broadcasting - Satellite
DVB-SI	Digital Video Broadcasting - Service Information
DVB-T	Digital Video Broadcasting – Terrestrial
DVMRP	Distance Vector Multicast Routing Protocol
EASI	ETSI Project: European ATM Services Interoperability
EC	European Commission
ECTRA	European Committee for Telecommunications Regulatory Affairs
EDGE	Enhanced Data rates for GSM Evolution
EII	European Information Infrastructure
EIRP	Effective Isotropically Radiated Power
EMC	Electro-Magnetic Compatibility
EN	European Standard (harmonized)
EP	ETSI Project

EPG	Electronic Program Guide
ER	Essential Requirements
ERC	European Radiocommunications Committee (subgroup of CEPT)
ERO	European Radiocommunications Office (of ERC)
ESA	European Space Agency
ESC	DAVIC End Service Consumer
ESP	DAVIC End Service Provider
ESTEC	European Space Research and Technology Centre (of ESA)
EU	European Union
FCC	US Federal Communications Commission
FDD	Frequency Division Duplexing
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FM	Frequency Modulation
FMC	Fixed-Mobile Convergence
FP5	EU 5th Framework Programme
FS	Fixed Service
FSAN	Full Service Access Network
FSS	Fixed Satellite Service
G/T	Gain - Temperature Ratio
GEO	Geostationary Earth Orbit
GII	Global Information Infrastructure
GMM	Global Multimedia Mobility
GMPCS	Global Mobile Personal Communications by Satellite
GMR	GEO Mobile Radio Interface
GoS	Grade of Service
GPRS	Generalized Packet Radio System
GSM	Global System for Mobile Communication
GSO	Geo-Stationary Orbit
GSTN	General Switched Telephone Network
HDTV	High Definition Television
ICGSAT	ITU Intersector Coordination Group on Satellite Matters
ICR	Initial Cell Rate
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IF	Intermediate Frequency
IGP	Internet Gateway Protocol
IMT2000	International Mobile Telecommunications 2000
IN	Intelligent Network
IP	Internet Protocol
IPR	Intellectual Property Rights
IPv6	Internet Protocol version 6
IS	Interim Standards (TIA)
ISDN	Integrated Services Digital Network
ISL	Inter Satellite Link
ISO	International Organization for Standardization
ISP	Internet Service Provider
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication sector
ITU-T	ITU Telecommunication Standardization sector
JWG	Joint Working Group (TIA)
LAN	Local Area Network
LEMF	Law Enforcement Monitoring Facility
LEO	Low Earth Orbit
LI	Lawful Interception
LMDS	Local Multipoint Distribution Service
LNB	Low Noise Block
MAC	Medium Access Control
MCR	Minimum Cell Rate

MEO	Medium Earth Orbit
MF-TDMA	Multi-Frequency TDMA
MHP	DVB Multimedia Home Platform
MLAC	EU Mutual Legal Assistance Convention
MoU	Memorandum of Understanding
MPEG	Moving Picture Expert Group
MPLS	Multi-Protocol Label Switching
MSS	Mobile Satellite Service
NASA	North American Space Agency
NGSO	Non-Geostationary Orbit
nrt-VBR	Non-Real-Time Variable Bit Rate
OAM	Operation, Administration and Maintenance
OBP	On Board Processing
OJEC	Official Journal of the European Commission
OSPF	Open Shortest Path First protocol
OSS	Operational Support Systems
PC	Personal Computer
PCS	Personal Communications Service
PDU	Protocol Data Unit
PEP	Performance Enhancing Proxy
PISN	Private Integrated Services Network
POTS	Plain Old Telephony Service
PSTN	Public Switched Telephone Network
PT	Project Team
PTT	Posts, Telegraph and Telephone company
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
R&TTE(D)	EU Radio and Telecommunication Terminal Equipment (Directive)
RBB	ATM Forum Residential Broadband architecture
RE	Radio Equipment
RF	Radio Frequency
RFC	IETF Request For Comments
RIP	Routing Information Protocol
RR	Radio Regulation
RSVP	Reservation Protocol
RTD	EU Research, Technological development and Demonstration activities
RTMC	Real Time Management Coordination (function)
RTT	Radio Transmission Technology
rt-VBR	Real Time Variable Bit Rate
SCN	Switched Circuit Networks
SDH	Synchronous Digital Hierarchy
SG	Study Group
SIM	Subscriber Identification Module
SIT	Satellite Interactive Terminal
SMATV	Satellite Master Antenna Satellite system
SN	Service Node
SNI	Service Node Interface
SOUS	Spectrum and Orbit Utilization Section (TIA)
SP	Service Provider
STAG	Security Techniques Advisory Group
STF	ETSI Specialist Task Force
S-UMTS	Satellite component of UMTS
SUT	Satellite User Terminal
SVC	Switched Virtual Circuit
SVP	Switched Virtual Path
TBD	To Be Defined
TC ERM	ETSI Technical Committee – EMC and Radio Spectrum Matters
TC HF	ETSI Technical Committee – Human Factors
TC SEC	ETSI Technical Committee - Security
TC SES	ETSI Technical Committee - Satellite Earth Stations and Systems

TC SMG	ETSI Technical Committee – Special Mobile Group
TC SPAN	ETSI Technical Committee – Services and Protocols for Advanced Networks
TC TMN	ETSI Technical Committee – Telecommunications Management Network
TC	ETSI Technical Committee
TCAM	Telecommunications Conformity Assessment and Market surveillance committee
TCP	Transmission Control Protocol
TDD	Time Division Duplexing
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
TIA	Telecommunications Industry Association (US)
TINA-C	Telecommunications Information Networking Architecture Consortium
TIPHON	ETSI Project: Telecommunications and Internet Protocol Harmonization Over Networks
TMF	Telemanagement Forum
TMN	Telecommunications Management Network
TSB	Telecommunications Systems Bulletin (TIA)
TSG	Technical Specification Group of 3GPP
TT&C	Telemetry, Tracking & Control
TTE	Telecommunications Terminal Equipment
TV	Television
UBR	Unspecified Bit Rate
UMTS	Universal Mobile Telecommunications Service
UNI	User Network Interface
URL	Universal Resource Locator
UTRA	Universal Terrestrial Radio Access
VASP	Value Added Service Provider
VC	Virtual Circuit
VDSL	Very High-speed Digital Subscriber Loop
VHE	Virtual Home Environment
VoDSL	Voice over DSL
VP	Virtual Path
VSAT	Very Small Aperture Terminal (satellite)
WAN	Wide Area Network
WG	Working Group
WISDOM	ACTS Wideband Satellite Demonstrator of Multimedia Services
WLAN	Wireless LAN
WRC	World Radiocommunication Conference

4 Trends in Telecommunication Networks

4.1 General

The GMM standardization framework in ETSI refers to an Information Infrastructure with four domains, which are closely related to the business roles in the EII/GII enterprise model. The framework includes terminals and networks that support both personal and terminal roaming. In the present document we will relate to these domains, which are:

- User Domain: user terminal equipment (fixed, mobile, consumer etc.);
- Access Domain: access networks;
- Core Network Domain: core transport networks; and
- Content Domain: applications services.

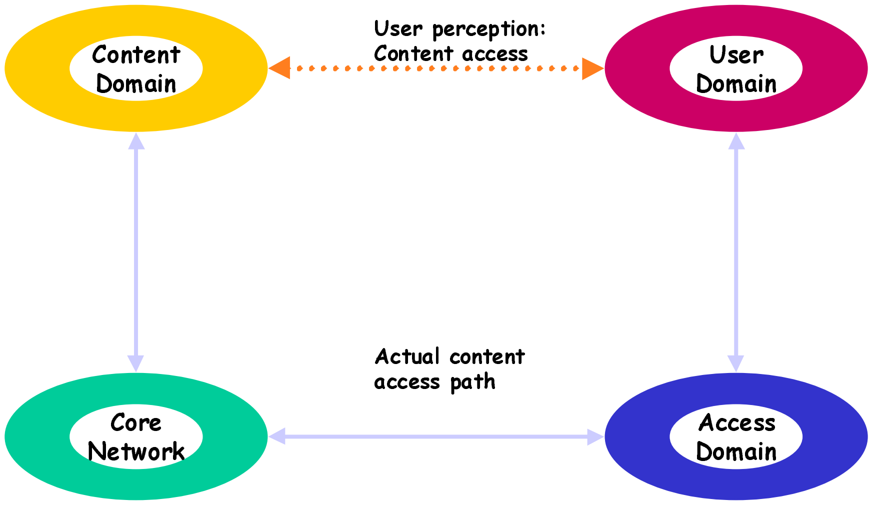


Figure 1: Communications domains, general view

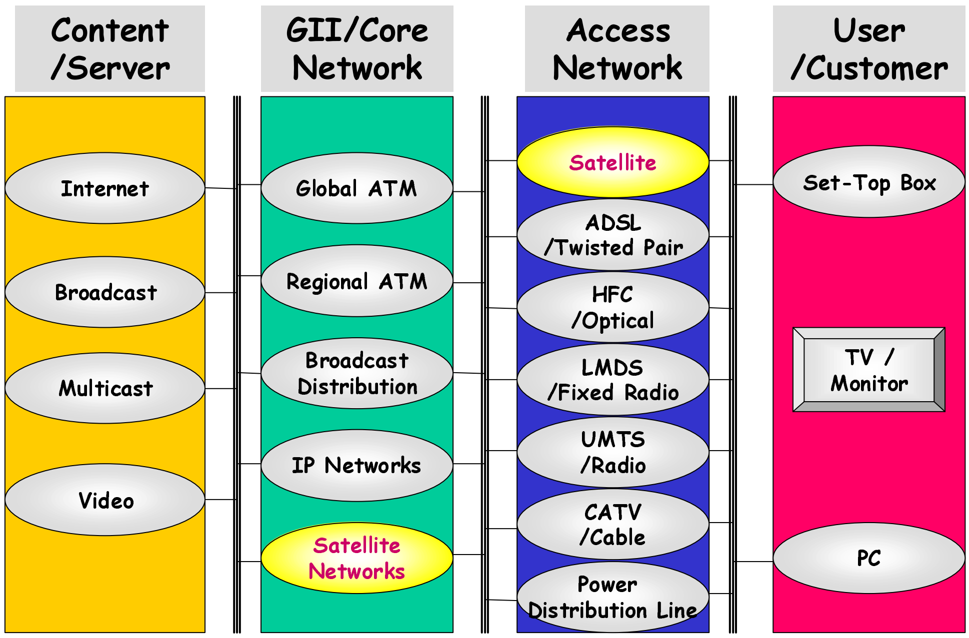


Figure 2: Four communications domains, detailed view

In practice, a high capacity back-haul system belongs to the core network, and may as well carry a number of voice channels as fewer multimedia sources. It is often a point-to-point connection, and/or often forms a part of a closed network. Connections are also established on a semi-permanent or permanent basis, and handled by professional operators and service providers.

In this study we focus the attention on broadband access for end-users, aimed at providing these users with interactive multimedia communications. An underlying assumption is that the connection is two-way via satellite. However, the connections can be asymmetric, and both transmissions paths do not need to follow the same path or provide the same capacity. One of the directions may not have the ability to transfer high quality audio-visual content, but at least one transmission path will need to have this capability.

4.2 Fixed - Mobile Convergence

Fixed - mobile convergence has for some time been a possibility. However, what has prevented convergence from taking place is not technological, but rather regulatory and commercial barriers. The situation has now changed, and it is expected that such convergence will take place.

Fixed–mobile convergence can be on a number of levels:

- Network level, where the same physical transmission and switching resources to route traffic, with differences only in the access technology to the customer.
- Service level, where the services offered are equally available to fixed or mobile users. This includes the VHE.
- Purchasing level, where fixed–mobile services will be supported by integrated billing and customer care systems.
- User equipment level, where e.g. a handset can be used for both GSM and DECT.
- System level, where different modes of operation can depend upon the "mobility" of the terminal.

In TR 101 458 [3] it is stated that the European Commission has recognized the many technological changes that are moving the media world towards convergence. They have initiated a major policy review to consider the impact so far of current telecommunication legislation and to consider what new legislation or revised existing legislation may need to be introduced in the post 2000 era.

One of the issues that emerged in the European commission's recent consultation [21] on the topic of regulatory convergence issues was there should be a more horizontal approach to future regulation. That is there should be similar regulatory treatment for all transport network infrastructures irrespective of the services they carry. This implies that networks conveying fixed services or networks conveying mobile services or networks conveying broadcast services etc should be treated the same from a regulatory perspective. This idea of regulatory separation between networks and services is something that does not currently exist in Europe – for instance fixed and mobile networks are traditionally regulated separately.

This form of regulation should in principle facilitate a greater degree of convergence at network level particularly between fixed and mobile and hence capabilities like VHE become a more realistic prospect to incorporate under the umbrella of UMTS.

The structure of the industry is also evolving taking into account both Market Convergence and Technology Convergence. The distinctions between fixed and mobile networks are becoming increasingly blurred and there is also convergence between the Telecommunications and IT industries.

FMC is a market driver for e.g. UMTS, and the service capabilities developed for fixed network multimedia users will be candidate services for mobile multimedia. It is argued that this should be taken into account when specifying UMTS systems e.g. specific source coding or compression techniques should be considered. Common Service Provision for different networks will need to be specified by ETSI. In the same respect, this is a valid argument for BSM systems.

The ITU considers that FSS shall be considered as part of the fixed telecommunications infrastructure. UMTS/GSM and IMT-2000 are mobile systems that also provide fixed services. Based on these facts and trends, it seems clear that a long-term distinction between fixed and mobiles BSM systems should not be made.

4.3 Network Convergence

There is a trend that former dedicated networks are being given more functionality and flexibility. A well-known example is the POTS (plain old telephony service) network, which is being upgraded to also provide data-communications in ISDN. Where that upgrade is not available, users can convert data into "voice" via a modem, and use the POTS network. ADSL technology will enable a further upgrade of the access network towards broadband access capability, enabling multimedia services through the phone-jack.

Cable-TV networks are being upgraded to support data-communications and Internet users, and data networks are being upgraded to support voice over IP. Broadband networks will allow broadcasting, and broadcast networks are being upgraded with interactive return channels that allow users to surf the web.

Dedicated networks are converging, and the trend is that dedicated networks will be replaced with – or evolved into – flexible multi-purpose networks.

Broadcast networks with return channels are being turned into Internet access and communications, as illustrated by the figure below.

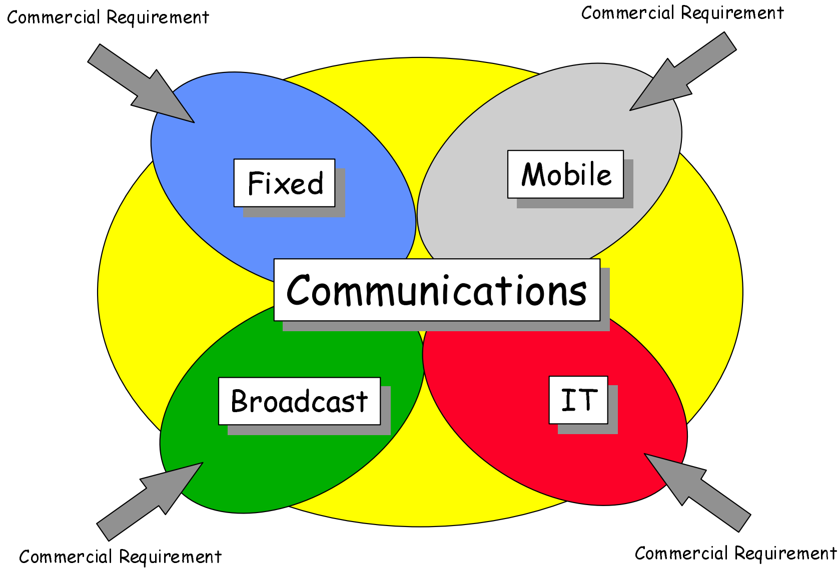


Figure 3: Network convergence

The "Information Society" will prosper on the convergence of telecommunication, entertainment, information exchange, digital video and commercial process services. It requires the integration of audio, video and data communications with computer-based intelligence and needs the support of an intelligent, interactive, communications highway. Access to that highway must be possible wherever the user happens to be. Mobile communications must accommodate the global shift away from voice-band telecommunications towards integrated, interactive, "broadband", multimedia communications.

Convergence is occurring on many levels: the goal should be to ensure that customers receive seamless service as they use "converged" products and as they pass from one service and/or network to another. To some extent this can be achieved by the use of common, network-independent, protocols such as IP. But there is also a need to ensure that services, features and so on also remain available to users, so far as this is feasible, as they make use of this new liberty.

Issues such as *security* and *Quality of Service* arise in such a scenario, and there may be need for a certain level of standardization and regulation in order to ensure a "minimum set" of services and performance levels. At the same time, this is a critical area enabling service providers and others to develop competitive advantage, so the amount of standardization and regulation should be restricted to the lowest possible level.

The provision of services through multiple inter-connected networks leads to three general requirements:

- Wherever practical and appropriate, the end user should have access to a consistent and coherent set of services and features across the different networks. To this end it should be possible for a user to use a single set of identities to access the same services from different networks.

- Inter-system roaming will be required to allow the users of terminals to use the services of different public and private systems without the need to have a separate subscription with each network. For roaming to take place between the different systems, features required include the availability of appropriate terminals and secure location registration, authentication, encryption and charging mechanisms. For calls in progress intra-system, and possibly inter-system, handover will be required.

- The means of network selection, and the presentation of options to the user, will need careful consideration and design. Whilst automatic selection may be appropriate in many situations, adequate and clear information will have to be provided to enable the user to select the network most appropriate to the user's specific current circumstances.

Multimedia services, particularly IP based services, are expected to result in asymmetric traffic flows. No doubt this asymmetry will be most pronounced where higher bandwidth services are in use, which may be mostly among the "slow mobility" or fixed users. The degree of asymmetry and its variation with time or location, however, is not clearly identifiable as yet and the ability to handle it in as flexible a manner as possible will be important.

4.4 Global Multimedia Mobility

The authors of the GMM companion document [20] have identified a number of drivers that reflect current and predicted trends. The first three in the following list were selected as having the most significant impact on GMM:

- rapidly growing importance of Internet services to the user (both residential and business);
- convergence of technology for telecommunications, data communications and consumer products (both in the private and public arenas);
- globalization of information;
- rapid growth in the number of mobile subscribers, especially among users who only require very limited mobility;
- rapidly growing interest of the mobile community for data and information services;
- competition between players using different infrastructures (CATV, railways, electricity companies, telecommunications operators, etc) driving prices rapidly downwards;
- continued shortening of technology life-cycles, resulting in dramatic reductions in the time available to amortize investment costs;
- differentiation of service offerings based on Quality of Service (QoS) and security;
- demands for genuine customer service management based on service level agreements;
- overlap between regulated and non-regulated areas of communication.

From the GMM report [19]:

> *It is clear that no one system can economically offer the full range of GMM services and applications since a lot of different economic players will be involved in providing them, using multiple networks made up of different network elements. Since the strategic goal in this competitive environment is to facilitate the market-led development of services through choice in the marketplace rather than a priori assessment of market needs, and* ***since many different economic players will be involved in the provision of the GMM services and applications based on diverse combinations of functional elements, an open and modular framework of standards should be developed****.*

And also (page 76):

> *…an open and modular framework of standards should be developed.*

Thus, the GMM clearly supports the approach of modular standards.

For convenience and comparison, the revised GMM service model is given below. This includes two access network domains, including one for the service provisioning capability. For the purpose of BSM systems, however, this network can either be neglected or considered as the same network as the access network connecting the users.

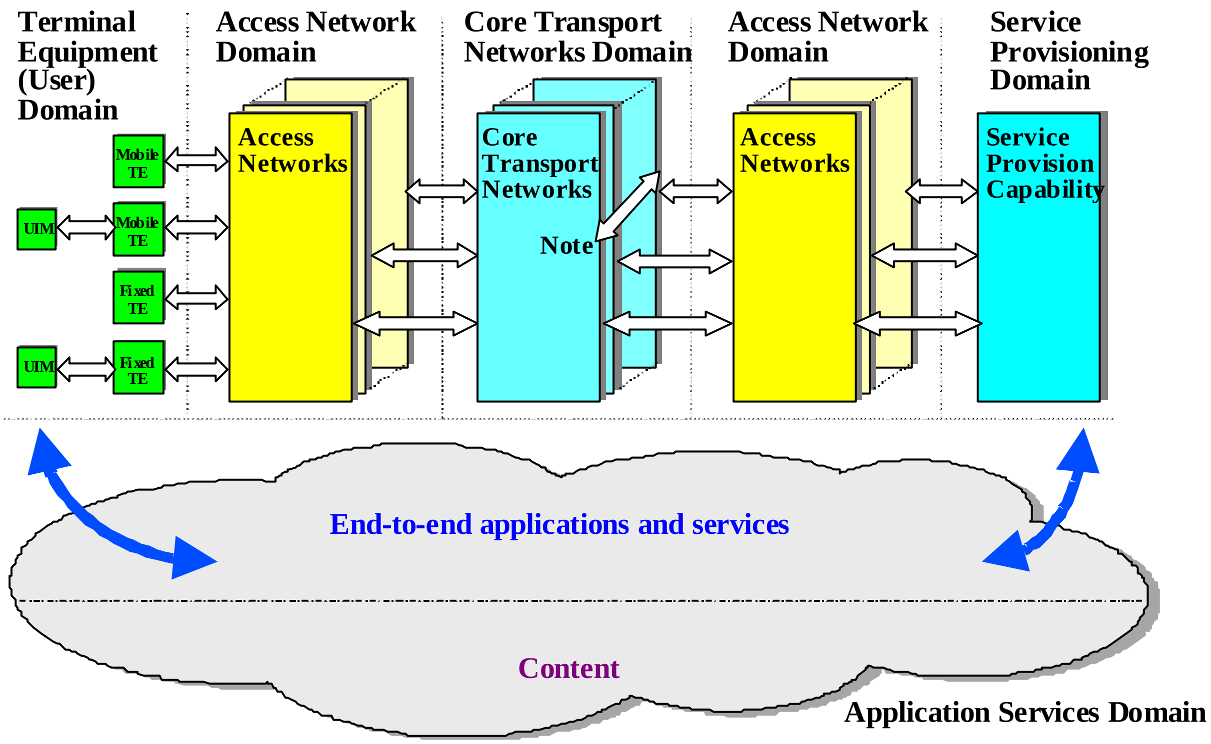


Figure 4: Revised GMM Network Model

Globalization of information brings an additional dimension to the convergence issues. From a user perspective those issues remain the same - access (real or apparent) to the same services and features as "at home". For operators and service providers, however, the matter becomes more complex with globalization. Not only are there technical aspects to be addressed: issues of a commercial and regulatory nature may also have to be accommodated (roaming agreements and the like).

As an example of the technical challenges of globalization one may consider the Virtual Home Environment (VHE) concept of the 3rd Generation mobile systems. This is a concept of supporting mechanisms that enables customized services to be made available to the user from different networks and terminals, irrespective of geographical location and type of network (e.g. mobile, fixed). The concept has been developed within ETSI, the ITU and other standards bodies and is expected to represent the future delivery mechanism for personal telecommunications services.

The key objectives of the VHE are to support and enable:

- Customized/personalized services;
- Seamless set of services from the user's perspective;
- Global service availability;
- Common service set for all forms of access (e.g. fixed, mobile etc.);
- Common service control and data independent of type of access.

The standards required to support these objectives need to be applicable to all types of future network as well as providing a framework for the evolution of existing networks. Additionally they need to have global significance so that users can access their services irrespective of their geographical location. This implies that all networks will need to have certain common characteristics (which may require standardizing), and that regional variants of those characteristics must be avoided.

4.5 Intelligent Networking

4.5.1 Virtual Home Environment

Virtual Home Environment is a system concept for service portability in IMT-2000 across network borders TS 122 121 [4]. In this concept a foreign network emulates for a particular user the behaviour of his home environment. For the user, adaptation of his service handling is therefore unnecessary.

VHE Definitions:

- Home Network;
- Foreign Network;
- Home Environment;
- Virtual Service Environment;
- Virtual Terminal Environment.

With a basis in a fixed-mobile convergence, the same user environment for both fixed and mobile services can be imagined.

One can also imagine a user roaming into a satellite network, even if the terminal is fixed. That could for instance happen if a user travels, or works from more than one location (where network access is provided via a satellite network).

Full service satellite networks will need to have some of the same abilities as both fixed and mobile networks. Taking into account the technical possibilities a satellite network can offer, fixed, nomadic and mobile terminals are possible.

In either case, looking at it from either the fixed or the mobile side, BSM networks will benefit from adopting a VHE concept.

General Description of the VHE

Virtual Home Environment (VHE) is defined as a concept for personalized service portability across network boundaries and between terminals. The concept of the VHE is such that users are consistently presented with the same personalized features, User Interface customization and services in whatever network and whatever terminal (within the capabilities of the terminal), whereever the user may be located.

Roles and components involved in realization of VHE consist of the following:

- Home Environment;
- One or more unique Identifiers;
- One User;
- One or more terminals (simultaneous activation of terminal providing the same service is not allowed);
- One or more Serving Network Operator;
- One Subscription;
- Possibly one or more value added service providers.

The key attributes that characterize a VHE may be summarized as:

- A portfolio of services offered by a Home Environment and a user profile that may be managed by the user;
- Capabilities to access Value Added Services from any VASP, possibly subject to appropriate agreements with the Home Environment.

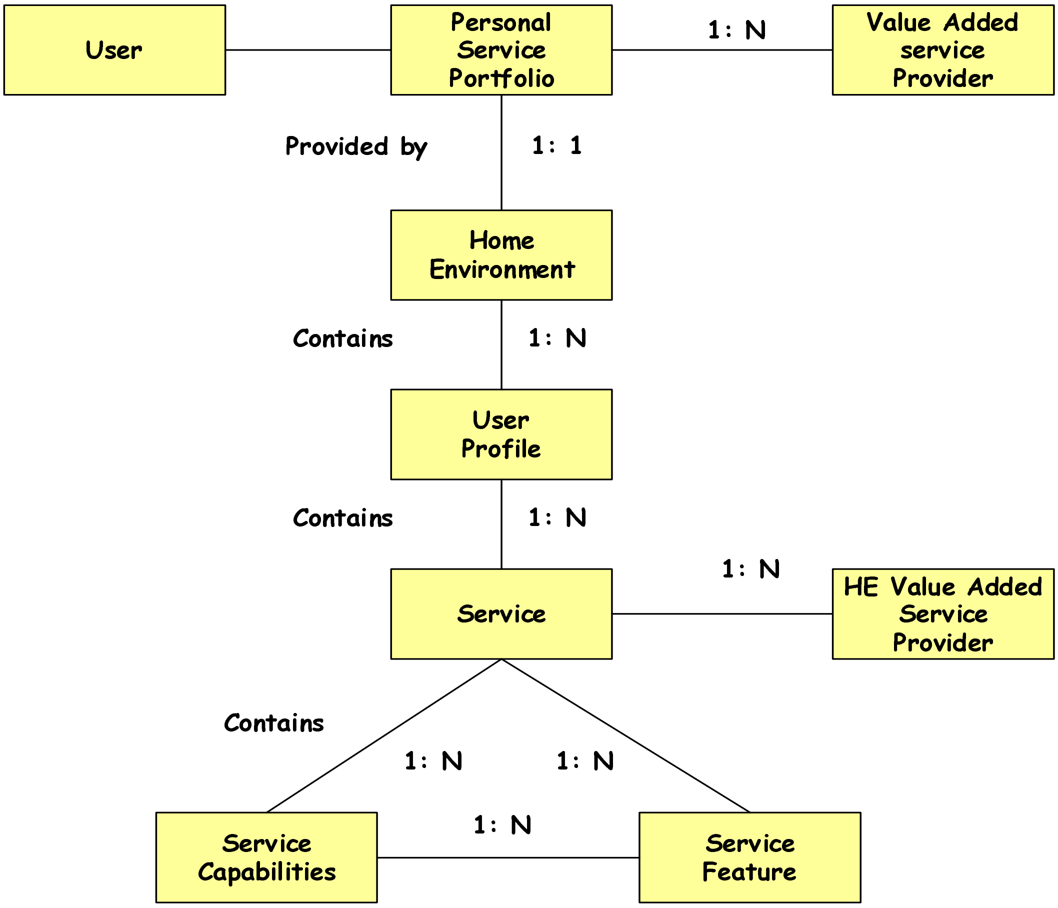


Figure 5: Role of Components involved in realization of VHE

The figure illustrates that a user may have several service providers with one VHE. The VHE contains several user profiles for a number of services. Each service has a number of capabilities and features. The same set of services is available independent of terminal, technology, roaming status etc., and all is kept within one virtual home environment.

The Home Environment is responsible for providing services to the user in a consistent manner. The user may have a number of user profiles which enable him to manage communications according to different situations or needs, for example being at work, in the car or at home. The user's VHE is a combination of services, profiles and personalized information that forms the user's personal service portfolio. The Home Environment provides services to the user in a managed way, possibly by collaborating with HE-VASPs, but this is transparent to the user.

Additionally, the user may access services directly from Value Added Service Providers. Services obtained directly from VASPs are not managed by the Home Environment and therefore are not part of the VHE offered by the Home Environment. A mechanism may be provided which allows the user to automate access to those services obtained directly from VASPs and personalize those services.

In the context of BSM systems, VHE will imply that a user should be able to access the GII via a correspondingly standardized BSM terminal, or via other access technologies, like ADSL, and get access to the same set of services. For instance, he may have a BSM terminal at one location, an ADSL modem at another, a LAN at a third location and a UMTS terminal. All terminals and connections may have different capabilities, but the network shall detect the capabilities of the terminals and, according to the service profile of the user, offer the services that are relevant for the current access means.

For instance, mobile services will not be available for fixed terminals, while high quality video may not be available for mobile terminals.

The following VHE definitions apply:

- HE-VASP Home Environment Value Added Service Provider.

This is a VASP that has an agreement with the Home Environment to provide services.

- Local Service — A service exclusively provided in the current serving network by a Value added Service Provider.
- Service Capabilities — Bearers defined by QoS parameters and/or mechanisms needed to realize services.
- Service Capability Feature — Functionality offered by a service capability mechanism that is accessible via open standardized interfaces.
- Service Feature — Functionality that a UMTS system shall offer to enable provision of services.

  Services are made up of different service features.
- Service Personalization — Modification and behaviour that may involve the service feature or data of a service, within the limitations set by the provider of the service.
- Home Environment — Responsible for overall provision of services to users
- User Interface Personalization — Modification of the user interface within the capabilities of the terminal and serving network.
- Value Added Service Provider — Provides services other than basic telecommunications service for which additional charges may be incurred.
- Virtual Home Environment — A concept for personalized service portability across network boundaries and between terminals.

4.5.2 Number Portability

Number portability is a facility provided by one operator to another, which enables customers to keep their telephone numbers when switching their business between those operators. Changing number can be a major inconvenience for customers and a barrier that prevents them from exercising choice and taking advantage of growing competition in the telecommunication markets. Number portability means that customers can change to a new operator without the hassle of having to change their number.

Number portability is a key issue in the development of network competition. There is clear evidence that customers are reluctant to consider changing network operators if this means that they have to change their phone number. Absence of number portability therefore gives the incumbent network operator a significant competitive advantage. Portability between operators promotes full competition in the market. As well as substantial direct benefits (e.g. customers do not have to incur costs of changing stationery; fewer wrong numbers are dialled), portability provides very significant indirect benefits, assisting greatly in the creation of genuine competition for all categories of customers, driving down prices, encouraging innovation and raising quality. (URL: http://www.oftel.org/numbers/port.htm).

Generally, a directory number is considered to be ported when a major change occurs to the subscription of a customer, but the customer retains his assigned number(s). Depending on the kind of subscription change the following types of number portability can be identified:

- service portability;
- service Provider portability;
- location portability.

From the customer point of view all three types of number portability are desirable because a change of directory number(s) is usually linked with considerable inconvenience and expense. In principle, the technical issues are the same for all types of number portability, but there are some differences. For example, location portability and service portability may be implemented within one operator's network domain - whereas Service Provider portability requires inter-network specifications and agreements. It is possible to combine the types of number portability, but this may be subject to regulatory approval and is outside the scope of the study of which the present document is part.

Number portability between operators is relevant to geographic, non-geographic and mobile services.

Many regulators require operator portability to be provided for some services or number ranges. Market entrants who use VoIP may be very concerned to obtain number allocations that look as similar as possible to those used by SCN networks and to obtain the number portability from existing operators. This may be essential in order to compete for customers from the existing networks. The market entrants may, in turn, have to offer portability from their network to other operators.

The ETSI reference on number portability is TR 101 118 [1].

4.6 IP

The Internet and the Internet Protocol (IP) are already dominating multimedia communications, and will continue to do so in the foreseeable future. For future BSM systems, it is quite obvious that IP must be supported, and preferably as efficiently as possible. For mobile multimedia networks there seems to be a trend towards pure IP networks, with ATM as an intermediate technology to support QoS. For fixed networks the trend is the same.

According to ITU, information technology and the use of IP (Internet Protocol)-based networks and applications has become a critical factor in development of telecommunications networks. Data traffic is growing at more than ten times the rate of voice traffic and it is estimated that in the near future data will account for 80 % of all traffic carried by telecommunications networks.

With this rapid change, the concept of circuit switched networks that also carry data is no longer applicable. In the future it will likely be predominately packet switched networks that also carry voice. In this regard, seamless interworking between IP-based networks and telecommunications networks and interoperability of their respective applications/services is essential to meet the burgeoning business requirements placed on modern communications networks.

The interaction of IP and telecommunications networks for the purposes of gaining access to Internet (or other IP networks/applications), and the interoperability of IP-based and telecommunications services, necessitates the provision of real time Internet, or other IP-based multimedia services, with the speed, capacity, ease of use, reliability and integrity currently available from the telephone network around the world.

The new IPv6 may play an important role. IPv6 supports mobility, based on GSM concepts like *home network, home address, home agent* etc. Mobile computers will be assigned *two addresses* whenever they are roaming away from their home network. This is similar to the concept of GSM, and UMTS.

From the umts.org-web site it can be seen that the UMTS Forum has announced a co-operation agreement with the IPv6 Forum, the world-wide consortium of Internet industry players founded to promote IPv6 (Internet Protocol version 6).

Objectives of the co-operation include:

- Respective market representation within each others' organizations.
- Identifying and building new markets for non-voice services and promotion of IPv6.
- Preparing for future IP-based Value Added Services.

A world-wide consortium of leading Internet solutions vendors, Internet Service Providers and research and education networks, the IPv6 Forum's mission is to promote Internet Protocol version 6 in order to create a higher quality and secure next generation Internet: The "New Internet". The IPv6 Forum will raise market awareness by providing world-wide, equitable access to information and technology about IPv6.

The UMTS Forum's ICT (Information and Communications Technology) Group has already forged links with key players from the IT and content industries, promoting the common vision of UMTS/IMT-2000 as the enabler for tomorrow's mass market for mobile multimedia services.

With mobile handsets already exceeding the number of fixed Internet devices world-wide, next-generation mobile will play a key role in delivering information, entertainment and commerce services to mass market users. IPv6 technology incorporates a range of key features to permit mobility between services and operators with a range of quality of service options. This "mobile friendly" architecture therefore provides vendors, service providers and network operators with the possibility of defining and developing IP-oriented applications and services for use in third generation networks.

4.7 ATM

Asynchronous transfer mode (ATM) is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic. ATM is a technology which enables carriers to capitalize on a number of revenue opportunites through multiple ATM classes of services, high-speed local area network (LAN) interconnection, voice, video, and future multimedia applications in business markets in the short term and in community and residential markets in a longer term. ATM has evolved as a major technology for core networks over the last decade or so.

ATM has been developed as an answer to many of the most pressing needs for modern telecommunications. Designed especially to carry large amounts of information at high speeds, ATM caters to the wide variety of telecommunications traffic that is encountered nowadays, such as voice, data, video and multimedia.

ATM is a "transport and switching technology" - a means of moving information efficiently and reliably from one place to another. One of its particular strengths is that it can be used to satisfy many different types of telecommunications needs. ATM has been defined as the "glue" that interconnects heterogeneous networks into a single, larger internetwork, seamlessly connecting various link and network layers. ATM deployment has increased dramatically in the 1990s, and is one of the favoured transport technologies for the provision of IP services. At the forefront of the movement toward efficient communication, the demand for ATM accelerates.

The market for ATM based products and services in business communications may be divided into three segments; Public Network Infrastructure (including the residential broadband market), Local Area Networks (LAN) and Wide Area Networks (WAN). Existing market structures, rate of new technology deployment and the regulatory environment determine the segmentation. ATM was conceived as a solution for use within WANs. However it was soon realized that the benefits of ATM could also be exploited in LANs, which typically serve business premises, conveying mainly data between computers, printers, manufacturing machinery and the like.

Slightly more than half of ATM world-wide equipment revenue is now generated in the U.S., but the balance will shift toward non-U.S. markets during the next several years. Outside the U.S., ATM is more generally accepted as the standard for broadband networking. Europe is the most significant non-U.S. regional market for ATM equipment, followed by South America, Canada and Asia/Pacific.

ATM is achieving major global acceptance within the information systems and telecommunications industries. Since the technology has been designed from the outset to be scaleable and flexible in terms of geographical distance, number of users, access and trunk bandwidths (currently the speeds range from megabits to gigabits), the intrinsic flexibility and scalability assures that ATM will be important for a long time.

ATM provides cell sequence integrity, i.e. cells arrive at the destination in the same order as they left the source. This may not be the case with other packet-switched networks. Cells are also much smaller than standard packet-switched networks. This reduces the value of delay variance, making ATM acceptable for timing sensitive information like voice. The fibre-like quality of transmission links has lead to the omission of overheads, such as error correction, in order to maximize efficiency. There is no space between cells. At times when the network is idle, unassigned cells are transported.

These techniques allow ATM to be more flexible than Narrow-band ISDN (N-ISDN), and hence ATM was chosen as the broadband access to ISDN. The broadband nature of ATM allows for a multitude of different types of services to be transported using the same format. This makes ATM ideal for true integration of voice, data and video facilities on the one network. By consolidation of services, network management and operation is simplified. However, new terms of network administration must be considered, such as billing rates and quality of service agreements.

The flexibility inherent in the cell structure of ATM allows it to match the rate at which it transmits to that generated by the source. Many new high bit-rate services, such as video, are variable bit rate (VBR). Compression techniques create bursty data, which is well suited for transmission using ATM cells.

The transportation medium is usually either electrical or optical, and can use SDH-based or cell-based framing.

The ATM layer is responsible for a number of functions as defined in the ATM Forum UNI specification. These functions include Multiplexing connections, Cell rate decoupling, Cell discrimination, Payload type discrimination, Loss priority and Traffic shaping.

The ATM adaptation layer (AAL) provides the interface from the user to the ATM system. Different data types require different types of AALs, due to the characteristics of the data. Real time data such as voice and high resolution video can handle some loss of data but requires low and fairly constant delay. Non real time data, however, can handle larger delays but cannot handle any losses.

There are currently five types of AAL defined, but AAL3 and 4 have been merged. ATM Forum is currently working on sixth AAL for MPEG2 video streams.

- AAL1 - connection oriented services constant bit rates, specific timing and delay requirements.
- AAL2 - connection oriented services do not require constant bit rates.
- AAL3/4 - both connection-less and connection oriented variable bit services.
- AAL5 - connection oriented, variable bit rate.

Along with providing the interface for the user, the AAL provides timing recovery, synchronization, and indication of loss of information, as well as other functions. The actual connection is done by the AAL management as well as setting up the connection characteristics.

4.8 UMTS/IMT-2000/3GPP

UMTS is the future universal system for mobile communications. It will evolve smoothly from the GSM basis. With respect to the fixed-mobile convergence, UMTS may form a framework within which BSM systems may fit.

UMTS will support a wide range of applications with different Quality of Service profiles. At present many of these applications are not possible to predict. Also the usage of the different applications is difficult to predict i.e. it is not possible to optimize UMTS to only one set of applications. One conclusion of this is that UMTS must be built in such a way that it is flexible and possible to evolve so it will have a long technical lifetime. Therefore a modular approach is recommended when defining the network parts of UMTS. This is in line with the recommendation from GMM. In this context a module represents a part of a UMTS network i.e. one or several physical network nodes that together implement some functionality. The modular approach should also make UMTS possible to implement efficiently in different environments.

UMTS work is now organized under the 3GPP umbrella. The partners have agreed to co-operate for the production of Technical Specifications for a 3rd Generation Mobile System based on the evolved GSM core networks and the radio access technologies that the Organizational Partners support (i.e. UTRA both FDD and TDD modes). The Project is called the "Third Generation Partnership Project" and is known by the acronym "3GPP".

The Technical Specification Groups (TSGs) prepare, approve and maintain the 3GPP Technical Specifications and Technical Reports. The Services and System Aspects group has a particular responsibility for the technical co-ordination of work being undertaken with 3GPP, and for overall system architecture and system integrity.

The Technical Specification Groups are:

- TSG CN (Core Network);
- TSG RAN (Radio Access Network);
- TSG SA (Services and System Aspects);
- TSG T (Terminals).

Current proposals for UMTS in 3GPP (e.g. from Japan) show an ATM based protocol stack using the ATM Adaptation Layer (AAL) profile No. 5 (AAL5) in conjunction with SS No. 7 across the Iu Interface. (The Iu interface is the interface between the RAN and the CN). Increasingly as more use is made of packet switching techniques evolving from GSM's Generalized Packet Radio System (GPRS), protocol stacks will be based on the AAL2 approach. Various views have been expressed as regards the evolution from this situation. They range from the full development of these ATM principles in UMTS Phase 1 and Phase 2 networks to the development of standards to support a fully IP based network. An intermediate view consists of an IP layer over ATM and the specification of adequate AALs for UMTS. There is also a lot of support for IP solutions based on the GSM GPRS standards.

4.8.1 Fourth Generation Systems

Fourth generation systems are already considered at the University, lab and conference level. Most probably these systems will not be operative before 2010, but their presence indicates that plans beyond IMT2000/UMTS are being considered. One of the issues that has been mentioned as relevant for 4th generation systems is the possibility of broadband radio networks, such as LMDS, merging with 3rd generation systems. LMDS, which stands for Local Multipoint Distribution System, aims to provide similar services to those of many proposed BSM systems.

4.9 LMDS

Local Multipoint Distribution System, LMDS, is a terrestrial radio concept for broadband access and communications. The ETSI Project BRAN is involved in standardization within this field. This project will provide facilities for access to wire-based networks in both private and public contexts by the year 2000. The BRAN project will address wireless access systems with bitrates of 25 Mbit/s or more and operating in either licensed or license exempt spectrum. These systems address both business use and residential access applications. Fixed wireless access systems are intended as high performance, quick to set up, competitive alternatives for wire-based access systems.

LMDS systems can both compete with and complement BSM systems.

4.10 Broadcasting Trends

The ITU-R is likely to consider two new concepts for broadcasting.

- TV Anytime; and
- TV Anywhere.

These concepts combine traditional broadcasting with the World Wide Web as a delivery means and hard disks in receivers as a means for time shifting received programmes. If these concepts prove attractive and viable, they will have far-reaching impact on broadcasting.

4.11 Standardization Trends

The pace of development does not favour a rigid standards development. Rapid development is required. Voluntary bodies, like the IETF, DVB, FSAN, ATM forum, ADSL forum, WAP-forum, Bluetooth etc. are increasingly important.

4.12 Discussion

As with other personal communication systems, one cannot expect that all connections will be between users on one and the same system. A broadband video-conference, for instance, could well include a party with a non-satellite terminal, or a party with a different type of satellite terminal. This observation is relevant from the viewpoint of considering direct terminal to terminal connections in satellite systems. Standards in a closed system can be proprietary, but if it is accepted that most public connections in fact are not within a closed system, the issue of open standardization may be even more appealing.

The general trend is to define minimum standard requirements. However, there are good reasons to believe that the success of technologies such as GSM, DVB, DECT and IP are related to their accepted standards. Similar observations can be made for the CD, and appears true for the DVD disc, the Compact Cassette, etc. Although manufacturers are free to produce consumer equipment according to proprietary standards, it is difficult to come up with a long list of such products that have had similar success.

5 Trends in Satellite Networks

Satellite communications has a bright future. This is due not only to advances in satellite technology, but also because of satellites' ability to provide broad coverage, fixed, nomadic and mobile services, and broadband multimedia services direct to the consumer. Satellite systems can also supply cost-effective broadcasting services, together with the ability to provide instantaneous re-deployment of capacity, instantly provide communications infrastructure, and avoid costly, time-consuming terrestrial system deployment, and provide overall flexibility and reliability [43].

The coming years are a critical window of opportunity for satellites with respect to countries with developed economies while a number of additional years seem likely for developing and industrializing countries with more limited terrestrial communications infrastructure. The following appear to be key guideposts to the future:

- whether the global shift to fully competitive telecommunications markets continues;
- whether new global trade agreements under the WTO are strenuously enforced and whether serious barriers to new satellite services continue to be encountered around the world;
- whether critical new technologies in optical communications, high power generation and storage systems, on-board processing systems, advanced antenna technologies and lower cost launch systems are developed;
- whether there is continuing global consolidation, merger and partnerships both in the spacecraft design and manufacture industries, and in the satellite communications service delivery industries, and how fast this takes place;
- whether INTELSAT, Inmarsat, and EUTELSAT and/or their subsidiary spin-off organizations are able to adapt to fully competitive markets and whether the parent organizations are "privatized," and become truly competitors without special protection under intergovernmental agreements;
- whether effective standards to support global hybrid wire, terrestrial wireless and satellite seamless interconnection can be developed in a timely way and whether the ITU proves to be the effective body to provide needed protocols and standards in a timely way;
- whether new broadband, multimedia services and applications will expand modestly, moderately or explosively over the next five years and whether dramatically different patterns of telecommunications will evolve around the world.

Current filings for future satellite systems, planned and newly operational systems are based on the premise of explosive growth for new high data rate services and surging consumer demand for multimedia type services. Projections of service demand now translate into huge new multi-billion dollar satellite systems which are typically too expensive to be entirely capitalized by even very large and established commercial organizations. This has led to a dizzying array of new alliances, partnerships and global coalitions.

Most important of all is the need to develop protocols for seamless interconnection of satellite, wireless and terrestrial fibre networks. In the 21st century inter-connection of satellite systems, particularly via intersatellite links, will be a key challenge.

5.1 Satellite Technology Trends

The traditional pattern of highly specialized, customized satellites, designed and built a few at a time, has changed. More emphasis is placed now on the use of common buses. There is a move towards new mass produced systems. It is believed that such techniques can reduce the cost of satellites significantly.

The power of the signal from the satellite is a critically important factor in the determination of the cost of the ground equipment or terminals. The more the power from the satellite, the less the cost of the terminal. The size of the antennas and the cost of the amplifiers decrease as the power from the satellite increases. Business customers benefit from this increased power for the same reasons. As these costs are driven down, new applications for satellite services emerge. Mobile and high bandwidth data services are dependent on the existence of low cost terminal equipment.

The importance of power and bandwidth for commercial satellites is obvious to all the satellite manufacturers. A challenge of the satellite manufacturers is to design and deliver a satellite with increased power, with limited consequences on the cost and weight.

The increased demand for power is the dominant factor in driving the development and utilization of new satellite technology, especially to meet these weight and cost constraints. Bandwidth per satellite has been increasing as combined C and Ku-band satellites become more common. The need for more bandwidth is especially evident for the new data applications, which are expected to be met with Ku-band, Ka-band and possibly V-band satellites. Here again, more total power is needed to meet power requirements.

The key trends in spacecraft antenna technology are toward larger effective apertures, significantly higher numbers of beams, and integrating computationally-intensive beam forming and switching activities with other onboard processing functions. These trends are an integral part of universal efforts to raise spacecraft effective radiated powers (EIRP), make communications payloads smarter and more flexible, and make earth terminals smaller and cheaper. Many manufacturers offer competing proprietary technologies to build these antennas. Details of ongoing research and development efforts are generally proprietary.

Phased array antenna technology is an area where cost breakthroughs are needed. Both direct radiating arrays and phased array feeds for reflectors are attractive solutions for multibeam spacecraft antennas that must route traffic dynamically. All major spacecraft and antenna manufacturers seem to be working on phased arrays.

The problems in phased array design are:

- Electromagnetically, the array must maintain the desired radiation pattern and polarization purity over the transponder bandwidth and the desired scan angle range.
- Electronically, the array must form and steer beams as fast as onboard traffic routing requires.
- Mechanically, the array structure must deliver control signals and DC power to (and often RF from) the radiating elements and dissipate heat while not screening the radiating elements.

There are many challenges in satellite communications ahead. One of them will be to keep the interest in supporting R&D in various necessary disciplines after the current wave of enthusiasm and spectrum allocation for new systems and higher frequencies subsides. The list of needed technology developments is long, but progress on all fronts is necessary if the longer-term future of satellite communications is to be assured. The following list of technologies needing long-term attention could define a well-rounded R&D program.

- Batteries;
- devices and structures for phased array and multiple spot beam antennas on ground and in space;
- fuels and combustion structures for launch vehicles;
- high frequency (> 20 GHz) devices;
- materials for electronic devices;
- solar cell materials and structures;
- network technology for high data rate, integrated space and terrestrial systems;
- optical components and sub-systems;
- radiation resistant device structures and circuits;
- strong and lightweight materials;
- thermal dissipation materials.

5.2 Specific Satellite System Issues

5.2.1 Satellite Orbits

Recent and coming satellite systems have taken the LEO and MEO orbits into use. There are plans to use LEO orbits for BSM systems in the Ka- and Ku-band. However, most of the planned Ka-band systems are at least initially looking at the geostationary orbit. Several GEO and non-GEO BSM systems are planned for service over the next five years.

Advances in phased array antenna technology may allow cheaper LEO terminals in the future.

5.2.2 Frequency Bands

There are proposals for BSM systems in both the Ku- and the Ka-bands. Additionally, some systems plan a combination of Ku and Ka-band technology, with Ka-band for the return link and Ku for the forward link. This scenario is typical for systems that evolve from DVB, and add on return channels TR 101 374-1 [2].

Looking even further ahead, there are already filings for systems in the Q and V bands, which are in the 40 GHz to 50 GHz range. However, such systems will not provide commercial services within at least the next five years. Therefore - whenever applicable - focus can be kept on the Ku-band and Ka-bands.

Standards should, to the extent possible, try to maintain independence from specific frequency bands.

5.2.3 Air Interfaces

The general practice within satellite communications has been to use proprietary standards. Within broadcasting the DVB format is the preferred digital format in Europe, while in the US, for instance, only one satellite operator (EchoStar, http://www.echostar.com) has been identified that implements the DVB format.

Inmarsat, as the world's largest operator of mobile satellite communications, has always used proprietary air-interfaces. Iridium, ICO and Globalstar all embrace the same philosophy.

ACeS, Ericsson, HNS, ICO, Inmarsat, Thuraya, and others are separately developing specifications for S-GPRS/EDGE, which are satellite adaptations of terrestrial GPRS/EDGE.

ESA has proposed two air-interfaces for satellite-UMTS, and there are four other proposals as well.

At the time of writing, no BSM systems have been identified that plan to use exactly the same air-interface yet, but there seems to be a convergence towards the DVB-RCS among some European systems (i.e. WeB&WEST from Matra Marconi Space, EuroSkyWay, SES-Astra, Eutelsat, Hispasat).

There are however good reasons for satellite systems to allow proprietary air-interfaces, as these may be necessary in the process of spacecraft and payload optimization. Different satellite systems may require different air interfaces because of different operational characteristics such as which orbits they use, which frequencies they use and which markets they will serve.

With respect to air-interfaces in particular there seem to be two trends: in favour of standardization and in favour of freedom in design.

5.2.4 Multicasting and Broadcasting

Multicasting has been identified as a particular strong capability of satellite communication, and multicasting is an increasingly common Internet technology.

Within broadcasting, satellites have long played an important role, and will continue to do so.

Technology for both broadcasting and multicasting is thus important.

5.2.5 Service Classes and QoS

Multimedia services in the future will require control over the Quality of Service. Paramters that can be controlled, in general, by QoS can relate to bit-rate, bit-error-rate, packet-error rate, availability, delay, etc. Also, satellite systems plan to offer such possibilities.

A set of service classes can be interpreted as a collection of predefined values for a number of these parameters, to fit different classes of service. For instance, one class may include web browsing, another file transfer, another video-conferencing etc., given a set of performance objectives.

Satellites will have some particular characteristics, and certainly some limitations as well, e.g. relating to delay for GEO systems.

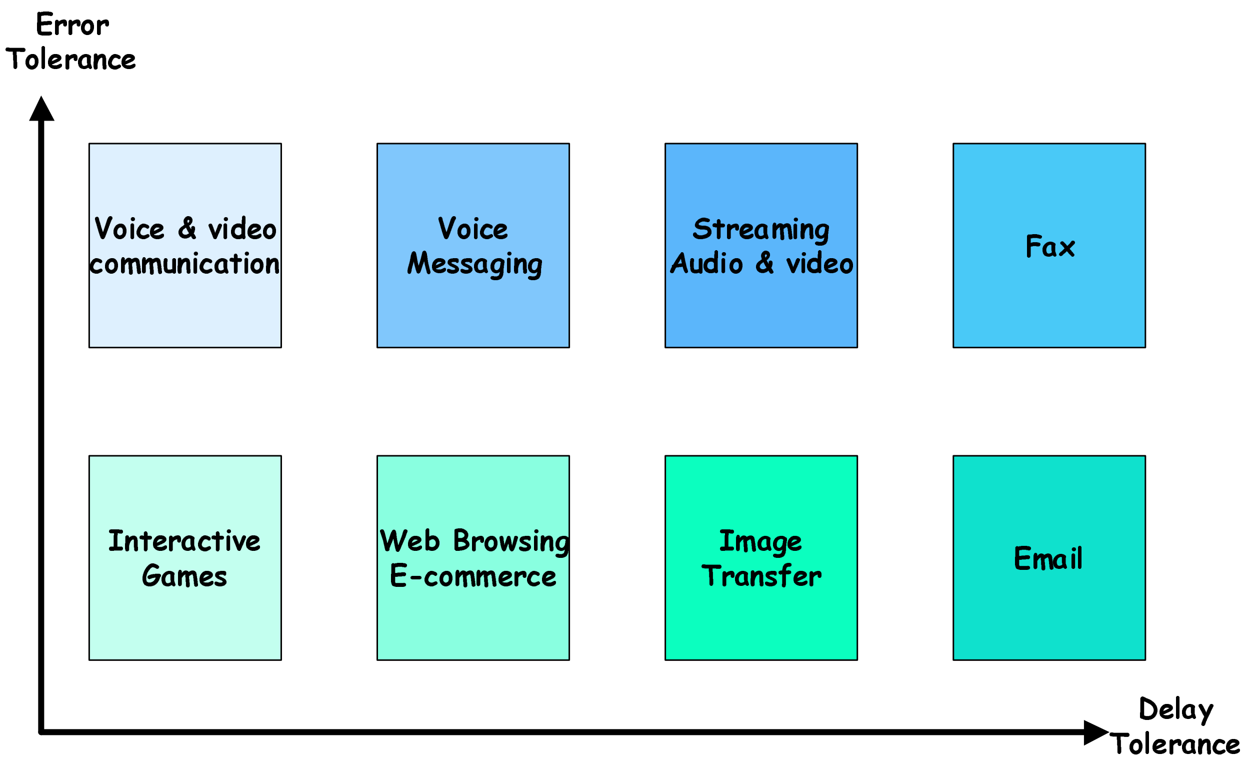


Figure 6: Illustration of some services, and different QoS requirements

5.2.6 OBP

Onboard processing (OBP) can provide improved performance and efficiency over non-processing satellite systems, at the expense of increased payload complexity. OBP can be used advantageously in four places in a communications satellite:

- Intermediate Frequency (IF) and radio frequency (RF) communications signal switching;
- support processing;
- phased array antenna control and beam forming;
- baseband processing and switching.

IF and RF switching is generally the simplest, requiring the least amount of processing power. It involves electronically controlled RF/IF switches, usually in a matrix format, that can be controlled statically or dynamically, and has been used commercially for some time.

Support processing has traditionally been associated with control of the satellite bus and includes such functions as attitude control, power management and telemetry, and tracking and control (TT&C). Most of these functions can be handled by general purpose onboard computer systems.

Phased array antennas with many independently steerable beams require a large number of radiating elements with individual phase (and amplitude) control for each beam. This signal control can be implemented with analog circuits (for a small number of beams) or digitally. This requires substantial digital processing, perhaps more than with the baseband processing and switching system. Phased array antennas are used on the Iridium and Globalstar satellites.

Baseband processing and switching involves functions similar to those performed in terrestrial local area networks and telephone switches. In addition, demodulation, demultiplexing, error detection and correction, switching, congestion control and notification, buffering, remultiplexing, modulation and network synchronization has to be performed. Most of these functions require specialized processors in order to be size/mass/power efficient.

5.2.7 Coverage Areas

Satellites will normally provide multi-national or even global coverage. This is due to the fact that they are either placed in a GEO orbit where current spot beam technology defines cells of several hundred kilometers diameter, or they orbit the earth in non-GEO orbits.

5.3 DVB over Satellite

There is major European interest in DVB and DVB with return channel (DVB-RCS). Several European systems plan to use the upcoming standard for DVB-RCS.

The DVB return channel work is described in subclause 6.10.1 of the present document.

5.4 ATM over Satellite

Most of the proposed US systems currently state that they will use a form of ATM over satellite, and TIA has been active in working on ATM over satellite.

Satellite ATM activities are discussed in more detail elsewhere in the present document (subclauses 6.2 and 6.3).

5.5 IP over Satellite

In both the DVB and ATM case, it is foreseen that end-users will use satellite access for multimedia and IP.

At least in the short term, all systems for multimedia are likely to support IP somehow. This may be implemented as IP over ATM or IP over DVB, but sometimes IP over ATM over DVB or IP over DVB over ATM may be encountered as well.

Some combinations of different protocols may waste valuable satellite capacity. Therefore more efficient ways of transferring IP over satellite may be advantageous.

Related to this, the IETF has an initiative on TCP over satellite (subclause 6.4.2).

5.6 Satellite IMT-2000

The following excerpts comprise the executive summary and conclusions from a TIA report assessing the potential standardization of the Satellite RTT. RTT stands for "Radio Transmission Technology", or what is also generally known as the air interface.

The conclusion of their study is that in the IMT-2000/S-UMTS context, it is not feasible to attempt to standardize a single air interface.

Summary of the TIA IMT-2000 report

This evaluation report was produced by the TIA TR-34 Ad Hoc IMT-2000 Satellite RTT Evaluation Committee, which was organized under the US TIA's Engineering Committee TR-34 on Satellite Equipment and Systems. The mission of the Committee was to evaluate the satellite Radio Transmission Technologies proposed for IMT-2000 and submitted to the ITU by June 30, 1998. These proposals are as follows:

- ICO proposed an RTT that represents a system in development by ICO, to be deployed around the year 2000.
- ESA proposed a Wideband CDMA RTT and a Wideband Hybrid CDMA/TDMA RTT, both without any specific reference to a satellite system or constellation.
- TTA proposed a Wideband CDMA RTT for a LEO system of 49 satellites.
- Inmarsat did not submit a full RTT proposal.

The methodology of the Committee was to develop Compliance Matrices, based on evaluation criteria supplied by ITU-R. These Compliance Matrices were filled out, based on a comparison of the submitted RTT proposals, and in some cases, self-evaluations and supporting documents. The scope of RTT evaluation was affected by the necessity to consider the overall system aspects, operating environments, and the set of user services provided. Thus, additional qualitative evaluations were performed and conclusions developed.

The Committee spent about a month in the evaluation process, with eight days of collaborative work, and relied heavily on email correspondence to progress the work. Both the direct participants and a wider circle of interested parties were included in the email distributions.

Key findings and conclusions of the Committee are as follows:

1) The IMT-2000 satellite component will form an essential part in realizing the IMT-2000 vision. As Recommendation ITU-R Recommendation M.1167 [34] "Framework for the Satellite Component of FPLMTS" notes, "The satellite component provides users with quality telecommunication services primarily on a virtually global coverage basis, and is most economic outside those areas covered by the terrestrial component. In providing this global coverage, the satellite component may, in more densely populated areas, precede and encourage later coverage by the terrestrial component".

2) The choice of a satellite RTT is based on, among other things, the services to be supported, the environments in which these services will be provided, and the orbital constellation utilized. It is therefore concluded that a single satellite RTT will not be appropriate for IMT-2000; multiple satellite RTTs will be required to fully realize the IMT-2000 potential. Furthermore, RTTs associated with satellite systems that support various IMT-2000 services should be considered as acceptable for the satellite component of IMT-2000.

3) Satellite-based systems are resource limited (e.g., power and spectrum), hence they require the RTT to be optimized to the operating scenarios. This implies that satellite systems will benefit from multiple RTTs.

4) Different access schemes such as TDMA, CDMA or hybrid schemes, will provide varying levels of performance under various operating scenarios. These scenarios include different constellations (e.g., LEO, MEO, GEO), different configuration (e.g., on-board processing, bent-pipe), different architecture (e.g., local, global), different operating environment (e.g., outdoor open space, outdoor shadowed, in-vehicle, in-building), different services (e.g., voice, data) and different load distributions (uniform, peaky).

5) RTTs constitute the radio physical layer. This process is an attempt to evaluate RTTs independent of other system parameters, in particular, the satellite constellation. We have found this methodology to be problematic when applied to the selection of the RTT for the satellite-based systems.

6) Because of the diverse service offerings, multiple satellite constellations, and a rapidly changing technological and operational base, it is important to maintain the flexibility to develop and present future RTTs for IMT-2000. The world has limited experience with satellite-based SPCN systems. As major systems will soon become operational, it is important to allow future RTTs, based on the experience gained from these operations.

7) Satellite systems development has been following a different timetable from terrestrial systems. While "second generation" mobile terrestrial systems have operated for some time, and experience with them has become part of "third generation" work, comparable "second generation" mobile satellite systems providing hand-held voice (and other) services are not yet in commercial operation. Thus, the efforts to propose and then evaluate "third generation" mobile satellite systems for the satellite component of IMT-2000 are in advance of actual work on many of these systems.

8) It is clear that future work on the satellite component on IMT-2000 will benefit from the experience gained in this current, initial, phase.

In conclusion, the IMT-2000 satellite component is essential to realizing the full IMT-2000 vision. Due to significant differences between terrestrial systems and satellite systems in the areas of design, operational scenarios, areas of optimization, scarcity of resources, cost of initial deployment, number of systems deployed, number of operators and timetable of deployment, it is necessary to have multiple RTTs for satellite systems. Additionally, field experience with second generation mobile satellite systems that are just beginning to be deployed will influence RTT design, hence the door must be kept open for future RTTs.

6 Related Standardization in other Bodies

There is a significant amount of work being carried out world-wide, both in official standardization bodies and in ad hoc groups of interested parties. As ETSI activity on BSM can not take place isolation of global developments, it is essential to know what other work is being carried out elsewhere. In this clause the most important relevant activities are outlined.

6.1 ITU

The ITU is arguably the single most important standardization body in global telecommunications. National and regional standardization activities, including ETSI work, can generally be considered as input to the ITU work and therefore a solid understanding of ITU study areas is essential.

6.1.1 ITU-T

Standardization work is carried out by 14 Study Groups in which representatives of the ITU-T membership develop Recommendations for the various fields of international telecommunications on the basis of the study of Questions (i.e. areas for study). Many of these Study Groups are working in various areas relevant to BSM.

The actual study areas and projects often involve collaboration between several of the Study Groups, under coordination of an identified Lead Study Group.

The Study Groups are:

- Study Group 2 - Network and service operation
- Study Group 3 - Tariff and accounting principles including related telecommunications economic and policy issues
- Study Group 4 - TMN and network maintenance
- Study Group 5 - Protection against electromagnetic environment effects
- Study Group 6 - Outside plant
- Study Group 7 - Data networks and open systems communications
- Study Group 8 - Characteristics of telematic systems
- Study Group 9 - Television and sound transmission
- Study Group 10 - Languages and general software aspects for telecommunication systems
- Study Group 11 - Signalling requirements and protocols
- Study Group 12 - End-to-end transmission performance of network and terminals
- Study Group 13 - General network aspects
- Study Group 15 - Transport networks, systems and equipment
- Study Group 16 - Multimedia services and systems

6.1.1.1 GII Activities

In ITU-T, the overall responsibility for this area of study is with SG 13. The ITU-T has an extensive number of activities on GII standardization, which fall under the Y-series of recommendations:

Y.1xx:	GII General
Y.2xx:	GII Services, Applications and Middleware
Y.3xx:	GII Network Aspects
Y.4xx:	GII Interfaces and Protocols

Y.5xx:	Numbering, Addressing and Naming
Y.6xx:	OAM
Y.7xx:	Security

To date, the Y-series recommendations published are (ITU-T Recommendation [31]):

Y.100 [31]	General overview of the Global Information Infrastructure standards development
Y.110 [32]	Global Information Infrastructure principles and framework architecture
Y.120 [33]	Global Information Infrastructure scenario methodology
Y.120 [33]	Annex A: Examples of use

The specific study areas are:

F Projects:	Framework aspects
N Projects:	Network aspects
M Projects:	Middleware aspects
A Projects:	Applications aspects
I Projects:	Internet-related aspects

A synopsis of the currently identified projects along with responsible Study Groups is provided in the table in Annex A.

Reference models used within SG 13 are presented in clause 10, and various reference points identified.

6.1.1.2 IP Project

At the September 1998 meeting of TSAG (Telecommunication Standardization Advisory Group), Study Group 13 was appointed as the Lead Study Group for "IP-related aspects" with the mandate "to provide a focal point in ITU-T for IP-related studies, including the inter-relationship between IP and telecommunication networks and their convergence".

In this area, ITU-T foresees a close collaboration with IETF. While the IETF strength lies in the protocol and application areas, the ITU-T contribution is mainly in the areas of network architecture, interworking and network evolution.

The ultimate value of IP and telecommunications networks interactions is the building of an integrated network through which people will have increased opportunities to interconnect and to exchange ideas. It is a major challenge for the ITU-T to respond and it is necessary, if the vision is to become reality, for the ITU-T to leverage it's knowledge, experience and competence in developing global standards for communications networks.

The primary objective of this project is to identify the issues relative to IP and telecommunications interoperability, utilizing the features of both to mutual advantage in the support of business needs.

The Internet Protocol suite, developed by the IETF is taken as a basis.

Further, the objective is to identify the areas of work germane to the ITU. Areas where the ITU can provide substantial added value, working in close cooperation with other key industry and standards organizations, such as the IETF, as appropriate.

Scope of the project

The following twelve work areas have been identified as being of current major concern to the ITU-T.

- Area 1 - Integrated architecture
- Area 2 - Impact to telecommunications access infrastructures of access to IP applications
- Area 3 - Interworking between IP-based network and switched-circuit networks, including wireless-based networks
- Area 4 - Multimedia applications over IP
- Area 5 - Numbering and addressing
- Area 6 - Transport for IP-structured signals

- Area 7 - Signalling support, IN and routing for services on IP-based networks
- Area 8 - Performance
- Area 9 - Integrated management of telecom and IP-based networks
- Area 10 - Security aspects
- Area 11 - Network capabilities including requirements for resource management
- Area 12 - Operations and Maintenance (OAM) for IP

For each of these areas Annex B describes the scope and focus of the work area, and the issues being studied. In relation to the IETF work an analysis of the IETF Working Group Charters is currently being undertaken to identify areas of potential overlap and areas where the ITU-T could collaborate with the IETF.

6.1.2 ITU-R

The Radiocommunication Study Groups:

- draft the technical bases for Radiocommunication Conferences
- develop draft ITU-R Recommendations on the technical characteristics of, and operational procedures for, radiocommunication services and systems
- compile handbooks on spectrum management and emerging radiocommunication services and systems.

At present, there are 8 Study Groups (SGs) addressing the following topics:

- SG 1 - Spectrum management
- SG 3 - Radiowave propagation
- SG 4 - Fixed-satellite service
- SG 7 - Science services
- SG 8 - Mobile, radiodetermination, amateur and related satellite services
- SG 9 - Fixed service
- SG 10 - Broadcasting service (sound)
- SG 11 - Broadcasting service (television)

The list of questions under study by SG 4 is given in Annex C of this report.

6.1.2.1 WP 4B - ATM via Satellite

From Working Party 4B of the ITU-Radiocommunications sector has started the development of two recommendations that are aligned with ITU-T Recommendation I.356 [27] "B-ISDN ATM Layer Cell Transfer Performance" and ITU-T Recommendation I.357 [28] "B-ISDN Semi Permanent Connection Availability" respectively. These are Preliminary Draft New Recommendations S.ATM titled as "Performance for B-ISDN ATM via Satellite" and S.ATM-AV "Availability for ATM via Satellite" (ATM Forum/98-0828 [39]).

S.ATM Recommendation

This new recommendation consists of two annexes: normative and informative. The normative section deals with a reference model for a satellite path, ATM performance objectives for satellite system, translation between TM layer and physical layer parameters and relationship between ITU-T Recommendations G.826 [23] and I.356 [27].

The informative section describes the simulated and measured performance of ATM over satellite, measured results of physical versus ATM layer performance, ATM application requirements and techniques to enhance performance of ATM over satellites.

ATM Performance Objectives for Satellite Links

This section provides an interpretation of the performance objectives defined in ITU-T Recommendation I.356 [27] and the corresponding requirements for the satellite portion(s) of an ATM connection. The end-to-end ATM Layer network performance parameters and objectives for public Broadband Integrated Services Digital Network (B-ISDN) are defined in ITU-T Recommendation I.356 [27]. To accommodate the characteristics and the requirements of various traffic types, ITU-T Recommendation I.356 [27] defines various Classes of Service. Class-1 (Stringent Class) is a delay sensitive class and it is intended to support Constant Bit Rate (CBR) and real-time Variable Bit Rate (VBR) services such as telephony and videoconference. Class-2 (tolerant Class) is a delay tolerant class and supports Available Bit Rate (ABR) and non-real-time Variable Bit Rate (VBR) services such as video and data. Class-3 (Bi-Level Class) supports VBR and ABR services such as high-speed data. Finally, Class-4 (Unspecified Class) supports Unspecified Bit Rate (UBR) services such as file transfers and email. Table 1 provides the ATM Layer performance objectives for the various service Classes. These objectives may be revised in the future based on real operational experience.

Table 1: QoS class definition and network performance parameters

	CTD Cell Transfer Delay	2-point CDV Cell Delay Variation	CLR0+1 Cell Loss Ratio, aggregate	CLR 0 Cell Loss Ratio, high priority	CER Cell Error Ratio	CMR Cell Misinsertion Rate	SECBR Severely Errored Cell Block Ratio
Default Objectives:	no default	no default	no default	no	4×10^{-6}	1/day	10^{-4}
QoS Classes:							
Class 1 (stringent class)	400 ms	3 ms	3×10^{-7}	none	default	default	default
Class 2 (tolerant class)	U	U	10^{-5}	none	default	default	default
Class 3 (Bi-level class)	U	U	U	10^{-5}	default	default	default
U class	U	U	U	U	U	U	U

The QoS class required by each application is part of the contract negotiation procedure between the user and the network. If the network can provide the requested service level, the connection will go through. If there is any performance objective that cannot be met, the connection will be denied. Once a connection is established, the network has to ensure that the performance objectives of the QoS class are not exceeded during the connection.

ATM Performance Objectives for Satellite Systems

Numerical values of ATM performance parameters for satellite systems can be derived by applying the allocations given in Table 1 to the performance objectives given in ITU-T Recommendation I.356 [27]. As an illustration, the ATM Performance Objectives for a satellite link used in the international portion that provides Class-1 Service and does not contain switching or cross-connect functions is shown in Table 2.

Table 2: ATM Performance Objectives for Satellites (Class-1 Services)

Performance Parameters	ITU Objective End-to-End	ITU Objective Satellite
CLR	3×10^{-7}	$7,5 \times 10^{-8}$
CER	4×10^{-6}	$1,4 \times 10^{-6}$
SECBR	1×10^{-4}	$3,0 \times 10^{-5}$
CTD	400 ms	320 ms (max)
CDV	3 ms	Negligible
CMR	1/day	For Further Study

Impact of Satellite Characteristics on ATM Performance

To meet stringent objectives of ATM, satellite systems will need to meet special challenges. One characteristic of satellites is the impact of occasional burst errors that can adversely affect the application performance, either directly or indirectly, via the ATM Layer or the ATM Adaptation Layer Protocols. Since satellites are prone to noise and interference from various sources, it is imperative to develop adequate transmission plans. This includes considerations on the selection frequency, transmit and receive power levels, and appropriate coding mechanisms. In particular, robust coding mechanisms such as Reed Solomon codes can reduce the amount of errors that otherwise may pass uncorrected by conventional Forward Error Correction techniques like convolutional encoding and Viterbi decoding. The informative section of the new recommendation on S.ATM describes simulation results of the concatenated coding.

QoS Requirements of ATM Services and Applications

To adopt the ATM Layer performance objectives shown in Table 1, various studies and measurement results of the Quality of Service (QoS) of ATM applications were submitted to the ITU Study Groups. The goal of these studies was to identify, for each ATM Layer network parameter, the performance objectives that would satisfy the service quality expected by the end-user. Among the various contributions submitted to the ITU was a study conducted by AT&T and Telstra during the AT&T-KDD-Telstra (AKT) ATM Field Trial. One of the objectives of the AKT ATM Trial was to assess the feasibility of transporting ATM over a combination of fibre and satellite connections. The informative section of the S.ATM recommendation provides the AKT trial results on the physical and ATM layer performance of 45 Mbit/s satellite facilities and on the QoS applications.

ATM Availability Considerations

ITU-T SG-13 has developed ITU-T Recommendation I.357 [28] to address the availability of permanent virtual connections. ITU-T Recommendation I.357 [28] establishes two types of availability parameters. The first parameter is the Availability Ratio (AR), well known to satellite engineers as the "satellite availability". The second parameter is the Mean Time Between Outages (MTBO), defined as the average duration of a continuous time interval during which the ATM network portion is available. At present, not enough is known about the MTBO exhibited by satellite systems, although existing propagation data could be used to investigate this and other statistics about the behavior of a satellite link during periods of degraded performance. Hence, the discussion on this section will be limited only to the Availability Ratio parameter. As opposed to fibre systems, satellites exhibit performance characteristics that are determined by changing atmospheric conditions that affect the signal propagation, the various sources of interference and the type of equipment used. Considering these aspects, ITU-R WP-4B has adopted the following expression to define the satellite system availability.

$A_{\text{Satellite Link}} = A_{\text{Propagation}} \times A_{\text{Earth Station}} \times A_{\text{Spacecraft}}$

$A_{\text{Propagation}}$ represents the availability due to rain attenuation and interference effects in the uplink and downlink

$A_{\text{Earth Station}}$ represents the availability (equipment reliability) of all Transmit and Receive earth station equipment up to the terrestrial interface. It also includes sun interference effects and the availability of any ATM equipment that may be used in a satellite connection.

$A_{\text{Spacecraft}}$ represents the total availability (equipment reliability) of the spacecraft including eclipse outages. It also includes the availability of any on-board ATM processing and/or switching equipment.

$A_{\text{Satellite Link}}$ represents the product of all availability components on a satellite link.

In addition to the parameters mentioned, traffic congestion is being considered by ITU-T. As applied to satellite systems, this parameter may include availability due to traffic congestion or queuing from on-board ATM equipment and/or any satellite-specific ATM equipment used at the earth stations.

The recommendation on availability objectives for transmission of B-ISDN ATM; in the fixed satellite service by Geosatellite system; operating below 15GHz provides the satellite hypothetical reference digital path availability. In addition, the measurements of availability of satellite links carrying B-ISDN ATM traffic in terms of BER, CLR, CER versus percentage of time is described. This recommendation relates to earth stations with antennas greater than 3 meters, and for smaller earth stations the work has yet to be done.

6.1.2.2 WP 4B - Satellite Link Performance for Transmission of IP

In May 1999, WP 4B commenced work on a New Question entitled "Performance Objectives of Digital Links in the Fixed-Satellite Service for Transmission of IP Packets". The Question is reproduced below ITU-R Working Party 4B:

The ITU Radiocommunication Assembly, considering:

a) that fixed-satellite systems must be part of the new global information infrastructure (GII);

b) that availability and performance criteria for transmission of IP packets may have an impact on satellite link design;

c) that new requirements for IP or higher layer protocols and applications are constantly appearing which may have an impact on satellite link design;

d) that transmission of IP packets on satellite links may require performance objectives different from those contained in (ITU-R Recommendations S.1062 [45] and S.[Doc.4/44]),

decides that the following Questions should be studied:

1 What are the reference satellite network architectures required to support IP?

2 What is the performance required of satellite links to support network layer protocols (for example RSVP, OSPF and IP multicast, ARP and inverse-ARP), the Internet specific protocols (for example DHCP, IGP and BGP) and transport layer protocols (for example TCP/IP, UDP/IP and their variants) running over IP?

3 What is the performance required of satellite links to support, for example voice, video, videotelephony and file transfer running over IP?

4 What are the needs for potential improvements to IP or higher level protocols that enhance their performance over satellite links?

5 What impact do IP privacy and security protocols and related issues have on satellite link requirements?

6 What arrangements should be made by the ITU-R to offer the most appropriate liaison with the ITU-T and other standards bodies (for example the IETF)?

further decides:

that the above studies should be completed by 2001.

6.1.2.3 Mobile-Satellite Service (MSS)

In order to foster rapid and orderly deployment of global MSS systems, the ITU-R has been preparing Recommendations to facilitate circulation and type approval of terminals, as follows:

- ITU-R Recommendation M.1343 [46]: Essential technical requirements of mobile earth stations for global non-geostationary MSS systems in the bands 1 GHz to 3 GHz

  Provides the essential technical requirements of mobile Earth stations (MESs) for global non-geostationary mobile-satellite systems in the bands 1 GHz to 3 GHz that should be used by administrations as a common technical basis for: establishing type approval requirements for MES terminals; facilitating the licensing of MES terminal operations; facilitating the development of mutual recognition arrangements of type approval of MES terminals; and facilitating the development of mutual recognition arrangements to facilitate the circulation and use of MES terminals.

- M.[MSS.TREQ]: Essential technical requirements of mobile earth stations of geostationary MSS systems in parts of the band 1 GHz to 3 GHz (approval by 2000).

  The type approval of equipment forms a part of the authorization for the use of MES terminals. The mutual recognition by administrations of type approval of MES terminals for geostationary MSS systems is a key element in facilitating the circulation of MES terminals. To achieve mutual recognition of the type approval of MES terminals on a global basis it is necessary to have common global technical requirements.

- M.[MSS.ETR]: Essential technical requirements of mobile earth stations for global non-geostationary MSS systems in the 148 MHz to 150,05 MHz frequency band (approval by 2001).

Work is continuing in ITU-R in different areas related to MSS standards, particularly on performance objectives and spectrum management aspects.

The ITU has been acting as the depository of the GMPCS-MoU. The MoU group agreed upon a series of "arrangements" to facilitate the introduction and development of GMPCS covering type approval and marking of GMPCS terminals, licensing, access to traffic data, customs matters, and the notification/implementation procedures. For example, type approval of handsets shall be based on ITU Recommendations. More detail about the GMPCS-MoU can be found at http://www.itu.int/GMPCS/gmpcs-mou/.

6.1.2.4 ITU-R activities on digital broadcasting

A reference for this text is ITU-R activities on digital broadcasting.

Digital Satellite TV

It is worth noting the important step taken in preparing standards for digital satellite TV as contained in the following ITU-R Recommendations:

- BO.1211: Digital multi-programme emission systems for television, sound and data services for satellites operating in the 11/12 GHz frequency range.
- BO.1294: Common functional requirements for the reception of digital multi-programme television emissions by satellites operating in the 11/12 GHz frequency range.
- BO.[DOC.11/62]: Transmission system for advanced multimedia services provided by Integrated Services Digital Broadcasting in a Broadcasting-Satellite Channel (ISDB-S)

Digital Sound Broadcasting (DSB)

As regards the establishment of unique world-wide system characteristics for terrestrial and satellite DAB, in 1995 the following ITU-R Recommendations were established:

- BS.1114: System for terrestrial DSB to vehicular, portable and fixed receivers in the frequency range 30 MHz to 3 000 MHz.
- BO.1130: Systems selection for DSB to vehicular, portable and fixed receivers for broadcasting-satellite service (sound) in the bands in the frequency range 1 400 MHz to 2 700 MHz.

Both Recommendations annexed a description of the EU 147 System as the recommended system fulfilling the requirements laid down in ITU-R Recommendations:

- BS.774: Service requirements for DSB to vehicular, portable and fixed receivers using terrestrial transmitters in the VHF/UHF bands; and
- BO.789: Service for DSB to vehicular portable and fixed receivers for broadcasting-satellite service (sound) in the frequency range 1 400 MHz to 2 700 MHz;

to be used for current DAB service implementations. The currently approved version of Recommendation ITU-R BO.1130 on satellite DAB includes two additional systems besides the EU 147 as well as a comparison table giving the applicability and the performance of each recommended system.

Multimedia Broadcasting

The ITU-R considers multimedia broadcasting to be the most important frontier of technology in digital broadcasting today. The most important technical issue to resolve is the language that is used for multimedia applications that are broadcast over air. This is the Application Programming Interface, or API. In this respect, the ITU-R has already produced a Recommendation:

- BT.1378: Basic requirements for multimedia-hypermedia broadcasting;

that recommends initial basis for multimedia-hypermedia broadcasting requirements.

This matter is considered so critical for broadcasting that the ITU-R is setting up a new group to work actively in this area to agree a common world-wide system.

6.1.3 ICGSAT

Studies of mutual interest to the Radiocommunication and Telecommunication Standardization Study Groups are overseen by Intersector Coordination Groups, which includes ICGSAT – Intersector Coordination Group on Satellite Matters.

Areas requiring coordination:

The following areas have been identified as requiring coordination:

- Performance and availability of satellite networks (work is proceeding with Recommendations developed by ITU-R SGs 4 and 8 for fixed and mobile satellite services and ITU-T SG 7 for Frame Relay and SG 13 for network performance);
- Interconnection of satellite networks with public switched networks (Recommendations are being prepared in ITU-T for interconnection of VSATs with PSTNs. Consideration should be given to new technologies linked with broadband access networks, such as Asymmetrical Digital Subscriber Line (ADSL));
- Routing, signalling, numbering, protocols (noting that the previous problem of signalling points for international operation has been solved in the present version of ITU-T Recommendation Q.708 [30]);
- Interworking of GMPCS and public networks (this is being considered by ITU-R SG 8; the ITU-D Sector is very active in this field);
- IP over satellite (this matter was referred to the Working Group);
- The multimedia environment (SG 16 is the lead Study Group within ITU-T for Multimedia services and systems. A coordination group has been established in ITU-R between SGs 10 and 11 for multimedia);
- Satellite terminal portability;
- Convergence (the matter was referred to the Working Group).

Working Group on IP over satellite matters:

It has been noted that synergy between the activities of the ITU-T and ITU-R on satellite matters is becoming increasingly important as the technology evolves. In particular, it has been recommended that:

1) Future standards for IP based networks be developed to facilitate operation over all types of transmission technology (including satellites operating in FSS and MSS);

2) The IP project, managed under the responsibility of ITU-T SG 13, should be expanded to explicitly cover the satellite specific aspects including architecture, performance, etc. and without precluding the responsibilities of ITU-R SG4 WP4B.

Working Group on Convergence:

Three specific topics have been considered: satellite services convergence (as defined in the radio regulations), convergence of services and networks, and future standardization framework for multimedia applications.

1) ITU-R JWP 10-11S concluded that no useful purpose would be served by abandoning the present distinction between the FSS and BSS and the methods of treatment of the two services in the International Radio Regulations.

2) Concerning convergence of terrestrial and satellite services and networks, SG 13 (general network aspects), SG 15 (transport networks, systems and equipment), and SG 16 (Multimedia services and systems) have been studying such issues.

3) About the standardization framework for future multimedia systems, ITU-T SG 16 has started to prepare a working plan for the next study period (2000-2004) under the name "Mediacom 2004".

6.2 TIA Telecommunications Industry Association

The TIA is accredited by the American National Standards Institute (ANSI) to develop voluntary industry standards for a wide variety of telecommunications products. TIA's Standards and Technology Department is composed of five divisions that sponsor over 70 standards-setting formulating groups. The committees and subcommittees that formulate the standards are sponsored by five divisions - Fiber Optics, User Premises Equipment, Network Equipment, Wireless Communications and Satellite Communications.

6.2.1 Satellite Standards Activities of TR-34

6.2.1.1 Satellite Communications Division (SCD) and TR-34

Within the TIA Standards and Technology overall structure, the Satellite Communications Division (SCD) and its associated TR-34 Satellite Equipment and Systems Engineering Committee are responsible for standards and studies related to satellite communications systems, including both the space and earth segments (TIA). The Committee focuses on standards for space-borne and terrestrial hardware; interfaces between satellite and terrestrial systems, as well as the efficient use of spectrum and orbital resources, including frequency sharing between satellite and terrestrial services-when these two types of telecommunications transmission systems operate in part or wholly in a common frequency band. Overall, TR-34 is responsible for standards for space telecommunications systems, including transmitters, receivers, antennas, spacecraft and associated equipment for space and earth segments, including multiple access and interfaces with other systems, as well as radiation phenomena, characteristics of propagation along the path, and data transmission systems which are an integral part of the space system. Active projects within the last several years (SCD and TR-34 were established in 1996) range from studies on how best to accomplish inter-service spectrum sharing and developing standards to achieve interoperability between satellite and terrestrial systems, networks, and services.

In addition to developing industry standards specifically for satellite communications equipment, TR-34 has been working with other standards development organizations to ensure that the standards it produces are acceptable for satellite services. In particular, Subcommittee TR-34.1, Communications and Interoperability, has been working closely with the ATM Forum and the Internet Engineering Task Force (IETF) to ensure the standards developed by these bodies take into consideration the special attributes and requirements of satellite communications. On the TIA website (http://www.tiaonline.com) one can also see that TIA expects the existing collaboration with ETSI to become closer in the future.

The demand for satellite communications equipment has been growing rapidly, as demonstrated by U.S. Department of Commerce financial data on the orders for spacecraft and ground (Earth Station) satellite communications equipment over the last five years. These include conventional Fixed-Satellite Service (FSS), Mobile-Satellite Service (MSS), Direct Broadcast Satellite (DBS) and Global Positioning System (GPS) hardware. The Federal Communications Commission (FCC) also received nine MSS system applications (including Letters of Intent from three non-U.S. systems wishing to offer MSS within the U.S.) by the September, 1997 deadline for applications, as well as Letters of Intent and amendments to applications in the 2 GHz MSS bands (1 990 MHz to 2 025 MHz, Earth-to-space; 2 165 MHz to 2 200 MHz space-to-Earth, in the U.S. Table of Frequency Allocations). However, the downlink bands for 2 GHz MSS are also utilized extensively by microwave point-to-point stations in the U.S.—both digital common carrier (formerly FCC Part 21) and analog Private Operational Fixed (formerly FCC Part 94) users, operating under FCC/CFR Part 101. This situation led to the formation, under the auspices of Subcommittee TR-34.2, Spectrum and Orbit Utilization (and TR-14 Point-to-Point Communications Systems), of a special Joint Working Group to study the potential for sharing the band 2 165 MHz to 2 200 MHz between satellite systems operating in the MSS and microwave systems operating in the FS. Some information on the more recent activities in the standards area, within Subcommittee TR-34.1, and in the spectrum area, under SubcommitteeTR-34.2, are provided below.

6.2.1.2 TR-34.1: Communications and Interoperability

Subcommittee TR-34.1, Communications and Interoperability, and the parallel Communications and Interoperability Section (CIS) works on challenging issues and problems of interoperability between terrestrial and satellite networks; and, among satellite networks. The CIS oversees the structure of Working Group Committees and Task Groups, which may address specific issues. These issues may include technical, standards, regulatory, policy, and market place matters, both domestic and global, which are important to the industry. The work covers standards applicable to both Fixed-Satellite Service (FSS) and Mobile-Satellite Service (MSS) networks. The major focus is on the existing and future standards development in Internet, ATM, GSM and their "seamless" operation over satellite transmission paths. The six TR-34.1 Working Groups (WGs) are as follows:

- Internet Via Satellite;
- ATM Traffic Management and Congestion Control;
- Common Air Interface: ATM Via Satellite;
- ATM Speech;
- ATM Multicast;
- Common Air Interface: Dual Mode GSM Compatible Geo Mobile System.

Different working groups work very closely with appropriate standards bodies such as ATM Forum, IETF, ETSI and the ITU-T. The outputs of the working groups consist of TIA Telecommunications System Bulletins (TSBs) and Interim Standards (ISs). The TSBs of TR-34.1, in turn, consist of two types of documents-information documents and requirements documents. For example, the work carried out by the ATM Traffic Management and Congestion Control WG will be published in a TSB to be balloted soon. This particular TSB describes in detail the issues which impact traffic management in ATM networks over satellite links; and, recommends specific procedures; e.g., the implementation of virtual source and virtual destination at the ingress of the satellite network. An example of the second category would be TSB-90-a TSB describing high-level requirements for Common Air Interface for Geo Mobile Radio (GMR) System. Two GMR specification families are also under preparation. These GMR systems are GSM-derived and are specified for geostationary satellites and handheld mobile user terminals that are equipped for dual-mode operation with satellite and terrestrial GSM.

In 1998,TR-34.1 completed the work which resulted in the successful balloting and publication of TSB-90, High Level Requirements for Common Air Interface for GEO-Mobile (Super GEO) Satellite Communications featuring Interoperation with Terrestrial GSM. In addition, TSB-91, Satellite ATM Networks: Architectures and Guidelines, was completed. These documents are intended to help ensure interoperability between the satellite and terrestrial components of such systems.

The WG on Common Air Interface: ATM via Satellite recently completed their work on ATM over point-to-point satellite links. The detailed specification on the Frame format, acquisition and synchronization procedure, and dynamic, adaptive coding has now been published as IS-787: Common Air for Satellite Interface (CASI) Interoperability Specification.

Most of the work by Internet via Satellite WG was done in IETF under the TCPSAT working group. Major issues considered were TCP, TCP extension, and their interoperability over satellite.

The WG on ATM Speech has been studying the evolving standards, their early implementations and operations in a test-bed environment.

Recently, a new project on ATM Multicast over Satellite was approved by TIA. The purpose is to develop a "point-to-multipoint" ATM multicast over satellite standard at the physical access layer.

TR-34.1 subcommittee is planning to investigate the following areas from the perspective of satellite/terrestrial interoperability: IP and Quality of Service (QoS), Packet Voice (ATM and IP), GSM Packet Radio Service (GPRS). In addition Ka-band satellite systems for FSS and third-generation compatible MSS are considered attractive areas of investigation under the aegis of TR-34.1 for the development and/or analysis of common air interfaces.

Selected Specifications

TR-34.1: Common Air Interface Working Group (CAI WG).

Purpose of the working group is to develop a common air interface standard for GEO Mobile Satellite Service enabling interoperation with terrestrial GSM. The current subject of standardization is the satellite-mobile link in both the uplink and downlink directions. The requirements document for the Common Air Interface for GSM over GEO mobile systems has been issued by the TIA as TSB-90 [41].

TR-34.1: Wireless ATM Working Group.

This working group produced the TSB-91 "Satellite ATM Networks: Architectures and Guidelines." in April, 1998. These architectures differ from one another in terms of required level of mobility, supported data rates, supported terrestrial interfaces, and on board processing and switching requirements.

The ATM network architectures for bent-pipe satellites defined in TSB-91 [42] are:

i) SATATM 1.1 - Fixed ATM Network Access and Network Interconnect;

ii) SATATM 1.2 - Mobile ATM Network Access;

iii) SATATM 1.3 - Mobile ATM Network Interconnect.

The ATM Network architectures defined for satellites with on-board ATM switches are:

i) SATATM 2.1 - ATM Network Access;

ii) SATATM 2.2 - ATM Network Interconnect; and

iii) SATATM 2.3 - Full Mesh ATM.

TIA TR 34.1 intends to use the present document as a basis in developing the technical specifications for these SATATM networks.

The Wireless ATM working group of TIA TR34.1 has finished its task and no longer exists.

TR-34.1: The Satellite Over ATM Common Air Interface Working Group.

This group began work in November, 1997 on developing a standard for ATM over geosynchronous satellite links. This work has involved establishing the ATM performance requirements that need to be met over the satellite link and choosing a technical approach that meets these requirements with the best benefit/efficiency trade-off. In autumn 1998 the group produced a preliminary specification for a Common ATM Satellite Interface (CASI) protocol which is defined such that interoperability is assured between various vendor implementations. This preliminary specification details the overall operation of the CASI, including specifying a frame format for transport of multiple ATM cells per frame over the satellite link, and forward error correction, which adapts to the satellite link condition, applied to each frame for maintaining ATM service quality.

TR-34.1: Interoperability Reference Models.

Purpose is to formalize the format and terminology used by the satellite community. This is to ensure compatibility with concepts put forth by other standards-making bodies. A draft document has been developed, but TSB number and the completion date have not been assigned.

TR-34.1: ATM Traffic Management.

TSB nearing completion on "Traffic Management in ATM Networks over Satellite Links". The TSB will provide a survey of the traffic management issues related to the design of satellite-ATM networks. While the main focus is on traffic management issues, several recommendations on the design options for efficiently carrying data services over satellite-ATM networks are presented.

6.2.1.3 TR-34.2: Spectrum and Orbit Utilization

Subcommittee TR-34.2, Spectrum and Orbit Utilization, and the parallel Spectrum and Orbit Utilization Section (SOUS), which oversees the formulation and functioning of Working Groups or Ad Hoc groups, is responsible for standards and studies related to the efficient use of spectrum and orbit resources for satellite communications systems. The work of TR-34.2 includes both space and earth segments of satellite communications systems and networks. TR-34.2 activities are focused and guided by priorities established in the SOUS, drawing on the broad interests and representation of the membership of TIA to create joint industry working groups for studying subjects of intense interest to the satellite communications community. These include examining technical aspects of inter-service sharing of spectrum (frequency sharing) between, for example, new satellite communications services and existing or new terrestrial systems which could operate in overlapping frequency bands or common frequency bands.

The major recent activities of TR-34.2 have taken place within two technical Joint Working Groups (JWGs) for inter-service sharing. One very complex JWG involves several different terrestrial telecommunications services potentially producing interference into satellite receivers at 18 GHz. The other JWG involves new MSS networks' downlink transmissions sharing frequencies with incumbent microwave receive stations at 2 GHz. In addition, an Ad Hoc Group was formed in 1998 to evaluate the IMT 2000 Satellite Radio Transmission Technologies (RTTs) Proposals that were submitted to the ITU-R, under aegis of Task Group 8/1.

While the work of the Ad Hoc IMT-2000 Satellite RTT Evaluation Committee was not a spectrum issue, in a strict sense, the methodology of the Committee was to develop Compliance Matrices, based on evaluation criteria supplied by the ITU-R (TG –8/1). These Compliance Matrices were filled out, based on a comparison of the submitted RTT proposals, and in some cases, self-evaluations and supporting documents supplied by the companies or entities which had submitted the RTT proposals to the ITU by June 30, 1998. It was found, through the evaluation process of the IMT-2000 Ad Hoc-RTT Evaluation Group that it is necessary to have multiple RTTs for satellite systems at this stage. This finding was made due to significant differences between terrestrial systems and satellite systems in the areas of design, operational scenarios, areas of optimization, scarcity of resources, cost of initial deployment, number of systems deployed, number of operators and timetables of deployment. The TR-34.2 IMT-2000 Ad Hoc-RTT Evaluation Report was approved by US TG 8/1 for adoption and input into the international TG 8/1 meeting in November, 1998, where the recommendations developed by the TR-34 Ad Hoc were adopted by that meeting.

In the case of the TR-34.2/TR-14.11 JWG (18 GHz), this Committee attempted, but was unable to find a technical basis for frequency sharing between the affected services: GSO satellite, NGSO satellite, Broadcast Satellite, Fixed Service Microwave (point-to-point) Common Carrier and Private Licensees, Wireless Cable Operators (point-to-multipoint), plus Broadcast Auxiliary Service (Electronic News Gathering). The Committee basically had agreed to a band segmentation plan, in lieu of co-channel frequency sharing. However, full agreement on this plan was not reached, and since the ground rule of 100% consensus had been set at the outset, the Committee was not able to publish its findings and recommendations. The Committee has not been disbanded as such but has become deactivated, pending such time as the FCC issues its Report and Order on 18 GHz, when the JWG may be reactivated.

The work of TR-34.2/TR-14.11 JWG (2 GHz) is nearly completed, after almost three years of technical studies-culminating in the production of TSB-86, which is being balloted within the TIA as of this writing. The main mission of the JWG was to study the potential for sharing the band 2165-2200 MHz between satellite systems operating in the Mobile-Satellite Service (MSS) and microwave systems operating in the Fixed Service (FS). The result of these studies was to determine the conditions under which sharing may be possible and the arrangements necessary for sharing to occur (if any).

After a long process of information exchange between the satellite and terrestrial industries, which helped to characterize the RF performance of the microwave links as well as the emissions from MSS satellite networks (including NGSO constellations) proposing to operate in the 2 GHz bands, it was decided that the purpose of TSB-86 would be primarily to provide a methodology for evaluating MSS (downlink) interference into FS receive stations, and to set interference thresholds or criteria to protect both analog and digital FS receivers, on a per hop basis. These criteria represent the maximum permissible levels of interference when coordinating MSS downlinks with respect to FS receiving stations. In publishing this TSB, the 2 GHz JWG and TIA make no claims or conclusions about the extent to which the 2 165 MHz to 2 200 MHz band can be shared between MSS and FS users.

Selected specifications

TR-34.2: 2GHz Joint Working Group with TR-14.11 and NSMA.

The purpose of the group is to study MSS/FS sharing in the 2 GHz band. TSB 86, version 9.1 is nearing completion. This TSB will serve as a "handbook" for the determination of interference in the 2 GHz band between MSS and FS services. The specific interference criteria are currently under discussion and it is anticipated that the document will be submitted for ballot in December 1998. Concurrently, another report is being prepared that will address non-interference issues. A completion date has not been assigned to that report.

TR-34.2: 18 GHz Joint Working Group with TR-14.11 and NSMA.

The purpose of the group is to study 1) FSS/FS sharing in the Ka GHz band and 2) blanket licensing of Earth stations in the Ka band. Output will be a TSB, completion date not yet assigned.

The TIA TR-34 formed an ad hoc committee to participate in the US TG-8/1 Ad Hoc RTT Evaluation Group evaluation of Radio Transmission Technology (RTT) proposals that had been submitted to the ITU regarding the role of satellites in next generation systems. The ad hoc committee reported that the proposals could not be properly evaluated for their efficacy because satellite related parameters were not included in the self-evaluation materials provided to the proposers. As a result the proposals were evaluated solely on the basis of whether they met the criteria of the submission guidelines.

6.2.2 Wireless Internet Protocol Partnership (WIPP)

TIA has recently launched an Internet Protocol (IP) over wireless standards project. The program will be to study IP requirements for all digital wireless technologies and to be access transparent. There is global interest and need to have IP capabilities over wireless. TIA recognizes the need to develop a common IP standard to encourage growth and easy accessibility to the Internet for the wireless technology industries.

The global public will benefit by having a common IP standard; a common standard will encourage lower implementation cost and increased operating reliability.

Assumptions

1. Computer manufacturers want wireless data services to be an alternative to wireline phone services (and cable modems) for Internet access to PCs and laptops.

2. Wireless manufacturers and carriers are interested in providing Internet services in a wireless environment on existing and future handsets as evidenced by WAP, MIPS Forum, et cetera.

3. Wireless related technology is evolving in three key areas to allow wireless Internet access - bandwidth, available MIPS in the device and display capabilities.

4. The Wireless Internet Protocol should be technology transparent: i.e., the proposed services and features will be available to all digital wireless technologies.

Areas of work

1. Wireless Data Services Interface and Operation

2. Application Programming Interfaces (APIs)

   APIs are the common link, which allow exchange of information among the user's device, the network, a client server and the actual Internet application.

3. Mobile Device Interface and Operation

   There are four critical factors that will determine mobile device interface and operation in a wireless IP environment: input, output, available MIPS and memory, and the available system data bandwidth.

4. Desktop Device Interface and Operation

   Computer and chip manufacturers are supporting partnerships that are developing the necessary APIs and support mechanisms that will allow full, wireless IP for desktop applications.

5. Marketing and PR Support

   A key part of WIP work efforts will center on marketing efforts. This will include recruiting new members, sharing the WIP vision with industry and media analysts, taking part or even sponsoring conferences and seminars, identifying key vertical market segments for early implementation, and establishing and providing PR for WIP membership and work efforts.

6. Application Development

   To assure that a great variety of compatible applications are available when wireless IP is provided as a commercial service, the WIP Partnership will educate, promote and encourage membership for application developers.

7. Service and Test Guides (i.e. Minimum Performance Standards)

8. Liaison with Appropriate Organizations

   In addition to the work-related organizations, there are a number of other industry groups both in and out of the computer and wireless areas which need to be identified and contacted to be made aware of the goals and objectives of the WIP Partnership.

9. Voice over Wireless IP

   Wireless industry sources indicate that voice over wireless IP is already being studied. It would be quite logical to include an industry wide work effort in the WIP Partnership for both development and standardization.

10. Video over Wireless

   Various video services will be able to be provided over the bandwidth and handset processing power, which is being forecast. Internationally, wireless video services are being discussed as a very attractive service.

Further remarks:

1. The proposed WIPP will be technology transparent (i.e. compatible with all wireless technologies) so that Internet services will be available to all digital wireless systems.

2. WIPP is answering the need to provide wireless functionality that will be available in the next 15 to 18 months. These will include two major breakthroughs: incremental bandwidth and increases in processing power and memory in the mobile devices. Hence, the planned mobility bandwidth would include up to 144 kbit/s in full mobility situations in all radio environments, up to 384 kbit/s in outdoor to indoor situations and pedestrians and up to 2 Mbit/s in indoor offices, pico-cells and fixed outdoor applications. In addition, upper end mobile devices such as laptops, palm devices, and an emerging class of wireless phones, which will all have the processing power and memory to be Internet compatible.

3. WIPP is also planning to support wireless functionality to desktop devices that will meet and exceed both current and planned wireline functionality.

4. WIPP will also inventory and coordinate all public computer and wireless work efforts on a world-wide basis so that any appropriate and needed work is not duplicated and any immediate work requirements are addressed.

5. WIPP will utilize its TIA (Telecommunication Industry Association) relationship to publish North American standards (which will also be liaisoned to all appropriate wireless, computer and Internet standards organizations) to fully utilize wireless technology to access Internet services.

6.3 ATM Forum

6.3.1 Overview

The ATM Forum is an international non-profit organization formed with the objective of accelerating the use of ATM (Asynchronous Transfer Mode) products and services through a rapid convergence of interoperability specifications. In addition, the Forum promotes industry cooperation and awareness. Currently the Forum is developing IP over ATM, voice over ATM, real-time multimedia over ATM (based on ITU-T Recommendation H.323 [69]), and a performance-testing specification as it seeks to secure the technology's future. The organization is using its expertise in the ATM market to transform itself into a multi-protocol forum. A newly established working group has been charged with intensifying ATM's support of IP-based services. The Forum also formed another working group to encourage the development of VoDSL technology, along with voice and data convergence.

In addition to activities carried out in cooperation with the ITU, satellite activities are mainly in a subgroup of the Wireless ATM Working Group, whose activities are described in more detail in the following clause.

Technical Committees in the ATM Forum are:

1) Control Signalling;
2) ATM/IP Collaboration;
3) Network Management;
4) Frame-Based ATM;
5) Residential Broadband;
6) Physical Layer;
7) Routing and Addressing;
8) Security;
9) Service Aspects and Applications (SAA);
10) SAA / API (Applications Programming Interface);
11) SAA / RMOA (Real-time Multimedia over ATM);
12) Testing (PICS, Protocol Implementation Conformance Statement);
13) Traffic Management;
14) Voice and Telephony over ATM (Voice over DSL);
15) Wireless ATM (including Infrastructure Mobility and Satellite Access Subgroup).

A list of ATM Forum work areas is presented in Annex E.

6.3.2 Infrastructure Mobility and Satellite Access Subgroup

This clause is adapted from ATM Forum Document Number: ATM_Forum/98-0735, entitled "Infrastructure Mobility and Satellite Access Sub Group Work Plans" [40].

6.3.2.1 Introduction

During the July 1998 ATM Forum meeting in Portland it was decided to develop a work plan on the Subgroup of the Wireless ATM Working Group focusing on the Infrastructure mobility and Satellite Access networks using ATM and/or ATM-like switching capabilities. Though a few contributions during the past two years have addressed the issues of infrastructure mobility, Airborne Platforms Communicating via satellite links, and Wireless ATM service scenarios with special reference to the satellite ATM, the progress has not been enough to develop its own baseline specifications document. However, during the past two ATM Forum meetings there was considerable interest among the satellite and mobility subgroup (including members from both commercial industry and Government organizations) to accelerate the activities.

This clause addresses two important areas driving the goals of this subgroup of the Wireless ATM working group. These are:

1) Multimedia Satellite Networking; and

2) Infrastructure Mobility.

6.3.2.2 Multimedia Satellite Networking

The rapid globalization of telecommunications industry and the exponential growth of the Internet are placing severe demands on global telecommunications. This demand is further increased by the convergence of computing and communications and by the increasing number of new applications such as web surfing and desk-top video conferencing. Satisfying this demand is one of the greatest challenges facing the 21st century technology innovations. Existing terrestrial infrastructure can address such telecommunications demands. However, hybrid solutions involving satellites can be used to achieve interconnectivity with distant/isolated nodes of the terrestrial network, thus reducing the congestion problems and providing better quality of service in a more economical fashion.

Satellite communications technology offers a number of advantages over traditional terrestrial point-to-point networks. These include:

1) Wide geographic coverage including interconnection of "ATM islands";

2) Bandwidth on demand, or Demand Assignment Multiple Access (DAMA) capabilities;

3) An alternative to damaged fibre optic networks for disaster recovery operations; and

4) Multipoint to multipoint communications facilitated by the inherent broadcasting ability of satellites.

With the widespread availability of multimedia technology, and an increasing demand for electronic connectivity across the world, satellite networks will play an indispensable role in the deployment of global networks. The multimedia satellites are the new generation communication satellites that will use on board processing and switching to provide full 2-way services to and from earth stations comparable in size to today's direct to home television receiving dish. The key technologies that make possible the new generation of multimedia satellites are a) multiple small high gain spot beam antennas, b) on board processing and switching and c) intersatellite links. The multimedia satellite communication systems are being developed to provide global, broadband communication services, including high data rate Internet access, private intranets and TV broadcasting. Some of these systems will offer data communication services at Ka band and digital TV broadcasting at Ku band. These systems are intended to interoperate with other technologies such as Ka-band satellites using the 20 GHz to 30 GHz frequency spectrum that can reach user terminals across most of the populated world. In the past three years, interest in Ka-band satellites has dramatically increased, with over 450 satellite applications filed with the ITU.

However, satellite systems have several inherent constraints. The resources of the satellite communication network, especially the satellite and the earth station are expensive and typically have low redundancy. These must be robust and be used efficiently.

To illustrate the different segments of a typical satellite network, Figure 7 shows a satellite-ATM network represented by a ground segment, a space segment, and a network control center. The ground segment consists of ATM networks that may be further connected to other legacy networks. The network control center (NCC) performs various management and resource allocation functions for the satellite media. Inter-satellite links (ISL) in the space segment provide seamless global connectivity to the satellite constellation. The network allows the transmission of ATM cells over satellite, multiplexes and demultiplexes ATM cell streams from uplinks and downlinks, and maintains the QoS objectives of the various connection types. The satellite-ATM network also includes a satellite-ATM interface device connecting the ATM network to the satellite system. The interface device transports ATM cells over the frame based satellite network, and demultiplexes ATM cells from the satellite frames. The device typically uses a DAMA technique to obtain media access to the satellite physical layer. The interface unit is also responsible for forward error correction techniques to reduce the error rates of the satellite link. The unit must maintain ATM quality of service parameters at the entrance to the satellite network. As a result, it translates the ATM QoS requirements into corresponding requirements for the satellite network. This interface is thus responsible for resource allocation, error control, and traffic control.

This architectural model presents several design options for the satellite and ground network segments. These options include:

1) On-board processing with ground ATM switching;

2) On-board processing and ATM switching.

More than half of the planned Ka-band satellite networks propose to use on-board ATM-like fast packet switching. In a simple satellite model without on-board processing or switching, minimal on-board buffering is required. However, if on-board processing is performed, then on-board buffering is needed to achieve the multiplexing gains provided by ATM. On-board processing can be used for resource allocation and medium access control (MAC). MAC options include TDMA, FDMA, and CDMA and can use contention based, reservation based, or fixed medium access control. Demand Assignment Multiple Access (DAMA) can be used with any of the MAC options. If on-board processing is not performed, DAMA must be controlled by the NCC. On-board DAMA decreases the response time of the medium access policy by half because link access requests need not travel to the NCC on the ground any more. In addition to medium access control, ABR explicit rate allocation or EFCI control, and UBR/GFR buffer management can also be performed on-board the satellite. On-board switching may be used for efficient use of the network by implementing adaptive routing/switching algorithms. Trade-offs must be made with respect to the complexity, power and weight requirements for providing on-board buffering, switching and processing features to the satellite network. In addition, on-board buffering and switching will introduce some additional delays within the space segment of the network. For fast packet or cell-switched satellite networks, the switching delay is negligible compared to the propagation delay, but the buffering delay can be significant.

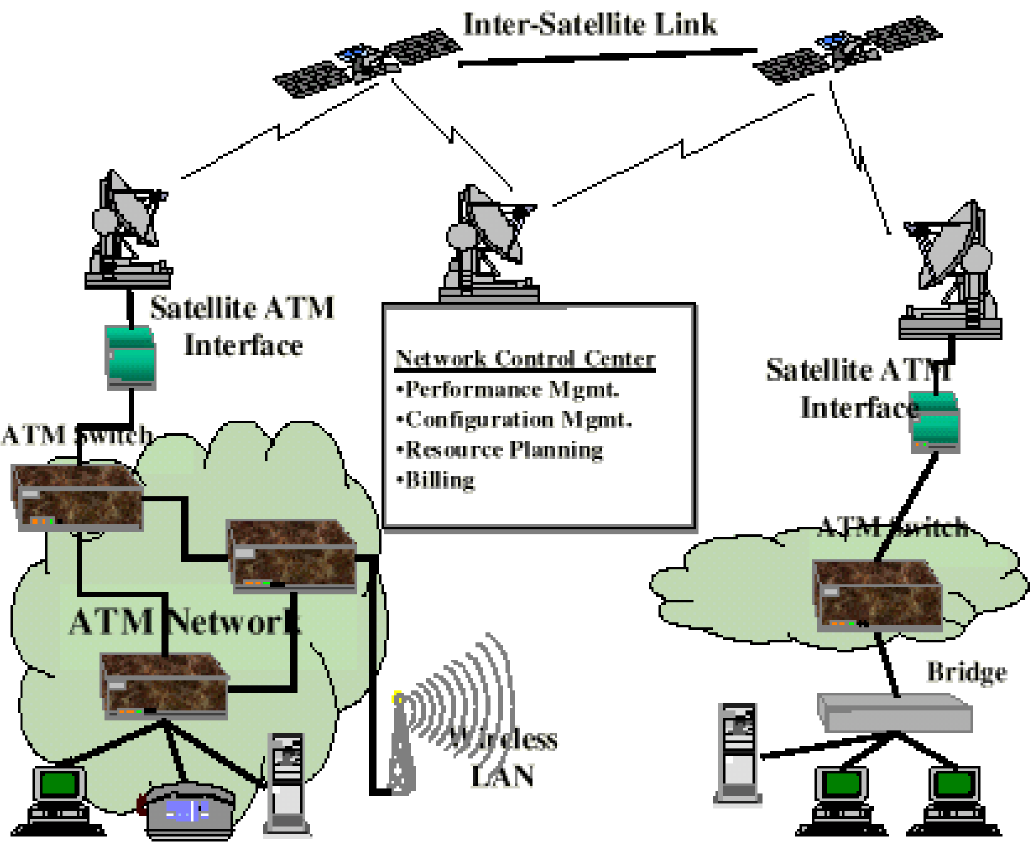


Figure 7: Satellite ATM Network Model

6.3.2.3 Infrastructure Mobility

To understand the motivation for considering infrastructure mobility as an essential component of ATM networking we note first the significant penetration of ATM in today's fixed backbone infrastructure. An ATM backbone provides the opportunity for seamless, end-to-end networking, with efficient use of bandwidth and QoS for providing both synchronous and asynchronous services. A natural extension of this scenario involves the introduction of mobility into the fixed infrastructure. In this picture a hybrid of fixed and mobile segments (each mobile segment being one or more ATM switches clumped together) are linked via radio links, providing essentially a mobile ATM infrastructure. We note that the mobility of the end-user with respect to the switch is not the issue here, rather the issue is mobility of the switch (or groups of switches) itself.

A scenario compatible with this picture is that of mobile platforms with multiple users on board such as airplanes, ships, trains, etc. An airplane may be wired with an on-board ATM network servicing several hundred passengers who are fixed with respect to the plane. The airplane constitutes the mobile segment and the ground infrastructure is the fixed segment. The fixed and mobile segments are connected with each other via satellite links forming a seamless mobile infrastructure that supports seamless in-flight air-to-ground communication. An example of infrastructure mobility involving airplanes is shown in Figure 8 below.

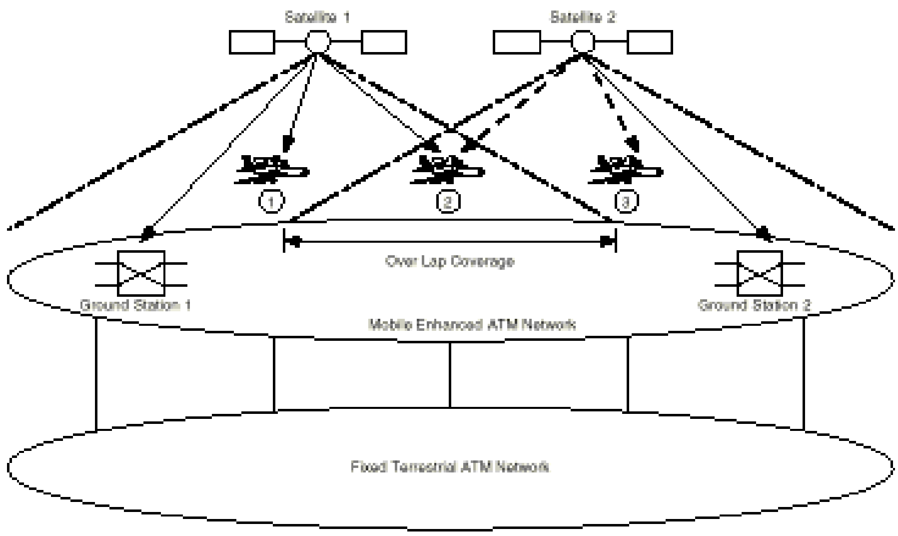


Figure 8: Infrastructure Mobile Network Example

6.4 IETF

6.4.1 Overview

The Internet Engineering Task Force (IETF) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual.

The actual technical work of the IETF is done in its working groups, which are organized by topic into several areas (e.g., routing, transport, security, etc.). Much of the work is handled via mailing lists. The IETF holds meetings three times per year.

The IETF working groups are grouped into areas, and managed by Area Directors, or ADs. The ADs are members of the Internet Engineering Steering Group (IESG). Providing architectural oversight is the Internet Architecture Board, (IAB). The IAB also adjudicates appeals when someone complains that the IESG has failed. The IAB and IESG are chartered by the Internet Society (ISOC) for these purposes. The General Area Director also serves as the chair of the IESG and of the IETF, and is an ex-officio member of the IAB.

The Internet Assigned Numbers Authority (IANA) is the central coordinator for the assignment of unique parameter values for Internet protocols. The IANA is chartered by the Internet Society (ISOC) to act as the clearinghouse to assign and coordinate the use of numerous Internet protocol parameters.

Active IETF Working Groups:

- Table of Contents;
- Applications Area;
- General Area;
- Internet Area;
- Operations and Management Area;
- Routing Area;
- Security Area;
- Transport Area;
- User Services Area.

Specific Working Group areas are listed in Annex D.

The IETF group most concerned with satellite matters is in the Transport area and is called "TCP over satellite working group" or TCPSAT, described in the next subclause.

6.4.2 TCP over Satellite Working Group, TCPSAT

Satellites are being used to extend the Global Internet geographically and will be more ubiquitous in the next decade with the deployment of several proposed systems capable of providing greater than T1 access to individual users anywhere in the world. However satellite links have a unique combination of characteristics that can affect the throughput of TCP traffic. Because of the high bandwidth-delay product, slow start and congestion control algorithms behave much differently when the path includes a satellite link than exclusively terrestrial ones.

The work of the TCPSAT group has so far resulted in two major outputs:

1) As of October 1999, the latest Internet-Draft is available from the on-line Internet-Drafts directories, entitled "Ongoing TCP Research Related to Satellites" [35].

   This document outlines possible TCP enhancements that may allow TCP to better utilize the available bandwidth provided by networks containing satellite channels. The algorithms and mechanisms outlined have not been judged to be mature enough to be recommended by the IETF as safe for the global Internet. The goal of the document is to educate researchers as to the current work and progress being done in TCP research related to satellite networks.

   A URL for the Internet-Draft is:

   http://www.ietf.org/internet-drafts/draft-ietf-tcpsat-res-issues-12.txt

2) In addition, an RFC 2488 [36], "Enhancing TCP Over Satellite Channels using Standard Mechanisms" is available since January 1999.

   The Transmission Control Protocol (TCP) provides reliable delivery of data across any network path, including network paths containing satellite channels. While TCP works over satellite channels there are several IETF standardized mechanisms that enable TCP to more effectively utilize the available capacity of the network path. The present document outlines some of these TCP mitigations. At this time, all mitigations discussed in the document are IETF standards track mechanisms (or are compliant with IETF standards).

One important factor to be taken into account is the incompatibility of the emerging IPSec security standard, which provides end-to-end security, with any of the proposed mitigations that require intermediate routers to inspect contents of the TCP header. This includes the class of so-called spoofing protocols.

6.4.3 Performance Implications of Link Characteristics (PILC)

Description of Working Group:

The Internet network-layer and transport-layer protocols are designed to accommodate a very wide range of networking technologies and characteristics. Nevertheless, experience has shown that the particular properties of different network links can have a significant impact on the performance of Internet protocols operating over those links, and on the performance of connections along paths that include such links. This is especially of concern to the wireless networking community.

The PILC working group is producing several BCP/Informational documents. The first document discusses considerations for link-layer designers from the perspective of best supporting existing IETF protocols. The next document discusses the capabilities, limitations and pitfalls of "performance enhancing proxies" (PEPs), i.e. active network elements that modify or splice end-to-end flows in an attempt to enhance the performance they attain in the face of particular link characteristics. The remaining documents discuss either the impact and mitigations for problematic link-layer characteristics (or group of closely related characteristics), or provide overviews of which other PILC documents apply to particular problem domains.

As one of its first work items, the WG reviewed an existing Internet Draft on considerations for "long, thin" networks, one of the salient characteristics of terrestrial wireless links. This will be published as a preliminary assessment of the problem domain, to be refined by later PILC documents.

All documents identify which of their considerations remain research topics versus which are established as advanced development. Research topics are explicitly flagged as not part of any recommendations. All documents also identify any security implications associated with their considerations.

The working group also serves as a forum for discussing possible modifications to IETF protocols to improve performance in environments with problematic link characteristics - however, not to the detriment of performance and stability in the general Internet, nor to undermine existing security models.

It is incumbent upon the chairs to ensure that the WG maintains good communications with other groups interested in related technology issues, such as wireless forums.

Internet-Drafts:

- End-to-end Performance Implications of Slow Links;
- End-to-end Performance Implications of Links with Errors;
- Performance Enhancing Proxies;
- Advice for Internet Subnetwork Designers;
- TCP Performance Implications of Network Asymmetry.

6.4.4 UniDirectional Link Routing (UDLR)

Description of Working Group:

High bandwidth, unidirectional transmission to low-cost, receiver-only hardware is becoming an emerging network fabric, e.g. broadcast satellite links or some cable links.

Two cases for unidirectional links support may be envisaged:

1) unidirectional links on top of bidirectional underlying network (wired Internet);
2) bidirectional islands connected via unidirectional links.

In both cases, the integration of unidirectional links may require changes to the routing protocols in order to preserve dynamic routing across these links. A short-term solution (i.e. to solve the first case) is to adopt current protocols with possible modifications. A long-term solution (i.e. for the second case) is to propose, design and implement protocols that remove assumed link symmetry (e.g. by supporting 2-way metrics).

There have been several proposed approaches for the short-term case. The first is based on the modification of the common routing protocols (RIP, OSPF, DVMRP) in order to support unidirectional links. The second is to add a layer between the network interface and the routing software to emulate bi-directional links through tunnels.

The purpose of the UDLR Working Group, therefore, is to study these approaches and suggest a short- term solution to provide dynamic routing (including multicast) in the presence of unidirectional links.

Internet Drafts:

- A Link Layer Tunnelling Mechanism for Unidirectional Links.

6.5 ISO/IEC JTC1

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for world-wide standardization. National Bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organizations to deal with particular fields of technical activity.

ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, government and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a Joint Technical Committee 1: ISO/IEC JTC 1, which is active in many areas including GII.

6.6 Telemanagement Forum

The TeleManagement Forum is a global consortium of over 200 member organizations that is concerned with telecommunications management and the development of "standardized" Management System solutions. It was established in 1988 as the OSI/Network Management Forum and after a change of name to the Network Management Forum (NMF) it has now become the TeleManagement Forum (TMF), a name that is intended to more clearly reflect today's telecommunications environment.

The TeleManagement Forum's focus is the development of TMN based standards. It does not want to produce additional standards itself but aims at making the existing ones workable. It has adopted a holistic approach and has established a context in which the individual parts comprising telecommunications management can be related to each other. It has recently launched an initiative, SMART TMN&tm, which is defining a pragmatic approach to achieving end-to-end telecom operations automation for service providers competing in a rapidly changing market.

Main Differences compared to ITU's TMN

The TeleManagement Forum is committed to TMN standards and is providing support to make them implementable. While adhering to the TMN standards, it has provided the glue and the context for implementing interoperable solutions for these standards. It has adopted a pragmatic approach based on a business model and so fills in some of the gaps that are missing in the TMN standards in order to aid developers implementing TMN systems. It is aware of the market place and trends in the telecommunications industry and has looked beyond current TMN standards by including technologies, such as CORBA and Java, in its solutions that are commercially available but which have not yet been endorsed by the TMN standards process. It provides an enterprise, or business, model and context that is more relevant to the situation today than the implicit TMN one.

The TeleManagement Forum work is complementary to TMN, as it has based its work on the TMN standards in order to provide systems that can be implemented.

6.7 TINA-C

The Telecommunications Information Networking Architecture (TINA) Consortium is an international collaboration aiming at defining and validating an open architecture for telecommunications systems for the broadband, multimedia, and information era. The architecture is based on distributed computing, object orientation, and other concepts and standards from the telecommunications and computing industries.

The TINA architecture addresses the needs of traditional voice-based services, future interactive multimedia services, information services, and operations and management type services, and will provide the flexibility to operate services over a wide variety of technologies. This vision implies a software architecture that offers reusable software components, supports network-wide software interoperability, eases service construction, testing, deployment and operation, and hides from the service designer the heterogeneity of the underlying technologies and the complexity introduced by distribution.

The intention is to make use of advances in distributed computing (e.g., Open Distributed Processing (ODP) and Distributed Communication Environment (DCE)), and in object-oriented analysis and design, to drastically improve interoperability, re-use of software and specifications, and flexible placement of software on computing platforms/nodes. In addition, the consistent application of software principles to both services and management software is a primary goal. The TINA architecture is furthermore ensuring that a multi-supplier/provider market for telecommunications services and management systems will be possible.

Collaborations with other bodies

TINA-C over the years has been active in developing relationships with many Standardization Bodies and Industry Fora. This has promoted sharing research results, orienting the marketplace towards common solutions and reducing duplication of efforts. Another benefit is to increase TINA awareness world-wide.

Currently, the most active collaborations and liaisons are:

ITU-T

ITU-T SG10 approved in February 1999 the Object Definition Language ITU-T Recommendation Z.130 [70], based on TINA-C ODL.

ITU-T SG11 (Q1), there is ongoing effort supported by TINA-C member companies towards the standardization of TINA-C Service Architecture, Ret specification and Business Model.

ITU-T SG11 (Q6) produced a Supplement (TRQ.2001) that includes TINA's "session" definitions and business model.

OMG

The Object Management Group mission is to create a component-based software marketplace by hastening the introduction of standardized object software.

TINA-C has reciprocal membership arrangements with the OMG.

TINA-C has been instrumental in founding OMG's Telecom Domain Task Force.

The main areas of TINA-C technology adoption are within the Telecom Domain Task Force. Current activities are related to answers to Service Access and Subscription RFP, Open Services Marketplace RFI and Telecom Management Work Areas RFI. Further TINA results are given as input to Electronic Commerce and Distributed Processing Environment.

TM Forum

TeleManagement Forum (TMF) is one of the largest organizations focusing on the management of telecommunication systems and services. Experts from TINA-C and TMF have collaborated together to identify common technical problems, and have authored a collaboration work plan.

The collaboration work plan includes work items such as mapping between TINA business model and TMF business process, which is pioneered by ACTS FlowThru project, UML-based information modeling methodology, connection management and reference points, and IP control management issues.

A liaison agreement is planned between TINA-C and TMF.

URL: http://www.tinac.com

6.8 NASA

Relevant NASA standardization activities are mainly those undertaken by the NASA Glenn Research Center as one of the leading contributors to the IETF's TCPSAT group. (see subclause 6.4.2 above).

6.9 ESA

ESA/ESTEC is initiating work toward the development of a set of common air interface standards for OBP satellites. This work will be carried out by a group called the "Ad-hoc Group to promote standardization of terminals for regenerative satellite multimedia systems (RSAT)", whose (draft) Terms of Reference are:

Mission Statement

To promote standardization of terminals for regenerative satellite multimedia systems through the fostering of commonalities in the Satellite Access Terminal (SAT).

Objective

The work of the first Ad-hoc Group resulted in a open recommendation which today serves as the basis for a draft ETSI Standard by the Return Channel for Satellite group (RCS) of the Digital Video Broadcast (DVB) Project.

This second Ad-hoc Group will extend that work to include systems using regenerative satellites. The activities will cover both geostationary and non-geostationary satellites in the FSS and BSS.

The scope of the work is to develop open recommendations that could form the basis for standards for SATs to be designed to work with a variety of regenerative multimedia satellite systems.

The outcome of the Ad-hoc Group work will be publicly available, and will be introduced to appropriate bodies in order to produce standards.

The activities should be completed within seven months from the Kick-off.

Programme of work

The Ad-hoc Group will address the following issues:

- Agree on a service scenario including performance requirements.
- Agree on a set of system architectures to be treated (Constellations, Orbits, Frequency bands).
- Identify commonalities between system architectures.
- Identify the interfaces for which standards may bring benefit.
- Produce suitable technical requirements for the interfaces identified.
- Examine the current draft of the DVB-RCS standard and determine if it can be made applicable and if so what enhancements would be required to satisfy the identified requirements.
- Examine other appropriate standards and determine if any can be made applicable and if so what enhancements would be required to satisfy the identified requirements.
- Consult as appropriate external bodies.

Publish the outcome of the Ad-hoc Group work and introduce it to appropriate bodies in order to produce standards.

Group Membership

Members of the Ad-hoc Group are organizations that are European satellite system designers or prospective or established satellite operators with the interest of promoting the Group's activities. The European Space Agency provides the secretariat services. European Commission and ETSI are invited as observers. The Group may accept new members and observers.

Working procedure

Agreements of the Group shall be made by consensus among members.

Any external action of the group (e.g. distribution of working papers, reports, communications to external entities, etc.) shall be based on consensus.

Input documents, contributions or any other information provided by members or observers shall not be disclosed outside the Group.

Group Deliverables

The Group will issue working papers, reports and guidelines in the name of the Members. Once approved by the members, the documents will be made available to the appropriate external bodies.

IPR

Members and observers have the obligation to inform the Group of essential IPRs they become aware of.

6.10 The DVB Project

The Digital Video Broadcasting Project (DVB) includes more than 220 well-known organizations in more than 30 countries world-wide. Members include broadcasters, manufacturers, network operators and regulatory bodies, committed to designing a global family of standards for the delivery of digital television.

DVB-compliant digital broadcasting and reception equipment for professional, commercial and consumer applications is widely available on the market, and numerous broadcast services using DVB standards are now operational, in Europe, North and South America, Africa, Asia, and Australasia.

The DVB Project has generated international standards for all programme delivery media: satellite, cable, terrestrial, microwave, MDS, CATV, SMATV. Equipment compliant to DVB standards dominates the marketplace and DVB transmissions are on the air over all five continents.

DVB systems deliver a flexible range of picture qualities, multi-channel sound, multimedia data, and the entire configuration can be tailored to meet the demands of any service provider and market.

The DVB family of standards includes:

- DVB-S a satellite system that can be used with any transponder, current or planned;
- DVB-C a matching cable system to suit the characteristics of all cable networks;
- DVB-T a digital terrestrial system;
- DVB-MC/S a microwave multipoint video distribution systems;
- DVB-SI a service information system, enabling the user to navigate through the DVB environment;
- DVB-CA a common scrambling system;
- DVB-CI a common interface for conditional access and other uses.

Once finalized, the DVB standards are published and maintained by ETSI.

Relevant ongoing projects are the DVB-RCS and MHP activities, described below.

6.10.1 DVB-RCS

The DVB project is in the process of defining a return channel standard for bent-pipe satellites, and will be submitted to ETSI for public enquiry for the purpose of publication as a DVB standard. This will be a voluntary standard under the R&TTE directive 1999/05/EC [22]. The work started as an ad-hoc group at ESA/ESTEC. Further details are presented in Annex G.

The following information was given to ETSI TC SES in June 1999:

- DVB-RCS is the DVB Working group preparing a specification proposal for approval by the technical module concerning RCST's (Return Channel via Satellite Terminals) called Terminals in the remainder of this subclause.
- The basis for the specification work is the requirement by the DVB commercial module. The requirement explicitly states the independence of the specification from the used frequencies (i.e. frequency bands).
- The specification should allow production of interchangeable Terminals.
- The specification will be separated into a specification part and a recommendation part.
- The specification part contains all mandatory requirements of the specification, whereas the recommendation part contains non-mandatory implementation recommendations.
- The specification is mainly concerned with the definition of the Air Interface. In the first step it defines systems with star topology. For such star systems it is based on the DVB-S specification for the forward channel and an MF-TDMA return channel. In a later step, mesh systems should also be defined.
- There will at least be two profiles for the return channel, one profile will be Reed Solomon based, the other will probably be Turbo code based.
- The first profile will probably be available for approval by the technical module in 1Q 2000.

The following list illustrates what issues are involved in the DVB-RCS specification, and their reference model.

Reference Models

- Protocol Stack Model
- System Model
- Reference Model of the Satellite Interactive Network

Return Link Base-band Physical Layer Specification and Multiple Access Definition

- Synchronization, timing control, clock, carrier and burst synchronization
- Traffic, Synchronization and acquisition burst formats
- Bit numbering and interpretation, transmission order
- Energy dispersal
- Coding (CRC error detection, outer and inner coding, convolutional or turbo)
- Modulation (bit to QPSK, shaping, modulation, power control, guard time)
- Capacity Request Mechanisms
- Data unit labelling method
- Multiple Access (MF-TDMA, Frame and Super-frame formats)

Protocol and Sequences of Operations with the NCC and the Gateways

- Initial Synchronization
- Network Entry (Logon Procedure, Acquisition Procedure, Synchronization Maintenance Procedures, Signalling Messages)
- Log-off Procedure (General, Normal, Abnormal)

Service support

- Capacity Categories (Continuous, Dynamic, Free) Assignment
- Queuing Strategy
- Requesting Strategy
- Assignment/Allocation Processing
- Access protocol time sequence
- Process and event synchronization

Network management

- Protocol stack (IP Only or ATM)
- Mesh networks
- Addressing
- Forward Link Signalling
- Return Link Signalling

6.10.2 DVB Multimedia Home Platform

In 1997 the DVB Project expanded its scope to the Multimedia Home Platform (MHP) comprising the home terminal (set top box, TV, PC), its peripherals and the in-home digital network. From a service and application point of view enhanced broadcasting, interactive services and Internet access will be covered. The intention is to develop standards and/or guidelines to create a basis for an unfragmented horizontal market in Europe with full competition in the various layers of the business (value) chain. A crucial role will be played by the Application Programming Interface (API). A comprehensive set of user and market based commercial requirements has been approved and are now used to produce specifications.

The work is being carried out in two DVB working groups:

- A commercially oriented group, DVB-MHP, to define the user and market requirements for enhanced and interactive broadcasting in the local cluster (including Internet access).
- A technical group, DVB-TAM (Technical issues Associated with MHP), to work on the specification of the DVB Application Programming Interface (API).

6.10.2.1 Basic requirements for the MHP and its API

According to DVB's market-led discipline, any work on MHP requirements should start from real applications and business needs. Following this approach two basic groups of requirements were identified:

- basic requirements; and
- application oriented requirements.

The MHP and its API have to fulfil a variety of basic user and market requirements. These requirements have been identified in order to deliver bridging between:

- the hardware and the software worlds;
- the consumer and computer worlds;
- the existing and future business environments,

thus providing a harmonious evolutionary path from today's fragmented vertical markets to future unfragmented horizontal markets.

The following is a selection of key elements from the basic requirements list.

Interoperability - The MHP specification including the API shall support a full range of services and low to high functionality implementations and shall be network and hardware-platform independent. This neutral approach will prevent lock-in to any proprietary format or single vendor etc. and allow cost-effective products to be produced using technologies from freely competing vendors.

Evolution, scalability, extensibility and backward compatibility - The MHP solution shall be designed to be extensible towards future functionality. Scalability and backward compatibility shall be maintained.

Scalability means enabling low-end and high-end terminal devices (e.g. simple set top boxes and PC theatres) as well as the whole platform to serve low- and high-end user requirements, respectively.

Enhancements to future MHP products in terms of hardware and software capabilities shall be backward-compatible with previous generation MHP solutions, so that future MHP applications do not cause older MHPs to crash and that older MHPs are able to provide some level of user-experience of the broadcast applications. Existing applications must be able to run on new generation devices.

The level of the user experience shall be scaled down according to the hardware capability. Capabilities shall be provided by the API.

Modularity - The MHP solution shall be modular, allowing a number of distinct product levels offering trade-offs between the scope of services enabled by the MHPs functionality and the complexity (cost) associated with its implementation.

Stability - Consumers shall have confidence in the marketplace and the perceived longevity of MHP products. The basic MHP solution shall be stable over time, with well-defined extension procedures for future enhancements.

Migration - A possible migration path shall be defined to evolve from the current situation based on proprietary systems towards the future common MHP environment, including the API.

Based on open standards - The MHP system shall be based on existing standards, if available. Existing solutions available on the market or any other solution that may seem appropriate should also be considered under the condition that each solution feature is disclosed and properly documented. The MHP system shall be fully published and accessible through a recognized standards body.

Upgradability/Downloadability - The definition of the MHP system shall not prevent firmware upgrades. The MHP shall be able to be upgraded through the network in an environment where several receiver implementations co-exist.

Controlled development path - The evolution of the MHP system over time shall be maintained by consensus through industry-wide bodies (e.g. under the control of both service providers and manufacturers).

Simplified and cost-controlled operation - Applications and data shall be transmitted in a bandwidth-efficient format that allows applications to be transmitted only once, therefore avoiding unnecessary simulcasting. In order to do this, MHP solutions shall be based on the separation of data from the applications. This shall enable different applications to use the same data. For an EPG as a typical application, this means use of the DVB service information (SI) data to the largest extent possible without the need to transmit this information as part of the EPG application.

Generic API - A single generic API shall be the target to be used in parallel to existing proprietary APIs. It shall:

- allow to support real-time streaming applications, downloaded and locally stored applications;
- allow any broadcaster or any application provider to write and supply applications;
- allow the look and feel of all applications to be under the control of the broadcaster and/or application provider;
- provide access to the DVB-SI data;
- allow any manufacturer to implement the API in its own way.

API candidates currently under consideration include:

- MHEG-5/Java;
- Mediahighway +;
- JavaTV;
- HTML/Java.

The API will have to be independent of the Conditional Access (CA) scheme but will support compatibility in a multi-CA environment.

6.10.2.2 Application-oriented requirements

Based on short- and medium-term business plans of broadcasters and service providers and an associated roadmap of services/applications, three main areas of applications have been identified:

- enhanced broadcasting with local interactivity;
- interactive broadcasting using a return channel;
- Internet access.

Commercial requirements have been derived for each of these areas. The multimedia home platform and its API must support these requirements. In addition benchmark applications have been used to define typical requirements for the application areas under consideration.

6.11 DAVIC

The Digital Audio-Visual Council (DAVIC) is a non-profit Association registered in Geneva. Its purpose is to advance the success of emerging digital audio-visual applications and services, initially of the broadcast and interactive type. This should be achieved by facilitating the timely availability of internationally agreed specifications of open interfaces and protocols that maximize interoperability across countries and applications or services. The DAVIC concept of Digital Audio-Visual Applications and Services includes all applications and services in which there is a significant digital audio-video component.

The goals of DAVIC were to identify, select, augment, develop and obtain the endorsement by formal standards bodies of specifications of interfaces, protocols and architectures of digital audio-visual applications and services. These are realized through the open international collaboration of all players in the field. DAVIC intends to make the results of such activities available to all interested parties on reasonable terms applied uniformly and openly and to contribute the results of its activities to appropriate formal standards bodies.

DAVIC has now completed its work.

The major task of DAVIC was to create complete sets of specifications using emerging digital audio-visual technologies. Typical services that could be the basis of such audio-visual specifications were defined, ranging from services-on-demand to enhanced broadcasting. Complete systems have been designed that enable these services.

The main achievements of DAVIC are:

- DAVIC 1.0 (published in January 1996) selected a set of tools to support basic applications such as TV distribution, near video on demand, video on demand and simple forms of tele-shopping.
- DAVIC 1.1 (September 1996) added tools to support basic "Internet Compatibility", the addition of microwave broadcast networks (MMDS and LMDS), set-top units that are network-independent and set-top units that can behave as "virtual machines".
- DAVIC 1.2 (December 1996) added tools to enable TV networks to provide Internet services at high speed to TV and PC users, as well as defining HDTV formats and systems for conditional access.
- DAVIC 1.3 (September 1997) added comprehensive Service and Network Management, multiple broadcast servers, mobile reception, scaleable audio, content and meta-data packaging, Java APIs for DVB service information and a new concept of "Contours" - the first instances are Enhanced Digital Broadcast and Interactive Digital Broadcast.
- DAVIC 1.4 (June 98) added basic security tools, MHEG-5 resident programs to access SI, Home network architecture and Home Network Technologies for Home Access Network (HAN) and Home LAN (HLN).

The final DAVIC release, version 1.5, (June 99) added the description of DAVIC Intranet for QoS management of audio-visual services over IP and DAVIC TV-anytime/anywhere for integration of digital TV and Internet Content.

The DAVIC specification has been accepted by ISO/IEC JTC 1 as an International Standard ISO/IEC 16500 [47].

6.12 FSAN

In 1995 a group of telecommunication network operators and equipment suppliers established an international initiative called "Full Services Access Networks (FSAN)". The objective was to create the conditions for the development and introduction of access systems supporting a full range of narrow-band and broadband services through the definition of a basic set of common requirements. These networks should be able to deliver existing and future services, in some cases not yet completely identified.

FSAN consists of 20 Telcos working, together with their strategic equipment suppliers, to agree upon a common broadband access system for the provision of both broadband and narrowband services. This common broadband access system is documented in the FSAN requirements specification and is a public document, with the contents available to relevant standardization bodies.

Participants in FSAN are:

i) Telcos

Bell Canada, Bell South, BT, DT, Dutch PTT, Telecom Eireann, FT, GTE, Korea Telecom, NTT, SBC, SingTel, Swisscom, Telefonica, Telia, Telstra, Telecom Italia, Bezeq, Chunghwa Telecom, and US West.

ii) Suppliers

Alcatel, Ascom, BBT, Bosch, Ericsson, Fujitsu, Italtel, Lucent, NEC, Nortel, Siemens, SAT.

Six work groups were established, responsible for the following areas:

- Systems Engineering and Architecture;
- Optical Access Networks;
- Home Networks and Network Termination;
- Operation Administration and Maintenance;
- VDSL;
- Component Technology.

After three years of successful collaborative development a common requirement specification was issued in June 99 for FSAN architectures. The FSAN goals have not been to produce new standards but to build on the resources available from the ATM Forum, ITU and ETSI standards, e.g. the FSAN approach follows the principles stated in ITU-T Recommendation G.902 [24] for generic access networks.

The FSAN architecture and application to BSM systems is presented in more detail in subclause 10.4.2 of the present document.

6.13 Wireless Standards

6.13.1 Bluetooth

URL: http://www.bluetooth.com

The technology is an open specification for wireless communication of data and voice. It is based on a low-cost short-range radio link, built into a 9 x 9 mm microchip, facilitating protected ad hoc connections for stationary and mobile communication environments.

Bluetooth technology allows for the replacement of the many proprietary cables that connect one device to another with one universal short-range radio link. For instance, Bluetooth radio technology built into both the cellular telephone and the laptop would replace the cable used today to connect a laptop to a cellular telephone. Printers, PDA's, desktops, fax machines, keyboards, joysticks and virtually any other digital device can be part of the Bluetooth system. But beyond untethering devices by replacing the cables, Bluetooth radio technology provides a universal bridge to existing data networks, a peripheral interface, and a mechanism to form small private ad hoc groupings of connected devices away from fixed network infrastructures. Designed to operate in a noisy radio frequency environment, the Bluetooth radio uses a fast acknowledgement and frequency hopping scheme to make the link robust. Bluetooth radio modules avoid interference from other signals by hopping to a new frequency after transmitting or receiving a packet. Compared with other systems operating in the same frequency band, the Bluetooth radio typically hops faster and uses shorter packets. This makes the Bluetooth radio more robust than other systems. Short packages and fast hopping also limit the impact of domestic and professional microwave ovens. Use of Forward Error Correction (FEC) limits the impact of random noise on long-distance links. The encoding is optimized for an uncoordinated environment.

Bluetooth radios operate in the unlicensed ISM band at 2,4 GHz. A frequency hop transceiver is applied to combat interference and fading. A shaped, binary FM modulation is applied to minimize transceiver complexity. The gross data rate is 1 Mb/s. A Time-Division Duplex scheme is used for full-duplex transmission.

The Bluetooth baseband protocol is a combination of circuit and packet switching. Slots can be reserved for synchronous packets. Each packet is transmitted in a different hop frequency. A packet nominally covers a single slot, but can be extended to cover up to five slots. Bluetooth can support an asynchronous data channel, up to three simultaneous synchronous voice channels, or a channel that simultaneously supports asynchronous data and synchronous voice. Each voice channel supports 64 kb/s synchronous (voice) link. The asynchronous channel can support an asymmetric link of maximally 721 kb/s in either direction while permitting 57,6 kb/s in the return direction, or a 432,6 kb/s symmetric link.

The different functions in the Bluetooth system are:

- a radio unit;
- a link control unit;
- link management;
- software functions.

6.13.2 Wireless Application Protocol, WAP

URL: http://www.wapforum.com/

The Wireless Application Protocol (WAP) is an open, global specification that enables mobile users with wireless devices to easily access and interact with information and services instantly.

The WAP Forum is the industry association that has developed the de-facto world standard for wireless information and telephony services on digital mobile phones and other wireless terminals.

WAP is designed to work with most wireless networks.

6.14 Mobile communications

6.14.1 UMTS Forum

URL: http://www.umts-forum.org

UMTS (Universal Mobile Telecommunications System) is one of the major new third generation mobile communications systems being developed within the framework which has been defined by the ITU and known as IMT-2000.

The subject of intense world-wide efforts on research and development throughout the last decade, UMTS has the support of many major telecommunications operators and manufacturers and represents a unique opportunity to create a mass market for highly personalized and user-friendly mobile access to tomorrow's "Information Society".

UMTS will deliver pictures, graphics, video communications and other wide-band information including voice and data, via fixed, wireless and satellite networks direct to people who may be on the move. UMTS will build on and extend the capability of today's mobile technologies (e.g. digital cellular and cordless) by providing increased capacity, data capability and a far greater range of services using an innovative radio access scheme and an enhanced, evolving core network.

The launch of UMTS services from the year 2002 will see the evolution of a new, "open" communications universe, with players from many sectors (including providers of information and entertainment services) coming together harmoniously to deliver new communications services, characterized by mobility and advanced multimedia capabilities. The successful deployment of UMTS requires new technologies, new partnerships and the addressing of many commercial and regulatory issues.

6.14.2 The GSM Association

URL: http://www.gsmworld.com

The GSM Association is the premier global body behind the world's leading wireless communications standard. It is responsible for the development, deployment and evolution of the GSM standard for digital wireless communications and for the promotion of the GSM platform.

Extending the boundaries of GSM

GSM is established as the global standard for mobile communications. As a technology, GSM continues to evolve, with high-bandwidth services becoming a reality for the current 2nd Generation technologies. The development path into the 3rd Generation is clearly mapped out and brings with it possibilities for new age data and multimedia applications.

The GSM network will evolve, with wireless, satellite and cordless systems offering greatly expanded services, including high speed, multimedia data services, in-built support for parallel usage of such services and seamless connection with the Internet and wire-line networks. This will see the convergence between various communications means and networks becoming a reality.

Global spectrum

In 1992 the International Telecommunication Union (ITU) identified specific frequency bands for IMT-2000. Similarly it is expected to identify additional spectrum to cater for the anticipated growth in broadband multimedia third generation services that will be in common use by the middle of the next decade.

The GSM Association believes that in addition to the existing GSM and IMT-2000 bands, extension bands totalling about 190 MHz will be required for 3rd Generation applications. Such additional frequency bands would ensure global spectrum for the mobile future.

A Powerful Force

The Association is already the focal point for 3rd Generation systems and operators, with a clear mandate and mission to manage all common and inter-operator issues - the first licensed 3rd Generation operators are already members of the Association. Many of the existing 2nd Generation operators are likely to evolve their networks to support 3rd Generation technology in the future. Collectively, the Association's members provide digital GSM services to over 200 million customers, globally. The Association is preparing to take a key role in the development of 3rd Generation systems and is well prepared to take on this challenge.

Cooperation with the 3GPP and the UMTS Forum

Through its membership in the 3rd Generation Partnership Program (3GPP), the global working organization responsible for producing the 3rd Generation technical specifications, it will ensure there are provisions for interoperability and compatibility between 3rd Generation Systems and existing GSM systems and services. From a consumer perspective, this integration of system and service profiles, and multi-mode terminals will mean world-wide roaming will be possible.

The GSM Association also works closely with the UMTS Forum, which focuses on spectrum availability, licensing issues, and long-term market surveys for 3rd Generation systems.

The 3GPP and UMTS Forum work together, addressing complementary tasks and issues.

7 Related Standardization in ETSI

7.1 TC SES

URL: http://www.etsi.org/ses/

SES stands for Satellite Earth Stations and Systems. Work within TC SES is carried out in working groups on:

- Harmonized Standard for Little LEO;

- Harmonization for TBRs;
- Ka-Band Earth Stations;
- GEO Mobile Radio Interface;
- Satellite Component of UMTS;
- European Co-operation for Space Standardization;
- Aeronautical Satellite Earth Stations.

It is expected that a WG for the development of a harmonized standard for Ku-band earth stations operating within non-geostationary satellite networks will be started in 2000.

7.1.1 Ka-Band Earth Stations

This WG produces European Norm and any other ETSI deliverables for earth stations operating to either geostationary or non-geostationary satellites in the Fixed Satellite Service (FSS)/Broadcast Satellite Service (BSS) 20/30 GHz band (Ka-band) for the protection of the spectrum and the orbital resources from unacceptable interference by taking into consideration the relevant ITU-R Recommendations for Region 1.

7.1.2 GEO Mobile Radio Interfaces (GMR)

GMR stands for GEO (Geostationary Earth Orbit) Mobile Radio interface, which is used for mobile satellite services (MSS) utilizing Geostationary satellite(s). The TC SES GMR Working Group is currently producing technical specifications for GEO MSS derived from the terrestrial digital cellular standard GSM and supporting access to GSM core networks. There are 2 families of similar, but not identical, specifications being developed. The first is based upon the Thuraya GEO system and is referred to as GMR-1, whilst the second, referred to as GMR-2, is based upon the ACeS GEO system.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM standard are necessary. Some GSM specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM specifications do not apply, while some GMR specifications have no corresponding GSM specification. Since GMR is derived from GSM, the organization of the GMR specifications closely follows that of GSM. It is anticipated that these specifications, which are based upon the GSM Phase 2 specifications, may in the future also address S-GPRS and perhaps S-EDGE. These higher data rates could thus enable advanced TDMA based MSS to deliver some terrestrial UMTS / IMT 2000 based services.

This Working Group's tasks are to:

- Prepare technical specifications (TSs) for two radio interfaces for Geostationary Earth orbit satellite access to the core network of GSM.
- Liaise with various SMG working groups on issues relating to the radio interface specifications.
- Prepare proposals for SMG work items relating to the radio interface specifications. For example proposals to add functionality to the SIM or the MAP.
- Liaise with TIA-TR34.1 on issues relating to these radio interface specifications.

This work shall adopt the co-operative procedure between ETSI TC SMG and ETSI TC SES as described in SMG Tdoc 251/98 (annex to SES33(98)22).

7.1.3 Satellite Component of UMTS (S-UMTS)

The working group covers the Satellite component of the Universal Mobile Telecommunication System (S-UMTS). It is the focal point in ETSI for liaising with the relevant bodies inside and outside ETSI on matters concerning the development of standards for S-UMTS.

Tasks are to:

- Produce Harmonized Standards for Mobile Earth Stations operating in the S-UMTS frequency bands.
- Produce Technical Specifications or any other ETSI deliverables to ensure the seamless integration of satellite component of UMTS enabling the satellite access network to directly inter-work with other UMTS networks. Therefore, it shall take full advantage of the ongoing standardization for the terrestrial component of UMTS by promoting use of a common Iu and Cu interface. In addition, development of open standards for radio interface shall be based on the UMTS Access Network architecture defining radio independent and radio dependent functions.
- Study compatibility of services defined for the terrestrial component with S-UMTS and to promote adoption of specific satellite services as applicable.
- As necessary liaise inside ETSI with the Technical Committees SMG, TMN, NA/SPS and with the ETSI Projects UMTS and TIPHON.
- As necessary liaise outside ETSI, in particular with: 3GPP, ITU-R TG8/1, ITU-T SG 11, ERC TG /1.

From the beginning the working group shall liaise with: 3GPP, ITU-R TG 8/1, ETSI SMG and ETSI UMTS.

7.1.4 ETSI SIT and SUT Standards

The relevant ETSI documents are:

1) EN 301 359 [16]: "Satellite Earth Stations and Systems (SES); Satellite Interactive Terminals (SIT) using satellites in geostationary orbit operating in the 11 GHz to 12 GHz (space-to-earth) and 29,5 GHz to 30,0 GHz (earth-to-space) frequency bands";
2) EN 301 358 [15]: "Satellite Earth Stations and Systems (SES); Satellite User Terminals (SUT) using satellites in geostationary orbit operating in the 19,7 GHz to 20,2 GHz (space-to-earth) and 29,5 GHz to 30 GHz (earth-to-space) frequency bands".
3) EN 301 360 [83]: "Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit in the 27,5 GHz to 29,5 GHz (earth to space) frequency band".

SIT/SUT aim at individual or collective use. SUT are used mainly for transmission and reception of data signals. SITs are used for reception of audio-visual signals as well as data and for providing a return channel for interactive services via satellite. Typically the received signal is digitally modulated as defined in the DVB-S standard EN 300 421 [9].

The two ENs should protect other users of the frequency spectrum, both satellite and terrestrial, from unacceptable interference. The requirements have been selected to ensure an adequate level of compatibility with other radio services.

Both ENs define the minimum specifications of the technical characteristics of SIT/SUT operating as part of a satellite network. The equipment considered comprises both the outdoor unit, usually composed of the antenna subsystem and associated up-converter, power amplifier and Low Noise Block (LNB) down-converter, and the indoor unit, usually composed of receive and transmit logic as well as the modulator, including cables between these two units.

SIT/SUT common characteristics:

- transmit through geostationary satellites with spacing down to 2° away from any other geostationary satellite operating in the same frequency band and covering the same area;
- linear or circular polarization is used for transmission or reception;
- received signals may be analogue and/or digital;
- transmitted signals are always of digital nature;
- antenna diameter does not exceed 1,8 m, or equivalent corresponding aperture;
- designed for unattended operations;
- transmission is in the frequency band allocated to FSS on a primary basis from 29,5 GHz to 30,0 GHz.

SIT only characteristics (EN 301 359 [16]):

- SIT reception is in the Fixed Satellite Service (FSS) frequency ranges from 10,70 GHz to 11,70 GHz and from 12,50 GHz to 12,75 GHz as well as the Broadcast Satellite Service (BSS) frequency range from 11,70 GHz to 12,50 GHz.

SUT only characteristics (EN 301 358 [15]):

- SUT reception is in the frequency band allocated to the Fixed Satellite Service (FSS) on a primary basis from 19,7 GHz to 20,2 GHz.

These standards are now replaced by EN 301 459 [17], "Satellite Earth Stations and Systems (SES); Harmonized EN for Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit in the 29,5 GHz to 30,0 GHz frequency bands covering essential requirements under article 3.2 of the R&TTE Directive".

7.2 TC SPAN

URL: http://www.etsi.org/span/

7.2.1 General

TC SPAN (Services and Protocols for Advanced Networks) is ETSI's core competence centre for fixed networks standardization including IP based networks. It is responsible for all aspects of standardization for present and future converged networks including mobility aspects within fixed networks, using existing and emerging technologies, in line with, and driven by, the commercial objectives of the ETSI membership. This will be accomplished in close co-operation with other ETSI Technical Bodies and external standardization activities.

7.2.2 Scope

SPAN Core Competence

Definition of general network and service aspects for all existing and new wireline access and core networks. Definition of information transport capabilities, signalling requirements, protocol design and associated test specifications. Standardization may also be based on requirements from other Technical Bodies or external bodies. Matters of consistency between public and corporate networks and between fixed and mobile networks including ensuring that standards take account of security and regulatory requirements.

These activities cover both circuit- and packet-switched networks including IP and ATM technologies.

Core competence of SPAN Working Groups

- SPAN Task Force: Co-ordination of ETSI members inputs to ITU-T SG2, SG11 and SG13.
- SPAN1 (formerly SPS1) Competence centre for Network Signalling and Interconnection Protocol Standardization.
- SPAN2 (formerly NA2) Competence centre for Numbering, Addressing, Naming, Routeing and Service Description.
- SPAN3 (formerly SPS3) Competence centre for IN.
- SPAN5 (formerly SPS5) Competence centre for Digital Access Signalling Protocol Standardization.
- SPAN6 (formerly NA6) Competence centre for Network Intelligence and Universal Mobility.
- SPAN8 (formerly NA8) Competence centre for Network Architecture and evolution.
- SPAN9 (formerly SPS9) Competence centre for Access Networks and Service-Node Interfaces.

Activities

- Network architecture and its evolution.
- Service descriptions from the user perspective (excluding details of the human interface).
- Relations between services and network. Network capabilities for service provision and interoperability of services (e.g. for Service Provider Access).
- Functional capabilities and information flows needed to support services.
- Service interworking.
- Technical requirements on terminals and network components to support the implementation of services, including the support of mobile services.
- Switching functions and switching systems for public networks.
- Common channel signalling systems and signalling networks.
- Access Networks and protocols.
- Numbering, naming, addressing and routing.
- Interworking between different network types.
- Interworking of protocols and signalling systems.
- Charging capabilities of circuit and packet switched networks.
- Quality of Service and Network Performance.
- Resource management e.g. congestion control in IP based networks.
- Network intelligence.
- Universal Mobility, including global mobility aspects in fixed networks.
- Specification of protocols and the means of testing those protocols.
- Operational, maintenance and technical performance requirements of switching and signalling systems including testing requirements.
- Collaboration with other bodies (both inside and outside ETSI)
- Provides overall guidelines to other ETSI Technical Bodies to ensure a co-ordinated approach to the development of standards for public networks including requirements from private networks.
- Primary Technical Body for co-ordinating the position of ETSI for ITU-T Study Groups, in particular SGs 2, 11 and 13.
- Primary Technical Body for liaising and collaborating as appropriate with the ECTRA Project Teams - Numbering and TRIS.
- Liaising and collaborating with the European Union on (Open Network Provision) ONP and other relevant network issues.
- Co-ordinating ETSI positions on network aspects as appropriate in IETF in collaboration with ETSI Project TIPHON.
- Liaison with ETSI Project UMTS (Universal Mobile Telecommunications System).
- Maintaining good relation with other appropriate bodies including:
  - 3GGP, IETF, ITU-R, ATM Forum, EURESCOM, ETNO, ICANN and its Supporting Organizations.

7.3 EP TIPHON

URL: http://www.etsi.org/tiphon/

ETSI Project TIPHON, Telecommunications and Internet Protocol Harmonization Over Networks, is the core group within ETSI for competence in IP matters.

7.3.1 Terms of Reference

There is a growing market for real-time voice communication and related multimedia aspects over IP based networks. The objective of this project is to support a market for voice communication and related multimedia aspects in various network scenarios by the production of appropriate ETSI deliverables. Mobility and roaming within IP based networks and also with other networks shall be supported.

The objective in this area are global standards, therefore co-operation with relevant groupings in ITU-T and IETF is essential. The role of ETSI should be opinion leadership and building consensus between all major market players. Co-operation is also required with relevant fora, especially IMTC, MSAF and TIPIA. Priority will be placed on areas needing special emphasis to reach the general objectives or where ETSI members have specific interests, such as technical requirements originating from existing or planned European networks.

7.3.2 Scope

The project focuses on voice communication and related multimedia aspects as required to enable interoperability within IP based networks and with other types of networks. The ETSI Project TIPHON does not have a mandate for regulatory aspects, but regulatory requirements should be taken into account (e.g. requirements for legal interception and emergency services).

The project covers:

- Scenario 0: Communication between IP based networks users.
- Scenario 1: Communication between an IP based networks voice user and users in a SCN in which the call set-up is originated by the IP based networks user. The objective is to give IP based networks users access to SCN services, including applicable supplementary and basic IN-based services, as far as possible based on existing features in these networks.
- Scenario 2: Communication between users in SCN and users in IP based networks in which the call set-up is originated by the user in SCN.
- Scenario 3: Communication between users of SCN using the IP based networks for the connection/trunking between the involved SCN.
- Scenario 4: Communication between IP based networks users using the SCN for the connection/trunking between the involved IP based networks.

The project is structured into 3 phases. Currently phase 1 deals with scenario 1, phase 2 with scenario 1 and 2 and phase 3 with all scenarios and with mobility, roaming and wireless issues. Project phases are accompanied by validation and interoperability testing activity.

7.3.3 Voice over IP and related multimedia aspects

In the initial phase, which is currently planned, the project will focus on voice communication and related multimedia aspects, e.g. the support of fax and modem traffic, the impact of multimedia traffic on voice communication within a session etc. The project will further cover some multimedia terminal aspects, e.g. for end-to-end quality of service considerations and interoperability verification testing. Amongst the variety of SCNs TIPHON is focussing on PSTN, ISDN (incl. PISN) and GSM.

7.3.4 Future work

The scope of the project may be extended to include related aspects, e.g. multimedia communication.

7.3.5 Technical objectives

The technical objective is to identify the requirements and to produce deliverables in cooperation with other organizations within ETSI or outside as applicable required to fulfill the terms of reference above. This will include:

- requirements for service interoperability;
- reference configurations and functional models, including position of gateway functions between IP based networks and SCN and interfaces at these gateways;
- call control procedures, information flows and protocols;
- address translation between ITU-T Recommendation E.164 [71] and IPv4/v6 addresses;
- technical aspects of charging/billing;
- technical aspects of security;
- end-to-end quality of service aspects, including transcoding and echo-cancellation;
- aspects of wireless access technology;
- support for roaming users.

According to the technical objectives of the Project the following working groups have been established:

- WG 1: Requirements for service interoperability, technical aspects of charging/billing and security.
- WG 2: Architecture and reference configurations.
- WG 3: Call control procedures, information flows and protocols.
- WG 4: Naming, Numbering and Addressing.
- WG 5: Quality of Service.
- WG 6: Verification and Demonstration Implementation.
- WG 7: Wireless and mobility aspects.
- WG 8: Security.

The work will be based on existing specifications, e.g. relevant parts of ITU-T Recommendation E.164 [71], IPv4/v6 and ITU-T Recommendation H.323 [69].

7.4 TC SEC

URL: http://www.etsi.org/sec/

Responsible for technical and regulatory aspects of security.

Security (ETSI SEC) is the focal point for security standardization within ETSI. ETSI SEC advises ETSI (via it's Technical Bodies) on how technical and regulatory aspects of security should be addressed in its technical work and ensures that security issues are appropriately and consistently addressed in all of ETSI's technical work. ETSI SEC also represents ETSI's interest with external bodies concerned with security.

ETSI SEC is the leading body for lawful interception standardization within ETSI, and WG 1 Lawful Interception is charged to execute the work. Its mandate is to:

- Discharge the responsibilities of ETSI Security to be the lead body within ETSI in relation to lawful interception, including the preparation of reports and other necessary activities.
- Develop generic standards relating to lawful interception, including handover interfaces.

- Liaise with other ETSI bodies in relation to lawful interception, including offering advice and guidance.
- Liaise with bodies external to ETSI in relation to lawful interception.
- Establish a continuing work plan in relation to lawful interception.
- Report to ETSI Security for formal approval of work plan deliverables.
- Report progress and make recommendations to ETSI Security.

One of the outputs of the group is a document entitled: "ETR 331 [18] (1996) Title: Security Techniques Advisory Group (STAG); Definition of user requirements for lawful interception of telecommunications; Requirements of the law enforcement agencies", and available on the ETSI website. The present document is evolving to take into account the specific problems of multimedia systems.

7.5 EP BRAN

URL: http://www.etsi.org/bran/

BRAN is the ETSI project for standardization of Broadband Radio Access Networks (BRAN).

This project will provide facilities for access to wire-based networks in both private and public contexts by the year 2000. The BRAN project will address wireless access systems with bitrates of 25 megabits per second or more and operating in either licensed or license exempt spectrum. These systems address both business use and residential access applications. Fixed wireless access systems are intended as high performance, quick to set up, competitive alternatives for wire-based access systems.

BRAN standards, existing and under development include:

- HIPERLAN/1

  HIPERLAN Type 1 is a Radio LAN standard designed to provide high-speed communications (20 Mbit/s) between portable devices in the 5 GHz range. It is intended to allow flexible wireless data networks to be created, without the need for an existing wired infrastructure. In addition it can be used as an extension of a wired LAN. The support of multimedia applications is possible. The HIPERLAN Type 1 Functional Specification is specified in EN 300 652 [48].

- HIPERLAN/2

  This short-range variant is intended for complementary access mechanism for UMTS systems as well as for private use as a wireless LAN. It will offer high-speed access (25 Mbit/s typical data rate) to a variety of networks including the UMTS core networks, ATM networks and IP based networks. Spectrum has been allocated for HIPERLANs in the 5 GHz range and the Project is working with CEPT/ERC to expand this allocation to enable both licensed and license exempt use. The main Technical Specifications were completed in February 2000.

- HIPERACCESS

  This long range variant is intended for point-to-multipoint, high-speed access (25 Mbit/s typical data rate) by residential and small business users to a wide variety of networks including the UMTS core networks, ATM networks and IP based networks (HIPERLAN/2 might be used for distribution within premises). Spectrum allocations are being discussed in CEPT FM29 and CITEL.

- HIPERLINK

  This variant provides short-range very high-speed interconnection of HIPERLANs and HIPERACCESS, e.g. up to 155 Mbit/s over distances up to 150 m. Spectrum for HIPERLINK is available in the 17 GHz range.

The specifications to be developed will address the physical (PHY) layer as well as the data link control (DLC) layer (with medium access and logical data link control sublayers as appropriate). Interworking specifications that allow broadband radio systems to interface to existing wired networks, notably those based on ATM and TCP/IP protocol suites, will also be developed.

BRAN is also intended to assist regulatory bodies with issues such as the requirements for spectrum and the radio certification specifications that will be required to implement the new broadband radio networks.

To ensure overall coherence with other existing and emerging technologies, close relationships have been or are being established with the ATM Forum, the IEEE Wireless LAN Committee P 802.11a, IEEE 802.1G [84] and 802 N-WEST, the IETF, the MMAC-PC High Speed Wireless Access Systems Group, the ITU-R and a number of internal ETSI Technical Bodies.

7.6 EP UMTS

URL: http://www.etsi.org/umts/

ETSI Project UMTS is responsible the development of standards for UMTS covering mobile communications systems that deliver seamless customized multi-media services from a converged network of fixed, cellular, wireless and satellite components. UMTS is to be a family member of the IMT-2000 system.

EP UMTS is responsible for collecting current and future ETSI activities relevant to UMTS outside those G-UMTS areas to be handled by the 3GPP. Specifically it is responsible for standards covering:

- Generic aspects applicable across different UMTS systems (e.g. based on GSM, ISDN and IP platforms) on subjects such as FMC, VHE, interoperability between different UMTS architectures, multi-mode terminal behaviour, QoS, etc.
- Aspects beyond the initial phase for all UMTS systems including cross-phase compatibility.

The tasks of EP UMTS include:

- Establishing a long-term vision for UMTS and IMT-2000.
- Developing scenarios for the evolution from existing 2nd generation mobile systems (e.g. GSM), the initial phase of UMTS (G-UMTS) and fixed access towards the long-term vision.
- Identifying UMTS target service and feature requirements.
- Developing concepts and requirements for realizing the VHE.
- Developing an overall UMTS system architecture encompassing cellular, fixed, wireless and satellite access technologies within the context of public, private and domestic scenarios.
- Identifying detailed UMTS requirements (e.g. signalling, addressing) as input to other ETSI bodies responsible for developments outside the EP's area of responsibility.
- Identifying requirements to the UMTS Terrestrial Radio Access Network (UTRAN) as input to other ETSI bodies responsible for developments outside the EP's area of responsibility.
- Ensuring that UMTS forms an integral part of the ITU's IMT-2000 development and satisfies the requirements of an IMT-2000 Family Member.
- Coordinating an overall UMTS work plan, including standards development within EP UMTS and other ETSI bodies.
- Ensuring that conformance test specifications for networks and terminals are met.

7.7 TC TMN

URL: http://www.etsi.org/tmn/

Responsible for the creation of network management standards for the telecommunication network, with the aim of providing consistent and harmonized management standards across all technologies.

The TMN (Telecommunications Management Network) concepts provide a generic framework to be applied to the management of different technologies. The TMN functional architecture introduces layering of TMN management functionality (fault, configuration, accounting, performance and security) into different layers (element, network, service and business management). TMN provides object modelling concepts and protocols to build interfaces between systems (managing and to be managed).

ETSI TMN, formed late in 1997, is responsible for the creation of network management standards for the telecommunication network, with the aim of providing consistent and harmonized management standards across all the following technologies under the ETSI umbrella:

- Network aspects of TMN
- Management aspects of the classic PSTN
- Generic Object Modelling
- Management of Broadband ISDN
- Integration of Intelligent Networks and TMN
- Network level transport management activities
- Element level management activities on transmission equipment
- Management of Access Networks
- Management of ATM Switches
- Management of V5/VB5 interfaces

In a further drive towards consistency, ETSI TMN maintains links with external organizations such as Study Group 4 of the International Telecommunication Union (ITU-T), the TeleManagement Forum (TMF), the ATM Forum, the Telecommunications Industry Association (TIA) and with ANSI T1M1 (responsible for internetwork OAM&P standards).

Achieved work

A major achievement was the completion of a number of Q3 interfaces, including the finalization of standards on centralized charging (I-ETS 300 819 [49]) and network routing (EN 300 292 [50]). Work is also complete on customer administration (EN 300 291 [51]) and traffic management (ETS 300 673 [52]). In addition, work was completed on Security in TMN (EN 301 261-3 [53]) and on Intelligent Network management (ES 201 386 [54]).

General documents are TR 101 648 [55] that gives guidelines on modelling of management objects and ES 200 653 [56] containing a library of network level generic classes.

Several documents were published on modelling of PDH, SDH and ATM networks. Work was completed on the support of configuration, fault and performance management functions associated with the VB5.1 reference point (EN 301 271 [57]).

ETSI TMN initiated co-operation with EURESCOM and the ETSI EASI in order to improve activities on the X interface. ES 201 654 [58] is on the X interface for SDH path provisioning and fault management, work is ongoing on the performance part (DES/TMN-03002). EN 300 820 [59] concerns the ATM management information model for the X-type interface between Operation Systems (OSs) of a Virtual Path (VP)/Virtual Channel (VC) cross-connected network.

Unified Modelling Language (UML) is now widely accepted and ETSI TMN is making efforts to introduce this new methodology to a wider audience.

Future developments

For the broadband access network, work is ongoing on the support of configuration, fault and performance management functions associated with the VB5.2 reference point (EN 301 754 [85]).

Also scheduled is work on general requirements should a protocol other than CMIP have to be utilized in a TMN context. Particular attention will be dedicated to CORBA.

The big challenge for the future is the management of the Internet, and discussions have already been initiated on this subject with the IETF to avoid the duplication of effort.

It was decided to review the "IP Management" related work as an area that in any case needs further attention. The objective is to identify what future standards development work needs to be undertaken by the ETSI TMN given the evolving technologies and the market needs.

7.8 TC HF

URL: http://www.etsi.org/hf/

ETSI HF is the committee responsible for standards and guidelines dealing with ease of use and accessibility of telecommunication equipment and services, including the requirements of older and disabled people.

Ease of use is a key factor for the commercial success of any telecommunication product or service. The growing complexity of telecommunication services and equipment makes this aspect more and more important.

ETSI HF has representatives from research bodies, manufacturers, service providers, users and consumers. It contributes to the following work areas:

- User interfaces for the Internet.
- Mobile communications.
- Multimedia and Videotelephony.
- User interfaces for network management.
- Numbering, addressing and service codes.

ETSI HF collaborates closely with EU funded projects and continues to support the aims of the European Commission by producing the necessary standards to allow universal access to information and communication technology (ICT). Accommodating the needs of the growing numbers of older users is also a high priority for ETSI HF.

A new STF is planned dealing with naming and addressing systems in future converging services and networks such as Universal Mobile Telecommunications System (UMTS). This should lead to the replacement of long telephone numbers with a more meaningful system of names and addresses.

7.9 TC ERM

URL: http://www.etsi.org/erm/

ERM is a "horizontal" technical committee that is responsible for the standardization of electromagnetic compatibility (EMC) and radio spectrum matters on behalf of all other technical bodies of ETSI. Its work can be considered in three main areas:

"Horizontal" issues

- The Electromagnetic Compatibility (EMC) working group is responsible for all ETSI Harmonized Standards related to the EMC Directive (89/336/EEC [60]) and article 3.1b of the R&TTE Directive. This group is also responsible for liaison on behalf of ETSI with CENELEC on EMC issues and with CISPR.
- The Radio Matters (RM) working group is responsible for co-operation with the European Radiocommunications Committee (ERC) to secure appropriate spectrum allocations in the CEPT countries for standardized systems, in order to ensure co-existence between different communications systems standardized by ETSI.

"Radio Project" activities

ERM has long-term working groups providing expertise in the following areas:

- Land-mobile radio (RP02 and RP08);
- Maritime radio (RP01);

- Aeronautical radio (RP05);
- Radio site engineering (RP11).

"Task group" activities

ERM has a number of task groups which are set up on a short-term basis to deal with particular issues, and which disband on the resolution of the issues. Current task groups are looking at:

- issues for radio equipment installed in motor vehicles (TG4)
- EMC requirements for marine radio (TG5) and aeronautical radio (TG15)
- ETSI input to the ERO Detailed Spectrum Review (TG7)
- Interference potential of CB radio (TG8)
- requirements for Radio LAN (TG11) and Cordless Telephone (TG13) equipment
- requirements for the declaration of interfaces under the R&TTE Directive (TG14)

7.10 TC SMG

URL: http://www.etsi.org/smg/

The mission of SMG is to develop standards for the GSM (Global System for Mobile Communications) family of public digital mobile communications systems with a built-in capability for unrestricted world-wide roaming of users and/or terminals between any networks belonging to this family.

Specifically, its task is to develop and maintain the specifications of the digital cellular telecommunications system operating in the 900 MHz band known as GSM 900 and of its variation in the 1800 MHz band, known as DCS 1800. In addition it is responsible for maintaining the integrity of the GSM platform by close cooperation with ANSI T1P1, who are responsible for the 1900 MHz version, known as PCS 1900.

The scope of the TC SMG work is focused on the GSM family. It includes the definition of the GSM services offered and the selection and specification of the most efficient radio techniques and speech coding algorithms including the coordination of validation programmes. SMG is also responsible for the elaboration of the GSM network architecture, signalling protocols and conditions of interworking with other networks. SMG deals with all technical aspects of data and telematic services. SMG specifies the appropriate security procedures. In addition SMG is charged with the application of the Telecommunications Management Network (TMN) concept to the GSM network entities. SMG specifies the SIM (subscriber identity module), an intelligent IC card. In addition Base Station and Mobile Station testing is standardized. SMG collaborates with other ETSI Technical Bodies, e.g. SPAN, and SAGE.

SMG has the primary responsibility within ETSI for co-ordinating with the GSM Association, ECTEL TMS, the UMTS FORUM, ANSI T1P1, the Advanced Communications Technologies and Services (ACTS) mobile project line and Task Group 8/1 of the International Telecommunication Union Radio Sector.

SMG will eventually publish the 3GPP specifications as ETSI standards.

7.11 EP EASI

URL: http://www.etsi.org/easi/

Asynchronous transfer mode (ATM) is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic. ATM is a technology which enable carriers to capitalize on a number of revenue opportunities through multiple ATM classes of services, high-speed local area network (LAN) interconnection, voice, video, and future multimedia applications in business markets in the short term and in community and residential markets in a longer term.

There is a growing need for greater capacity and bandwidth in the telephony network. Internet, with many of its applications, has been growing fast, and the holding times and patterns of Internet connections differ from those of voice telephony. In many countries, data traffic already exceeds voice traffic. More and more applications are hungry for bandwidth. Better graphics and the need for transmitting video clips have resulted in longer waiting. Electronic commerce is already introduced over the Internet and this too generates more traffic to the network. Unfortunately, in the increasingly competitive environment, many vendors and/or network operators have developed their own service offerings, which are often not compatible between them. There is therefore a need to ensure a global ATM network interoperability.

For achieving such a task ETSI established in October 1997 a project called "EASI", which stands for "European ATM Services Interoperability". The intention of this study is to identify appropriate existing standards, close any options or ambiguities and stimulate the production of any further standards that may be required. The scope is to produce enough of an unambiguous system specification to allow the manufacture and deployment of ATM equipment that will readily enable operators to offer interoperable ATM services across and between their various networks. Some Network-to-Network interfaces need to be specified in the Network User and Control planes and in the Network Management Plane.

Individual networks are protected by gateway functions that allow those networks to develop independently. Other network aspects shall be taken into account such as user service requirements, network architecture, quality of service and performance objectives.

The work has been split into two phases:

1) the first phase is to describe an overview of all services required and to provide specification needed to support:
    - permanent and semi-permanent VP and VC connections;
    - SVC connections and TCP/IP.
2) the second phase is to provide specification for supporting SVP connections and interworking capabilities (e.g. 64 kbit/s, Frame Relay,...).

Achieved work

For each phase the aim is to specify both User and Control Plane (including Network Functions and Service Aspects) and Network Management Specifications for Phase implementation. The work programme is set as follows:

- Network-Network Interface (NNI) User and Control plane specification Phase 1;
- Network-Network Interface (X.easi) Network Management specification for Phase 1;
- Network-Network Interface (NNI) User and Control plane specification Phase 2;
- Network-Network Interface (X.easi) Network Management specification for Phase 2.

So far, TR 101 673 [61] is the deliverable which describes an overview of a set of specifications defining Network-Network Interface (NNI) to enable service interoperability between ATM networks. The Technical Specifications for Network Functions and Services Aspects for Phase 1 has been published as deliverable numbered TS 101 674-1 [86].

No further work is planned on Phase 1. Deliverables relevant to Phase 2 have been started more or less in parallel and should be achieved before end of 2000.

8 Regulatory Environment

8.1 The R&TTE Directive

The most significant aspect of the R&TTE Directive [22] is that it conforms to the "New Approach to technical harmonization". This introduces a market-led approach into the Radio and Telecommunications Terminal Equipment sector, and removes the regime of type approvals. Conformity to the essential requirements (ERs) in Article 3 of the R&TTED is by supplier's declaration, and may be based on Harmonized Standards or other means. Essential requirements are substantially reduced compared to the earlier regime.

The Directive contains essential requirements that are to be met. In producing Harmonized Standards for application under the Directive, ETSI shall ensure that the standards do not exceed the degree of regulation envisaged by the Commission (after consultation with TCAM), and shall apply discernment in order not to inhibit technological innovation or the meeting of the needs of a free-market economy.

Following a Mandate from the EC, ETSI had prepared an ETSI Guide EG 201 399 [62], "A guide to the production of Harmonized standards for application under the R&TTE Directive" to inform of the implications.

8.1.1 Scope of the Directive

The R&TTED covers Apparatus within its scope that is either TTE or RE, as defined in its Article 2b and 2c, or that is both TTE and RE (for example, cellular phones).

The scope of the R&TTED excludes equipment listed in its Annex I (radio amateur kits, certain marine equipment, cabling and wiring, receive-only radio/TV, certain civil aviation equipment, certain air-traffic-management equipment), and equipment used exclusively for activities of the State (Article 1.5). It applies only to the communication aspects of certain medical devices (Article 1.2) and vehicles (Article 1.3). These limitations on the scope of the Directive apply to all TTE or RE.

TTE was previously covered by Directive 98/13/EC [63], although there are differences in the definition of "TTE" between the two Directives.

RE was not previously covered by a specific Directive, although there were provisions on RE included in the EMC Directive.

For the products within its scope, the R&TTE Directive covers all aspects of placing on the market and putting into service, except for licensing of RE, which remains a national matter. The aspects of safety and EMC covered in other Directives are taken over into the R&TTE Directive, although the supplier has the option of using the procedures in these earlier Directives, for equipment which falls within their scope (R&TTED Article 10.2), as a means to demonstrate conformity to the requirements of article 3.1a and 3.1b in the R&TTED.

8.1.2 Implications for Telecommunications Terminal Equipment

The definition of TTE given in the R&TTED is "a product enabling communication or relevant component thereof which is intended to be connected directly or indirectly by any means whatsoever to interfaces of public telecommunications networks". In contrast to the earlier Directive 98/13/EC [63] Article 1.2, interworking with the network is not part of the definition for indirectly connected terminals.

Under the R&TTE Directive, TTE will no longer be subject to type approval. Products can be placed on the market under the responsibility of the supplier. The supplier makes a Declaration of Conformity to the essential requirements of the Directive, and shall keep this declaration, together with supportive product technical documentation, as outlined in R&TTED Annex II, for at least ten years after the last product of that type has been manufactured.

Suppliers are responsible for ensuring that each item of TTE produced meets the ERs. There is no simple relationship between the "new" essential requirements of the R&TTED and the "old" essential requirements applied to TTE under Directive 98/13/EC [63], except for satellite earth stations, for which the essential requirements are effectively the same.

8.1.3 Implications for Radio Equipment

The definition of Radio Equipment (RE) given in the R&TTED, Article 2(c), is "a product, or relevant component thereof, capable of communication by means of the emission and/or reception of radio waves utilizing the spectrum allocated to terrestrial/space radiocommunication". This definition has no lower limit on the transmitted power.

RE shall be constructed to avoid harmful interference, defined as "interference which endangers the functioning of a radionavigation service or of other safety services or which otherwise seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with the applicable Community or national regulations". RE using frequency bands whose use is not harmonized throughout the Community shall be notified to national spectrum management authorities at least four weeks before it is placed on that national market.

For radio transmitters, including TTE which uses radio transmission, essential radio test suites shall be carried out for the product (refer to Annex III of the R&TTE Directive). If the test suites are not defined in Harmonized Standards, a Notified Body of the supplier's choice shall be consulted to identify which test suites are essential for the product concerned, and that body's identification number forms part of the CE marking. The supplier's Declaration of Conformity to the ERs shall state that the essential radio transmitter tests have been carried out.

8.1.4 Article 3.2

Article 3.2 is "The effective use of the radio spectrum allocated to terrestrial/space radio communication and orbital resources so as to avoid "harmful interference"

In general, assumptions are necessary for spectrum management purposes concerning the performance of transmitters, receivers and control functions in the areas of signalling, code domain considerations and frequency resource sharing etc. In the case of Article 3.2 the inclusion of technical requirements in Harmonized Standards is limited to only those necessary for the avoidance of *"harmful interference"* (which is a term defined in the Directive). Thus requirements necessary to provide a presumption of conformity to the Directive are a small subset of those used for spectrum management.

It is noted that the parameters that are not included in the Harmonized Standard are available or will be made available to the public in other documents. Technical Bodies writing Harmonized Standards may consider it appropriate to make reference to these non-essential requirements for guidance, but only with a strict clarification that such reference forms no part of the essential requirements and thus it forms no part of the Harmonized Standard for the purposes of conformity assessment.

NOTE: Radio Regulations (RR), definition of Interference:

Interference is defined as " the effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio-communications system, manifested by any performance degradation".

8.1.5 Procedure for generation of Harmonized Standards

8.1.5.1 Identification of a Work Programme

The European Commission has requested ETSI to provide a programme of standardization work it considers necessary to provide Harmonized Standards under the R&TTED. This programme of standardization work will provide the basis for a standardization mandate.

8.1.5.2 Standardization mandate

ENs cannot be quoted in the OJEC as Harmonized Standards unless they have been developed under an EC standardization mandate. Mandates under the R&TTED are proposed by the Commission, after consultation with TCAM, and approved by the Committee established under the terms of Directive 98/34/EC [64] before being presented to ETSI.

The EC standardization mandate exists, M/284 and has been accepted by ETSI.

8.1.5.3 Handling of candidate Harmonized Standards

Candidate Harmonized Standards are adopted according to specific procedures under the ETSI Technical Working Procedures (TWP). Before a candidate Harmonized Standard is submitted to the voting procedure, the standard shall be finally examined to ascertain that the conditions imposed by the R&TTE Directive, the conditions of the standardization mandate, and the conditions stemming from this Guide are met.

Once adopted by ETSI, Harmonized Standards developed under the R&TTED mandate are presented to the Commission by the ETSI Secretariat. The Commission will decide whether or not the Harmonized Standard is acceptable in whole or in part as suitable for establishing a presumption of conformity against the relevant essential requirements.

Revisions of Harmonized Standards developed under R&TTED mandate do not require a specific modification to the standardization mandate. However, publication of the revised standard in the OJEC is necessary to amend the requirements that give a presumption of conformity with the R&TTED.

If an ETSI technical body considers that technical modifications to a Harmonized Standard are required, it should raise a work item according to the TWP. The ETSI Secretariat will present the work item to TCAM with a justification covering why the revision of the Harmonized Standard is required. The EC may decide not to cite the revision in the OJEC.

If, following the Commission's action, the relevant ETSI technical body considers that the Harmonized Standard should be withdrawn, the standard shall follow the withdrawal procedures of the TWP. The ETSI Secretariat shall ensure that the standard is archived so as to remain available if requested, including traceability that the standard had been published in the OJEC, with the relevant dates of publication and withdrawal.

ETSI has designed a modular structure for the standards. Each standard is a module in the structure. The modular structure is shown below.

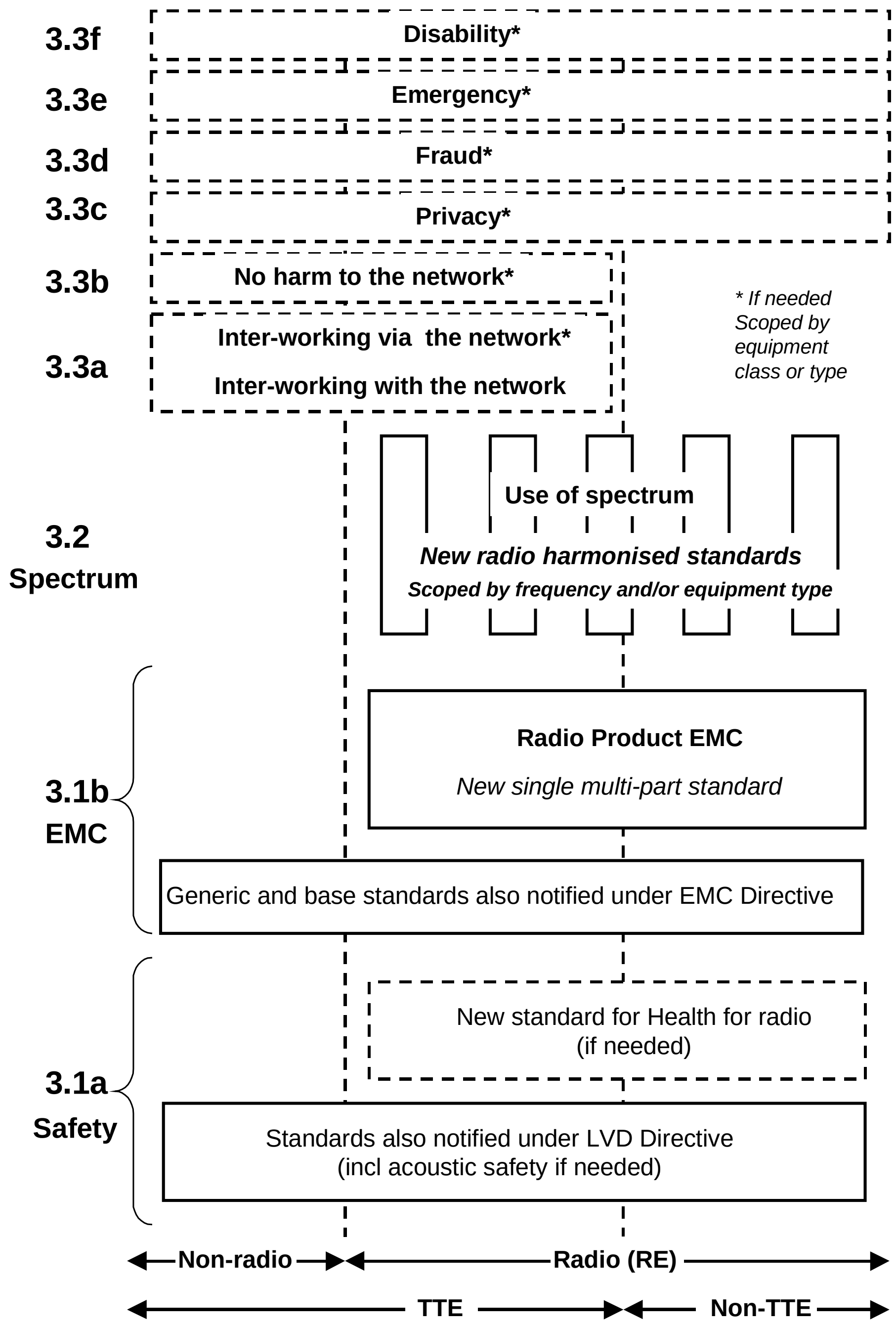


Figure 9: Modular structure for the various standards used under the R&TTE Directive

The left-hand edge of the figure shows the different sub-clauses of Article 3 of the Directive.

The vertical boxes show the standards under article 3.2 for the use of the radio spectrum. The scopes of these standards are specified either by frequency (normally in the case where frequency bands are harmonized) or by radio equipment type.

For article 3.3 various horizontal boxes are shown. Their dotted lines indicate that no essential requirements in these areas have yet been adopted by the Commission. If such essential requirements are adopted, they will be elaborated in individual standards whose scope is likely to be specified by function or interface type.

The bottom of the figure shows the relationship of the standards to radio equipment and telecommunications terminal equipment. A particular equipment may be radio equipment, telecommunications terminal equipment or both.

8.1.6 Article 4.2

Article 4, Essential Requirements, clause 2 states the new European Directive:

> "Each Member State shall notify to the Commission the types of interface offered in that State by operators of public telecommunications networks. Member States shall ensure that such operators publish accurate and adequate technical specifications of such interfaces before services provided through those interfaces are made publicly available, and regularly publish any updated specifications. The specifications shall be in sufficient detail to permit the design of telecommunications terminal equipment capable of utilizing all services provided through the corresponding interface. The specifications shall include, inter alia, all the information necessary to allow manufacturers to carry out, at their choice, the relevant tests for the essential requirements applicable to the telecommunications terminal equipment. Member States shall ensure that those specifications are made readily available by the operators".

An impact of the R&TTE directive, article 4.2, related to the standardization scenario for BSM seems to be that air interfaces may need to be published before service is offered to the public.

It is necessary to clarify what implications this may have on closed (i.e. unpublished) air interfaces. The R&TTE directive may provide good arguments for a set of voluntary standards.

For the case of a new, niche-market system the situation can be different, especially when there are no similar systems available on the market. Also, given the significant research and development investment that will need to go into the design of a conceptually new terminal design and function, the requirement to publish the complete air-interface at service launch could be dissuasive to a system developer. Finally, the inherent diversity of many satellite system characteristics could cast uncertainty on the feasibility of producing a multi-system terminal.

8.2 Requirements for Lawful Interception

Any BSM system that shall operate in Europe is required to have a mechanism for lawful interception. Legal authorities will need a mechanism to listen to any data in the system, both that associated with the content of a call, but also call-associated data as user addresses, call duration, the caller and recipient location etc.

There are currently no clear and consistent requirements across Europe. Depending upon the type of system, the interception may occur at a hub/gateway or at the satellite. For satellites that provide direct terminal to terminal connections, special challenges arise.

The actual legal control over who is to be intercepted and when such interception shall or may occur is beyond the scope of the present document to elaborate on. This is defined in *Council Resolution of 17 January 1995 on the lawful interception of telecommunications*, published in the EU *Official Journal C 329, 04/11/1996 p. 0001 - 0006.*

The responsibility of considering security issues and lawful interception in ETSI lies with TC SEC.

According to TC SEC, as a rule of thumb approximately 1 in every 10 000 subscribers will be the subject of lawful interception.

The ETSI documents ETR 331 [18], ES 201 671 [7] and ES 201 158 [6] relate to Lawful Interception. ETR 331 [18] is currently being updated to take into account IP and multimedia systems. For convenience, the general requirements from ETR 331 [18] are listed below:

The obligation of the network operator/service provider as to which telecommunications traffic shall be intercepted is subject to national laws.

In accordance with the relevant lawful authorization a network operator/service provider shall ensure that:

- the entire content of communication associated with a target identity being intercepted can be intercepted during the entire period;
- any content of communication associated with a target identity being intercepted which is routed to technical storage facilities or is retrieved from such storage facilities can be intercepted during the entire period;
- if the results of interception can not be delivered immediately to the relevant LEMF, then the content of communication and/or the intercept related information shall be buffered until they can be delivered;
- he shall not monitor or permanently record the results of interception.

The ability to intercept telecommunications shall be provided relating to all interception subjects operating permanently within a telecommunications system (e.g. a PSTN subscriber).

The ability to intercept telecommunications shall be provided relating to all interception subjects operating temporarily within a telecommunications system (e.g. a visiting mobile subscriber).

The results of interception relating to a target service shall be provided by the network operator/service provider in such a way that any telecommunications that do not fall within the scope of the lawful authorization shall be excluded by the network operator/service provider.

All results of interception provided at the handover interface shall be given a unique identification relating to lawful authorization.

Statewatch, an organization for monitoring civil liberties in the European Union, informs on their Internet site ((http://www.statewatch.org) that the EU and the FBI are in the process of launching a global surveillance system, and that global S-PCN satellite systems are within their focus. The Council of the European Union and the FBI in Washington, USA have been cooperating for at least five years on a plan to introduce a global telecommunications tapping system. The system takes advantage of the liberalization of telecommunications - where private companies are taking over from national telephone systems - and the replacement of land/sea based lines and microwave towers by satellite communications.

8.2.1 Perspective of TC SEC

WG LI have given some thought to the matter of satellites and Lawful Interception, and offer the following initial answers:

Legal requirements

LI is an activity, which must always be undertaken according to national legislation. This national legislation will respect and refer to international agreements. There is no European body whose authority extends to this issue.

In national LI legislation different approaches are taken (although international alignment is endorsed by the EU resolution of 17th January 1995 http://europa.eu.int/eur-lex/en/lif/dat/1996/en_496Y1104_01.html).

National differences are particularly found in the target or the targets' communication being the subject of interception.

Licensing

The national LI demands will in many, if not all, cases be coupled to licences for frequency use or operator or provider licences. If arrangements for LI are not made then an operator will be in breach of licence conditions, with the threat that their licence to operate the licensed system could be withdrawn.

Crossing national jurisdiction

The target (terminal) and/or the associated communication may cross national jurisdictions, and this is a complicating factor for satellite and other wide coverage systems.

The national jurisdiction can, according to national legislation and international treaties, be limited to the (sovereign) national territory, international territories (such as sea areas), other national territories or a combination of these. This will differ per country and per lawful authorization (depending on the crime involved).

The involved provider or system should therefore have the capability to limit an intercept to the appropriate geographical area as accurately as possible, according to the position of the intercepted terminal.

EU mutual legal assistance convention (MLAC)

For networks with crucial system parts outside the national jurisdiction the general legal approach, according to law enforcement, is that the interception is done by the law enforcement agency by "listening" to the communication. The (place of) technical interception done by the provider or operator to make the legal interception possible is legally not relevant. International treaties and mutual legal assistance are brought in place to safeguard the operator or provider that might operate practically from another jurisdiction.

A network operator might take a different view.

The draft EU mutual legal assistance convention, MLAC, describes LI in Title III.
(This document is available at http://docbox.etsi.org/Tech-Org/security/Document/security/LI/1999-10%20Sophia%20Antipolis/16wglitd049%20draft%20mlac.pdf).

Technical requirements

The interest of law enforcement is, in general, not in broadcast (generally available content) information received by a target. The interest of law enforcement is in information flows specifically addressed to and from the target.

In cases where the communication does not touch a network element on the ground, or in territorial space, then forced grounding of the technical information to be intercepted is necessary for delivery. One such ground point can, in principle, serve more than one territory depending on the ground point territory's view of the MLAC. Usually the grounding point would be a ground station used for access or control, and traditionally would be chosen for engineering reasons rather than through any consideration of LI.

The need for standards

The thought of many operators dealing with many territories, each of which have many law enforcement authorities, on a bilateral basis, is horrifying. The market needs standards to allow pre-packaged solutions that may readily be adopted across all territories, with appropriate national configuration.

The essential reason why the GSM operators started the initial work on GSM standardization was to counter a situation in which each network operator was paying their chosen manufacturer(s) for bespoke LI solutions. The GSM operators felt that a standardized approach would be cheaper, quicker to market and more likely to meet LEA requirements in the long run.

Consequences of poor handling

The essential consequence is that in most Western European countries an operator is unlikely to be granted a licence.

Handling of issues by system proponents

One may draw ones own conclusions. In terms of an architectural approach, WG LI is currently developing a document describing LI architectures, but this work is still at an early stage. WG LI could consider satellite and other broad area coverage systems if given some specific (typical) systems to think about.

Further questions

ETSI document ETR 331 [18] addresses some of the questions relating to international operation without giving any answers. WG LI is currently revising that document, and expects to consider the MLAC as part of that activity. The new ETR 331 [18] can be expected by early 2000. The new version will handle IP multimedia matters, while the older version focuses on voice.

8.3 CEPT/ERC; Frequency Allocation and Terminal Licensing Issues

The ongoing work of the European Radiocommunications Committee (ERC) is organized in three permanent working groups in the areas of Frequency Management (FM)- Spectrum Engineering (SE)- Radio Regulations (RR). Another permanent working group the Conference Preparatory Group (CPG) coordinates the preparations for ITU World Radio Conferences (WRCs) and Radio Assemblies. The ERC and the Working Groups create Project Teams (PTs) to work to well defined tasks and limited time periods: for this aim four PTs have been created.

In particular, the PT1 of the CEPT-CPG2000 addresses all procedural/regulatory issues of WRC-2000 agenda items, prepares the necessary European Common Proposals (ECP) and related briefs, the relevant draft section of the CEPT brief and the draft briefs on the proposals to the Conference from other administrations.

Moreover, the PT1 coordinates the CEPT positions for the Regulatory Special Committee and the actions of the CEPT administrations. Finally it reports to CPG.

8.3.1 Ku-band and Ka-band by NGSO satellite systems

The ITU World Radiocommunications Conference of 1997 (WRC-97) adopted regulatory provisions facilitating the use of Ku-band and Ka-band frequencies by non-geostationary systems of the fixed-satellite service. It is expected that WRC-2000 will adopt some further changes to the regulatory provisions under which non-GSO systems of the fixed-satellite service share spectrum with incumbent GSO FSS, fixed service and other radio services, based on the conclusions of the Conference preparatory meeting held in Geneva November 1999. These regulatory provisions allow for more efficient use of the orbit/spectrum resource through the introduction of non-geostationary satellite systems of the FSS whilst enabling BSM high data rate, low latency services to be provided on a global basis.

8.3.2 Terminal Licensing and Authorization Procedures and Conditions

The important issues of harmonization of licensing and authorization procedures and conditions for terminals of BSM type systems are currently being addressed within various CEPT and EU groups or project teams. These fora include the EU Satellite Action Plan - Regulatory Working Group (SAP RWG) and the Joint ERC/ECTRA Project Team /Satellites (JPT SAT). The JPT SAT is currently addressing such issues within the framework of an EC mandate on harmonization measures for S-PCS systems operating above 3 GHz.

8.3.3 Mobile Use of the Ka-Band

There is a strong growth in mobile multimedia services, and with UMTS mobility and multimedia are key driving factors. This enlarges the broadband multimedia applications and the BSM systems to the "on the move" scenario.

Agenda Item 7.2 text of WRC-2000 is the following: "*to recommend to the Council items for inclusion in the agenda for the WRC-01, and to give its views on the preliminary agenda for the 2003 Conference and on possible agenda items for future conferences*". The CEPT/ERC PT1 is the appropriate place for such a discussion.

The frequency bands currently allocated by the Radio Regulations to the Mobile Satellite Service (MSS) in the 1 GHz to 3 GHz range (up to now the technically preferred frequency range for MSS) are rapidly approaching saturation due to an increasing number of operational and planned MSS systems with growing spectrum need. Solutions need to be sought urgently to accommodate the increasing MSS spectrum demand, possibly avoiding the major constraints and sharing problems that the new proposed MSS systems are facing to operate in the 1 GHz to 3 GHz range.

As a general principle for efficient spectrum management, the new broadband technologies must use the minimum bandwidth to ensure transmission of information at the rate and with the quality required under specified conditions and should operate at the highest and least occupied frequency bands consistent with their operating characteristics.

A recent market analysis, performed in the European framework and based on the use of a predictive model developed by Italian industry, assessed potential users and market penetration of satellite based mobile multimedia services operating in Ka-band. It confirmed that the possible lack of available spectrum could in the future be a major barrier to meet the expected demand for broadband MSS in the various Regions.

To implement such services it is desirable to have a global coverage, and in order to access the widest class of broadband telecommunication services, the use of increased bandwidth is necessary. An opportunity exists in Ka-band.

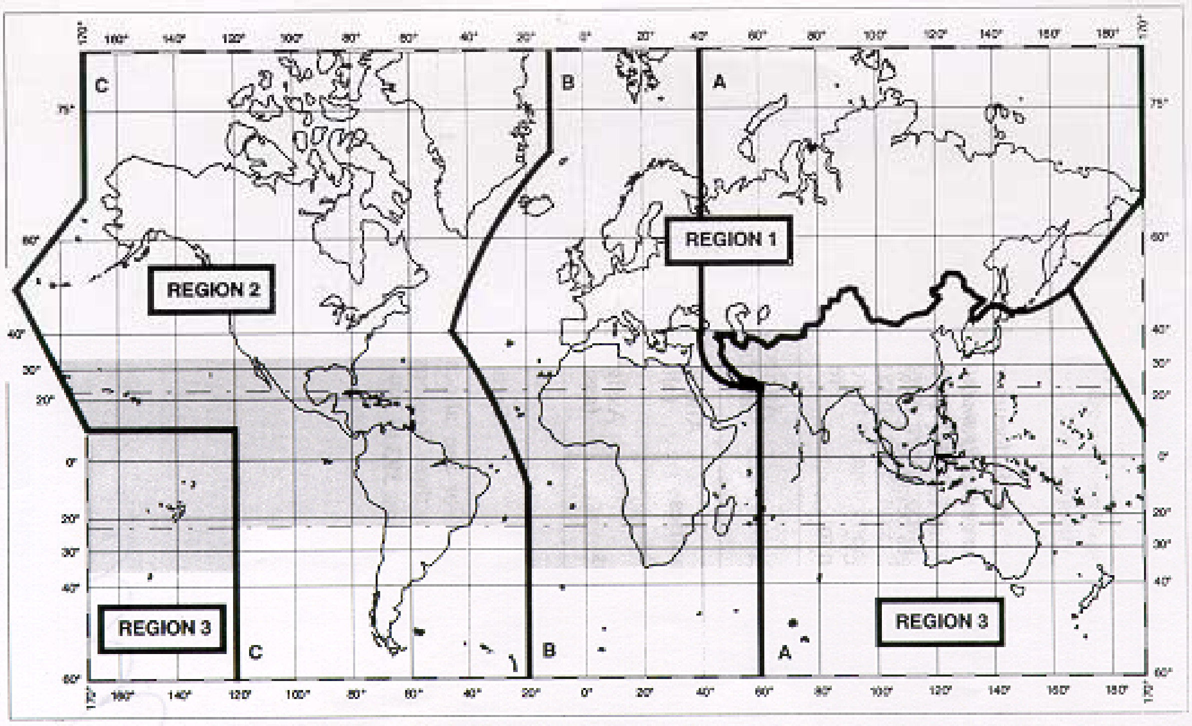
The Radio Regulations, in the ITU Regions 1 and 3, in the 19,7 GHz to 20,2 GHz and 29,5 GHz to 30 GHz frequency bands, have for now allocated to the MSS, on co-primary basis with FSS (Fixed Satellite Service), a spectrum amount of only 2 x 100 MHz. The remaining 2 x 400 MHz are on a secondary basis. In ITU Region 2, the whole frequency band of 2 x 500 MHz is allocated to MSS on a co-primary basis with FSS.

To overcome present constraints and to ensure consistent development of MSS world-wide, an innovation could be done in the regulatory environment to increase the co-primary allocations in all ITU Regions up to 2 x 500 MHz.

Another innovation is needed in the technology, and is related to the fixed-mobile convergence. Present technological trends will allow operation with small satellite terminals in the frequency bands 19,7 GHz to 20,2 GHz (space-to-Earth) and 29,5 GHz to 30 GHz (Earth-to-space), to support broadband wireless applications both in fixed and mobile configuration. Small Satellite User Terminals (SUTs) developed in accordance with the European standard EN 301 358 [15] can meet all requirements imposed to facilitate coordination and the licensing process. The specifications have been set in order to allow simultaneous operation in the same frequency band and in the same service area, with negligible interference between two geostationary satellite systems having at least 2 degrees orbital separation. Therefore a SUT complying with the minimum specifications reported in EN 301 358 [15] will avoid harmful interference to other satellite systems.

When mounted on mobile platforms (such as terrestrial vehicles, ships, airplanes, etc.), Ka-band systems can provide access to broadband MSS at various rates.

The minimum RF (Radio Frequency) specifications for the SUT are expressed in terms of off-axis spurious radiation, on-axis spurious radiation, off-axis EIRP density in-band emission, transmit polarization discrimination (linear) or voltage axial ratio (circular), transmit antenna gain pattern, carrier suppression and antenna pointing accuracy.



The shaded part represents the Tropical Zones as defined in Nos. 406 to 410 and 411.

Figure 10: ITU Regions

There is a general agreement that when the efficient use of the frequency spectrum is not at risk and as long as harmful interference is unlikely, the installation and use of radio equipment can be exempted from a licence.

CEPT/ERC/REC 01-07 [65], which was adopted in 1995, listed harmonized criteria for the administrations to decide whether an exemption of individual license should be applied. In 1999 there is a draft of an ERC Decision on "Exemption from individual licensing of SUT", since compliance with EN 301 358 [15] also fulfils the criteria for exemption listed in CEPT/ERC/REC 01-07 [65].

With the exemption from individual licensing, it is possible to buy, install, and use such terminals without any prior individual permission by the administrations. Therefore it can be argued that the SUT could be used in either a fixed or mobile environment, provided that the performance specified in the mentioned ETSI standard (especially the pointing accuracy) is guaranteed also for the mobile case.

Italy is promoting with the due procedures to the competent European authorities an action to include the following *resolve* in the agenda for the WRC-01 (World Radiocommunication Conference of year 2001):

R*eview of the use of 19,7 GHZ to 20,2 GHz and 29,5 GHz to 30 GHz bands in order to allocate on primary basis the available spectrum for both FSS (Fixed Satellite Service) and MSS (Mobile Satellite Service).*

The request is based on the following considerations:

- the standardized SUTs (see EN 301 358 [15]) are foreseen to be subject to licence exemption;
- market estimation and relevant traffic analysis for MSS;
- EU policy on radio spectrum management (refer to "Green Paper on Radio Spectrum Policy") which aims to stimulate the deployment of new services and systems in accordance with the principles of openness, transparency and non-discrimination.

9 Relevant Research Activities

In addition to specific research activities conducted at numerous universities throughout Europe, several programmes exist that support Europe-wide research and development of satellite-based networks and services. The most prominent of these are the EU programmes and EURESCOM, which are briefly described in this clause.

9.1 EU 5th Framework Programme

The Fifth Framework Programme (FP5) sets out the priorities for the European Union's research, technological development and demonstration (RTD) activities for the period 1998-2002. These priorities have been selected on the basis of a set of common criteria reflecting the major concerns of increasing industrial competitiveness and the quality of life for European citizens.

The Fifth Framework Programme has two distinct parts: the European Community (EC) framework programme covering research, technological development and demonstration activities; and the Euratom framework programme covering research and training activities in the nuclear sector.

The FP5 programme comprises the concept of "key actions", which is regarded as a cluster of small and large, applied, generic and, as appropriate, basic research projects directed towards a common European challenge or problem, not excluding global issues.

The theme of relevance to the present document is entitled "User-friendly information society", and includes the "key actions":

- KA1: Systems and services for the citizen;
- KA2: New methods of work and electronic commerce;
- KA3: Multimedia content and tools;
- KA4: Essential technologies and infrastructures.

Key Action 4 is further broken down into the following work areas:

E 1: Technologies for and the management of information processing, communications and networks, including broadband, together with their implementation, interoperability and application. The work will focus on the development and convergence of information processing, telecommunications and broadcast network and system technologies.

RTD Activities:

- Cross-programme RTD: identify open interfaces, standards and codes of practice to support access to and the inter-working and inter-management of different infrastructures and services;
- Concurrent Systems: development and execution environments to support distributed applications;
- Real-time Systems: design and implementation of data- and/or compute-intensive real-time applications;
- Network Integration: network service provision and network level interworking;
- Services and Communication Management: interworking at the management and service platform levels, to increase intelligence, capacity, flexibility and functionality;
- Multi-service Optical Networks: all-optical core and access networks to support multiple services.

E 2: Technologies and engineering for software, systems and services, including high-quality statistics. Work will centre around the development, deployment, operation and evolution of software-intensive systems embedded in goods and services as well as facilitating production and enterprise processes, including technologies and tools for testing and validation at all stages.

E 3: Real-time and large-scale simulation and visualization technologies. Work will address the development and integration of advanced simulation and visualization technologies and environments in all applications. Work will include distributed simulations and shared virtual environments. Interfaces making use of the various senses. Work will address the provision of intuitive ways to capture, deliver and interact with systems. Work will include the development and integration of advanced sensor, actuator and display technologies.

E 4: Mobile and personal communications and systems, including satellite-based systems and services. Work will target the move to an integrated seamless network that ensures global personal connectivity and enables access to wireless multimedia communications and services by anyone, from anywhere, at any time, with capabilities, quality and performance comparable to those of fixed network services. (Goals of this work area described in more detail below)

E 5: Peripherals, sub-systems and microsystems. Work will address the need for advanced intelligent (computing and communications) network peripherals that can have multiple functionality yet remain user-friendly. Work on sub-systems will cover the building blocks of information processing and communications systems and networks. Work on intelligent microsystems will, in this context, cover miniaturized systems comprising sensing and/or actuating with processing functions, and normally combining two or more of electrical, mechanical, optical, chemical, organic, biological, magnetic or other properties, integrated onto a single chip or a multichip hybrid.

E 6: Microelectronics. Work will address materials, equipment, processes, design and test methodologies and tools which enable the development of electronic components, their packaging, interconnection and application. The approach will be system-oriented and application-driven, and will aim at reinforcing strengths and exploiting technological opportunities drawing on appropriate microelectronic technology solutions best filling generic application requirements.

The **most relevant of these work areas for satellite communications is the E 4**, described in further detail below:

The new Unit E 4 (Mobile and personal communications and systems, including satellite-based systems and services) focuses on the development of advanced wireless-based technologies, systems and networks, both terrestrial and satellite-based and on the integration of the associated services in a seamless infrastructure ensuring global personal connectivity and access to broadband wireless multimedia communications and services by anyone, from anywhere, at any time.

In particular the work addresses **re-configurable radio systems and networks**, the objective of which is to lay the foundations for allowing the radio network, including terminals and base stations, to adaptively/automatically adjust to traffic and user requirements. It encompasses work on **terrestrial wireless systems and networks**, the objective of which is to investigate, develop, test and validate advanced terrestrial wireless systems and architectures (e.g. UMTS, MBS, WLAN, MMDS, LMDS etc) and their interworking and interoperation in particular with fixed/broadcasting networks. It includes the development of advanced positioning and navigation concepts and systems, their integration with communications based systems and their overall end-to-end management. The work on **satellite systems and services** aims to develop, demonstrate and validate novel technologies, architectures and innovative broadband services in the context of satellite-based communication systems with regional or global coverage and integrated where appropriate with terrestrial and satellite based navigation services**. Advanced tools and technologies for wireless communications** investigate, develop, integrate and validate advanced innovative tools and wireless technologies that are necessary to facilitate a mass-market take-up of diversified wireless terminals, networks, services and applications. Particular emphasis is placed on the integration of such technologies in future generation broadband systems and networks, from cellular to broadband fixed radio access and broadband wireless local area networks for both interactive and distributive services.

A key aspect of the work to be undertaken is that of the validation and demonstration of mobile and wireless broadband multimedia technologies and generic services for novel systems and networks. The unit is responsible for all cross-programme clustering and concertation activities dealing with the subject of mobile and wireless communications both terrestrial and satellite and will take all initiatives relating to the development of the associated standards. The unit will also undertake all required dissemination and technology transfer measures (conferences, workshops), and will provide the required visibility of the research results in scientific journals.

An essential role of the unit is to provide support to policy related activities conducted by DGXIII, in the following major areas:

Satellite Telecommunications

To support European industry competitiveness in the field of satellite communication systems capable of providing innovative services such as interactive broadband multimedia services and supporting the emergence of a mass market in the downstream sectors, such as terminals, services and applications.

To support the development of spectrum efficient systems, with a view to allowing for band sharing and competition between systems and to explore new spectrum capabilities (higher frequency bands) for future longer term systems and to develop supporting technology.

To support standardization activities at regional (e.g **ETSI**) or world-wide (e.g ITU) level.

To support the co-operation mechanisms with third countries, particularly on issues requiring specific concertation and global agreement (e.g. spectrum).

Mobile Telecommunications

To support the development of new means to optimize the efficiency both of spectrum and of wireless network usage, thereby providing for capacity enhancements and performance improvements in various geographical environments.

To support standardization activities at regional (e.g. **ETSI**) or world-wide (e.g. ITU) level.

To support the co-operation mechanisms with third countries, particularly on issues requiring specific concertation and global agreement (e.g. spectrum).

Spectrum

To participate in the development of Commission policies relating to both satellite and terrestrial use of spectrum and to notably contribute to Commission and support position papers, Commission decisions, action plans and standardization mandates (e.g. Convergence issues, Euro-communications Act). This support takes the form of a participation in bilateral and multilateral working groups on matters relating to spectrum issues (ETSI, ITU, WRC) including European delegations at regional and international conferences.

To support spectrum related studies and activities leading to the definition of the spectrum required for wireless services at European (e.g. CEPT) and world-wide (e.g. ITU) level (e.g. Spectrum Green Paper).

9.2 EU TEN-Telecom

TEN-Telecom covers "Trans-European Networks for Telecommunications". It is a European Union initiative aimed at facilitating the development of the Information Society. The programme promotes the launch of trans-European and global telecommunications applications and services. TEN-Telecom was launched in June 1997 by a European Parliament and Council Decision, and will run until the end of 2001. TEN-Telecom supports deployment. Although not part of the research Framework Programme, TEN-Telecom is nevertheless a key tool for the exploitation of successful research activities from technical development to the market.

TEN-Telecom is intended to stimulate investment in the launch of new multimedia applications and generic services in the areas of public interest and to support the strategic development of global networks that will deliver such services. In this way TEN-Telecom aims at sustaining the efforts of the private and public sectors to broaden the markets, reduce the gap between information "haves" and "have-nots", and create the conditions of better access to and use of information.

In particular, under the category of "Trans-European Telecommunications Basic Networks", the development of satellite networks is supported as area TI 3.2.1 - Satellite Networks.

Satellite-based infrastructures will increasingly meet key user requirements such as personal mobility, access to high speed Internet for multimedia services, and global connectivity. The EU Action Plan on satellite communications in the information society calls for reinforcing market perspective and industry co-ordination in the satellite communications sector. TEN-Telecom will support the deployment of multimedia satellite systems, services and applications, along the following lines:

Commercial validation of applications and services using satellite infrastructures

Building on the strengths of the satellite television markets in Europe, satellite systems are well placed to support some of the development in the field of multimedia, in particular high-speed Internet-type services.

This action will concern interactive and broadcast multimedia applications and services, using asymmetric or symmetric services. It should stimulate a creative set of applications with a high socio-economic value with a business potential in a competitive environment. It should stimulate the involvement of a range of actors of the value chain (application developers, content providers, service and network providers, terminal equipment suppliers, financing bodies, etc.) committed to becoming global players.

"Application specific" technology should be avoided and reliance on existing and future European and international standards will be ensured.

The validation should lead to a proper assessment of the value of the service, including analyses of investment expenditures and operating costs, user acceptance and forecasted revenues, break-even points as well as financing means. There should be a clear commitment to proceed with deployment and commercial offering provided the validation meets proposed targets.

The validation should encompass a wide range of countries within the Community. Further expansion in Eastern countries and the non-EU Mediterranean area is advisable (companies established outside the Community can not be funded by TEN-telecom, other sources of funding need to be investigated in these cases).

Multimedia services market surveys

As a preliminary action, cost-shared surveys identifying target market segments and industry sectors for satellite multimedia services will be opened in 1998. These studies should define business and private use application scenarios, investigate the user requirements and generate traffic patterns of use for the services. The surveys should develop a quantitative market model to assess subscriber base, equipment sales and volume of demand.

The survey could cover the Community as well as Central and Eastern Europe and the Mediterranean.

Interoperation of satellites and different terrestrial networks

Satellites systems have been designed primarily to handle television broadcasting or to act as a communication backbone. The interoperation of the multimedia communication satellites systems with the terrestrial infrastructure raises new issues in traffic modelling, and system and network management.

Studies, simulation designs and pilot implementations need to be undertaken. Traffic models for the most common interactive services should be developed taking into account the likely mixed satellite/terrestrial infrastructures (e.g. return channels). Development of simulation tools should be developed to assess the impact of the various combined traffic patterns on different infrastructures and to evaluate the different space technologies.

Concepts and tools need also to be developed to manage and configure the mixed satellites/terrestrial environment, to monitor the status and the performance of the global information infrastructure and its major subsystems, and to provide support services such as integrated billing. These models and tools should be able to provide guidelines for the management of available satellite capacity, the provision of adequate quality of service and tariff structure and to promote the use of the economically most appropriate network technology for a given application.

NOTE: Reference to this section is http://www.echo.lu/tentelecom/.

9.3 EURESCOM

EURESCOM is an Institute for performing collaborative Projects on research and strategic studies in all areas of telecommunications. Founded in 1991 and located in Heidelberg, Germany, there are currently 24 Shareholders from 23 European countries involved in EURESCOM. For the most part these are the ex-PTTs of the different countries, although EURESCOM is open to any network operator or service provider who wishes to join.

EURESCOM's main function is to perform collaborative R&D projects that identify and develop new telecommunications scenarios, network solutions and advanced services. In this role it acts as a forum for sharing visions and concepts, an initiator of innovative activities, and a facilitator for common undertakings on technical issues.

Many EURESCOM projects provide inputs to ETSI standardization activities.

The following five areas make up the EURESCOM workplan:

Strategic Studies

Research into this area identifies topics deemed to be strategically important to shareholders, explores them and formulates further actions to be taken by the shareholders either individually or collectively.

Services and applications

Addresses issues associated with the development of services and applications where collaboration between the shareholders would lead to greater market access and service portability across Europe.

Middleware, service and network management

This area supports the concept of separating services from the network infrastructure, thereby adding a new layer of functionality. In the liberalization of the telecommunications market, middleware will play an important role in the seamless interworking of services across network platforms.

Internet and IP technology

With the growth in the implementation of IP based technology, IP infrastructure and service/applications are being deployed at a rapid rate. This area includes the relative usage and exploitation of connectionless versus connection-oriented services and applications.

Networking

This area covers studies associated with telecommunications access and core networks. The emphasis is on optical systems, broadband issues, and convergence of fixed and mobile networks.

EURESCOM has been particularly active in the standardization, specification and implementation of TMN Related systems, middleware and the fixed-mobile convergence. In addition, it has close ties to TINA-C, Telemanagement Forum, ATM Forum, ITU, IEEE and other bodies.

Specific projects of interest include the following:

Strategic Studies:

P847-GI:	What is TINA and is it useful for TelCos?
P846-GI:	What will we have OSS for in the Future?
P701:	Numbering for a Competitive Environment

Services and Applications:

P922-PF:	Architecture and Technology for the next Generation of Collaborative Multimedia Applications
P806-GI:	A Common Framework for QoS/Network Performance in a multi-Provider Environment

Middleware, Service and Network Management:

P925-PF:	Internet Middleware (for customized Service Bundling)
P910-GI:	Technology Assessment of Middleware for Telecommunications
P812-GI:	TMN Evolution - Service Providers' Needs for the Next Millennium

Internet

P912-PF:	Security for Mobility in IP
P911-PF:	IP Multicast

Networking

P921-PF:	UMTS Radio Access
P920-GI:	UMTS Network Aspects
P919-GI:	Evolution of Integrated Fixed and Mobile Networks
P917-GI:	BOBAN - Building and Operating Broadband Access Network
P813-PF:	Technical Development and Support for European ATM Service Introduction
P810-PF:	Wireless ATM access and advanced software techniques for mobile network architecture
P809-GI:	Support of broadband mobile and fixed services based on IN evolution
P614:	Implementation strategies for advanced access networks

URL: http://www.eurescom.de

10 Reference Models

10.1 General

This clause presents a number of reference models. The purpose is to make the reader able to compare different models that are used for different situations, and to provide interpretations of some of the models that show they often fit into the same basic structure.

In general the interfaces are associated with a label. However, these labels may be different for the models used within the different fora and standardization bodies. Therefore, the illustrations that are made for this work leave the interfaces unnamed. This would be a task for an eventual work group making use of these models.

10.2 Enterprise Models

10.2.1 Introduction of the model

Fast-packet based services are set to dominate the telecommunications business at the beginning of the new millennium. The commercial and technical reasons for using technologies such as Asynchronous Transfer Mode (ATM), Frame Relay (FR) and the Internetworking Protocol (IP) within terrestrial networks are well documented and the techniques for managing such networks are fairly well understood. Future broadband networks, including IMT2000/UMTS are likely to be based on a fast-packet architecture even if the core and access elements use different technology.

Satellite systems are set to adopt the same transport technologies as terrestrial systems and support the same applications and services. Many of the network and service management issues will also be similar, but some characteristics of satellite systems will raise different issues to be resolved. Significant differences are introduced by:

- The satellite capacity is a shared resource between users and between service providers.
- Satellite systems tend to cover several national territories from the same satellite.

Access to satellite capacity is managed in different ways at different points in the distribution chain. This is illustrated in Figure 11 for today's fixed satellite services.

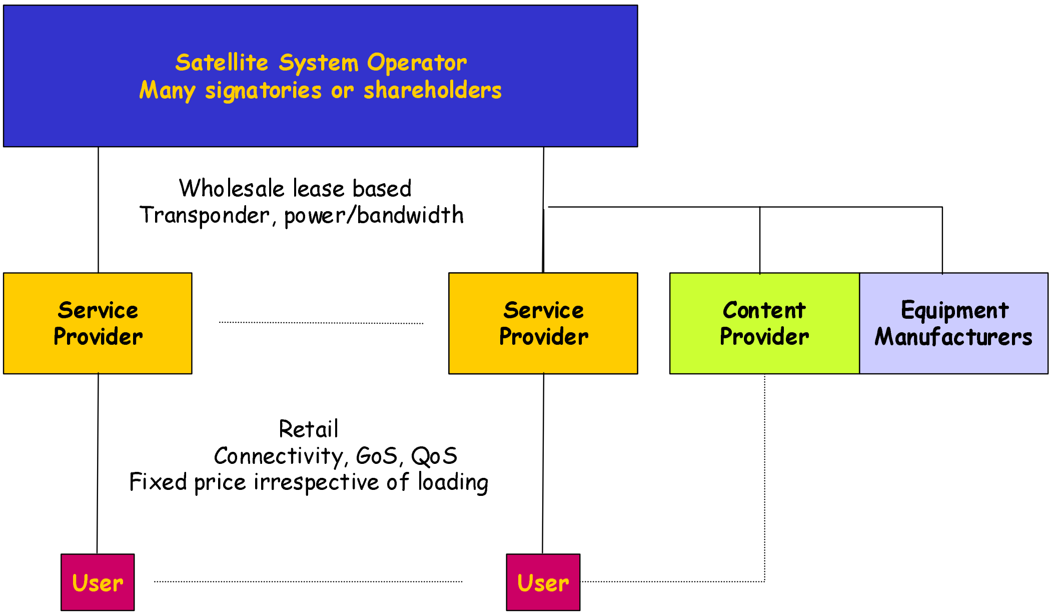


Figure 11: Current Enterprise model

The enterprise model shows that the customer/supplier relationship is based on the sale of chunks of capacity on a lease basis, irrespective of user traffic load. While this makes billing relatively simple at all points in the distribution chain it restricts the flexibility of use of the space segment.

Mobile satellite systems are not as constrained in their allocation of bandwidth to individual users, but the users are served on a first-come-first-served basis, rather than buying a guaranteed level of service. Offered bandwidth tends to be fixed by the service that is bought by the user. The capacity of individual Land Earth Station (LES) gateways is dependent on the number of channel units provided. This again can lead to relatively inefficient use of the space segment in terms of capacity occupation relative to actual user traffic carried.

Next generation satellite systems aim to provide duplex broadband services. Most such proposals talk about using ATM or "ATM-like" technology at the link layer with a packet switching function performed within the satellite system. This is either supported by an on-board switch element or by a "virtual switch" made up of a switching function on the ground and a sophisticated media access control (MAC) technique. Both of these architectures are capable of supporting distributed management facilities which could enable service providers to manage the grade of service and cost to their customers on a session-by-session basis. This represents a departure from the traditional approach and will require new commercial and technical interfaces between operators and service providers.

Future satellite systems will need a different approach to management of space segment capacity in order to increase the number of simultaneous users and reduce the cost per bit. This will require a more flexible and dynamic approach to system management, which takes more account of service provider and customer requirements. The use of packet based transport would appear to be the ideal technology to achieve this due to inherent statistical multiplexing capabilities. The application of dynamic management will depend on the architecture of the system itself and the facilities required by the service providers.

10.2.2 Requirements for Service Providers

To identify a satellite service provider's requirements it is useful to draw on some existing access network management developments:

- There are similarities between the terrestrial access networks now being developed and planned BSM system proposals.
- Future access network architectures may use ATM as the transport mechanism in order to benefit from multiplexing in the access network itself.
- Many potential satellite service providers will also have terrestrial access networks that are managed in a particular way and they will want to re-use their management resources in the satellite domain in order to provide a consistent set of services and reduce costs.
- A consistent management philosophy across the terrestrial and satellite domains would also help to achieve the seamless integration of satellite and terrestrial networks.

From an operational viewpoint it will be beneficial for the service provider to have a standardized management interface to different types of access systems. This is also true for the different types of satellite systems.

For instance, a service provider (SP) may offer services to the same customers over L/S-band UMTS based systems, DVB-based systems in the Ku-band and Ka-band based system with ATM as baseline protocol. The Internet Protocol (IP), will likely be used over all systems.

The SP may also choose to buy capacity from more than one satellite operator in each class, depending on where shopping for capacity is most beneficial, and depending to some degree on the ability that the users have to access different satellite systems.

An influential factor will be on how long terms the capacity is sold. Users without a motorized antenna most probably will not want to physically readjust their equipment too often, but on a long-term basis they may still be willing to do so, providing their terminal has the ability to handle the other system.

The "convenience factor" for the user will play an important role in the service provider enterprise scenario. A multi-protocol terminal for GEO satellites with a steerable antenna would enable the user to take advantage of different offers from different systems.

It can be considered that:

- Users subscribe to the satellite services via a service provider, and in general not directly from the satellite system owner or operator.
- Users can have agreements with several service providers.
- Service providers can also have agreements with other access providers (than satellite).
- Users can have separate agreements with content providers.
- Service providers buy wholesale and sell retail. *There has to be competition*.
- Equipment manufacturers may interface with everyone.

The figure below illustrates the enterprise model used as a starting point for the discussion in this clause, while the following figure shows a modified version taking into account the possibility of users having relationships with multiple service providers.

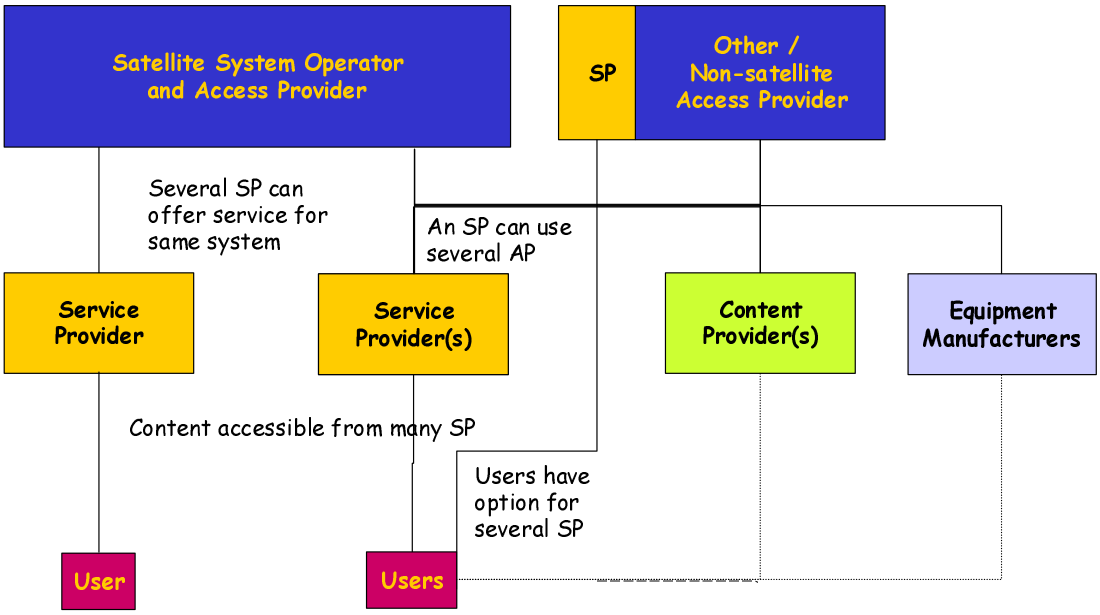


Figure 12: Candidate Enterprise model for BSM

10.3 Network Logical Models

10.3.1 Four Basic Domains

The following figure shows the basic model for relationships between the four domains identified in the GMM report [19] in line with the ITU-T approach [34]. The interfaces are indicated, but not named. Any of these interfaces can potentially be subject to standardization.

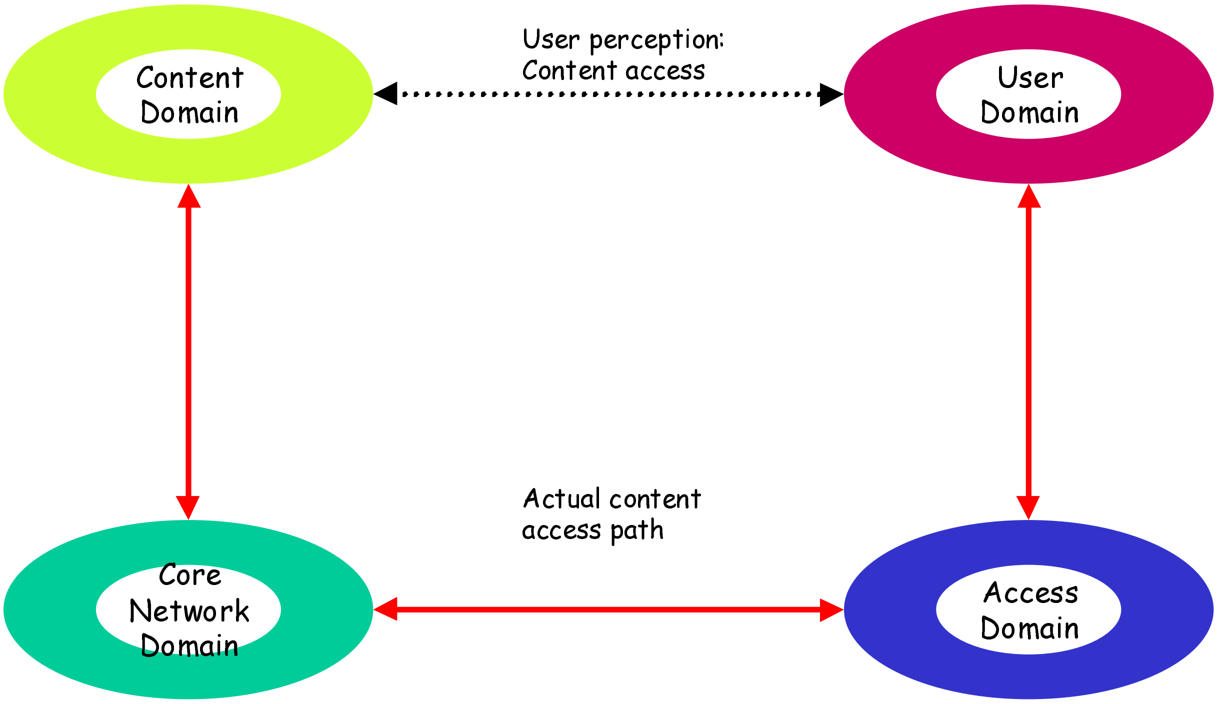


Figure 13: Logical model based on four basic domains

10.3.2 Extended Logical Model

The next figure expands the access domain into the gateway, satellite and terminal, the user domain into application and users, and includes the service provider and operator. The operator is basically associated with this specific satellite system, and may sell satellite capacity to several service providers. The service providers resell capacity to end users, possibly as part of a larger service concept. The service provider may provide access to users over several media, and in fact the same users may use different media, such as ADSL, LMDS or satellite, depending upon their current location. This illustrates why issues like Virtual Home Environment are important. In such cases, satellites must be essentially transparent to the users.

As a further refinement of the logical model, in the next figure, content broker is included. The content broker searches for and offers customized content to end users. The figure also illustrates that the service provider may demand some control over the terminal and gateway, which may also be the case for the operator. A user will have a subscription via a service provider, but can also subscribe to specific content from one of many content brokers. Note that this model now includes most of the essential features of the enterprise models discussed in subclause 10.2.

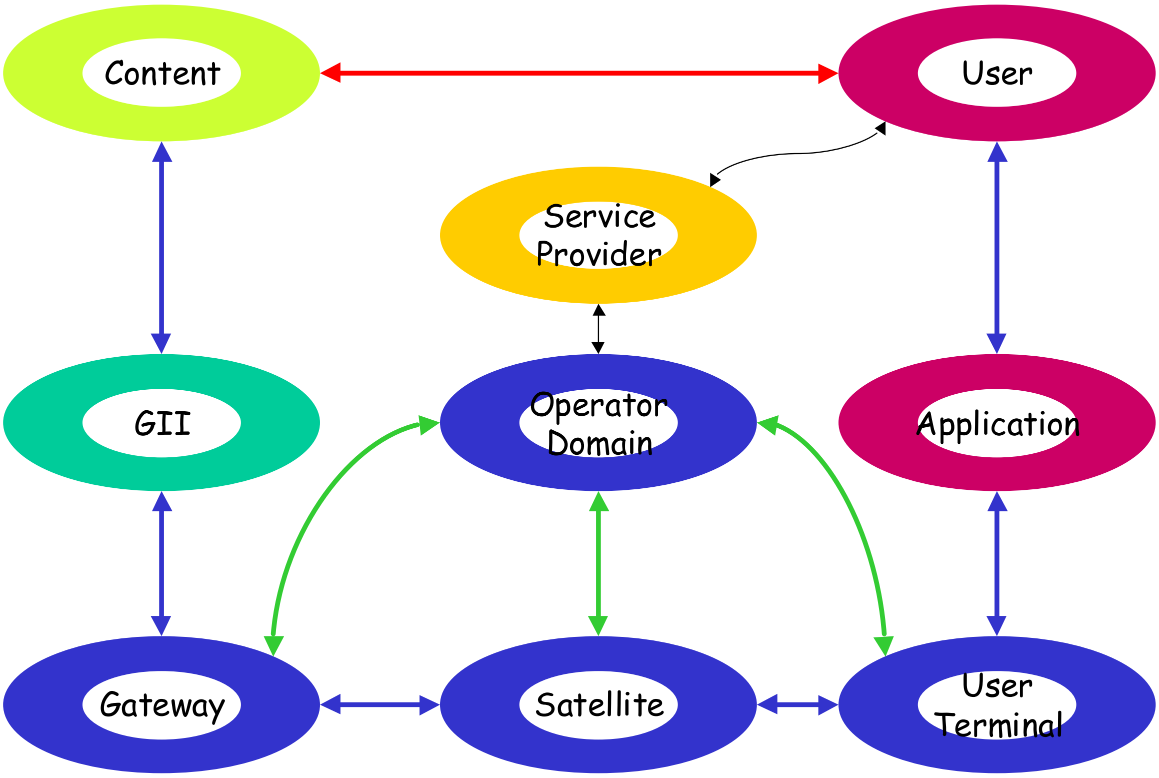


Figure 14: Extended logical model, based upon four basic domains

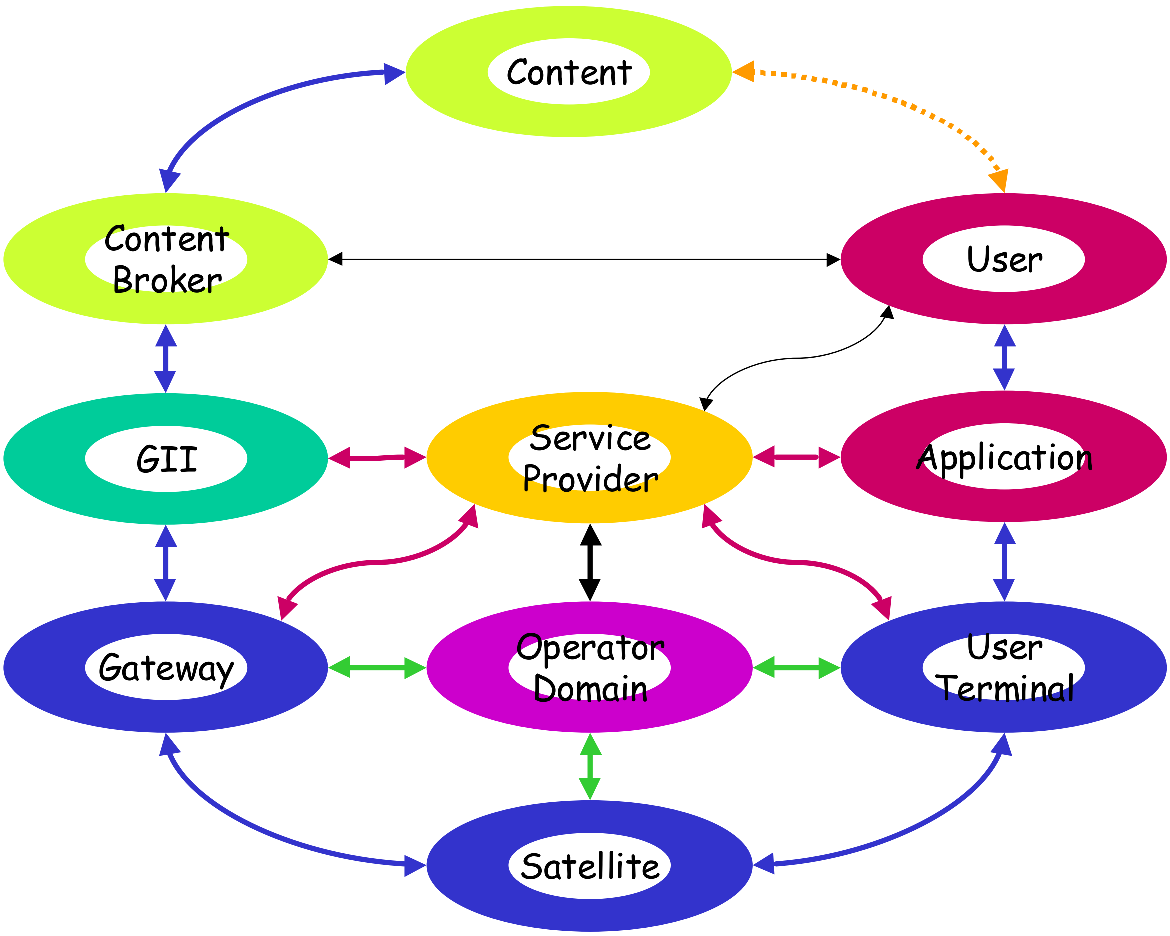


Figure 15: Extended logical model including content broker

10.3.3 Model including Lawful Interception

Figure 16 illustrates the scenario with Lawful Interception (LI) included. It also depicts the situation where a user communicates with another user directly via satellite, possibly via an inter-satellite link. Entities like satellite operation and network operation are included, as these are relevant with respect to LI. In this figure, the domains are given brief names, so that it is possible to construct interface names indicating i.e. the L1-A1, the N1-M1, M1-S1 interface etc. The figure here illustrates the number of possible interfaces and thus the potential complexity involved in implementing LI, as an interceptor needs to have access not only to the traffic data, but also call records etc.

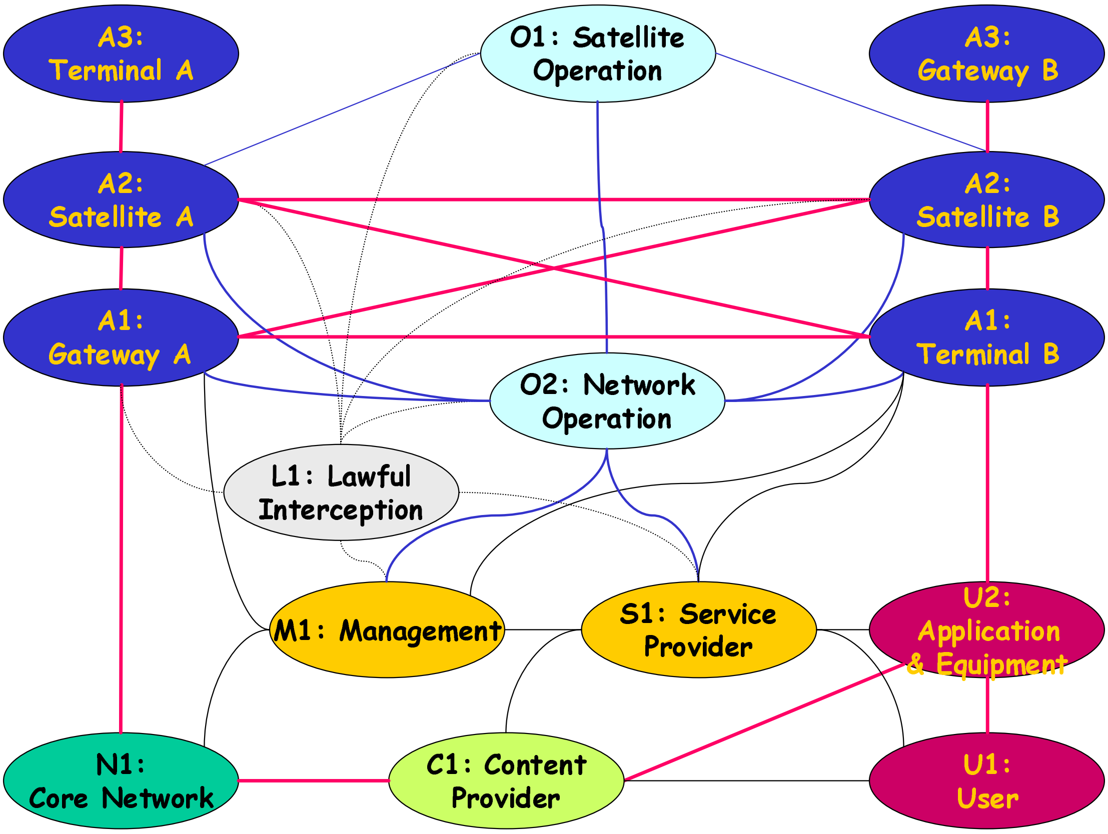


Figure 16: Logical relationships including Lawful Interception

10.3.4 UMTS/3GPP Network Model

The UMTS / 3GPP reference model emphasizes the location management aspect. The terms mobility management and location management imply the same thing with respect to BSM, which is determining a user's location in the network (i.e. the beam they are in). Detailed models can be found in the 3GPP documents, which illustrate details of the location management concept.

It is the fixed-mobile convergence trend that motivates introducing the UMTS reference model. While BSM systems can of course be mobile, given suitable technology, it is also worth noting that even when the terminals are fixed, users can roam between different terminals with a subscriber identification card/module (SIM) similar to or possibly the same as in UMTS. Which service provider a SIM card is associated with will depend upon the service provider scenario.

Location management may be required for BSM systems, and in such a case it should be based on already developed and proven concepts. This implies that requirements for satellite systems must be integrated into IN-nodes and databases in the GII.

UMTS is more suited for data and mobile multimedia than GSM. For instance, with UMTS it is possible that data traffic can be routed via UMTS, while voice can be kept in GSM. This is a likely scenario, at least for a transition period. The model reflects this by having the ability to route the received data into the PSTN network or into the general GII for e.g. Internet traffic.

It is also worth noting that the UMTS reference model can be mapped onto the four-domain structure, as shown in the lower part of Figure 17.

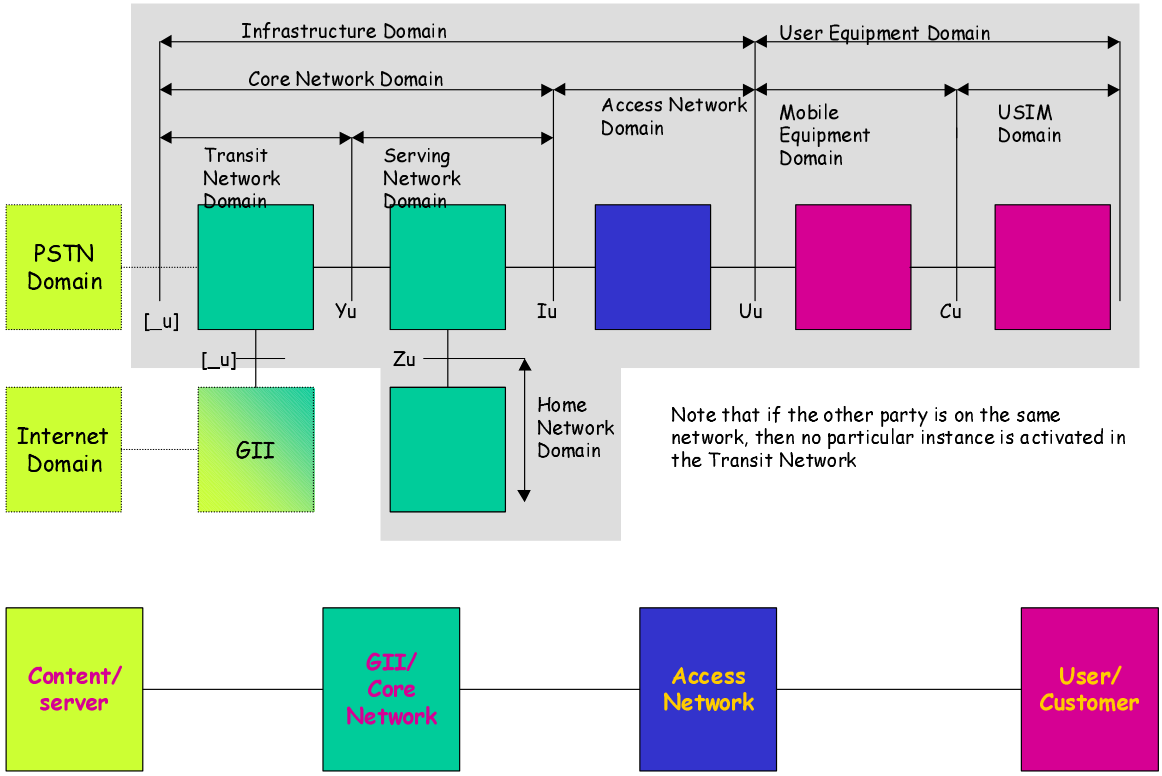


Figure 17: The UMTS and 3GPP network model

10.4 Access Network (AN) Architectural Models

The most important application of BSM systems is to provide broadband access directly to end users, and therefore the satellite network normally acts as an access network. As such it is relevant to identify the reference models already being used within other bodies for access network architectures.

10.4.1 ITU-T Work on Satellites in Access Network

ITU-T Recommendation G.902 [24] is a framework recommendation on the architecture and functions of access networks. It describes access types, management and service node aspects. An AN as defined by ITU-T Recommendation G.902 [24] is bound by User Network Interfaces (UNI) at the customer side and Service Node Interfaces (SNI) at the core network side and does not interpret user-network signalling. ITU-T Recommendation G.902 [24] builds on the concepts that were developed in ETSI in the context of the narrowband SNI (V5) to encompass also broadband access networks (VB5).

ITU-T activities on Access Networks are carried out by various SGs under the lead of SG15. SG15 has allocated the co-ordination of work on Access Networks to Q.1/15.

The ITU-T model also comprises the 4 main components ITU-T:

- Service Function: such as Video Server and Video Service Provider for video service;
- Core Network: such as Telecommunication Network, PSTN, N-ISDN, B-ISDN;
- Access Network: such as CATV Network, ADSL/VDSL, Fibre Network, RITL, Satellite;
- CPN (Customer Premise Network): such as Access Unit, TV, PC, Phone, Wireless Phone.

The various interface reference points are:

- $SNIS_n$: between Service Function and Access Network (n - seq. number);
- SNI_{Cn}: between Core Network and Access Network (n - seq. number);
- XNI_{XXn}: between Access Network and CPN (x: type of access technology/medium);
- L_n: between Access Networks;
- Q_n: between Access Network and Management Agent/Network.

The following XNI_{XXn} were identified in the scenarios:

- XNI_{CPn} For copper interfaces (e.g. UNI for ISDN);
- XNI_{CXn} For Coax interfaces (e.g. CATV);
- $XNIS_{An}$ For Satellite interfaces (e.g. ptp or broadcast);
- XNI_{WIn} For wireless interfaces (e.g. RITL);
- XNI_{OPn} For Optical (Passive) interfaces (e.g. BPON);
- XNI_{LAn} For LAN interfaces (e.g. 10-BASE-T).

The following scenario describes B-ISDN, Internet and mobile communications services that are supported by satellite networks and the pathways by which they can be delivered to the customer premise. Video and broadcast services via satellite are not part of this scenario.

B-ISDN

Satellite networks capable of supporting B-ISDN can deliver full asynchronous transfer mode services either directly to a customer premise earth station ("access unit") or via a gateway earth station which is not customer equipment. The same satellite system can carry B-ISDN traffic to and from a terrestrial carrier network through such a gateway. These paths are represented by the set of reference points L_A, $XNIS_{A1}$, SNI_{C8} and XNI_{CP5}. Depending on the characteristics of the satellite network, key interfaces may be present at points SNI_{C8}, XNI_{CP5}. These interfaces maintain end-to-end ATM quality of service parameters between the satellite and terrestrial carrier networks or between the satellite network and the Customer Premise network (CPN).

Internet

In the case of the Internet backbone satellite network, the Internet service provider uses the satellite network to deliver Internet traffic either directly to the customer premise or to a shared gateway. This service is represented by reference points L_B, XNI_{CO5} and $XNIS_{A1}$. Since certain TCP/IP flow and congestion control protocols can perform relatively poorly over high-delay links, key interfaces may be present at reference points L_B, $XNIS_{A1}$ and (possibly) XNI_{CO1} to provide optimal TCP/IP interworking between the satellite and terrestrial network pathways.

Mobile Satellite Services

Mobile satellite systems provide voice, fax and low-rate data services to the customer. Several service pathways are indicated by reference points XNI_{WI3}, XNI_{WI1}, L_F, SNI_{C8}, XNI_{CO5}, XNI_{CO1}, and $XNIS_{A1}$. In this case, traffic to and from the mobile user appliances flows into the mobile-satellite service network (XNI_{WI3}, XNI_{WI1}). From there it can be delivered to customer premises via several possible paths (for example, through $XNIS_{A1}$, or L_F - SNI_{C8}- XNI_{CP1}). The speech compression techniques typically used in mobile services may indicate a need for key interfaces between the mobile appliance and the fixed appliance in order to maintain voice quality of service. Candidate reference points for this type of interface are $XNIS_{A1}$, XNI_{CP5}, $SNI_{C8}$and/or $XNIS_{A1}$.

It should be noted that several combinations of these services can be supported by this scenario (e.g. mobile Internet); however, for purposes of brevity they are not discussed here.

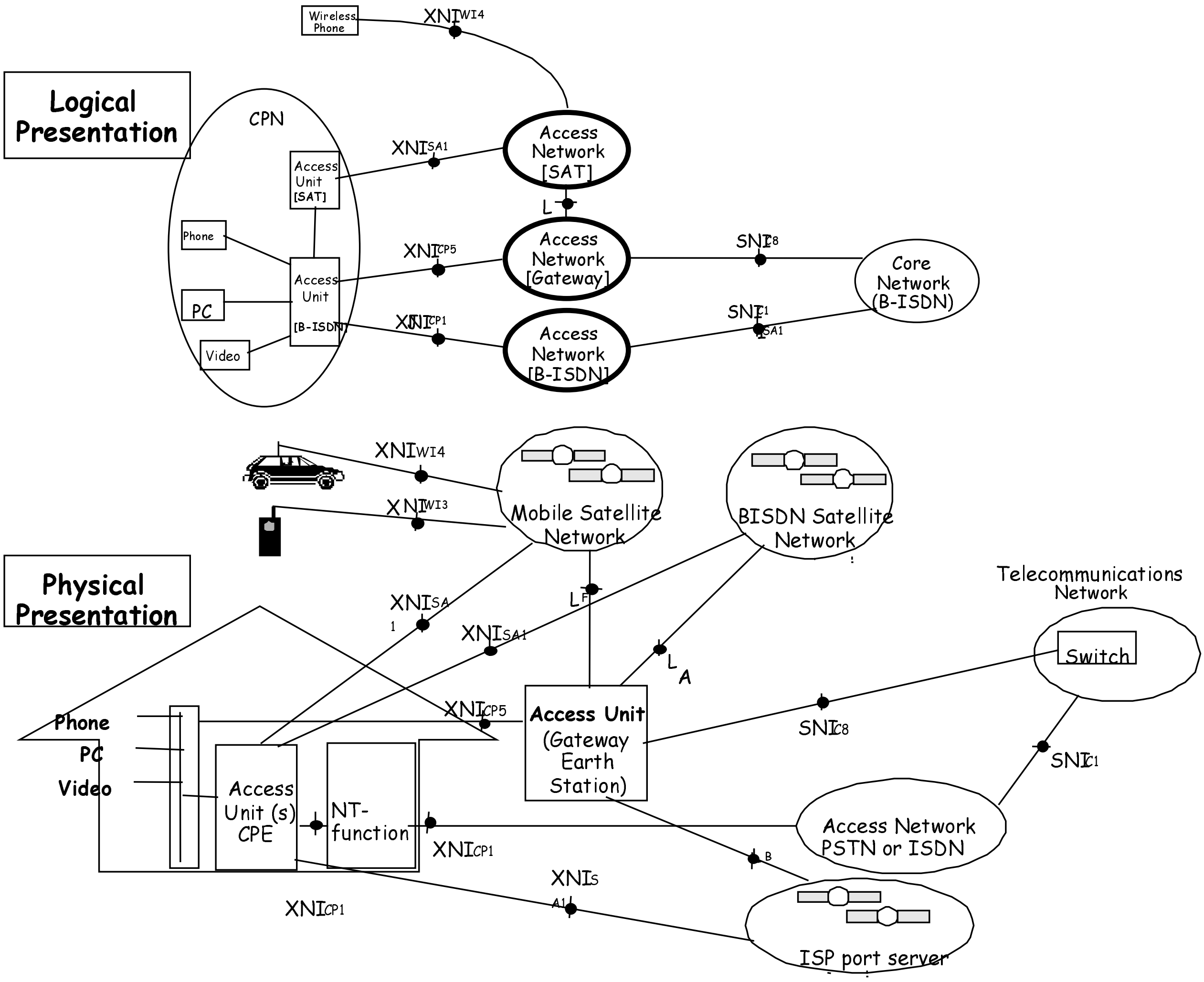


Figure 18: Access Network Transport - Access using satellites scenario

10.4.2 FSAN

The Full Service Access Network Initiative (FSAN) has produced a specification focusing on access elements. It is divided into the following sections:

- Services and deployment - the first two sections explain the dimensioning and;
- Architecture and performance - performance requirements of the common access elements;
- Transport;
- Infrastructure - physical realization requirements;
- Signalling and control - access specific requirements;
- Operations, Administration, and Maintenance.

10.4.2.1 FSAN Architecture

The most important result from the Full Service Access Network Initiative is the recognition that all operators require the same elements in their access network, as shown in the generic FSAN architecture below.

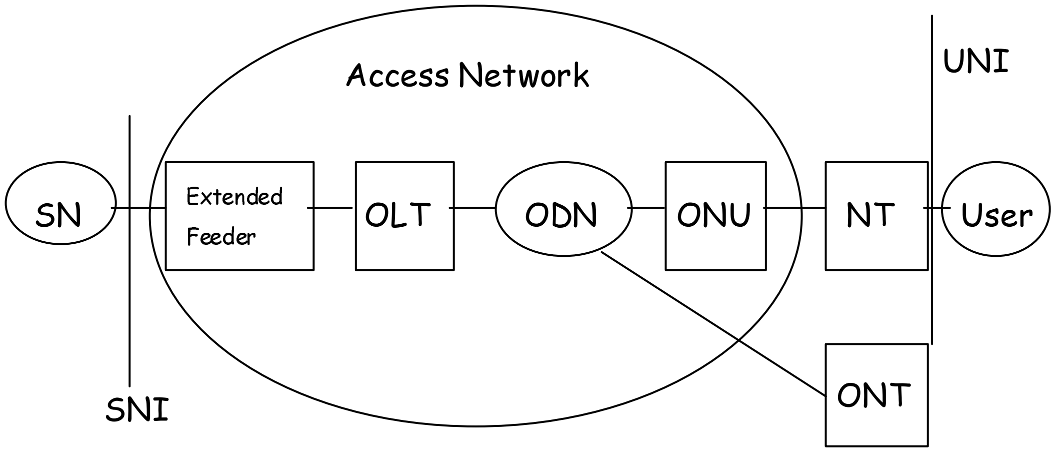


Figure 19: Generic FSAN Architecture

The key components in the generic FSAN architecture are:

- The Service Node (SN), which is the network element that provides access to the various switched and or permanent telecommunications services. For switched services the SN provides call control, connection control and resource handling functions.
- The Access Network (AN), which refers to the equipment used to provide the transport capability for the provision of telecommunication services between a Service Node Interface (SNI) and one or more associated User Network Interfaces (UNI). User signalling is carried transparently by the AN.
- The Extender Feeder, which can be used to provide the physical resources to extend the AN over larger distances.
- The Optical Line Termination (OLT), which provides the network side interface of the AN. An OLT can be connected to more than one ODN.
- The Optical Distribution Network (ODN) refers to the point-to-multipoint fibre network used to transport services in a common format from the OLT to the ONU/ONT. The ODN may consist of Passive Optical Networks (PONs).
- The Optical Network Unit/Termination (ONU/ONT) provides the customer side-interface of the AN. It is connected to the ODN. For some operators the ONU and NT functions will be combined into one physical resource referred to as an ONT.
- The Network Termination (NT) is the physical resource which resides in the customer premises and forms the boundary of the AN. This interface is referred to as the User Network Interface (UNI). The NT provides the onward transmission of services over building wiring to Customer Premise Equipment (CPE).

The FSAN architecture is based on the delivery of Asynchronous Transfer Mode (ATM) narrowband and broadband services using a selection of drop media to take the required services from the remote node to the customer termination unit. The key drop modes are a combination of fibre and copper Asymmetrical Digital Subscriber Line (ADSL) and Very high speed Digital Subscriber Line (VDSL) for Fibre to the Exchange, Kerb and Cabin, with fibre optic only networks for fibre to the home networks. The major differences come from the positioning of the ONU (Optical Network Unit). Figure 20 below shows the system architectures.

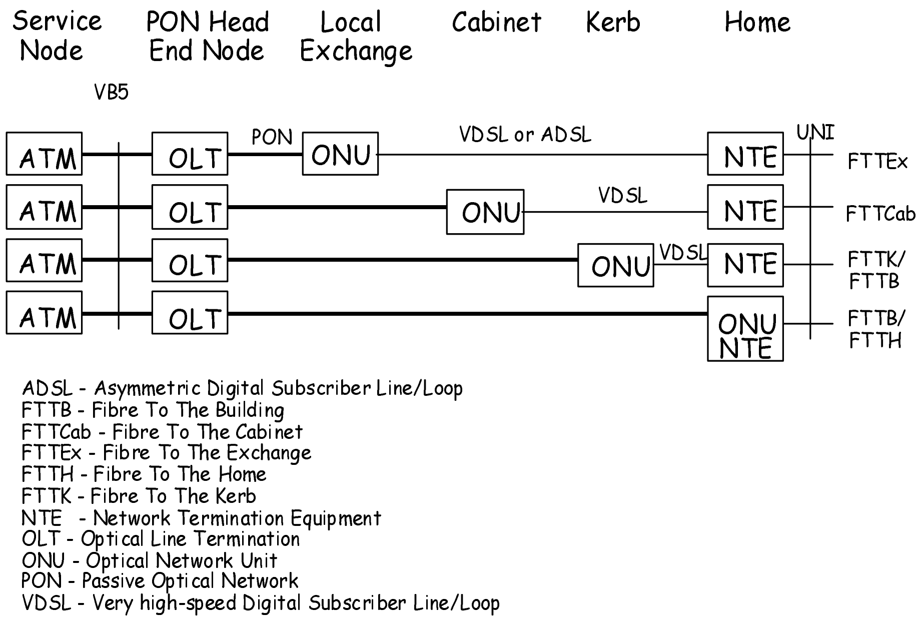


Figure 20: FSAN Common Network Elements

10.4.2.2 SNI and UNI architectures

The FSAN Common Technical Specification specifies the use of V interfaces at the digital SNI for the support of broadband or combined narrow-band and broadband access networks. There are two types of VB interfaces VB5.1 and VB5.2 both standardized within the ITU and ETSI. The functionality of the VB5.1 interface is to:

- Define the access type, ATM multiplexing and cross-connectivity in the AN at the Virtual Path (VP) and Virtual Connection (VC) level. This includes the allocation of VPs and VCs. This is required to provide the multiplexed and demultiplexed streams from the UNI to the SNI and vice-versa. VB5.1 supports the use of the ATM layer for user plane, control plane and management plane links.

- Define the time critical management functions and real time co-ordination between the AN and the SN. This is achieved through a Real Time Management plane Co-ordination (RTMC) protocol.

- Definition of the timing and Operation Administration and Maintenance (OAM) flows between the AN and the SN.

This functionality is shown in the figure below. The Ia interface is the VB5.1 interface point adjacent to the AN equipment and the Ib interface is the VB5.1 interface point adjacent to the SN equipment.

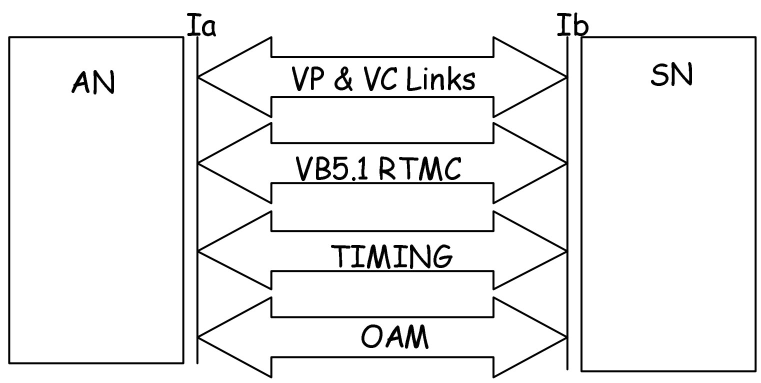


Figure 21: VB5.1 Functions

The following key issues should also be noted:

- In VB5.1 the AN transparently passes on any user signalling and charging information directly to the SN.
- All call control and associated connection control resides in the SN.
- The selection of a Service Provider (SP) by the AN, based on user signalling is not possible since this would require the existence of SN functionality in the AN.
- The establishment of VC and VPs in the AN is under the control of the SN at all times.

The VB5.1 interface architecture is defined in detail by the ITU and ETSI in documents ITU-T Recommendation G.967.1 [25] and EN 301 005 [12] respectively.

VB5.2 provides the additional functionality of been able to establish on demand flexible provisioned VC and VP connectivity in the AN under the control of the SN. This achieved through the addition of a Broadband Bearer Connection (B-BCC) protocol that provides the mechanism by which the SN can request the AN to establish, modify and release VP and VC links on demand in the AN, based on negotiated connection attributes such as traffic descriptors and Grade of Service/Quality of Service parameters. The VB5.2 interface architecture is defined in detail by the ITU and ETSI in documents ITU-T Recommendation G.967.2 [26] and EN 301 217 [14] respectively.

With respect to the UNI for the support of broadband access networks, the FSAN Common Technical Specification specifies the use of the latest ATM Forum UNI architecture, presently UNI 3.1 [37].

10.4.2.3 FSAN and Satellite Systems

While the FSAN initiative has clearly to date been focussed exclusively on terrestrial optical and wireline technologies, the user applications and the approach to network management can be mapped onto the proposed future broadband satellite systems.

Basically there are two options for generic satellite access networks, the first being to use transparent satellites which are capable of delivering packet based services over existing systems using ITU-T Recommendation X.25 [72], ATM, Frame Relay and IP technology and secondly the next generation satellites offering Onboard Processing (OBP) capabilities. With transparent systems the satellite access network can be considered as a bent pipe delivery system since no processing is done above the physical layer.

However with the next generation OBP systems the aim is to combine the multiplexing capability of ATM transport with advanced Medium Access Control (MAC) processing on board. With OBP, ATM layer and above processing will be carried out on board the satellite. This principle is nicely compatible with the FSAN architecture, which also assumes an ATM transport platform and performs multiplexing in the access network through the ONU. FSAN further maps onto broadband satellite systems with the key network intelligence being at the SN so that the AN can be managed from the SN. This bodes well for satellite systems since it can reduce the intelligence required on board to the minimum for operational reasons and reliability.

One approach to mapping FSAN onto the proposed BSM systems is shown in Figure 22 below.

This mapping of FSAN is based on the assumptions that:

- a gateway satellite earth station can be considered as the satellite equivalent of an OLT;
- the satellite access network can be considered as the satellite equivalent of the ODN with the satellite(s) acting as ONUs;
- a remote satellite terminal can be considered as the satellite equivalent of a terrestrial NT unit.

The above assumptions can be used for mapping both standard transparent satellite systems and the new OBP proposals. However, the OBP issues needs further investigation since the level of intelligence on-board could move the satellite into areas traditionally addressed at the SN.

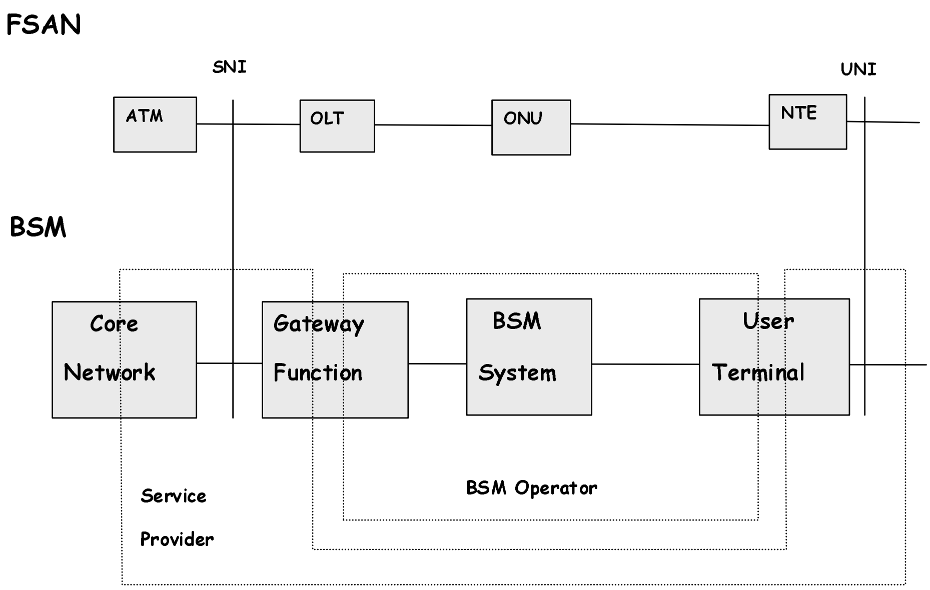


Figure 22: FSAN Applied to BSM

To better show the relationship to the basic four domain model, the figure above can be redrawn as in Figure 23 below. This figure also illustrates that both BSM operators and service providers will need to control parts of the terminal and gateways. The precise definitions of these interfaces need to be sorted out. One of the most important issues is the location of the UNI - is this at the user premises as an interface on the User Terminal as depicted in Figure 22, or could it be e.g. at the gateway station? The answer is dependent on the specific satellite system network architecture, and as such it is likely that different scenarios will have to be considered.

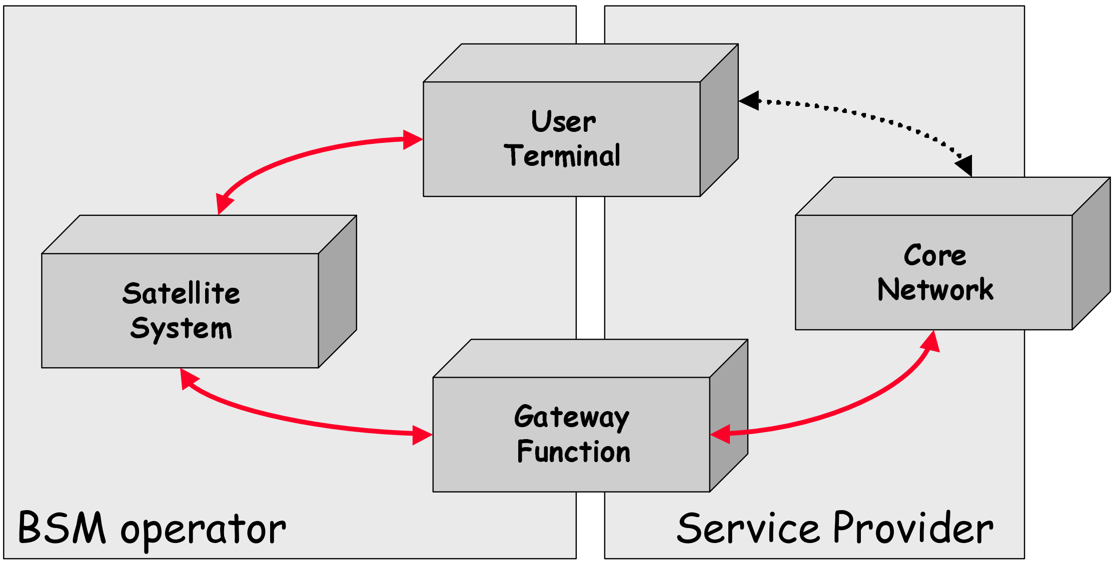


Figure 23: Redrawing of the FSAN model

10.4.3 Comparison of AN Reference Models

It should be recognized that the choice of external interfaces is as much a commercial and regulatory issue as a technical question. This means that a particular interface may be perceived by one standards group as AN internal, while another group may pursue the same interface as AN external. The undesirable but unavoidable consequence of the classification of interfaces as internal or external is therefore that some interfaces will appear under both.

The figure below shows the reference models that are used in ETSI, the ITU-T, the ATM Forum, DAVIC 1.0 and in DVB. The figure highlights the different terms that are used and their relationship. It should be noted that there is less resemblance between the models than one would think at first sight; this is due to differences in interface and functional definitions.

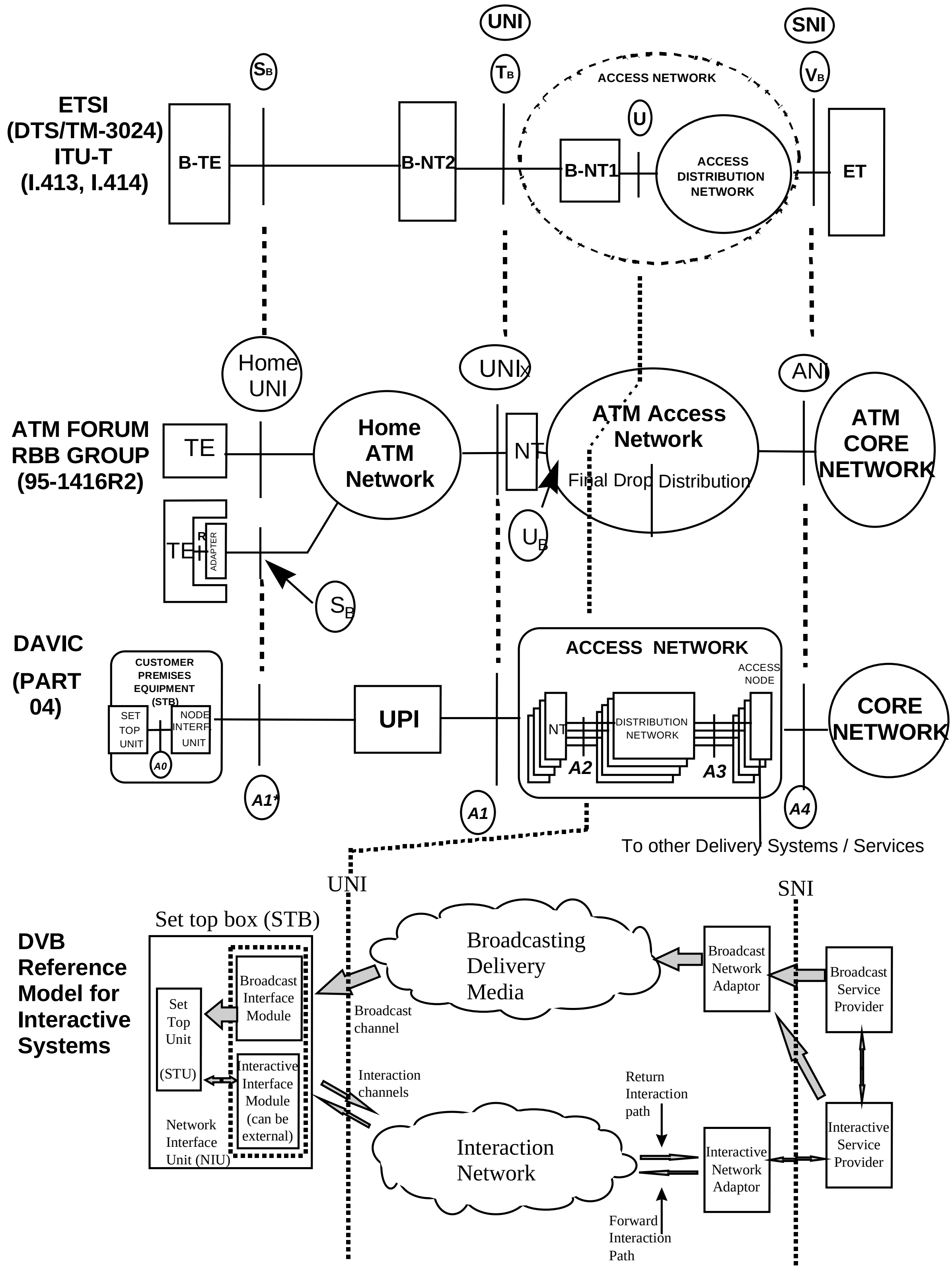


Figure 24: Access network reference models [8]

The Digital Audio Visual Council (DAVIC) Specification part 04 gives an overview of delivery system architecture and interfaces. DAVIC has classified networked delivery systems into cabled, hertzian and hybrid networks. The delivery system is partitioned into a core network (CN) and an access network (AN). A number of wired access network types are distinguished. These are referred to by DAVIC as Asymmetric Digital Subscriber Line (ADSL) AN, Very high bit rate Digital Subscriber Line (VDSL) AN, Fibre To The Curb (FTTC) AN, and Fibre To The Home (FTTH) AN. FTTH ANs are assumed to use "active" Network Terminations (NT). The other types may use "passive" NTs. Terrestrial broadcasting networks have also been addressed by a recent DAVIC call for proposals.

Asynchronous Transfer Mode (ATM) Forum AF-RBB-0099.000 [38] documents the progress of the work in the ATM Forum Residential Broadband (RBB) working group. It shows the RBB reference architecture and the interfaces for which the ATM Forum seeks specifications.

Annex F, entitled "Synergy between Terrestrial and Satellite Broadband Access Proposals and Standards", considers in detail the different approaches to access network standards and their applicability to BSM systems. The objective is to identify areas where ETSI work on BSM system standards could be based on existing recognized and adopted terrestrial access network standards. An overview of the various network architectures and management approaches adopted by industry groups such as the FSAN consortium, the ATM Forum and DAVIC is provided and relationships with ITU and ETSI standards are identified. FSAN is covered in the most detail because it provides a common architecture, interface and network management approach for access networks that could be applied to the BSM case. Areas of synergy and conflict are discussed and a possible way forward for ETSI BSM standards work is proposed.

Common Elements

After reviewing the relevant standards and initiatives it is clear that the following issues are common and hence should be considered for adoption in any future broadband satellite system proposal:

- The use of the ETSI/ITU VB5 architecture at the SNI.
- The use of the ATM Forum UNI, NNI and PNNI architectures at the UNI interface.
- The use of TMN based manager to manager communications for end to end service management.
- The use of some form of RTMC, B-BCC and ITU-T Recommendation Q.2931 [73] signalling.
- The common use of physical interfaces and service sets.
- The common use of asymmetric and symmetrical services.

The above issues are shown schematically in Figures 25 and 26 below, which show the domains and reference points for the various initiatives mapped onto a satellite access network.

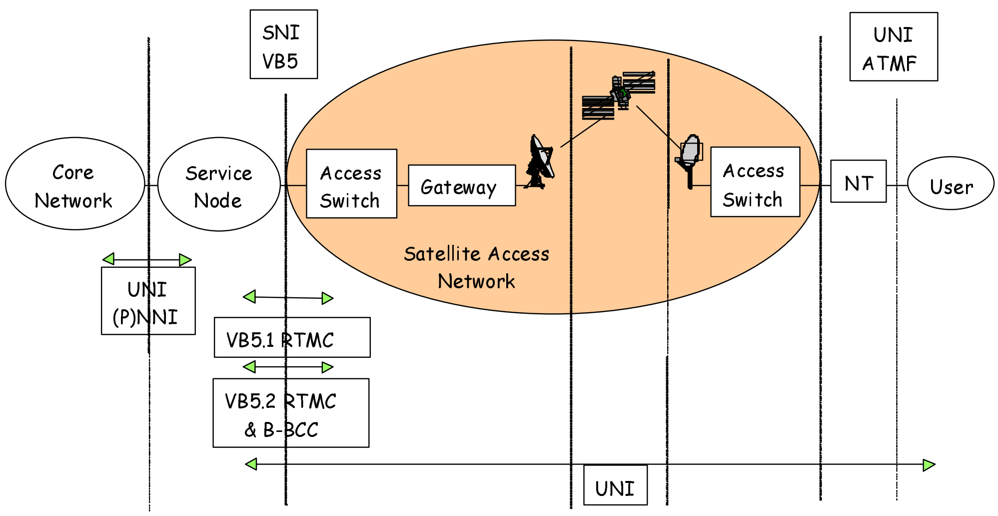


Figure 25: Common Interface Domains

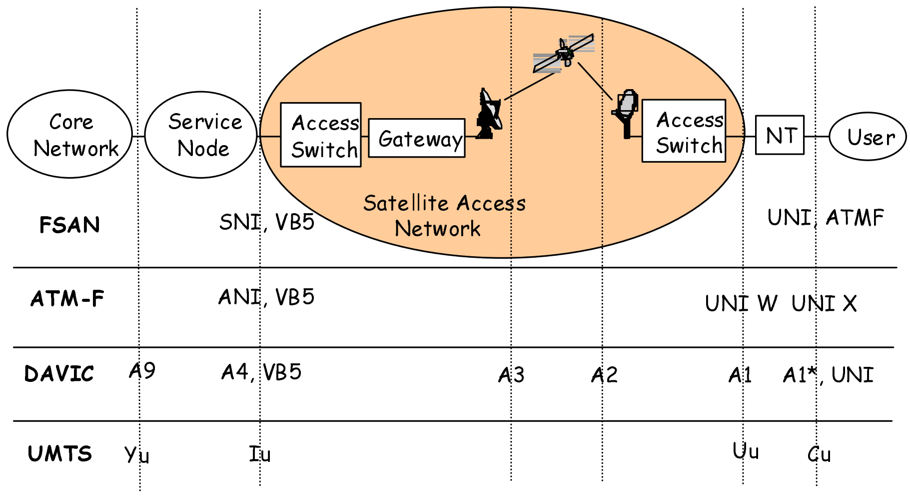


Figure 26: Cross Interface Signalling

Key Differences

However, the following differences exist across the various standards and initiatives:

- The FSAN approach is based on transparent signalling and no intelligence in the access network. This ideally maps onto present day transparent bent pipe satellite systems, but may raise issues with OBP satellite systems, which generally include some intelligence. FSAN architecture is also based on management from the core network, which is a good approach for satellite applications since it reduces the intelligence needed on board the satellite.

- The ATM Forum approach is based on active signalling and ATM layer processing within the access network which may map onto future broadband systems using OBP but is incompatible with present day transparent systems. However the use of signalling proxy agents may be able to resolve this issue by moving the intelligence back to the core network.

- TIA activities have identified that a different ATM interface will be required at the satellite to gateway, satellite to satellite and satellite to remote terminal interfaces dependent on the network configuration e.g. ATM interconnect or full mesh architecture and connection between public or private networks.

- The DAVIC specification highlights the issue of where to locate the network management and intelligence boundaries for example who manages the user terminal equipment, etc.

- Finally there is the issue of running the VB5 RTMC and B-BCC over a satellite access link, i.e. will the round trip access delay effect their operation.

Conclusion

In conclusion it is recommended that standardization of future broadband satellite systems should consider the use of the ITU/ETSI VB5 and ATM Forum UNI interfaces at the Service Node and Access Node Interfaces of their networks since these architectures are common across all the various standards.

10.5 Terminal

This subclause details interfaces in a possible terminal. The modules found are in this case include a User Identification Module, UIM, Terminal Operational Support Systems (OSS), Access management, access unit, middleware and other general terminal functions. One could easily also introduce more interfaces, such as for example between the indoor and outdoor unit. The interfaces named are those that are found in GSM/UMTS. A possible standardization process may decide to work on only some of these interfaces and not on others. I.e. a UIM has to comply with standards if standard modules from UMTS are to be used. Applications outside the terminal, like a browser, may need a standard way of interfacing with the middleware domain. An implementation of for instance FSAN allowing different service providers on different systems to manage terminals consistently will require some standard related to management.

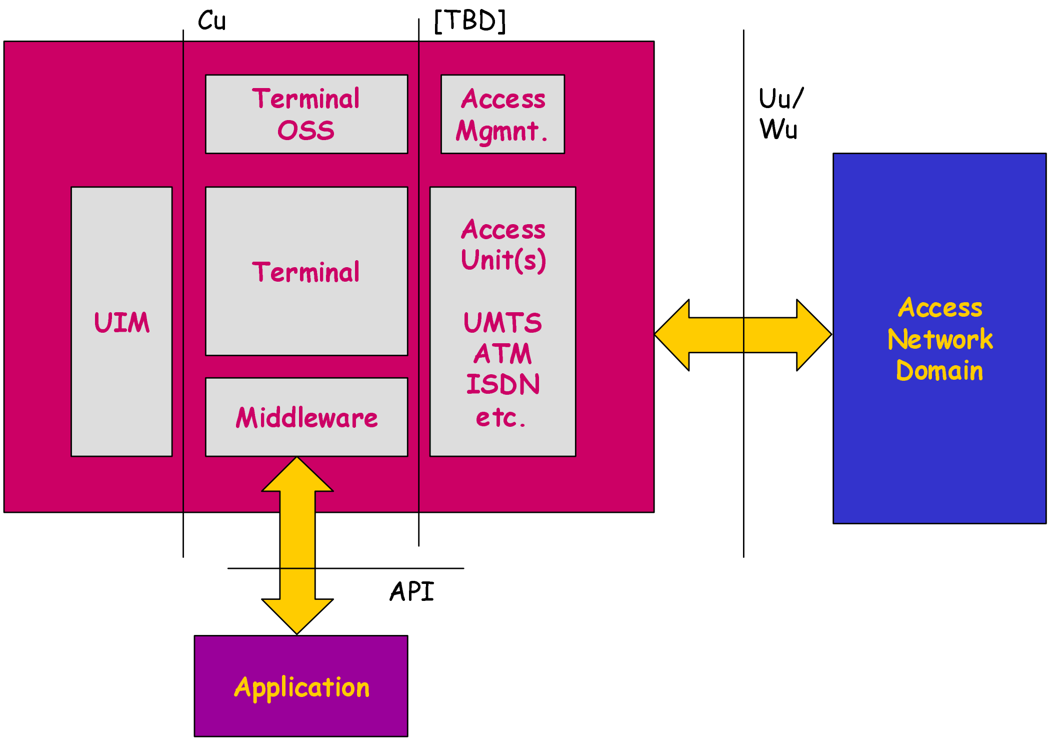


Figure 27: Candidate reference model for BSM terminal

10.6 Management Model

10.6.1 TMN Layered Architecture

The ITU's Telecommunications Management Network (TMN) layered architecture, defined in ITU-T Recommendation M.3010 [29], is shown schematically in Figure 28.

The Network Element Layer (NEL) contains the physical resources called network elements (NE). These include elements such as Line Terminations (LT), Network Terminations (NT), access switches, gateways, etc.

The Element Management Layer (EML) manages the physical resources and provides a common interface to the Network Management Layer (NML) for the various types of managed network elements. This layer is responsible for understanding the details of manufacturer specific information and equipment thus removing the need for this complexity of information to be held at the NML. It contains an operations system (OS) which would normally deals with functions such as configuration, fault management and performance monitoring of the physical resources which reside in the access network. The interface between the EML OS (also known as the Element Manager) and the NML OS(s) is seen as a point for standardization. Typical management functions at this level are configuration, fault management and performance monitoring.

The Network Management Layer (NML) provides the functionality to bind the individual network elements into the managed network. This is the layer where the co-ordination of multiple EML OSs is undertaken to provide overall network supervision. It provides the end to end configuration of services and also provides links between different network components to form a complete network.

The Service Management Layer (SML) manages the services supported by the network and is less concerned with the physical nature of the network but more with the overall function. It also provides the customer interface. Service creation, provision, cessation, billing and accounting information are some of the functions supported by this layer.

The Business Management Layer (BML) is concerned with managing the complete undertaking, in accordance with the business objectives and customer requirements.

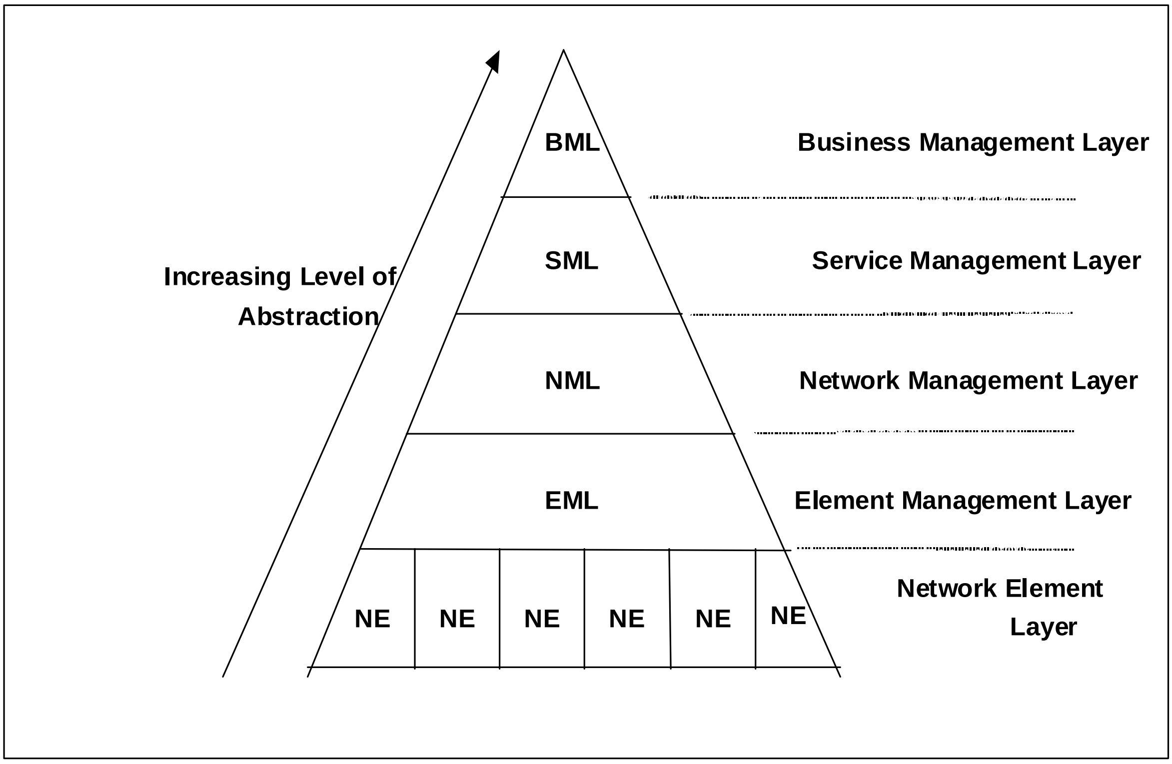


Figure 28: TMN Network Management Hierarchy

10.6.2 FSAN Management Architecture

The FSAN network management architecture is shown in detail in Annex F. The way in which this can be mapped to the satellite varies with the satellite system architecture. An important issue for satellite systems will be the protocol used for the Service Node Interface (SNI). The FSAN group assumes the use of VB5.1 or VB5.2, which are being developed within ETSI for the broadband access network interface EN 301 005 [12]. The ETSI specification is expected to be a subset of the higher level ITU-T Recommendations.

The main difference between the VB5.1 and VB5.2 interfaces that is important to satellite systems is that VB5.2 supports dynamic allocation of resources in the Access Network (AN) on a connection by connection basis under the control of the SN. This enables local routing to be performed in the AN itself which is not supported in VB5.1. However, the degree of access that the SP has to this capability depends on the system architecture and commercial structure.

Figure 29 shows a mapping of the FSAN management architecture to the satellite case. All user signalling is terminated at the Service Node (SN), which in turn controls the satellite access network within agreed capacity limits. The multiplexing function of the FSAN ONT is in fact distributed across the satellite network by the Access Switch functions at the gateway and the user terminal, which perform the MAC function.

The FSAN management architecture defines a management service and recommended protocol implementation for each management reference point, as listed in Table 3 below.

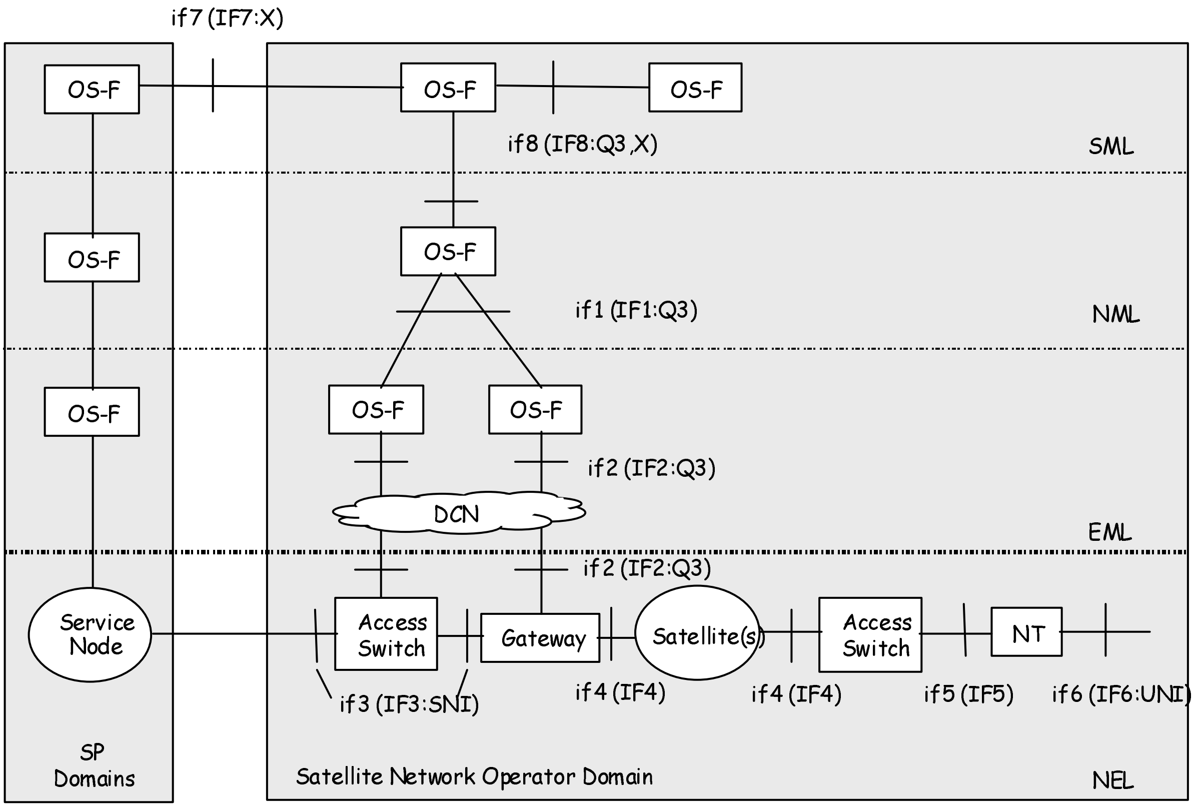


Figure 29: FSAN management model applied to Satellite Access Network

Table 3: Services Provided over Management Interfaces

Reference Point	Management Services	Comments on implementation of reference point
if0	topology, service configuration and provisioning trouble/test administration account/billing/QoS performance reporting	Q3
if1	configuration/provisioning/test/fault/performance management of transport resources equipment management configuration/fault/performance management of transmission system	based on the TMN Q3 interface using the Common Management Interface Protocol (CMIP) Network Management Hierarchy
if2	configuration/fault/performance/test management of network element network element consistency checks network element initialization/authentication/ security management	SNMP initially but does not preclude migration to Q3.
if3	termination of SNI management/control/maintenance/testing of interface connection establishment mapping of bearer services to access transport resources	SNI
if4	multiplexing of bearer services management communications connection/fault/performance management link initialization media access control security and user data encryption	Management communications between OLT and ONU/ONT is via management channel over this interface.
if5	error detection/reporting fault detection/reporting reset control configuration/activation/deactivation of NT resource	this reference point may not be implemented if the ONU and NT are combined as in the case of the ONT
if6	termination of UNI management/control/maintenance/testing of interface activation/deactivation	UNI
if7	ordering, service configuration and provisioning trouble/test administration account/billing/QoS performance reporting	X: this interface should have special security aspects as it links 2 different domains
if8	topology, ordering, service configuration and provisioning trouble/test administration account/billing/QoS performance reporting for the purposes of the service user.	Q3/X: this interface should have special security aspects as it links a customer OSF to a network provider OSF.

The key issues to note from the Table 3 above is that the FSAN network management architecture is predominantly based on the ITU TMN model using the Common Management Interface Protocol (CMIP) for the Q3 and X interfaces. However, it is interesting to note that the architecture also considers the availability of Simple Network Management Protocol (SNMP) interfaces for the management of network element layer equipment.

With respect to the system architecture it is predicted that initially only the IF1 and some IF3 interfaces will be standardized, based on the Q3 and VB5.x interfaces respectively. However, it is desirable that interface IF2 is also standardized in the future to permit the EM OS and network elements to be procured from different suppliers. The TINA-C proposal of an open, distributed computing environment using building blocks with contract interfaces or the latest Common Object Request Broker Architecture (CORBA) could also be used as a possible framework which would lead to the adoption of a common standard for this interface. The FSAN OAM working group recommends that a consistent set of parameters are defined for each interface even if it is proprietary to allow future migration to a standard interface.

The FSAN OAM group recommend that further study is needed on this and the other interfaces before any firm recommendation can be given.

11 Standardization scenarios

This clause concludes with recommended issues for standardization. The topics are grouped into different categories. Each topic is introduced briefly, also mentioning benefits of standardization, before a suggested working method is listed.

All the recommendations for standards, except one, are for Voluntary Standards. Any organization that sees benefits in having a standard can thus support it, while others who are not interested need not comply.

To establish a Work Item, it is sufficient to have the support of four full ETSI members. The work items can be carried out in one or more Working Groups.

11.1 Services

11.1.1 Service classes

Scope and Purpose:

Many of the services satellite systems can provide have specific requirements for a quality of service. These can for instance relate to:

- Bit-rate
- Error rates
- Delay
- Availability, due to rain fading and other issues
- Billing

Not all types of service have the same set of requirements. In general, voice, audio, pictures and video can tolerate relatively high data error rates if the source coders are designed for that purpose. The actual transfer may or may not be delay sensitive. ATM-type of communication may require very low error rates. There may be variable requirements, and the dynamics of the variability may vary from service to service. ATM has a set of QoS parameters, and QoS is in general required for multimedia communication. Not all possible options may be required in all possible combinations.

Recognizing that there may be an almost infinite amount of possible combinations of different sources of data in a multimedia scenario, there are sets of typical services that may be offered to the public for instance by service brokers.

Satellites may set specific limitations, for instance with respect to the delay. Different satellite systems may choose different solutions that result in different characteristics.

From a service providers point of view it will be beneficial to know what to expect, and within what limits satellite systems operate. A well-defined set of targets will be able to guide a system entrepreneur towards a design target. This could include recommended values for QoS subsets and variable bit-rate handling.

Recommendation 1:

ETSI TC SES, together with other appropriate bodies, should specify satellite specific requirements and issues relating to the different service classes for BSM systems.

Working method and liaisons:

Initially this work may focus on GEO satellites.

The work could be done in a TC SES WG in co-operation with other ETSI bodies (SPAN, EASI, TIPHON, UMTS), ESA, DVB, TIA, IETF, ATM Forum and ITU.

11.1.2 Number portability

Scope and Purpose:

Number portability involves the ability for users to change a service provider and keep their addressing number. For multimedia systems this will also involve IP domain addresses.

The ability for a user to keep the same address encourages competition in the market. It will lower the threshold for a user to move between other access technologies and satellite access, and between different satellite systems.

Satellite systems are part of the global information infrastructure. They have to offer the same capabilities as in the fixed / mobile networks. A number portability scheme for satellites should be in harmony with the GII, and satellite systems should be a natural branch on the tree of possible access methods.

Recommendation 2:

ETSI TC SES should define satellite specific requirements and issues to ensure that BSM systems can comply with global number portability schemes.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with SPAN, TC HF and EP UMTS.

11.1.3 Global satellite addressing

Scope and Purpose:

Addressing in BSM needs to be resolved. BSM systems can be used both for accessing a service provider, and for point-to-point connections. Services may include Voice over IP, Internet access, multicast and Pay TV, to mention a few. BSM terminals may be nomadic or even mobile in the future. Addressing should consider global mobility. It has to be possible to call a BSM user. Satellite specific access codes are possible, as well as country codes, service provider addresses (as in GSM). Further, addressing may be both in form of numbers and / or IP addresses. Consistency is required.

Global addressing should be in harmony with other broadband access technologies.

Recommendation 3:

ETSI TC SES should develop satellite-specific recommendations for consistent broadband addressing and mapping between satellite end-users and IP addresses.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with SPAN, TC HF, TIPHON and EP UMTS.

11.1.4 Virtual Home Environment (VHE)

Scope and Purpose:

There is a definite trend towards supplying users with a Virtual Home Environment when they are roaming in other networks. VHE is a key element in UMTS.

For global broadband satellite systems, relevant roaming may occur between different BSM systems, between BSM and other access technologies or even between different operators on the same satellite system. A user with a mobile or nomadic terminal may log on via different gateways world-wide.

A clear trend is identified regarding fixed-mobile convergence. Therefore, a firm long-term distinction between the two should not be made.

Broadband satellite systems shall be considered as a natural part of the global telecommunications infrastructure, and provide users with a familiar environment and set of services across regional borders and different technologies.

Recommendation 4:

ETSI TC SES should define satellite-specific issues relating to Virtual Home Environment (VHE) and define requirements needed in BSM systems to comply with global VHE.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with SPAN, TC HF, 3GPP and EP UMTS.

11.1.5 System interoperability

Scope and Purpose:

Intersystem interoperability across different technologies and systems is required. A BSM user should ideally be able to communicate as efficiently with broadband users on different systems as with those on his own system. Further, other users should be able to communicate as smoothly with BSM users as with terrestrial users. For instance, real-time video telephony should run equally well between users on two different BSM systems as between any other users. This may be particularly challenging when considering systems with long delay. While this could present a specific challenge, it would not be to the BSM community advantage if satellite users could not communicate as effectively with other satellite users as they could with non-satellite users.

Capabilities of general services should be transparent to the satellite access technology. Satellite service providers may offer specific value added services.

Inter-operability could for instance be between BSM systems and UMTS, or between ATM-based, DVB-based, IP-based and proprietary systems. Multicasting and group management may function differently on different systems, as may security, management and lawful interception. Protocol conversion can be less or more efficient.

The goal of an activity on interoperability is to identify more closely the potential areas where the most performance can be gained (or at least not lost) and to define how the best possible performance can be achieved.

Fixed satellite services are to be seen as part of the GII, and BSM systems will have to interact with the general core network.

The interfaces to the core network will define the capabilities of BSM systems. Capabilities to offer many services, like VHE, number portability, standard billing and so on depend on this interface being adequately defined.

Recommendation 5:

ETSI TC SES should define requirements for efficient BSM system interoperability, at the network to network level.

ETSI TC SES should also define a standard for BSM interface to the core network.

Working method and liaisons:

The work should be done in a TC SES WG in co-operation with TC SPAN and ITU-T SG11 (Network to Network Interoperability), EP EASI (ATM Forum), EP TIPHON (IETF), EP UMTS and TIA.

11.1.6 System Management

Scope and Purpose:

BSM systems and terminals need to be an attractive alternative for a service provider to provide broadband services through. An important aspect is a consistent management method for BSM subscribers. Consistency can be across different BSM systems, but more generally across BSM systems and other broadband access systems, such as xDSL and LMDS. There is an initiative called FSAN (Full Service Access Network) that has the support of a large number of major service providers and equipment manufacturers. Satellite systems can fit in with this initiative.

FSAN characteristics:

- Provides a common architecture, interface and access network management approach.
- Supported by major operators.

- Active initiative.
- Based on the discussion in subclause 10.4, specific areas identified for study are:
  1) The effects of running the VB5 RTMC and B-BCC protocols (EN 301 005 [12], EN 301 217 [14]) over a satellite access network.
  2) The advantages and disadvantages to be obtained from placing ATM layer and network management intelligence/processing on board future satellite systems and the associated mappings to the ATM and FSAN approaches. For example, are there any advantages of putting connection admission control and access based signalling on board as proposed by the ATM forum or rather to maintain this functionality at the core network as proposed by the FSAN architecture.
  3) The identification of which different ATM interfaces are required at the satellite-to-gateway earth station, satellite-to-satellite and satellite-to-remote terminal interfaces for different network configurations e.g. ATM interconnect or full mesh architecture and connection between public or private networks.
  4) The development of TMN-based X Co-operative interfaces between satellite operators, network providers and service provides to provide seamless network and service management capabilities. Also identification of the network and service management boundaries in a broadband satellite multimedia environment, e.g. who manages the user terminal equipment.

Recommendation 6:

ETSI TC SES should develop a voluntary standard for BSM management, and in particular study FSAN as a candidate method.

Working method and liaisons:

- TC SES needs to create a liaison with FSAN, TC TMN and TC SPAN, and specifically to:
- Provide satellite specific know-how.
- Promote satellite access.

The work could be done by a TC SES WG in co-operation with FSAN, TC TMN and TC SPAN.

11.1.7 Mobile and Nomadic BSM

Scope and Purpose:

- Satellite communications is a wireless communications form. There is a very significant trend towards mobile communications, and another towards an increasing use of the Internet. Both show an exponential growth, and indications are that they are correlated, as the majority of GSM users, for instance, are also Internet users. All indications are that there will be a growing and strong interest in Global Mobile Multimedia (GMM).
- Satellite systems are able to provide global multimedia services, and with the right technology satellite systems can support transportable, nomadic or even mobile multimedia terminals. UMTS will be able to provide mobile multimedia services, but for high bitrate services a constant shortage of spectrum in many places is envisioned. Ku and Ka-band systems may be the satellite alternative to GMM. Given a technology to ensure correct antenna pointing according to the ETSI Ka-band harmonized standard for SIT/SUT, Ka-band systems could be mobile. The ability to support mobility is important for instance if BSM terminals are to be mounted on cars, a potentially large user group. Other broadband access schemes like cable, powerline, xDSL and also LMDS to a large degree cannot support mobility. This ability may be an important selling argument for the BSM community.
- The fixed-mobile convergence supports mobility in fixed networks and vice versa.
- A network topology limited to fixed terminals may not easily support mobility, and as BSM networks are now in the process of being constructed, it is also the most convenient time to take mobility and location management into account.

- A future option for mobility need not necessarily be implemented during the first years or in all networks. Technology developments are needed. However, the network design can assume such developments already now. Issues may involve hand-over between other access technologies and hand-over between different service providers on the same or different satellite systems.
- For nomadic and mobile terminals a location management scheme is required, so that users can be accessed globally. Location management is solved in GSM, and is also a key issue in UMTS.
- Global wireless connectivity is identified as a particular strong side of BSM in phase 1.
- Nomadic terminals may need roaming management.
- In line with fundamental inputs, e.g. GMM.
- Mobility may be a long-term issue.
- Position determination is a value-added service.

Recommendation 7:

ETSI TC SES should develop standards for mobile BSM.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with EP UMTS, TC SMG and 3GPP.

11.2 Reference Models

Scope and Purpose:

There are several classes and variants of BSM systems. However, many show resemblance, and there is a possibility to categorize these into different classes.

With respect to issues like lawful interception, standardized architectures are considered beneficial. It will also increase the possibility of developing standard equipment, both in the space domain and in the infrastructure domain, which in turn can lower the cost of the system and make BSM more competitive.

Standard reference models will also be useful for management purposes.

Recommendation 8:

ETSI TC SES should define standard architectural reference models for different categories of BSM systems.

Working method and liaisons:

The work could be done in a TC SES Architecture WG, that should liaison with TC SPAN (ITU-T), FSAN, ESA, DVB and TIA.

11.3 Transport mechanisms

11.3.1 ATM over Satellite

Scope and Purpose:

- Many of the planned BSM systems tend to favour ATM as a transport mechanism able to offer the required QoS for multimedia applications. Many BSM systems aim for global service, and European industry will want to be involved in the production of equipment and the delivery of services.
- TIA are producing ATM/satellite standards. ETSI has not started any Satellite-ATM activity, but could consider standards approved by ATM forum or other trusted body (e.g. TIA). Global harmonization has benefits, and co-operative development with other bodies needs to be considered.

- There are a numbers of issues still at the research stage, which are identified in Annex H.

ATM standards for satellites are also useful when satellites are used in the core network.

Recommendation 9:

ETSI TC SES should define requirements for ATM over satellite, and publish a voluntary standard.

Focus should be on services, interfaces and interoperability.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with TC SPAN, EP EASI, TIA, ATM Forum, and ITU-R.

11.3.2 Internet Protocols over Satellite

Scope and Purpose:

IP dominates as a multimedia protocol, and the trends indicate a move toward pure IP networks in the future.

All proposed BSM systems are likely to support IP, either over DVB, over ATM or proprietary protocols.

There is a large interest in IP over satellite, and several solutions to optimizing performance have been proposed, ranging from using LEO satellites, to implementing specific adaptations of the protocol (e.g. spoofing). A number of field trials with IP over satellite have been performed.

- ITU-T is starting a new work area on IP matters, in co-operation with IETF.
- ITU-T has major expertise on network architecture.
- IETF has major expertise on protocols and are already producing satellite standards (TCPSAT).
- ITU-R also studying performance requirements for IP over satellite.
- TIPHON responsible for IP matters in ETSI.

One of the significant issues to be resolved is the lack of compatibility of the IPSec security protocol with the spoofing techniques proposed for satellite links.

Satellite IP standards can also be useful in the core network.

Activities on IP must be in agreement with IETF, and TC SES cannot work on such matters in isolation. However, satellite specific knowledge can be offered, and other standardization activities can be related to satellite IP activities.

Recommendation 10:

ETSI TC SES should define requirements for Internet protocols (e.g. IP, TCP, UDP) over satellite, and publish appropriate voluntary standards.

Focus should be on services, interfaces and interoperability.

Working method and liaisons:

The work could be done in a TC SES WG on IP over satellite, in co-operation with EP TIPHON, TC SPAN, IETF/TCPSAT, TIA, ITU-T, and ITU-R.

11.4 Multicasting

Scope and Purpose:

Multicasting is a particularly strong capability of satellite systems.

Multicasting involves issues including group management, security, interoperability and air interfaces. Further issues need to be identified.

Multicasting can be across different technologies, as end-users can reside on xDSL, cable modems, LMDS systems or others. This issue is therefore of particular importance to consider.

However, multicasting in virtually closed networks should also be considered. Applications include local updates of company data for global organizations, e.g. spare parts for an automobile manufacturer, software updating, corporate TV, and many more.

The TIA has an activity on multicasting, and as any standards will benefit from being global, co-operation is essential.

- Multicasting standards must take into account developments in IP and the Internet
- Existing multicast protocols are generally designed for terrestrial networks, while satellite system topologies are considerably different.
- Standards could promote new applications.

Recommendation 11:

ETSI TC SES should work on voluntary standards for satellite multicasting.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with ESA, IETF and TIA, and possibly DVB.

11.5 Interfaces

Current satellite communications systems in many cases use proprietary and closed standards. The satellite communications market is a very small niche market compared to the terrestrial wireless market. The terrestrial market benefits from standards such as GSM and, in the near future, UMTS.

In the broadcasting field the DVB standard can be considered a success. This may be partly contributed to the capabilities of GEO satellite systems in general, but there are strong indications that having a standard has significantly helped the market.

The R&TTE Directive [62] states that operators must publish their offered interfaces for the purpose of increasing competition in the terminal market. If operators and service providers refer to an ETSI standard air-interface, this would satisfy the R&TTE Directive in this respect.

Having standard air-interface(s) could promote competition in the terminal market. Furthermore, when the market is shared by more than one similar system, a standard air-interface could offer security for the customers, for whom the equipment investment is independent of, and could be used with different service providers. The ability to change service providers easily is in line with the viewpoint of the European Commission (See also 8.2.6).

Outside of ETSI both the DVB project and TIA are working on air interfaces for GEO systems, and ETSI will eventually publish the DVB-RCS standards. ESA has twice taken an initiative now for air interface standardization in BSM systems.

The question of whether ETSI wants to be an active player or a passive observer needs to be addressed. The recommendation is that ETSI takes on a co-ordinating role, ensuring that the interfaces fit a modular and layered structure. While the DVB project would focus on broadcasting aspects, ETSI would focus on telecommunication aspects. ETSI should also ensure that ATM and IP over satellite interests are sufficiently considered.

It is proposed to start an activity on the concept of a family of Radio Transmission Technologies (RTT), in the same way as has been done for UMTS/IMT2000, encompassing terrestrial and satellite system. This could be done using the methodology used for UMTS/IMT2000, which lead to a functional separation of Radio Dependent (RD) and Radio Independent (RI) functions.

In any case, ETSI should consider not one single air interface, but rather a limited family, for the purpose of supporting different satellite architectures.

11.5.1 Air Interfaces for Transparent Satellites

Scope and Purpose:

Transparent GEO satellites have been used over time for providing broadcast and communications services. They will play an important role also for BSM systems. The DVB project is in the process of specifying a return channel applicable for Digital Video Broadcasting. Other services may require standards, such as e.g. ATM.

Recommendation 12: ETSI TC SES should develop voluntary air interface standards for transparent satellites.

Working method and liaisons:

ETSI should follow the DVB-RCS work for a transparent GSO satellite through the current DVB-RCS liaison.

The work could be done in a TC SES WG in co-operation with TIA, ESA and DVB.

11.5.2 Air Interfaces for Regenerative Satellites

Scope and Purpose:

ESA/ESTEC has twice taken an initiative for defining interfaces for multimedia satellites. The first initiative was for bent-pipe satellites, while the second is for OBP satellites (subclause 6.8). Regenerative satellites (OBP) are generally intended for telecommunications purposes.

TC SES should get involved, and take responsibility for the telecommunications part, which is the responsibility of ETSI to standardize in Europe.

Recommendation 13: ETSI TC SES should develop voluntary air interface standards for regenerative satellite systems.

Working method and liaisons:

For OBP satellites, TC SES should take a more active role. ETSI currently participates in the ESA initiative as observers.

The work could be done in a TC SES WG in co-operation with TIA, ESA and DVB.

11.5.3 Indoor / Outdoor Unit Interface

Scope and Purpose:

In the Phase-1 report [2], one of the opinions expressed by system proponents is that it would be beneficial to have a standard interface between the indoor unit and the outdoor unit.

A standard interface will allow independent manufactures to compete on indoor and outdoor units.

It may also allow replacement of one of the two modules only. This can be relevant for fixed terminals, e.g. if the outdoor unit can be used with different GEO BSM system, and system specific functions are kept in the indoor unit. Such an arrangement could increase competition among the service providers, and users may not need to replace the wall- or roof-mounted outdoor unit to change a satellite specific terminal, but only replace a set-top box.

Recommendation 14: ETSI TC SES should develop voluntary standards for interfaces between the in-door and out-door unit for BSM terminals. The standard can include both wired and wireless options.

Working method and liaisons:

A TC SES WG should liaison with DVB-MHP.

11.5.4 Middleware / API

Scope and Purpose:

The middleware domain and the APIs will contain many satellite specific functions. There is a need to identify and standardize these, so that application programs have a consistent set of functions and interfaces to relate to.

The middleware domain shall ensure that applications work across different technologies, and as such that satellite broadband access is in harmony with other broadband access schemes.

The middleware domain must be seen in relation to the rest of the network, and TC SPAN is identified as the major ETSI body to relate to.

Recommendation 15:

ETSI TC SES should define requirements and develop voluntary standards for middleware / API for BSM related to intelligent networks.

Working method and liaisons:

The work could be done in a TC SES WG in co-operation with TC SPAN and DVB-MHP.

11.6 Lawful Interception

Scope and Purpose:

Lawful interception possibilities will be required before an operator will be allowed to provide services in Europe. For OBP systems this is a particular challenge, both technologically and politically. The technological aspect is of interest here.

With a standardized set of satellite network architecture, it may be possible to define technical standards and requirements for how to handle the LI aspect.

LI is a complex and somewhat unclear issue. Exact technical requirements do not exist, but the required legal and general capabilities are basically defined.

LI is the responsibility of TC SEC in ETSI.

Recommendation 16:

ETSI TC SES should work together with TC SEC and clarify and define requirements on LI within BSM systems.

Working method and liaisons:

The work could be done basically by TC SEC in co-operation with TC SES.

11.7 Working Approach: Layered and modular standards

The family of BSM standards should be:

1) Layered

- So that e.g. different air interfaces can be used with different management, protocols, etc.
- This will allow independent updating of layers.

2) Modular

- So that there can e.g. be different air interface versions.
- Will allow freedom in designing new technology.

The figure below illustrates the idea with a possible architecture concept. The idea borrows elements from the DVB-RCS, such as the ability of a module to have different options (i.e. for coding). Changing for instance coding or modulation should not affect compliance with other possible standards.

BSM standards should depend as little as possible on the frequency band in which the system is operating.

For BSM standards to become successful, it is important to recognize that there is a need for freedom in design of the payload, as otherwise the consequences for the space segment can become significant.

The satellite channel, seen from a communications theoretic point of view, is much simpler for a fixed satellite service than for, e.g. the GSM system. The variations in received power, fading characteristics, etc. are larger. Limitations in the satellite domain are to a large degree technological constraints, which eventually will be challenged by new and improved technology.

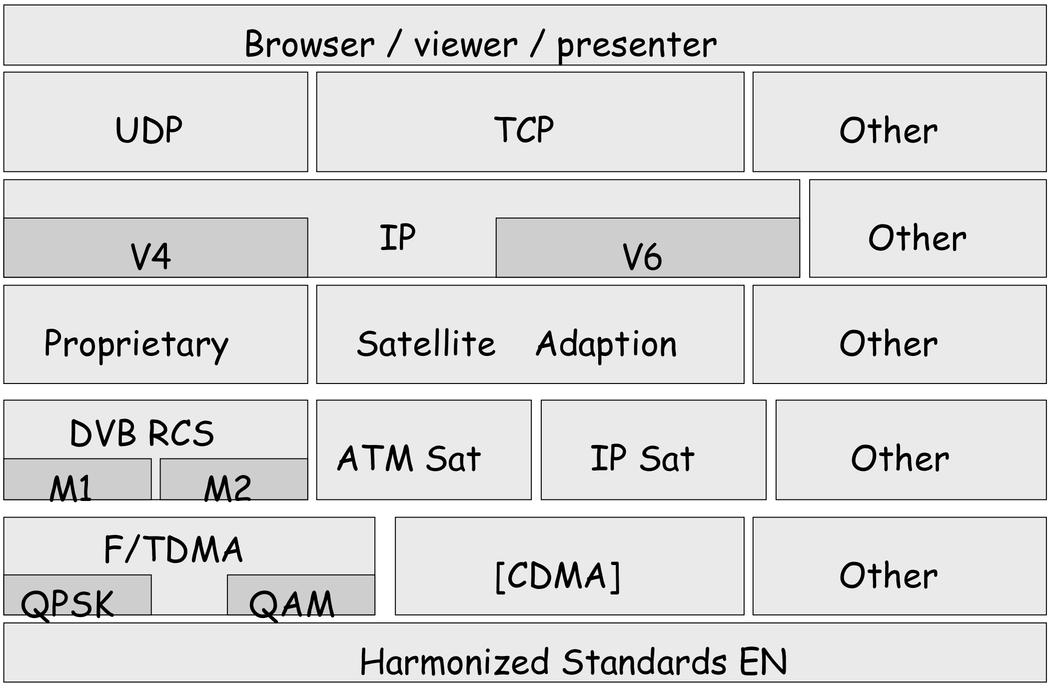


Figure 30: Example of how standards could be structured. The lower layer is a harmonized standard, the others are voluntary standards. At each layer different alternatives may exist, and within each alternative, different options, or modes, may exist

Standards must encourage advances in technology, and be modular enough to support changes in one segment without negative consequences in another. A one-standard solution with a fixed air-interface, protocol, bit-rate, etc. is not considered a viable solution for the future. A family of BSM standards with the following characteristics could be beneficial:

- Only essential requirements are mandatory.
- The standards may be considered as horizontal and vertical modules.
- Some, all, or none can be complied with.
- Proprietary solutions can be combined with the standards.
- Modules can be added later.
- Modules can be removed.
- Modules can be changed.
- Modules can have several options.

The frequency-dependent harmonized standards should be supplemented by voluntary non-frequency-dependent standards.

A way to achieve this is to create modular standards.

Recommendation 17:

ETSI TC SES should define different categories, i.e. layers / modules, that are relevant and practical for BSM.

The BSM standards that ETSI develops should fit within this structure, and allow proprietary solutions for one or more modules.

Working method and liaisons:

The work can be done in a TC SES WG, possibly in co-operation with the DVB project (RCS) and TIA.

11.8 Harmonized Standards

Scope and Purpose:

The EC mandate M/284 allows ETSI to produce necessary Harmonized Standards covering the R&TTE Directive requirements. Therefore ETSI could decide within the mandate to produce Harmonized Standards for BSM.

Recommendation 18:

ETSI TC SES should develop harmonized R&TTE Directive standards for BSM terminals.

Where required, ETSI TC SES should continue to develop harmonized standards specifying essential technical requirements for compliance with Article 3.2 of the R&TTE Directive. This process has already started, for example with the development of the Harmonized Standard EN 301 459 [17] for SIT/SUT.

12 Summary Recommendations for ETSI

No.	Title	Recommended Liaisons
1	Service Classes	TC SPAN (>ITU-T), EP TIPHON (>IETF), EP EASI (>ATM Forum), EP UMTS, ESA, DVB, TIA
2	Number Portability	TC SPAN (>ITU-T), TC HF, EP UMTS
3	Global Satellite Addressing	TC SPAN (>ITU-T), EP TIPHON (>IETF), TC HF, EP UMTS
4	Virtual Home Environment	TC SPAN (>ITU-T), TC HF, 3GPP, EP UMTS
5	System Interoperability	TC SPAN (>ITU-T SG11), EP EASI (>ATM Forum), EP TIPHON (>IETF), EP UMTS, TIA
6	System Management	FSAN, TC TMN (>ATM Forum, TMF, EURESCOM), TC SPAN (>ITU-T)
7	Mobile and Nomadic BSM	EP UMTS, TC SMG (> 3GPP)
8	Reference Models	TC SPAN (>ITU-T), FSAN, ESA, DVB, TIA
9	ATM over Satellite	TC SPAN, EP EASI (>ATM Forum), TIA, ITU-R
10	IP over Satellite	EP TIPHON (>IETF/TCPSAT), TC SPAN (>ITU-T), TIA, ITU-R
11	Multicasting	ESA, IETF, TIA, DVB
12	Air Interfaces for Transparent Satellites	ESA, TIA, DVB
13	Air Interfaces for Regenerative Satellites	ESA, TIA, DVB
14	Indoor / Outdoor Unit Interface	DVB-MHP
15	Middleware / API	TC SPAN (>EURESCOM), DVB-MHP
16	Lawful Interception	TC SEC
17	Working Approach: Layered and modular standards	DVB-RCS, TIA
18	Harmonized R&TTED standards for BSM terminals	
NOTE: The '>' sign means that there is liasion between the bodies.		

Annex A (informative): ITU-T Projects in GII

NOTE 1: Previous Projects I.1 and I.2 form the basis of IP projects and have been therefore deleted from this table.

NOTE 2: Study Group 2 has announced that they are not concerned with Projects A1 to A9, however the Projects are kept for the time being in the Work Programme as they are of interest for other partners as e.g. ISO/IEC/JTC 1.

No.	Name of Project	Lead Body in ITU-T	Collaborating Bodies
F.1	Principles and framework for GII	ITU-T SG 13	ISO/IEC JTC 1
F.2	Scenarios and key interfaces for GII	ITU-T SG 13	ISO/IEC JTC 1 SG 9 (Q.24)
F.3	Information appliance	ITU-T SG 16 (Q.2, 11, 12, 13, 17)	ITU-T SG 8 (Q.1, 3, 4), SG 9 (Q.17, 19, 20, 24, 25, 27, 28, 32) DAVIC IEC TC 100, JTC 1
F.4	End-to-end interoperability	ITU-T 16 (Q.2, 3, 12, 13, 14, 15, 16, 17, 18)	ITU-T SG 8 (Q.4, 6, 7, 9), SG 9 (Q.19, 24, 29) ITU-T SG 12 (Q.16, 18, 21) DAVIC IEC TC 100, JTC 1
N.1	Architecture and Layer 1 aspects of narrow-band/ broadband access infrastructures for GII	ITU-T SG 15 (Q.1, 2, 3, 4)	ITU-T SG 9 (Q.15, 18, 19, 20, 26) ITU-T SG 13 (Q. 11, 12, 26) DAVIC ATM Forum
N.2.1	Signalling and control aspects of wideband/ broadband access interfaces for GII	ITU-T SG 11 (Q.1, 6, 11)	ITU-T SG 2 ITU-T SG 13 (Q.12) ITU-T SG 16 (Q.1,12) DAVIC IEEE ATM Forum ISO/IEC JTC 1 IETF
N.2.2	Signalling and control aspects for wideband/ broadband network element to network element interfaces for GII	ITU-T SG 11 (Q.1, 6, 11)	ITU-T SG 2 ITU-T SG 13 (Q.12) DAVIC ATM Forum IETF
N.3	Network interworking for the GII	ITU-T SG 13 (Q.2, 8, 9 10, 27)	ITU-T SG 2 (Q.2) ITU-T SG 7 (Q.1, 6, 8, 9) ITU-T SG 10 (Q.6, 7) ITU-T SG 12 (Q.16, 18, 21) ISO/IEC JTC 1 ATM Forum Frame Relay Forum
N.5.1	"Intelligent Mobility" for the GII, IMT-2000 (former FPLMTS)	ITU-T SG 11 (Q.7, 8, 11, 13)	ITU-R (TG 8) ITU-T SG 2 (Q.13), SG 10 ITU-T SG 13 (Q.1, 23, 27, 29)
N.5.2	"Intelligent Mobility" for the GII, Global Mobility	ITU-T SG 13 (Q.1, 23, 27, 29)	ITU-R (TG 8) ITU-T SG 10, SG 11 (Q.5, 7)
N.6	Harmonization of B-ISDN Signalling Protocols and their interfaces to public Broadband Networks	ITU-T 11 (Q.11)	ITU-T SG 13 (Q.8) ATM Forum ISO/IEC JTC 1

No.	Name of Project	Lead Body in ITU-T	Collaborating Bodies
N.7	Enhanced network intelligence for the GII	ITU-T SG 11 (Q.5) [IN],	ITU-T SG 4 (Q.13-17, 19-20) [TMN], ITU-T SG 4 (Q.21) [IN information model] ITU-T SG 13 (Q. 23, 29)
N.8	Quality of Service and network performance	ITU-T SG 13 (Q.13, 14, 15, 16, 17)	ITU-T SG 2 (Q.3, 6, 8) ITU-T SG 9, ITU-T SG 12 (Q.16, 18, 21), ITU-T SG 7 (Q.2) ATM Forum IETF
N.9	Addressing for the GII	ITU-T SG 2 (Q.1)	ITU-T SG 7 (Q.3, 21) ITU-T SG 13 (Q.2) ISO/IEC JTC 1 ATM Forum IETF
N.10	Conditional access methods	ITU-T SG 9	
N.11	Interactive Television and sound programming	ITU-T SG 9	
M.1	Network-oriented middleware and network operating systems for GII	ITU-T SG 13 (Q.3, 29) [initially]	ITU-T SG 10 (Q.1, 3) IETF ATM Forum DAVIC OMG Others
M.2	APIs harmonized with network capabilities	ITU-T SG 8 (Q.8, 9)	ATM Forum ITU-T SG 16 (Q.2)
M.3	Technical framework for electronic commerce	ITU-T SG 16	ISO/IEC SC 18, 30, TINA-C
M.4	Middleware for multimedia	ITU-T SG 16 (Q.16,17)	ITU-T SG 7 (Q.24) SG 10, OMG, TINA-C, DAVIC, Open Group
M.5.1	Service, Network and System Management for GII (TMN)	ITU-T SG 4 (Q.13-21)	Network Management Forum
M.5.2	Service, Network and System Management for GII (Open Distributed Management)	ITU-T SG 4(Q.14)	
M.6.1	Security (end-to-end)	ITU-T SG 7 (Q.20)	ITU-T SG 11 (Q.3), IETF
M.6.2	Network Security		
M.7	High-level naming	ITU-T SG 7 (Q.15, 17, 21)	IETF
M.8	Object-oriented environments	ITU-T SG 10 (Q.7)	
M.9	Advanced HCIs for telecommunications management	ITU-T SG 10 (Q.3)	SGs 2, 4
M.10	Software architectures for advanced HCIs	ITU-T SG 10 (Q.3)	t.b.d.
M.11	Network capabilities for charging and billing in GII		

A.1	Medical informatics	ITU-T SG 2	t.b.d.
A.2	Libraries	ITU-T SG 2	t.b.d.
A.3	Electronic museums	ITU-T SG 2	t.b.d.
A.4	Road transport informatics	ITU-T SG 2	t.b.d.
A.5	Electronic purse	ITU-T SG 2	t.b.d.
A.6	Industrial multimedia communication	ITU-T SG 2	t.b.d.
A.7	Ergonomics	ITU-T SG 2	t.b.d.
A.8	Character set	ITU-T SG 2	t.b.d.
A.9	Geographic information systems	ITU-T SG 2	t.b.d.

Annex B (informative): ITU-T IP Project Work Areas

Area 1 - Integrated architecture

The advent of IP networks and their integration into telecommunications networks, including both fixed and mobile networks, provides substantial new thinking for the evolution of both networks. For example, the separation of service provision from transport, a key element in IN development and in Internet applications, changes much of the basic telecommunications architecture.

Also, control systems, which in telecommunications networks have evolved to outband SS7 and ISDN signalling systems as opposed to inband approaches in an IP based network, provide opportunities for new developments. One example under consideration is to use an IP overlay as a control structure for both telecommunications and Internet type networks.

The future of the IP protocol also requires analysis. With new approaches for integrating connectionless services with traditional telecommunications services and with new applications and business coming into use, it is likely that a new IP protocol, meeting all the new needs, including additional control requirements will be developed. The architectural implications of this have yet to be determined.

The initial focus is to identify the new network concepts and to propose architectural approaches that meet the challenging future needs of data, video and voice as well as multi-media applications.

Area 2 - Impact on telecommunications access infrastructures of access to IP applications

The key objective is to identify the key access network interface requirements and access configurations to provide an effective gateway from telecommunications access networks and telecommunications access components to IP networks (including both wired and wireless accesses).

The project will address the issues (including interfaces, protocols, network management, etc.) related to access to IP applications via an IP based network Points of Presence (POPs), using the various access networks and technologies.

Some access networks, such as cable TV networks and broadcast satellites, were only designed to broadcast signals to the home, not to carry data back towards the core network. One-way access systems have to be enhanced to two-way capability or used in combination with other techniques (e.g. upstream modem/phone line configurations) to support bi-directional communication, for example, in client-server applications.

In addition, problems related to traffic management in the case of switched access to Internet over PSTN/ISDN may require the development of dedicated functions and interfaces on voice switches to re-route data traffic on dedicated Points-of-Presence as close as possible to the source.

The initial focus will be on terminal interfaces from PSTN and ISDN (e.g. ADSL) and on access network interfaces (e.g. V interfaces) to determine changes necessary to accommodate additional requirements for access to IP based applications.

Area 3 - Interworking between IP based network and switched-circuit networks, including wireless based networks

The primary objective is to identify and analyse potential network configurations and network interface requirements (for both fixed and mobile networks) to ensure mutually effective IP and telecommunications network support to the burgeoning business requirements encompassing both technologies.

Concerning network interworking the area will address interworking (including network management capabilities) between IP-based networks (Intranets, the Internet, etc.) and a number of typical core networks. The project will also consider related issues, such as traffic management. For example networks supporting Internet traffic have different traffic characteristic from telephony and solutions must be developed to ensure efficient management of processing power, network capacity and memory resources. The initial focus is the identification and analysis of alternative inter-related architectures to determine the key interface requirements between IP network and telecommunications network components.

The project will also include study of the various voice over IP scenarios and the support of the integration of PSTN services (e.g., a telephone call) with those offered by an IP based network through the World Wide Web. Examples of such services are Click-to-Dial, Click-to-Fax, and Voice access to content. The initial focus is on identification and preliminary definition of interactive services for which functional and architectural requirements will be determined for input to the Access and Interworking considerations.

Area 4 - Multimedia applications over IP

There is a growing market for real-time multimedia communication over IP-based networks and for extending this over the PSTN/ISDN. The objective of this project is to support this market through the coordination of ITU-T activities, and ensure inter-operation for a variety of scenarios.

The initial benchmark service to be supported in this area of the project is interworking between voice over IP-based networks and PSTN/ISDN.

This area of the project will address a number of issues, including:

- requirements for interoperability between IP networks and PSTN/ISDN;
- service definitions;
- requirements for service interoperability;
- reference configurations and functional models;
- multimedia coding;
- call control procedures, information flows and protocols;
- numbering and addressing;
- charging/billing;
- security;
- end-to-end quality of service aspects, including transcoding and echo-cancellation.

Area 5 - Naming, Numbering, Addressing and Routing

The increasing demand to extend the capabilities afforded by provision of an IP based telecommunications infrastructure which provides the flexibility and capacity required to satisfy the growing international multimedia needs has resulted in urgent commercial necessity to enable interworking with conventional telecommunication networks e.g. PSTN/ISDN and PSPDN.

Initially the key issues to be addressed under this area are:

- Numbering, and Addressing to provide international access to users who are IP based initially for the purpose of VoIP;
- The operational requirements to route international correspondence traffic to IP based networks and user interfaces; and
- The service interworking for the provision of international public correspondence including evolving multimedia applications.

Area 6 - Transport for IP-structured signals

Currently IP traffic is transported largely over telecommunications facilities, using telecommunications channels to support IP protocols and applications. Depending on the tariffs and other cost considerations, IP network traffic is moving to dedicated transport, independent of the telecommunications networks. If this trend continues, the Internet could eventually overlay the telephone network, removing much of the data traffic from telecommunications networks, causing severe decline in telecommunications business. On the other hand it is axiomatic that joint use of networks for voice and data provides more efficient use of precious resources.

The focus of this part of the project deals with evolutionary aspects of the transport used for IP-based networks. This includes the optimization for the direct transport of IP traffic over Synchronous Digital Hierarchy (SDH) and optical infrastructures. One example is their possible evolution towards integration with ATM Networks.

ATM has become the chosen technology for the B-ISDN within traditional telecommunication networks. As such it is ideally suited to fulfil the needs of large multi-function networks requiring high-speed connections in the backbone and access segments. In addition, ATM provides defined quality of service parameters, in contrast to the current "best effort" of the Internet. Thus ATM can support the foreseen evolution towards a highly reliable and highly available Internet, with defined qualities of service. ATM may also make use of SDH and optical network infrastructures.

The objective of this section of the project is to determine approaches to share network resources to the mutual benefit of both IP and telecommunications networks, and their users.

Area 7 - Signalling support, IN and routing for services on IP-based networks

This area of the project will address at least the following topics:

- Efficiently identifying and routing traffic destined for Internet Service Providers (ISPs) to minimize negative impact upon the Public Switched Telephone Network (PSTN), which has been engineered for relatively short holding time calls;
- defining signaling support for new, value added services which may enable public network operators, as well as ISPs, to capitalize on the growing demand for Internet based and Intelligent Network (IN) based capabilities;
- serving the need of ISPs, Internet Access Providers, and "Internet users" to flexibly manage dynamic bandwidth and quality of service demands from a public network;
- defining mobile wireless access to services over an IP based network, e.g., virtual private networks, provided by either ISPs or public network operators; and
- signaling support for Service Interworking of both dial-up Internet access data applications and Voice over IP applications with traditional telecommunication services, including support of signaling applications and user parts over IP based networks.

Area 8 - Performance

Performance Recommendations for IP-based networks and services, interpreted broadly to include IP based networks and affiliated technologies (e.g., World Wide Web) are being developed by a number of Study Groups. The planned work will:

- Build upon and specialize ongoing GII performance studies.
- Apply and revise the existing ITU-T Recommendations that establish performance and quality requirements for end-user services in light of the unique performance issues of IP-based networks and services.
- Develop new performance-related ITU-T Recommendations (i.e., define performance parameters and objectives) for IP-based networks and services.
- As necessary, revise or develop ITU-T Recommendations addressing the performance of the lower layer networking ("layer 2 networking") to support the transport of IP networking ("layer 3 networking"), e.g., timing and synchronization issues as they relate to IP-based networks and services.
- Address a broad range of performance issues, including IP-network interworking with and integration with other telecommunications services and networks (e.g., public switched telephone network, Integrated Services Digital Networks, radio/mobile telecommunications networks, broadcast/cable networks, SDH, ATM, frame relay).

The initial focus is on the definition of quantitative quality-of-service (QoS) commitments applicable to well-defined IP-based services and meeting performance needs of end-users for real-time IP-based services (e.g., telephony, multimedia) while continuing to support conventional best-effort IP communication services.

Areas 9, 11 and 12 - Management of mixed telecom and IP-based environments

The objectives of these areas are two-fold:

- To address the evolution of TMN Recommendations to support the integrated remote management of mixed environments as well as management of their constituent parts; and
- To address the management of mixed environments not covered by the evolution of TMN Recommendations.

Integrated remote management is expected to be essential to gain the full benefits of integrating IP with traditional telecom technologies. Currently management of IP-based networks is focused on the use of IETF management standards while the management of traditional telecom networks is supported by ITU-T TMN Recommendations. However there is a need to understand the management needs of both domains in order to develop an integrated perspective. It is expected that as the distinction between these two network domains blurs, the convergence of their management approaches will naturally follow. During this convergence period and in part to ensure its success, integrated remote management will be needed and will focus on the creation of an integrated set of management architecture, requirements, information, and protocols.

It expected that a similar philosophy will drive the creation of ITU-T management specifications outside of the realm of TMN.

Area 10 - Security aspects

There are many interworking scenarios with existing telecommunication networks and IP-based networks. Due to the fact that the structure of the IP-based networks and the associated security aspects are completely different to those of telecommunication networks, the security aspects have to be analysed in relation with interworking between telecommunication and IP-based networks. Requirements have to be developed for these scenarios, especially for:

- A voice call from an IP terminal connected to an IP-based network to a GSTN phone;
- A voice call from a GSTN phone to an IP terminal connected to an IP-based network;
- A voice call from a GSTN phone to another GSTN phone via an IP network;
- A voice call from an IP terminal connected to an IP-based network to another IP terminal connected to an IP-based network via the GSTN.

When the word "security" is used without qualification there are usually many interpretations of the term. Hence it is useful to provide a taxonomy of security-related issues so that a common understanding can be more quickly reached. Within a telecommunications context there are four roles, each with a different set of security related concerns. These are the user, network operator, third party and government. These roles are not mutually exclusive and any given individual or organization may assume two or more of the roles. For example, a third party is inevitably also a user, and a network operator may assume a government role.

There are ranges of security concerns. Some are of interest to a single role, and some to several. These include end-to-end privacy of data, user identification, anonymous access, access control intrusion detection, non-repudiation and lawful intercept.

Annex C (informative): ITU-R SG4 Questions Under Study

FIXED-SATELLITE SERVICE, (reference ITU-R Radiocommunication Study Group 4)

Question ITU-R No.	Title	Category	Page number
7-3/4	Baseband transmission variability, delay and echoes in systems in the fixed-satellite service	S2	7
32-3/4	Methods for determining the interference potential of earth stations in the fixed-satellite service in the frequency bands shared with radio-relay systems	S2	8
42-1/4	Characteristics of antennas at earth stations in the fixed-satellite service	S1	9
44-1/4	Use of transportable transmitting earth stations in the fixed-satellite service including use for feeder links to broadcasting satellites	S2	10
46-2/4	Preferred multiple-access characteristics in the fixed-satellite service	S2	11
55-2/4	Feeder links in the fixed-satellite service used for the connections to and from geostationary satellites in various mobile-satellite services	S1	12
56-1/4	Frequency sharing between the inter-satellite service when used for links of the fixed-satellite service and terrestrial radiocommunication services	S2	14
57-1/4	Preferred technical characteristics and selection of sites for earth stations in the fixed-satellite service to facilitate sharing with terrestrial services	S2	15
60-1/4	Sharing criteria for protecting systems in the fixed-satellite service against interference from line-of-sight radio-relay transmitters operating in shared frequency bands	S2	16
61/4	Criteria for frequency sharing between the fixed service and the fixed-satellite service in bidirectionally allocated frequency bands	S3	17
62/4	Frequency sharing of the fixed-satellite service and the inter-satellite service with the fixed service under provisions of RR Article 14	S2	18
63-1/4	Frequency sharing of the fixed-satellite service with terrestrial radio services other than the fixed service under the provisions of Article 14 of the Radio Regulations	S3	20
67-1/4	Frequency sharing between the fixed-satellite service and the Earth exploration-satellite (passive) and space research (passive) services near 19 GHz	C1	22
68-1/4	Frequency sharing of the fixed-satellite service and the inter-satellite service with other space radio services under provisions of Article 14 of the Radio Regulations	S2	23
70-1/4	Protection of the geostationary-satellite orbit against unacceptable interference from transmitting earth stations in the fixed-satellite service at frequencies above 15 GHz	S2	25
73-1/4	Availability and interruptions to traffic on digital paths or circuits in the fixed-satellite service	S2	27
75-3/4	Performance objectives of international digital transmission links in the fixed-satellite service	S1	28
76-1/4	Voice and data signal processing for international digital transmission links in the fixed-satellite service	S2	29
77-1/4	Video signal processing for international digital transmission links in the fixed-satellite service	S2	30
78-1/4	Use of satellite communication systems in the B-ISDN	S2	31
81-1/4	Frequency sharing among networks in the fixed-satellite service, the mobile-satellite service and those of satellites equipped to operate in more than one service in the 20 - 50 GHz band	S2	32
201-1/4	Digital satellite systems in the FSS in synchronous transport networks based on the SDH	S1	34
202-1/4	Interference criteria in the fixed-satellite service for the optimum inhomogeneous use of the available capacity of the geostationary orbit	S1	36
203-1/4	The impact of using small antennas on the efficient use of the geostationary-satellite orbit	S1	38
204/4	Interference of undetermined origin on Earth-to-satellite links	S2	39
205-1/4	Frequency sharing between non-geostationary satellite feeder links in the fixed-satellite service used by the mobile-satellite service	S1	40

Question ITU-R No.	Title	Category	Page number
206-2/4	Sharing between non-geostationary satellite feeder links in the fixed-satellite service used by the mobile-satellite service and other space services, and networks of the fixed-satellite service using geostationary satellites	S1	41
208/4	Use of statistical and stochastic methods in evaluation of interference between satellite networks in the fixed-satellite service	S2	43
209/4	The use of frequency bands allocated to the fixed-satellite service for both the up and down links of geostationary-satellite systems	S2	45
214/4	Technical implications of steerable and reconfigurable satellite beams	S1	46
216/4	Interruptions to traffic due to site diversity arrangements and/or equipment protection arrangements on digital paths or circuits in the fixed-satellite service	S2	47
218-1/4	Compatibility between on-board processing satellites in the FSS and terrestrial networks	S2	49
219/4	Protection of non-geostationary satellite feeder links in the fixed-satellite service used by the mobile-satellite service from radio-relay systems in the shared frequency bands	S2	51
220/4	Interference criteria for systems in the fixed-satellite service using spread spectrum multiple access	S2	52
221/4	Selection of radio stars visible in southern hemisphere for use in determining G/T values for antennas in the fixed-satellite service	S2	53
222/4	Protection ratio masks for TV/FM carriers	S1	54
223/4	Interference criteria for short-term interference events into the fixed-satellite service networks	S1	55
224/4	Technical coordination and optimization methods for systems in the fixed-satellite service to be used under Appendix 30B of the Radio Regulations	S1	57
226-1/4	Use of portable and transportable transmitting earth stations for digital transmission of digital high-definition television for news gathering and outside broadcasts via satellite	S1	59
227/4	Use of digital transmission techniques for satellite news gathering (sound)	S2	61
230/4	Studies on efficient use of FSS orbit/spectrum resources resulting from Resolution 18 (Kyoto-94)	C1	62
231/4	Sharing between networks of the fixed-satellite service using non-geostationary satellites and other networks of the fixed-satellite service	S1	64
232/4	Use of regenerative processing in FSS allocations	S2	65
233/4	Dedicated user digital satellite communications systems and their associated architectures	S2	66
234/4	Phase jitter and wander requirements for satellite earth station modems	S1	68
235/4	Use of operational facilities to meet power-flux-density limitation under Article 28 of the Radio Regulations	S1	69
236/4	Interference criteria and calculation methods for the fixed-satellite service	S1	70
237-1/4	Sharing criteria for systems in the fixed-satellite service involving a large number of non-geostationary satellites with radio-relay systems in the 18,8 to 19,3 GHz and 28,6 to 29,1 GHz bands	S1	72
238/4	Sharing criteria for intersatellite links between non-geostationary satellites in connection with feeder links for the mobile-satellite service using the same frequency bands with radio-relay systems	S2	73
239/4	Sharing criteria between systems utilizing inter-satellite links	C1	75
240/4	Technical implications of possible definition of the quasi-geostationary orbit on the fixed-satellite service sharing frequency bands with the fixed service	C1	76
241/4	Technical implications of possible definition of the quasi-geostationary orbit on the fixed-satellite service using geostationary and non-geostationary orbits	C1	77
242/4	Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the space-to-Earth direction in the band 15,4 - 15,7 GHz and the protection of the radioastronomy service in the band 15,35 - 15,4 GHz	C1	78
243-1/4	Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the Earth-to-space direction in the band 15,45 - 15,65 GHz	C1	80
244/4	Sharing between feeder links of the mobile-satellite (non-geostationary) service in the band 5 091 - 5 250 MHz and the aeronautical radionavigation service in the band 5 000 - 5 250 MHz	C2	82
245/4	Out-of-band and spurious emission limits	C1	84
246/4	Sharing between the inter-satellite service, Earth-exploration satellite (passive) service and other services in frequency bands above 50 GHz	C1	85

Question ITU-R No.	Title	Category	Page number
247/4	Design objectives for radiation patterns applicable to non-geostationary-satellite orbit/mobile-satellite service feeder link Earth stations operating in the 5/7 GHz band	S1	86
248/4	Frequency sharing between systems in the fixed-satellite service and wireless digital networks around 5 GHz	S1	87
249/4	Interoperability of equipment for digital transmission of television news gathering via satellite news gathering (SNG)	S1	88
250/4	Feasibility of the fixed-satellite service sharing with the fixed service operating on the same frequencies in the range 30 - 52 GHz	S1	89
251/4	Sharing criteria for systems in the fixed-satellite service using the same frequency bands with stratospheric high density systems in the fixed service	S1	91
252/4	Criteria for the protection of Appendix 30B Plan against intereference from NGSO systems	S1	93
253/4	Determination of coordination area for Earth stations operating with non-geostationary satellites in the fixed-satellite service in the frequency bands shared with the fixed service	S1	94

Annex D (informative): IETF Working Group Areas

D.1 Applications Area Working Groups

- Application Configuration Access Protocol (acap).
- Calendaring and Scheduling (calsch).
- Common Name Resolution Protocol (cnrp).
- Content Negotiation (conneg).
- DAV Searching and Locating (dasl).
- Detailed Revision/Update of Message Standards (drums).
- Electronic Data Interchange-Internet Integration (ediint).
- Extensions to FTP (ftpext).
- HyperText Transfer Protocol (http).
- Instant Messaging and Presence Protocol (impp).
- Internet Fax (fax).
- Internet Open Trading Protocol (trade).
- Internet Printing Protocol (ipp).
- LDAP Duplication/Replication/Update Protocols (ldup).
- LDAP Extension (ldapext).
- Large Scale Multicast Applications (lsma).
- Mail and Directory Management (madman).
- Message Tracking Protocol (msgtrk).
- NNTP Extensions (nntpext).
- Printer MIB (printmib).
- Schema Registration (schema).
- Telnet TN3270 Enhancements (tn3270e).
- Uniform Resource Locator Registration Procedures (urlreg).
- Uniform Resource Names (urn).
- Usenet Article Standard Update (usefor).
- WWW Distributed Authoring and Versioning (webdav).
- Web Replication and Caching (wrec).
- Web Versioning and Configuration Management (deltav).

D.2 General Area Working Group

- Process for Organization of Internet Standards ONg (poisson).

D.3 Internet Area Working Groups

- AToM MIB (atommib).
- DNS IXFR, Notification, and Dynamic Update (dnsind).
- Dynamic Host Configuration (dhc).
- Frame Relay Service MIB (frnetmib).
- IP Over Fibre Channel (ipfc).
- IP Over IEEE 1394 [66] (ip1394).
- IP over Cable Data Network (ipcdn).
- IP over VBI (ipvbi).
- IPNG (ipngwg).
- Interfaces MIB (ifmib).
- Internetworking Over NBMA (ion).
- Point-to-Point Protocol Extensions (pppext).
- Service Location Protocol (svrloc).
- Zero Configuration Networking (zeroconf).

D.4 Operations and Management Area Working Groups

- ADSL MIB (adslmib).
- Authentication, Authorization and Accounting (aaa).
- Benchmarking Methodology (bmwg).
- Bridge MIB (bridge).
- Distributed Management (disman).
- Domain Name Server Operations (dnsop).
- Entity MIB (entmib).
- Ethernet Interfaces and Hub MIB (hubmib).
- G and R for Security Incident Processing (grip).
- MBONE Deployment (mboned).
- Network Access Server Requirements (nasreq).
- Next Generation Transition (ngtrans).

- Physical Topology MIB (ptopomib).
- Policy Framework (policy).
- Remote Authentication Dial-In User Service (radius).
- Remote Network Monitoring (rmonmib).
- Roaming Operations (roamops).
- Routing Policy System (rps).
- SNMP Agent Extensibility (agentx).
- SNMP Version 3 (snmpv3).
- The Internet and the Millennium Problem (2000).

D.5 Routing Area Working Group

- Border Gateway Multicast Protocol (bgmp).
- Data Link Switching MIB (dlswmib).
- General Switch Management Protocol (gsmp).
- IP Routing for Wireless/Mobile Hosts (mobileip).
- IS-IS for IP Internets (isis).
- Inter-Domain Multicast Routing (idmr).
- Inter-Domain Routing (idr).
- Mobile Ad-hoc Networks (manet).
- Multicast Extensions to OSPF (mospf).
- Multicast Source Discovery Protocol (msdp).
- Multiprotocol Label Switching (mpls).
- Open Shortest Path First IGP (ospf).
- Protocol Independent Multicast (pim).
- Routing Information Protocol (rip).
- SNA DLC Services MIB (snadlc).
- UniDirectional Link Routing (udlr).
- Virtual Router Redundancy Protocol (vrrp).

D.6 Security Area Working Groups

- An Open Specification for Pretty Good Privacy (openpgp).
- Authenticated Firewall Traversal (aft).
- Common Authentication Technology (cat).

- Domain Name System Security (dnssec).
- IP Security Protocol (ipsec).
- Intrusion Detection Exchange Format (idwg).
- One Time Password Authentication (otp).
- Public-Key Infrastructure (ITU-T Recommendation X.509 [74]) (pkix).
- S/MIME Mail Security (smime).
- Secure Network Time Protocol (stime).
- Secure Shell (secsh).
- Simple Public Key Infrastructure (spki).
- Transport Layer Security (tls).
- Web Transaction Security (wts).
- XML Digital Signatures (xmldsig).

D.7 Transport Area Working Groups

- Audio/Video Transport (avt).
- Differentiated Services (diffserv).
- IP Performance Metrics (ippm).
- IP Telephony (iptel).
- Integrated Services (intserv).
- Integrated Services over Specific Link Layers (issll).
- Media Gateway Control (megaco).
- Multicast-Address Allocation (malloc).
- Multiparty Multimedia Session Control (mmusic).
- Network Address Translators (nat).
- Network File System Version 4 (nfsv4).
- ONC Remote Procedure Call (oncrpc).
- PSTN and Internet Internetworking (pint).
- Performance Implications of Link Characteristics (pilc).
- Realtime Traffic Flow Measurement (rtfm).
- Reliable Multicast Transport (rmt).
- Resource Allocation Protocol (rap).
- Resource Reservation Setup Protocol (rsvp).
- Session Initiation Protocol (sip).

- Signaling Transport (sigtran).
- TCP Implementation (tcpimpl).
- TCP Over Satellite (tcpsat).

D.8 User Services Area Working Groups

- FYI Updates (fyiup).
- Responsible Use of the Network (run).
- User Services (uswg).
- Web Elucidation of Internet-Related Developments (weird).

Annex E (informative): ATM Forum Work Areas

Current Items as of August 1999				
Control Signalling				
	Network Call Correlation Identifier	Work in Progress	12/99	
	GFR Signalling	Work in Progress	12/99	
	Call Rerouting	Work in Progress	12/99	
	BICI v2.2	Work in Progress	12/99	
	DiffServ Signalling	Work in Progress	12/99	
	Connection Modify	Work in Progress	12/99	
	Path and Correction Trace	Work in Progress	12/99	
Joint CS and RA				
Lan Emulation/ MPOA	MPOA Addendum for Frame Relay Links	Work in Progress	5/00	
	MPOA v1.1 Addendum for VPN Support	Final Ballot	9/99	
	MPOA v1.1 Addendum for QoS	Work in Progress	5/00	
Network Management Chair: Roger Kosak				
	Carrier Interface (M5) Requirements and CMIP MIB	Work in Progress	7/00	
	Usage Measurement Requirements and Logical MIB	Work in Progress	12/99	
	CORBA	Work In Progress	7/00	
	Customer/Sevice Provider Interface M3	Work in Progress	7/00	
Physical Layer Chair: John Mick				
	PHY Control	Final Ballot	11/99	
	Fractional Nx64 on E1/T1	Final Ballot	11/99	
	2,4 Gbps SONET PHY	Final Ballot	11/99	
	Utopia Level 3 (2,4 Gbps)	Straw Ballot	2/00	
	Utopia Level 4 (10 Gbps)	Work in Progress	TBD	
	1,0 Gbit Cell Based PHY	Work in Progress	TBD	
	Frame Based ATM/PHY Interface	Work in Progress	TBD	
	Device Control Protocol	Work in Progress	TBD	
	10 Gbps SONET Interface	Work in Progress	TBD	
	Multiplexed Status Polling for UL3	Work in Progress	TBD	

Current Items as of August 1999				
Control Signalling				
RBB (Residential Broadband)				
Routing and Addressing				
	Bi-Level Addressing	Work in Progress	TBD	
	PNNI 1.0 Addendum - Secure PNNI Routing	Work in Progress	TBD	
	PAR Addendum: Interoperability with ILMI-based Server Discovery	Work in Progress	TBD	
Security Chair: Richard Graveman	Security Specification Version 1.1	Work In Progress	2/00	
	Secure User Registration	Work In Progress	TBD	
Service Aspects and Applications Chair: Bahman Mobasser	Java API	Work in Progress	9/99	
	Frame Based ATM over Sonet/SDH	Work in Progress	TBD	
	ATM Name Server v.2	Work in Progress	9/99	
	Frame Based ATM over Ethernet	Work in Progress	2/00	
	Frame Based ATM over Blue Tooth	Work in Progress	TBD	
Testing	Conformance Abstract Test Suite for Signalling (UNI 3.1 [37]) for the User Side	Work in Progress	11/99	
	Performance Testing Specification	Final Ballot	9/99	
	Conformance Abstract Test Suite for LANE 1.0 Server	Inactive	TBD	
	Conformance Abstract Test Suite for UNI 3.0/3.1 ILMI Registration (User Side and Network Side)	Inactive	TBD	
	UNI Signalling Performance Test Suite	Work in Progress	TBD	
	Interoperability Test Suite for LANE v1.0	Inactive	TBD	
	Introduction to ATM Forum Test Specification v2.0	Work in Progress	11/99	
	Conformance Abstract Test Suite for SSCOP v1.1	Final Ballot	4/99	
	PICS Style Guide	Straw Ballot	11/99	
	Conformance Abstract Test Suite for ABR	Straw Ballot	11/99	
	PNNI Signalling Abstract Test Suite	Work in Progress	TBD	
	Conformance Abstract Test Suite for Signalling (UNI 3.1 [37]) for the Network side v2.0	Final Ballot	9/99	
Traffic Management Chair: Tim Dwight				
	Addendum to TM4.1 Supporting IP Differentiated Services and IEEE 802.10	Work in Progress	2/00	
	Addendum to TM4.1 Supporting Specification of a MCR for UBR	Work in Progress	2/00	

Current Items as of August 1999				
Control Signalling				
Voice and Telephony over ATM Chair: Don Choi	Local Loop Emulation using AAL2	Work in Progress	12/99	
Wireless ATM	WATM Spec 1.0	Straw Ballot	11/99	
	WATM Wireless Interworking	Straw Ballot	4/00	

Annex F (informative): Full Service Access Network (FSAN)

F.1 Introduction

In 1995 a group of telecommunication network operators and equipment suppliers established an international three year initiative to create the conditions for the development and introduction of access systems supporting a full range of narrow-band and broadband services. This activity was achieved through six working groups responsible for the following areas:

- Systems Engineering and Architecture;
- Optical Access Networks;
- Home Networks and Network Termination;
- Operation Administration and Maintenance;
- VDSL;
- Component Technology.

After three years of successful collaborative development a common requirement specification was issued in June 99 for FSAN architectures. The FSAN goals have not been to produce new standards but to build on the resources available from the ATM Forum, ITU and ETSI standards, e.g. the FSAN approach follows the principles stated in ITU-T Recommendation G.902 [24] for generic access networks.

This clause reviews the synergy between the current standards for broadband terrestrial access networks and the proposals for the future Broadband Satellite Multimedia (BSM) systems. The objective is to identify areas where ETSI work on BSM system standards could be based on existing recognized and adopted terrestrial access network standards. An overview of the various network architectures and management approaches adopted by industry groups such as the FSAN consortium, the ATM Forum and DAVIC is provided and relationships with ITU and ETSI standards are identified. FSAN is covered in the most detail because it provides a common architecture, interface and network management approach for access networks, which could be applied to the BSM case. Areas of synergy and conflict are discussed and a possible way forward for ETSI BSM standards work is proposed.

F.2 FSAN

F.2.1 Architecture

The generic FSAN architecture is shown in Figure F.1 below.

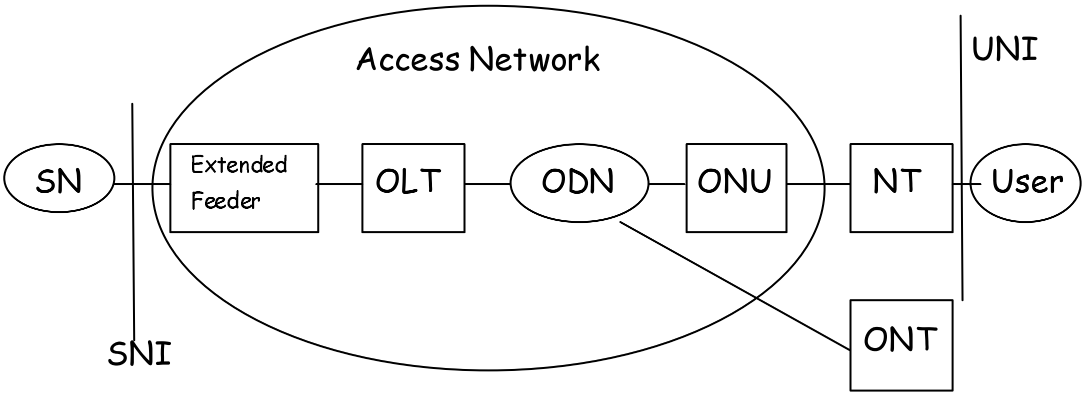


Figure F.1: Generic FSAN Architecture

The key components in the generic FSAN architecture are:

- The Service Node (SN), which is the network element that provides access to the various switched and or permanent telecommunications services. For switched services the SN provides call control, connection control and resource handling functions.
- The Access Network (AN) which refers to the equipment used to provide the transport capability for the provision of telecommunication services between a Service Node Interface (SNI) and one more associated User Network Interfaces (UNI). User signalling is carried transparently by the AN.
- The Extender Feeder which can be used to provide the physical resources to extend the AN over larger distances.
- The Optical Line Termination (OLT) which provides the network side interface of the AN. An OLT can be connected to more than one ODN.
- The Optical Distribution Network (ODN) refers to the point to multipoint fibre network used to transport services in a common format from the OLT to the ONU/ONT. The ODN may consist of Passive Optical Networks (PONs).
- The Optical Network Unit/Termination (ONU/ONT) provides the customer side-interface of the AN. It is connected to the ODN. For some operators the ONU and NT functions will be combined into one physical resource referred to as an ONT.
- The Network Termination (NT) is the physical resource which resides in the customer premises and forms the boundary of the AN. This interface is referred to as the User Network Interface (UNI). The NT provides the onward transmission of services over building wiring to Customer Premise Equipment (CPE).

The FSAN architecture is based on the delivery of Asynchronous Transfer Mode (ATM) narrow-band and broadband services using a selection of drop medium to take the required services from the remote node to the customer termination unit. The key drop modes being a combination of fibre and copper Asymmetrical Digital Subscriber Line (ADSL) and Very high speed Digital Subscriber Line (VDSL) for Fibre to the Exchange, Kerb and Cabin. Whilst the user of fibre optic only networks for fibre to the home networks. This principle is shown schematically in the figure below.

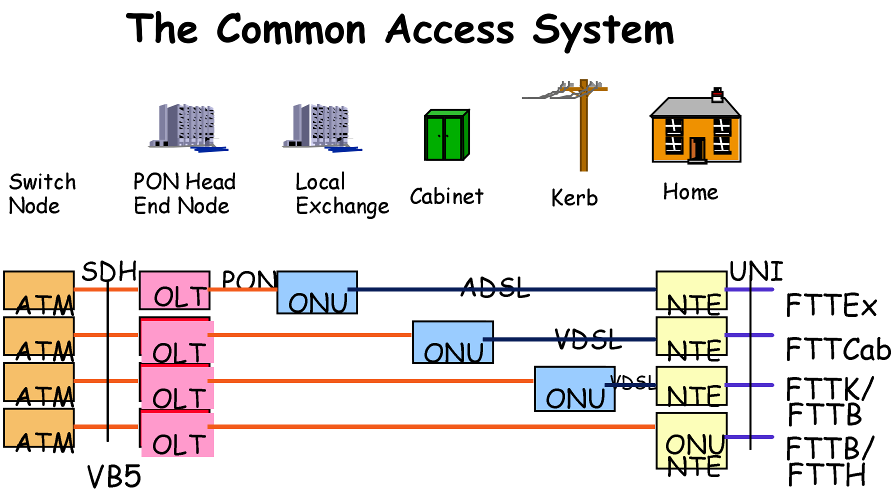


Figure F.2: FSAN Delivery Architectures

F.2.2 SNI and UNI architectures

The FSAN Common Technical Specification specifies the use of V interfaces at the digital SNI for the support of broadband or combined narrow-band and broadband access networks. There are two types of VB interfaces VB5.1 and VB5.2 both standardized within the ITU and ETSI. The functionality of the VB5.1 interface is to:

- Define the access type, ATM multiplexing and cross-connectivity in the AN at the Virtual Path (VP) and Virtual Connection (VC) level. This includes the allocation of VPs and VCs. This is required to provide the multiplexed and demultiplexed streams from the UNI to the SNI and vice-versa. VB5.1 supports the use of the ATM layer for user plane, control plane and management plane links.

- Define the time critical management functions and real time co-ordination between the AN and the SN. This is achieved through a Real Time Management plane Co-ordination (RTMC) protocol.

- Definition of the timing and Operation Administration and Maintenance (OAM) flows between the AN and the SN.

This functionality is shown in figure 3. The Ia interface is the VB5.1 interface point adjacent to the AN equipment and the Ib interface is the VB5.1 interface point adjacent to the SN equipment.

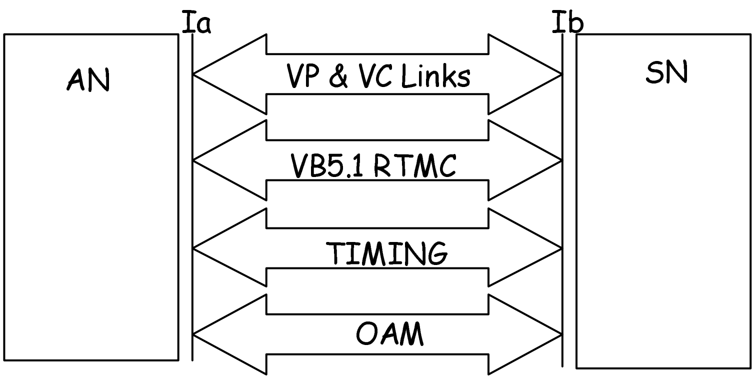


Figure F.3: VB5.1 Functions

The following key issues should also be noted:

- In VB5.1 the AN passes on transparently any user signalling and charging information directly to the SN.

- All call control and associated connection control resides in the SN.

- The selection of a Service Provider (SP) by the AN, based on user signalling is not possible since this would require the existence of SN functionality in the AN.
- The establishment of VC and VPs in the AN is under the control of the SN at all times.

The VB5.1 interface architecture is defined in detail by the ITU and ETSI in documents ITU-T Recommendation G.967.1 [25] and EN 301 005 [12] respectively.

VB5.2 provides the additional functionality of been able to establish on demand/flexible provisioned VC and VP connectivity in the AN under the control of the SN. This achieved through the addition of a Broadband Bearer Connection (B-BCC) protocol that provides the mechanism by which the SN can request the AN to establish, modify and release VP and VC links on demand in the AN based on negotiated connection attributes such as traffic descriptors and Grade of Service/Quality of Service parameters. The VB5.2 interface architecture is defined in detail by the ITU and ETSI in documents ITU-T Recommendation G.967.2 [26] and EN 301 217 [14] respectively.

With respect to the UNI for the support of broadband access networks, the FSAN Common Technical Specification specifies the use of the latest ATM Forum UNI architecture, presently UNI3.1.

F.2.3 Physical Interfaces and Services Sets

The FSAN is aimed at providing the following service sets:

- Internet/Intranet Access;
- VoD;
- Midband asymmetric and symmetrical applications;
- Interactive Multimedia Services;
- Video Conferencing;
- Business TV.

Using the following delivery mechanisms:

- Hybrid Fibre Coax;
- ADSL/VDSL;
- Fibre To The Curb;
- Fibre To The Home.

Within the FSAN architecture the following line rates are available for an Optical Distribution Network:

- Option 1 Symmetrical 155,2 Mps;
- Option 2 Asymmetric 155,2 Mbit/s upstream and 622,8 Mbit/s downstream;
- Option 3 Asymmetric 25,92 Mbit/s upstream and 155,2 Mbit/s downstream.

With the use of hybrid coax VDSL and fibre technologies the following line rates are available:

- Asymmetric 2 Mbit/s upstream and 26 Mbit/s downstream with a VDSL reach of less than 1 km;
- Asymmetric 2 Mbit/s upstream and 13 Mbit/s downstream with a VDSL reach of less than 1,5 km;
- Symmetrical 13 Mbit/s to 26 Mbit/s with a VDSL reach of up 500 m.

The FSAN Common Technical Specification specifies an overall bit error rate of one in 10^{-9} across the whole PON and one in of 10^{-7} across the VDSL network. Also the mean transmission time delay across the access network should be less than 1,5 ms as defined in ITU-T Recommendation G.982 [67].

The physical interface and service specifications for the SNI are shown in Table F.1.

Table F.1: SNI Physical Interface and Service Specification

Service Type	IP Routing	ATM Switch Virtual Circuits	Video On Demand	Switched DVB	VP Leased Lines	ISDN
VB Interface Version	5.1	5.1	5.1, 5.2	5.1	5.1	5.1
Physical Interfaces	10BaseT ATM 25 Mbit/s	ATM 25 Mbit/s	ATM 25 Mbit/s	ATM 25 Mbit/s	ATM 25 Mbit/s ATM 155 Mbit/s	ISDN
ATM Services	VBR	CBR, VBR, ABR	CBR	CBR	-	-
Bandwidth	10 Mbit/s	150 Mbit/s	6 Mbit/s	6 Mbit/s	-	-
Peak access transmission delay	1,5 ms	1,5 ms	< 1,5 ms	< 1,5 ms	-	-
Access Delay	< 1 s	-	< 3,0 ms	< 3,0 ms	-	-
Response Time	-	-	-	< 500 ms	-	-
Cell Loss	-	10-5	10-8	-	-	-

NOTE: With respect to VP/VC usage when a VC connection is set-up by the SNI the CAC function on the SNI needs to ensure that the bandwidth requested is available on the physical link. The number of simultaneous signalling links required for VB5.1 is four or more whilst 4 or more pairs are required for VB5.2.

F.2.4 OLT Requirements

F.2.4.1 Physical Interfaces

The following physical interfaces are specified for the OLT:

- ATM UNI (fibre 155,52 Mbit/s PON);
- SDH 51,58 Mbit/s, 155,52 Mbit/s, 2,048 Mbit/s;
- PDH 2,048 Mbit/s, 6,312 Mbit/s, 8,448 Mbit/s, 34,368 Mbit/s, 44,736 Mbit/s;
- Circuit Emulation;
- 10/100 BaseT.

Also the system shall be capable of supporting and accommodating different line interface cards (non-duplicated and duplicated) simultaneously for the purpose of redundancy etc. Specifically the system shall accommodate the following maximum number of line interfaces in the case of non-duplicated configuration:

- 32 or more for 2, 6,3, 8, 34, 45, 50, 150 Mbit/s interfaces;
- 8 or more for 600 Mbit/s interfaces;
- 4 or more for 150 Mbit/s interfaces.

For circuit protection a duplicated or non-duplicated configuration shall be arbitrarily switchable for transport lines except the 2 Mbit/s, 6,3 Mbit/s, 8 Mbit/s, 34 Mbit/s and 45 Mbit/s interfaces. Furthermore the protection schemes shall comply with the ITU-T Recommendation G.783 [68] for duplicated configuration.

F.2.4.2 Cell Switching Function

The cell switching function shall have a 8x8 or greater matrix in terms of the 600 Mbit/s switch port and should exhibit non-blocking characteristics. The connection matrix should be capable of setting up both point to point and at least 1 to N multipoint connections, where N is 48 or more. The Cell Switching Function is also responsible for multiplexing cells based on their Virtual Path Identifiers (VPIs).

F.2.4.3 ATM Transfer Capability (ATC)

The OLT is required to support the following ATC's DBR classes 1,2 and U (UBR.1) as defined in ITU-T Recommendations I.356 [27] and I.371 [75]. Furthermore BT would like to see additional support for SBR (classes 2 and 3), GFR (classes 1 and 2) and ABR (class 3). Presently there is no requirement for ATM Block Transfer (ABT) capabilities.

The system shall also be capable of multiplexing different ATC's into a transport line and an access-line so as to increase line utilization, whilst still retaining the required quality of service for each ATC feed. EPD/PPD shall be used for GFR.

Parameters associated with the total access network will be qualified in terms of supported traffic parameters ranges and granularity, for example Peak Cell Rate (PCR) and Cell Delay Variation (CDV). In particular the access network shall be defined using worst case quality of service parameters, for example the upper bounds on CDV and Cell Loss Ratio (CLR).

F.2.4.5 Call Connection Control

Within the OLT, Usage Parameter Control (UPC) should be used for all set-up connections originating at an access-line interface. In contrast Network Parameter Control (NPC) should be used for all set-up connections originating at a transport line interface. UPC/NPC parameters to be compliant with ITU Recommendation I.371 [75]. The UPC/NPC shall discard, tag or pass on non-conforming cells for each connection. The Call Connection Control side of the OLT shall also be responsible for recording the number of passed cells, number of non-conforming cells and number of discarded cells.

The OLT shall also support Cell Congestion Control by detecting QoS degradation for DBR classes 2 and UBR.1. Including EFCI/BECN compliance as per ITU Recommendation I.371 [75].

F.2.5 Network and Service Management

F.2.5.1 Mapping onto TMN Architecture

The network and service management architecture for the FSAN was defined by the Operations Administration and Maintenance Working Group with the basic aim to manage the range of services available from a common platform. The FSAN network and service management architecture is based on the ITU's Telecommunications Management Network (TMN) layered architecture defined in ITU-T Recommendation M.3010 [29]. The TMN management architecture is shown schematically below.

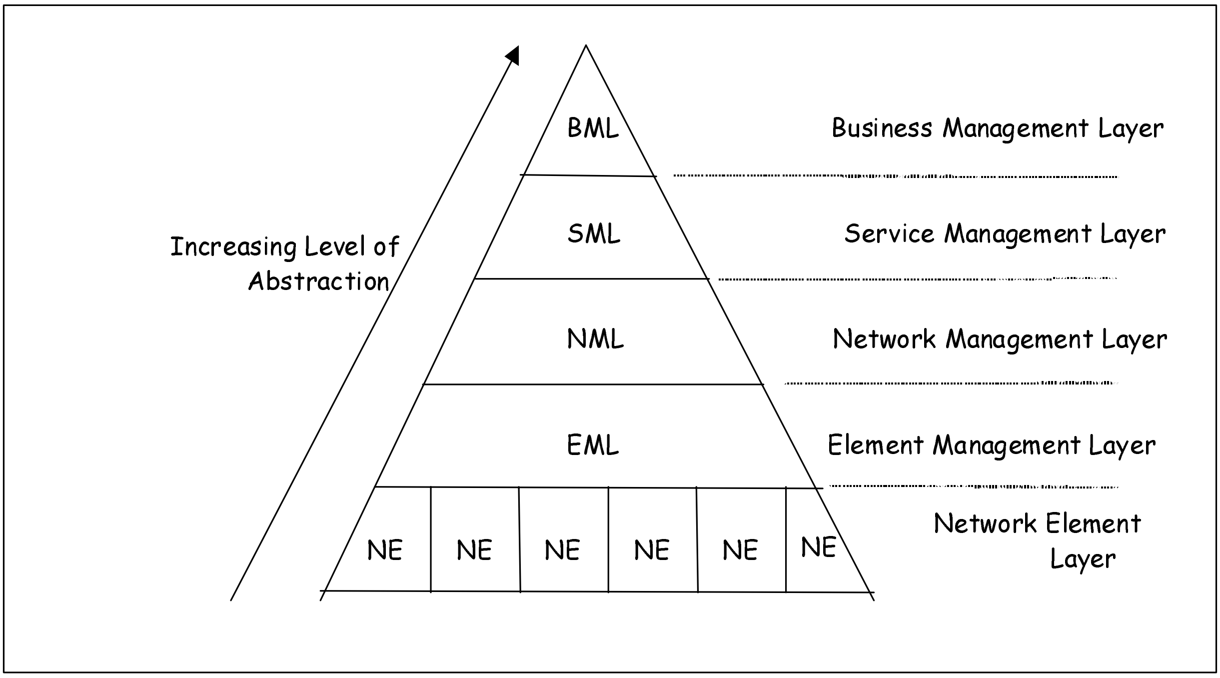


Figure F.4: TMN Network Management Hierarchy

The Network Element Layer (NEL) contains the physical resources called network elements. The following FSAN elements that can be mapped onto this layer are the following access network elements: Optical Line Termination (OLT), Optical Network Unit (ONU), Optical Distribution Network (ODN) and the drop medium.

The Element Management Layer (EML) manages the physical resources and provides a common interface to the Network Management Layer (NML) for the various types of managed network elements. This layer is responsible for understanding the details of manufacturer specific information and equipment thus removing the need for this complexity of information to be held at the NML. It will contain a operations system (OS) which would normally deal with functions such as configuration, fault management and performance monitoring of the physical resources which reside in the access network. The interface between the EML OS (also known as the Element Manager) and the NML OS(s) is seen as a point for standardization. Typical management functions at this level are configuration, fault management and performance monitoring.

The Network Management Layer (NML) provides the functionality to bind the individual network elements into the managed network. This is the layer where the co-ordination of multiple EML OSs is undertaken to provide overall network supervision. It provides the end to end configuration of services and also provides links between different network components to form a complete network.

The Service Management Layer (SML) manages the services supported by the network and is less concerned with the physical nature of the network but more with the overall function. It also provides the customer interface. Service creation, provision, cessation billing and accounting information are some of the functions supported by this layer.

The Business Management Layer (BML) is concerned with managing the complete undertaking, in accordance with the business objectives and customer requirements.

F.2.5.2 FSAN Management Architecture

It is proposed that FSAN services are managed using a TMM based architecture consisting of several interconnected management systems that control and monitor the architecture from predetermined reference points. The FSAN Management Architecture is shown schematically below.

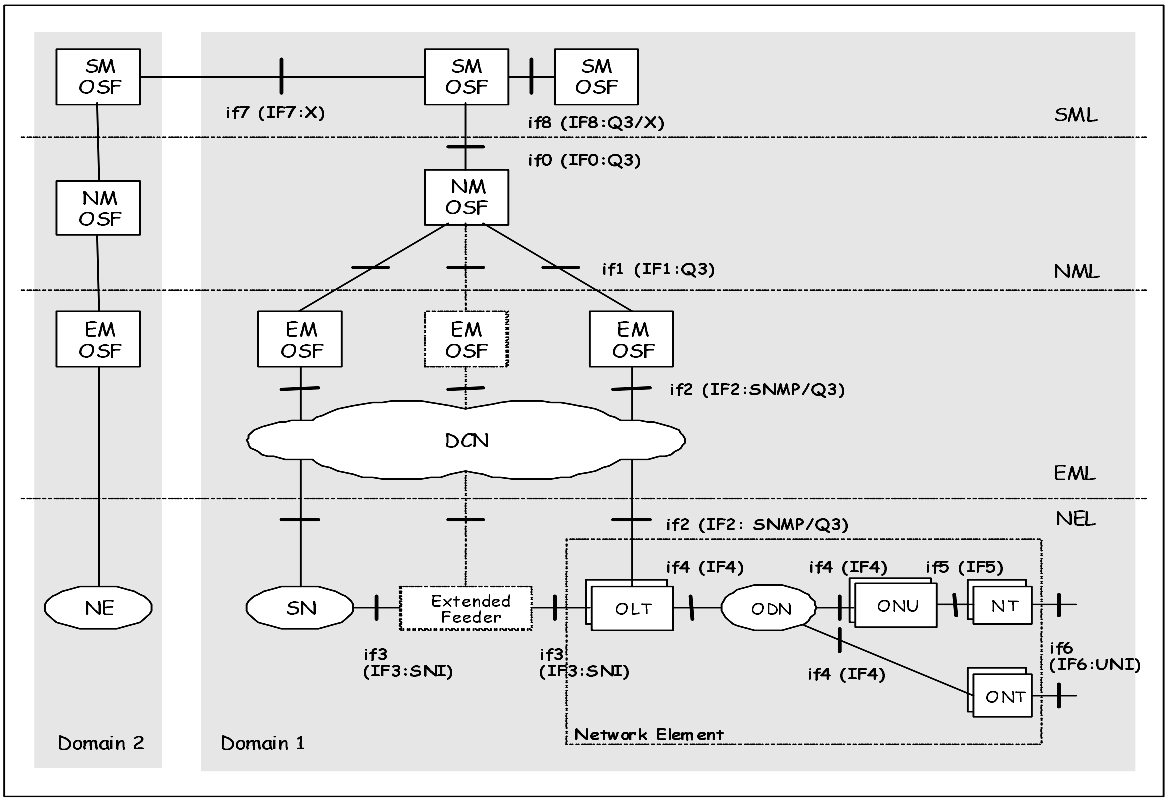


Figure F.5: FSAN Management Architecture

The FSAN management architecture defines a management service and recommended protocol implementation for each management reference point, as listed in Table F.2.

Table F.2: Services Provided over Management Interfaces

Reference Point	Management Services	Comments on implementation of reference point
if0	**topology, service configuration and provisioning** • trouble/test administration • account/billing/QoS performance reporting	**Q3**
if1	**configuration/provisioning/test/fault/performance management of transport resources** • equipment management • configuration/fault/performance management of transmission system	**based on the TMN Q3 interface using the Common Management Interface Protocol (CMIP) Network Management Hierarchy**
if2	**configuration/fault/performance/test management of network element** • network element consistency checks • network element initialization/authentication/ security management	**SNMP initially but does not preclude migration to Q3.**
if3	**termination of SNI** • management/control/maintenance/testing of interface • connection establishment • mapping of bearer services to access transport resources	**SNI**
if4	**multiplexing of bearer services** • management communications • connection/fault/performance management • link initialization • media access control • security and user data encryption	**Management communications between OLT and ONU/ONT is via management channel over this interface.**
if5	**error detection/reporting** • fault detection/reporting • reset control • configuration/activation/deactivation of NT resource	**this reference point may not be implemented if the ONU and NT are combined as in the case of the ONT**
if6	**termination of UNI** • management/control/maintenance/testing of interface • activation/deactivation	**UNI**
if7	**ordering, service configuration and provisioning** • trouble/test administration • account/billing/QoS performance reporting	**X** this interface should have special security aspects because it links two different domains
if8	**topology, ordering, service configuration and provisioning** • trouble/test administration • account/billing/QoS performance reporting for the purposes of the service user	**Q3/X** this interface should have special security aspects because it links a customer OSF to a network provider OSF

The key issues to note from Table F2 is that the FSAN network management architecture is predominantly based on the ITU TMN model using the Common Management Interface Protocol (CMIP) for the Q3 and X interfaces. However it is interesting to note that the architecture also considers the availability of Simple Network Management Protocol (SNM P) interfaces for the management of network element layer equipment.

With respect to the system architecture it is predicted that initially only the IF1 and some IF3 interfaces will be standardized, based on the Q3 and VB5.x interfaces respectively. However, it is desirable that interface IF2 is also standardized in the future to permit the EM OS and network elements to be procured from different suppliers. The TINA-C proposal of an open, distributed computing environment using building blocks with contract interfaces or the latest Common Object Request Broker Architecture (CORBA) could also be used as a possible framework which would lead to the adoption of a common standard for this interface. The FSAN OAM working group recommends that a consistent set of parameters are defined for each interface even if it is proprietary to allow future migration to a standard interface.

In conclusion, the FSAN OAM group recommend that further study is needed on this and the other interfaces before any firm recommendation can be given.

F.2.5.3 FSAN Management Requirements

The FSAN management requirements can be summarized by the FCAPS acronym standing for Fault, Configuration, Accounting, Provisioning and Security aspects. The key requirements associated with the FSAN management architecture are discussed below.

Automatic Control Function

System faults should be automatically detected by the system self-diagnostics and then trigger an automatic switch over process between the standby and faulty unit or card. To aid the switch over process all systems should be capable of remembering their current and past card configuration.

OAM Functionality

The OLT and the FSAN management architecture shall be capable of performing the following OAM end-to-end measurements as defined in ITU-T Recommendation I.610 [76] to ensure facilitate the successful monitoring and reconfiguration of the physical layer resources:

- F1 Signal detection and frame alignment flows.
- F2 and F3 Error monitoring and automatic protection flows.
- F4 Fault Performance monitoring information on Virtual Channels.
- F5 Fault Performance monitoring information on Virtual Circuits.
- AIS and RDI.
- Performance and Monitoring.
- Loopback.
- Continuity Check.
- VP and VC tests measuring the number of bit errors, lost cells etc.

Configuration Management

The ability to offer the following key configuration management functionality:

- The registration and deletion of network elements and circuit cards.
- Forced switch function if a network element suffers from a duplicated configuration.
- Searching and listing functions for circuit card configurations including historical information as shown.
- Management functions for the programme version installed in each network element.
- Management functions for setting up PONS sections.
- Management functions for assigning bandwidth to each ONT stream.
- Management functions for setting up and releasing VP and VC connections at every termination point.
- Management functions for setting up the NPC and UPC features.
- Management of SNI and Circuit Emulation parameters.

Fault Management Functions

- The ability to deliver event reports related to various equipment sections, VPs and VCs.
- The ability to identify rapidly switched events for failure protection.
- The ability to conduct VP and VC test functions, loopback and continuity checks.

Performance Management Functions

- The ability to collect data (auto discovery), time stamp and save performance information.
- Thresholding and alarm forwarding capabilities.
- The ability to produce scheduled reports.
- Configure and utilize OAM flows.
- Capacity Management functions such as network equipment in use, spare equipment and faulty equipment, etc.

Security Functions

Security level for all management systems should be equal to or exceed the C1 standards defined in DoD 5200.28-STD.

F.2.6 Future of FSAN

The FSAN architecture was initiated and devised during the time when the vision of an ATM based core network was popular. However we are now in a time of uncertainty regarding the future core network architecture due to the vast growth of the Internet and IP based networks beginning to challenge the ATM stance. An example of this uncertainty is demonstrated by the fact that many ATM and traditional switch vendors are currently acquiring IP based network vendors to try and guarantee their future security, for example Nortel's recent acquirement of Bay Networks. Furthermore new standards such as MPLS, DIFFSERV and RSVP are been introduce to enhance the present day IP with desirable features from the broadband ISDN/ATM standards. For example IP is inherently un-guaranteed and connectionless, whilst ATM offers connection oriented guaranteed services.

Multi-Protocol Label Switching (MPLS) claims to be the technology key that will open up the gate into New World IP VPN services by giving providers the ability to offer mega-scale, differentiated business IP VPN services with simpler configuration and management for both providers and subscribers. It is proposed that this will be achieved by using an innovative label-based forwarding paradigm, whereby labels indicate both routes and service attributes. At the ingress edge, incoming packets are processed and labels are selected and applied. The core reads the labels, applies appropriate services, and forwards packets based on the label. Processor-intensive analysis, classification, and filtering happens only once, at the ingress edge. At the egress edge, labels are stripped, and packets are forwarded to their final destination.

The Internet Engineering Task Force (IETF) has issued a proposed standard for differentiated services (DiffServ), enabling either end-to-end or intradomain service discrimination. By establishing a way to deliver differentiated per-hop forwarding behaviour to IP packets, DiffServ allows a shared network to accommodate different QoS levels for traffic streams using the same infrastructure. DiffServ will enable Internet service providers (ISPs) to define classes of service (CoS) to support the particular requirements of consumer, business, commerce, and multimedia traffic, and to offer "premium" services for special data types such as voice.

The Resource Reservation Setup Protocol (RSVP) is designed to be used by an IP based host to request specific qualities of service from the network for particular application data streams or flows. RSVP could also be used by routers to deliver QoS requests to all nodes along a route thus guaranteeing end-to-end quality/grades of service.

Hence the long-term future of FSAN could really depend on whether the future core network will be ATM based as originally predicted or IP based. However for the Satellite environment an ATM environment has many advantages due to its end to end connectivity and management capabilities.

F.2.7 Synergy with Satellite Systems

Clearly the FSAN initiative has been to date focussed exclusively on terrestrial optical and wireline technologies, but the user applications and the approach to network management can be mapped onto the proposed future broadband satellite systems.

For example many of the future broadband satellite systems proposed for launch in year 2003/4 have similar service sets and physical interfaces to that of the FSAN services, as shown in Table F.3.

Table F.3: Example BSM System Service Sets

System	Orbit	Technology	Upstream Data rates	Downstream Data rates	Terminal Interfaces
Teledesic	LEO	**Fast Packet** Switching	**2 Mbit/s**	**64 Mbit/s**	**IP, ISDN, ATM**
Astrolink	GEO	**ATM Switching**	**< 20 Mbit/s**	**< 110 Mbit/s**	**ATM, IP**
Skybridge	LEO	**ATM Switching**	**Res. 2 Mbit/s Bus. nx2 Mbit/s**	**Res. 20 Mbit/s** Bus. nx20 **Mbit/s**	**ATM, USB, Ethernet, ISDN, WAN, PBX**

Basically there are two option for generic satellite access networks, the first been to use transparent satellites which are capable of delivering packet based services over existing systems using ITU-T Recommendation X.25 [72], ATM, Frame Relay and IP technology and secondly the next generation satellites offering Onboard Processing (OBP) capabilities. With transparent systems that satellite access network can just be considered as a bent pipe delivery system since no processing is done above the physical layer.

However with OBP next generation systems, the aim is to combine the multiplexing capability of ATM transport with advanced Medium Access Control (MAC) processing on board. With OBP, ATM-layer and above processing will be carried out on board the satellite. This principle parallels well with the FSAN architecture, which also assumes an ATM transport platform and performs multiplexing in the access network through the ONU. FSAN further maps onto broadband satellite systems with the key network intelligence been at the SN so that the AN can be managed from the SN. This bodes well for satellite systems since it can reduce the intelligence required on board to the minimum for operational reasons and reliability.

One approach of mapping FSAN onto the proposed broadband satellite systems is shown below.

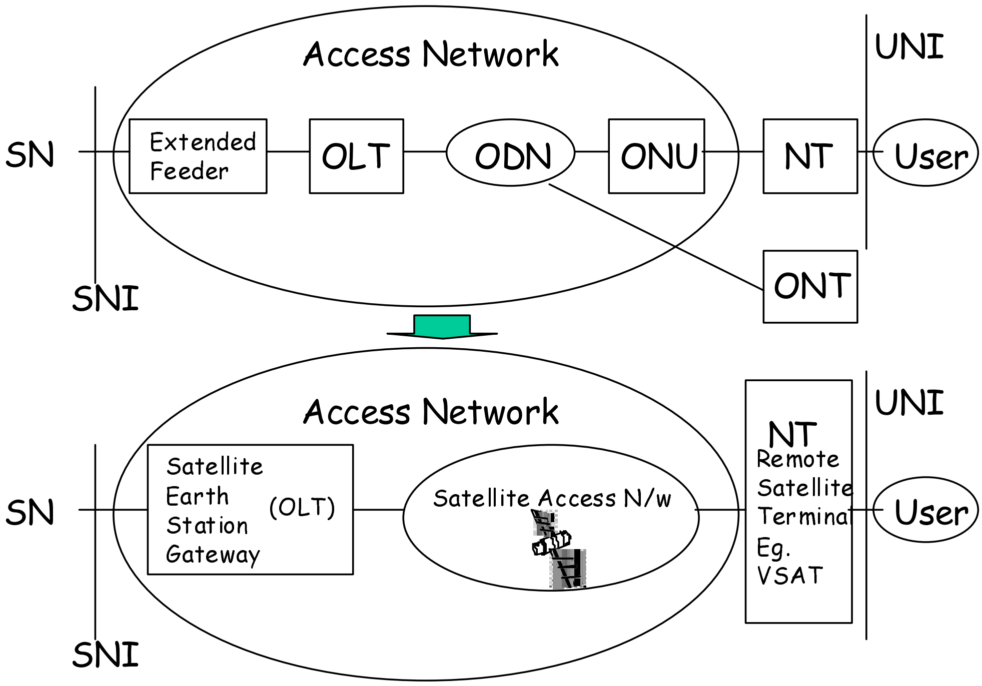


Figure F6: Mapping FSAN onto Satellite Access Network

This mapping of FSAN is based on the following assumptions that:

- a gateway satellite earth station can be considered as the satellite equivalent of an OLT;
- the satellite access network can be considered as the satellite equivalent of the ODN with the satellite(s) acting as ONUs;
- a remote satellite terminal can be considered as the satellite equivalent of a terrestrial NT unit.

The above assumption can be used for mapping standard transparent satellite systems and the new OBP proposals. However the OBP issues needs further investigation since the level of intelligence on-board could move the satellite into areas traditionally addressed at the SN.

It is also possible that the FSAN, TMN based, network management architecture that is currently been applied in many existing terrestrial networks can be mapped onto the management of future satellite systems. This is illustrated in Figure F.7 below.

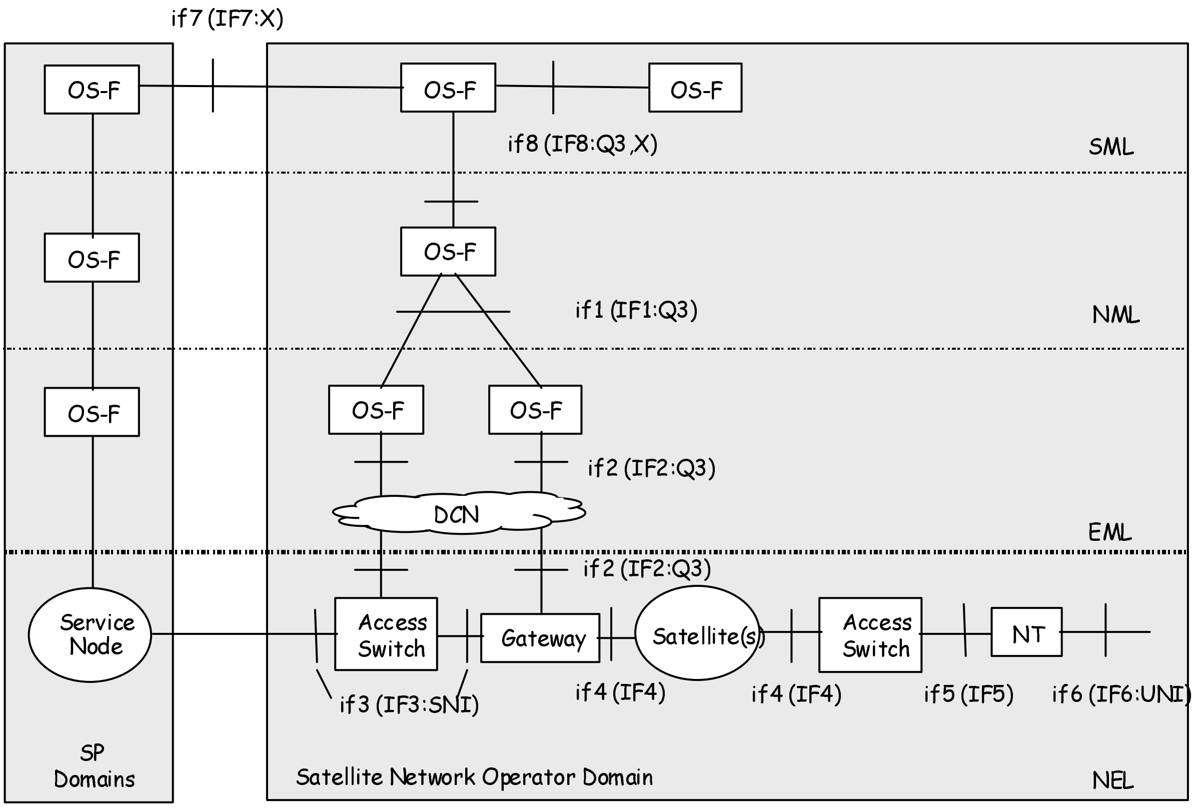


Figure F.7: Satellite mapping of FSAN Management Architecture

With future broadband terrestrial and satellite systems it will become increasingly important for the end user, content provider and service provider to have dynamic management access to the resources of the access network. Presently satellite space segment is arranged by voice, fax or emails. Hence the satellite operators need to adopt a management system for the future capable of handling dynamic space segment requests between service providers, network operators and their own network management systems. The FSAN TMN based management architecture is an ideal vehicle for this issue since a TMN X interface could be adopted between the service provider/network operator and satellite operator service management platforms. However further work is required lower down the management stack since the majority of satellite based network equipment is not SNMP or CMIP compatible but instead based on proprietary ASCII and/or closed contact alarm management. This issue could be resolved with the use of SNMP/CMIP proxy agents.

F.3 ATM Forum

The ATM Forum has several different scenarios for the development of ATM based broadband access networks, two of which incorporate the VB5.1 and VB5.2 interfaces and hence are very similar to the FSAN initiative as discussed earlier.

However the majority of their solutions differ from the ITU-T generic and FSAN approaches in that they place far more functionality within the AN itself, including the termination of user signalling. The aim behind this is provide more autonomy in the AN if there is significant intra-AN traffic and to reduce the signalling load on the core network. This may be particularly relevant to the proposed broadband satellite system, especially those of inter-satellite link capabilities.

F.3.1 Residential Broadband Architecture

The basic ATM Forum access network approach is defined in their Residential Broadband (RBB) architecture as shown in Figure F.8.

Figure F.8: ATM Forum RBB Architecture

The Core ATM network defined as containing one more ATM switches as well as been the location for network management and other application servers, as shown in Figure F.9.

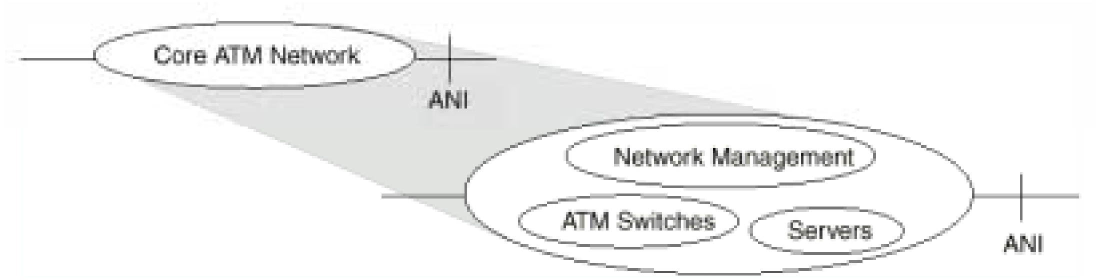


Figure F.9: ATM Core Network

The ATM Access Network is comprised of two key elements: the ATM Digital Terminal (ADT) and the Access Distribution Network, as shown in Figure F.10. The Access Network termination (NT) defined as the functional grouping that connects the ATM Access Network to the home ATM network. UNI W is the interface at the Access Network side of the NT. UNI X is the interface at the home side of the NT. The function of the NT is dependent upon the Access Network and home network technologies. The NT may be either passive or active.

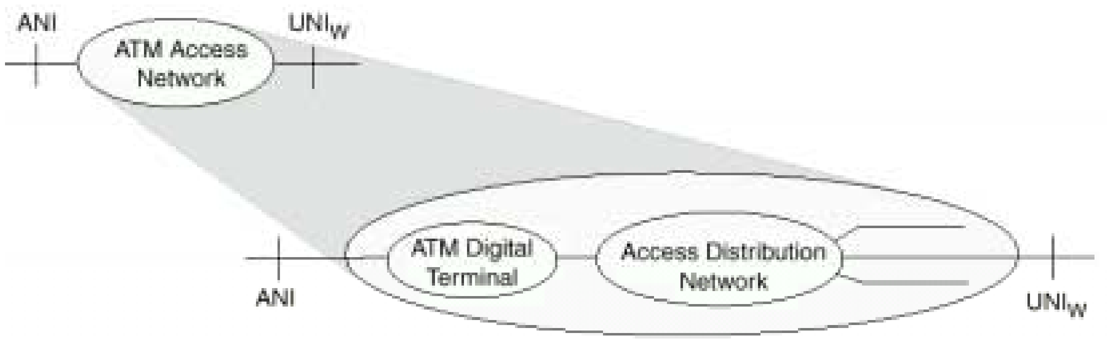


Figure F.10: ATM Access Network

The Home ATM Network (HAN) is defined as been responsible for the connection of the Access Network Termination and the ATM End System(s). Realizations of the HAN may range from a simple transparent-pass-through passive network to a complete local network with switching functions. The HAN is comprised of two functional groups a Home Distribution Device and Home Distribution Network as shown in figure F.11. The Home Distribution Device performs switching and/or concentration of ATM virtual connections between the UNI_X and devices connected to the home ATM network at UNI_H (including support for ATM virtual connections between such devices). It may contain PHY, MAC or ATM layer functionality and may also contain signalling. The Home Distribution Device is optional and need not be present in all Home ATM Networks. Some of its functions could be realized together with the Network Termination in a single device. The Home Distribution Network transports ATM traffic to and from the ATM End System and may be implemented with a single point to point link, with a star configuration or with a shared media tree and branch topology.

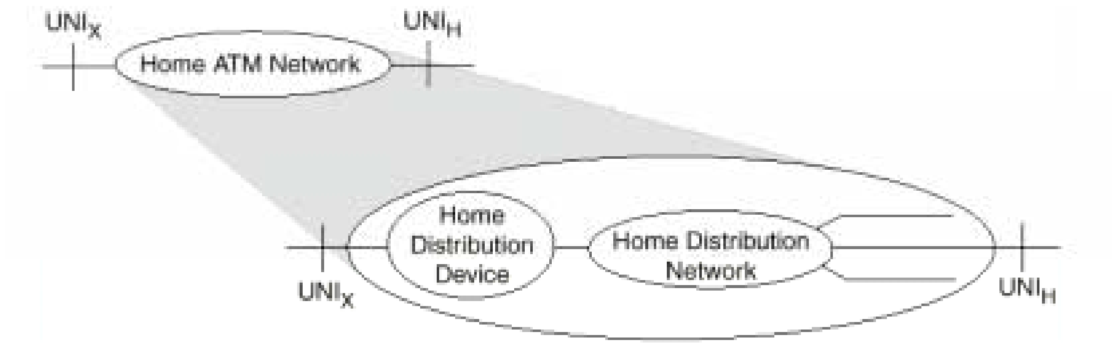


Figure F.11: Home ATM Network

F.3.2 RBB Reference Interfaces

F.3.2.1 Access Network Interface

The Access Network Interface (ANI) is the interface between the Access Network and the Core ATM network. It is independent of any specific Access Network technology. This interface is based on the ITU-T VB5.1, VB5.2 and SNI network architecture model as described in ITU-T Recommendation G.902 [24].

The ATM Inter-Network Interface (AINI) is an interface between two ATM networks. The design of the AINI is based on existing intra-network protocol specifications, i.e., B-ISUP and PNNI. The AINI uses a subset of PNNI signalling to provide SVC services.

The UNIW, UNIX and UNIH interfaces are specific to the Access Network technology, Access Network termination, Home Network and ATM End System. These interfaces support a cell-based UNI, or optionally a frame-based UNI for ATM transport between these elements, hence signalling may be terminated within the access network. A UNI as defined in the ATM Forum UNI 3.1 [37] and SIG 4.0 Specifications may be used as an ANI.

In order to perform dynamic resource management, the ATM Forum perceive that the Access Network needs the following capabilities:

- The capability to distinguish between cells belonging to different VCs (as well as to different subscribers) and to perform ATM or MAC layer concentration and/or switching.
- The capability to perform cell-level scheduling.
- The capability to perform Connection admission Control processes
- The ability to process and possibly negotiate ATM service categories, traffic contracts and QoS.
- Knowledge of its own resources and the capability to allocate them.

This is where the ATM Forum approach strongly differs from the FSAN approach since they are advocating the use of network intelligence and ATM layer processing within the access network. In contrast the FSAN initiative restricts all network intelligence and ATM layer processing to the Service Node and Core Network infrastructure.

However the ATM Forum appreciate that different commercial scenarios will require different levels of intelligence distributed across the core and access networks and hence have produced five key scenarios.

In Scenario 1 (see Figure F.12), the Access Network serves as an ATM concentrator, and does not perform any dynamic resource management. In the control plane, all services and capabilities and usage accounting and billing are located in the Core ATM network.

At the ANI, there is a signalling VCC, an ILMI VCC, and possibly other reserved VCCs for each UNI. Messages on these reserved VCCs are not interpreted or modified by the Access Network. The ANI in this scenario corresponds to the VB5.1 interface.

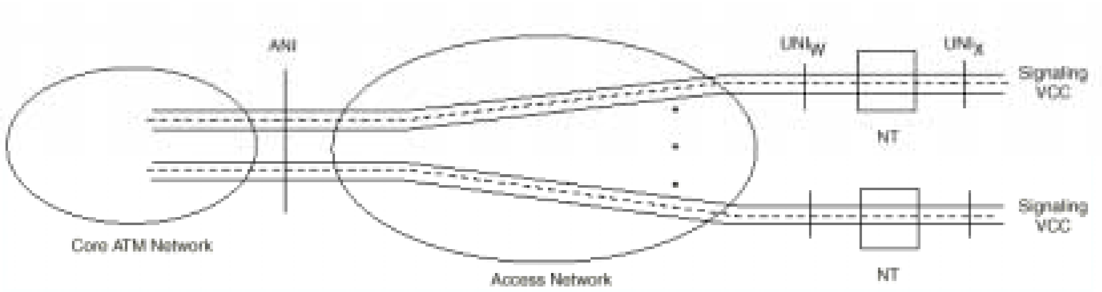


Figure F.12: ATM RBB Scenario 1

In Scenario 2, the Access Network serves as an ATM concentrator, and performs dynamic resource management. In the control plane, all services and capabilities, switching, higher layer services and usage accounting are located in the Core ATM network. At the ANI, there is a signalling VCC, an ILMI VCC, and possibly other reserved VCCs for each UNI (see Figure F13). Signalling messages are not interpreted or modified by the Access Network. There is also a Bearer Connection Control protocol, and one VCC is reserved to carry it. The BCCP requires an additional information flow across the ANI. The ANI in this scenario corresponds to the VB5.2 interface.

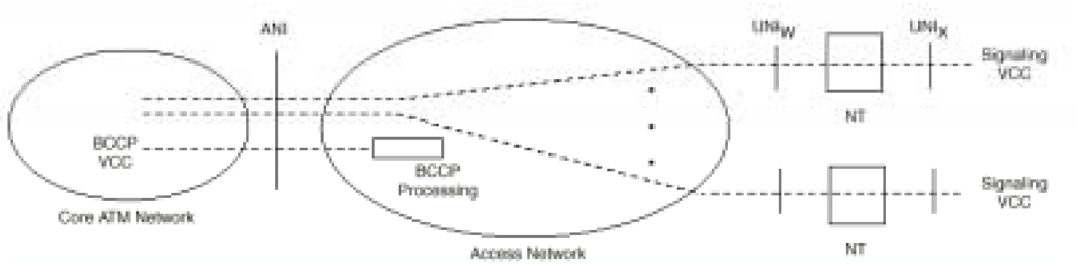


Figure F.13: ATM RBB Scenario 2

In Scenario 3 (see Figure F.14), the Access Network may perform dynamic resource management. It serves as either an ATM concentrator or as an ATM switch. The Access Network may provide services and capabilities in the control plane, but does not perform usage accounting. It may also provide switching and/or higher layer services, as long as there is no ATM layer usage based accounting for these capabilities. In order to provide these services, a service profile is present in the Core ATM network. At the ANI, the signalling VCC is shared among subscribers. Signalling messages are interpreted and possibly modified to the extent that the Access Network is able to:

1) negotiate the service category traffic contract and QoS parameters for the VCC;
2) support control plane services offered by the Access Network;
3) validate the Calling Party Number for the Core ATM network.

This requires the Core ATM network to operate signalling protocol state machines at the UNI and ANI. The ANI is either an ATM Inter-Network Interface (AINI) or a UNI. In the latter case, the Access Network is the user side of the interface and the ATM core network is the network side.

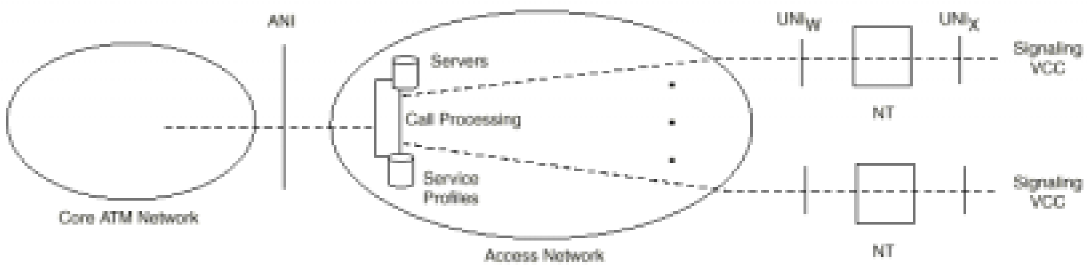


Figure F.14: ATM RBB Scenario 3

In Scenario 4 (see Figure F.15), the Access Network may perform dynamic resource management. It serves as an ATM switch. The Access Network may provide services in the control plane and/or higher layer services, and provides usage accounting. The Access Network includes a service profile and usage accounting records.

At the ANI, the signalling VCC is shared among subscribers. Signalling messages are interpreted and modified to the extent that the Access Network is able to:

1) negotiate the service category, traffic contract and QoS parameters for the VCC;
2) remap VPI/VCI at the UNI w to VPI/VCI at the ANI;
3) perform usage accounting;
4) support any other control plane services that it offers.

This requires the Core ATM network to operate signalling protocol state machines at the UNI and ANI. The ANI is either an ATM Inter-Network Interface (AINI) or a UNI.

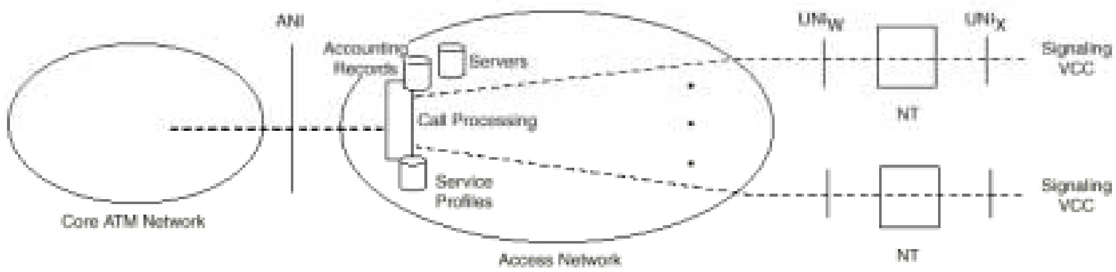


Figure F.15: ATM RBB Scenario 4

Scenario 5 (see Figure F.16) represents the case where proxy signaling is used in Scenarios 3 and 4. In this case, the signalling channel (or channels) between the Access Network and the Core ATM network does not traverse the ANI but is present on a different interface. This other interface may be either a UNI or an NNI between the access call processing agent and the Core ATM network. This may be of particular interest to Satellite Operators and SPs since this could be used to extend user signalling to the satellite system gateway for the centralization of network intelligence. This approach would then map more closely to the FSAN initiative.

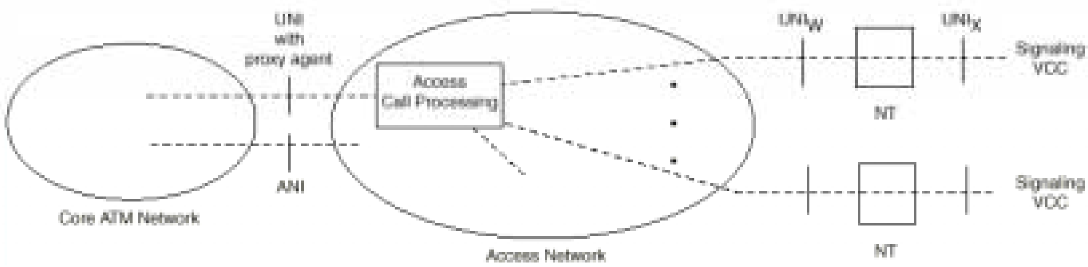


Figure F.16: ATM RBB Scenario 5

F.3.2.2 RBB Service Sets

The service sets for RBB are:

- Point to point and point to multipoint services as in UNI3.1.
- VPCs and VCCs as specified in UNI3.1.
- PVCs and SVCs as per UNI 3.1 [37].
- Traffic Management - CBR, nrt-VBR, rt-VBR, ABR and UBR service categories as per TM4.0.

These are available across the following RBB Physical Interfaces:

- ATM Fibre 25,6, 51,2 and 155 Mbit/s Private UNI.
- ATM 25,6 Mbit/s Cable Category.
- Automatic speed detection is available at remote end.

F.3.3 ATM Network Management Reference Model

The ATM Network Management architecture is different from the FSAN TMN approach in that it is a flat management architecture as opposed to a layered approach. The ATM network management architecture is fundamentally based on a series of M flows that are used to manage specific segments of the RBB architecture. The ATM network management is shown schematically in Figure F.17.

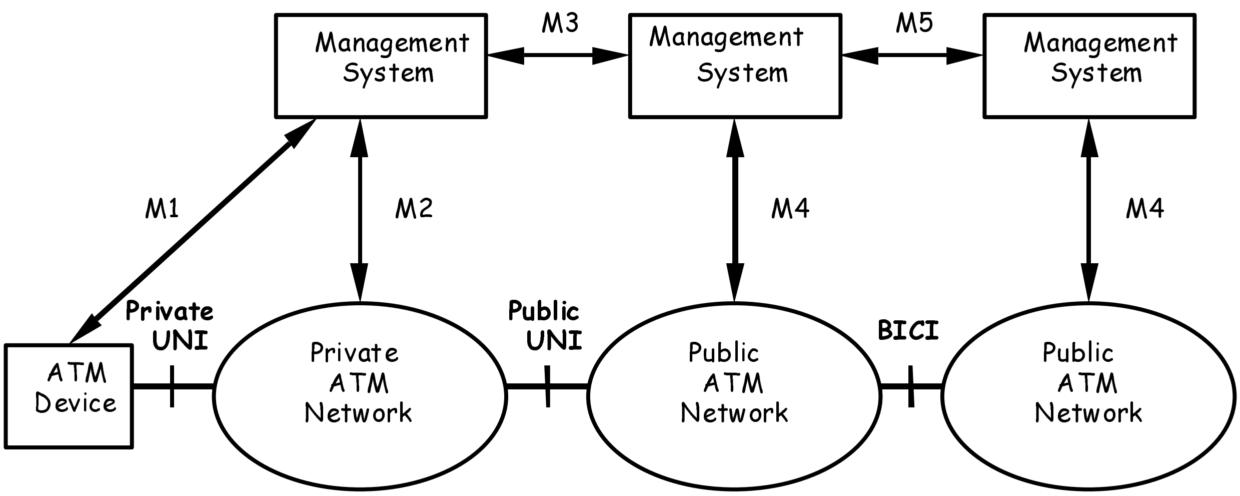


Figure F.17: ATM Network management model

In this model, M1 is the ATM management interface needed to manage an ATM terminal device. M2 is the management interface needed to manage a private ATM network. M3 is the management interface needed to allow a customer to supervise their use of their portion of a public ATM network. Within the M3 protocol there are two classes; class 1 for monitoring information only and class 2 for monitoring and control. M4 is the management interface needed to manage a public network service, including both network element management and service management functions. M5 is the management interface needed for management interaction between two public network providers. M3 functions defined in the present document include configuration, fault and performance management at this time.

To date the ATM Forum has defined both SNMP and CMIP implementations (including MIBs) for the M4 flow. An SNMP implementation has also been defined for both M3 classes.

While the M2, M3, M4 and M5 management definitions can provide a top down network wide view, they are not the only management functions relevant to ATM. The Interim Local Management Interface (ILMI) provides an ATM link-specific view of the configuration and fault parameters of a User Network Interface (UNI). The UNI also provides some layer management functionality via Operations Administration and Maintenance (OAM) cells.

F.4 Digital Audio-Visual Council

The Digital Audio-Visual Council (DAVIC) has recently produced a specification (DAVIC v1.4) defining the minimum specification for tools and the dynamic behaviour required by digital audio-visual systems for end to end interoperability across countries, applications and services. This is based on a set of defined reference points, information transfer interfaces, physical signal transfer interfaces, management flows and stacks.

Key DAVIC definitions are:

1) The Access Network is defined as a part of the overall delivery system, containing a collection of equipment and infrastructure that link a number of service consumer systems to the rest of the delivery system through a single or limited number of common ports.

2) Access Control is defined as the provision of access services and protection against unauthorized interception.

3) Control Information is defined as information that may change the state of objects intercepting data flows for example a remote control channel up command.

4) The Distribution Network is defined as a collection of equipment and infrastructures that delivers information flows from the access network to the network termination elements of the access network.

The core DAVIC functions are:

- Bit Transport.
- Session Transport eg. Point to Point, Point to Multipoint.
- Access Control.
- Navigation, Programme Selection and control.
- Application launching.
- Media Synchronization.
- Application Control.
- Presentation Control.
- Usage Data.
- User Profile.

F.4.1 DAVIC System Reference Model

Unlike the ITU-T and ATM Forum approaches the DAVIC specification also addresses the information flows between Content Providers, Service Providers and End Service Consumer systems as well as those between the access and core networks. Figure F.18 shows the reference points for the End Service Provider (ESP) to End Service Consumer (ESC) architecture.

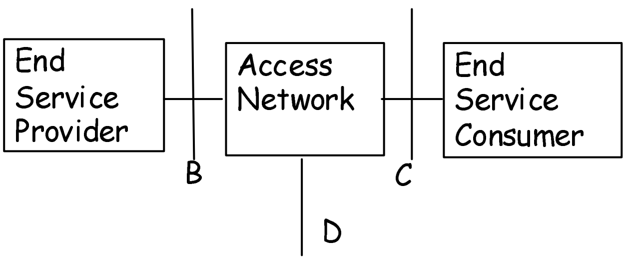


Figure F.18: DAVIC Plane Reference Model

Reference Point B represents a set of ESP-ISP (Internet Service Provider) interfaces that are local to the region and a set of ESP interfaces to objects in other regions. Reference Point C represents a set of ISP-ESC interfaces that are local to the region and a set of ESC interfaces to objects in other regions. Reference point D represents a set of interfaces between ESPs and ESCs in the same region. Information flowing through Reference Point D is transparent to the ISP. Figure F19 expands the reference points for the particular area of access networks. It is interesting to note that the DAVIC specifications include a Home LAN similar to the ATM Forum architecture.

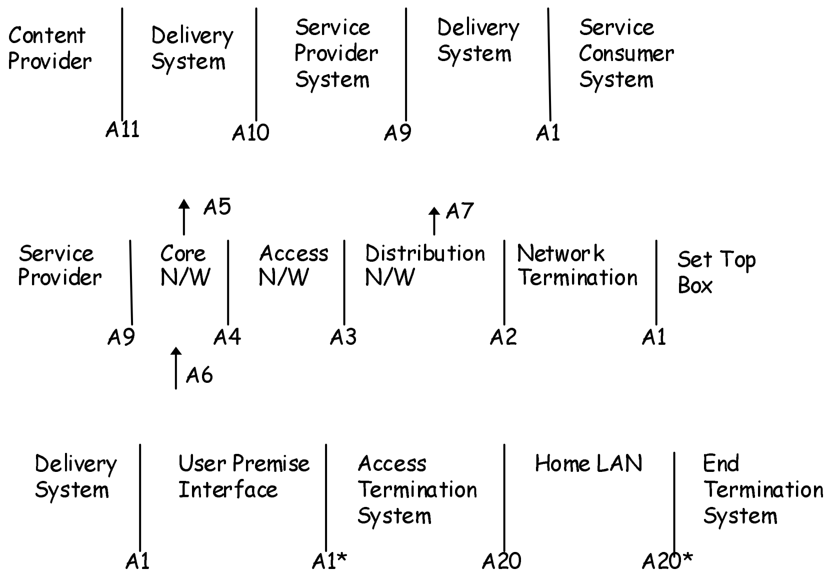


Figure F.19: DAVIC System Reference Model

Table F.4 defines the various A reference points within the DAVIC system reference model.

Table F.4: DAVIC Reference Points

Reference Point	Information Flow
A1	Service Consumer System to Distribution System
A1*	DAVIC Home Access Network
A2	Distribution Network to Network Termination
A3	Distribution Network to Access Network
A4	Core to Access Network
A5	Network related control flows
A6	Service related control flows
A7	Network related control and access links
A8	Management Objects
A9	Service Provider to Core Network/Distribution System
A10	Delivery System to Service Provider
A11	Content Provider to Delivery System
A20	Access Termination System to Home LAN
A20*	Home LAN to End Termination System

Concentrating on the A4 reference point: this is based on a fully digital ATM based interface supporting ATM SVC, PVC, VPI and VCI functions. The DAVIC architecture is similar to the FSAN initiative in that the following assumptions apply:

- Signalling in the access network is transparent.
- All local switching is performed in the core network.
- Routing, channel concentration, user connection and OAM flows to be performed in the access network.
- Billing and charging procedures are transparent to the access network.

Also like the FSAN and ATM Forum approaches, DAVIC have adopted the ITU-T VB5.1 as the Access Interface Specification, but future versions may adopt VB5.2 as it matures with time. Dynamic allocation of the access network resources will be achieved using the VB5.2 Bearer Control Channel Connection protocol (B-BCC). Multiplexing of ATM UNI interfaces (VB5.1) within the DAVIC Access Network is permitted. However the concentration of upstream traffic on a per connection basis is not permitted. Downstream traffic can be assigned on a per connection basis by switches in the core network.

Using the above reference points the DAVIC specification includes a specific mapping for asymmetric satellite based access network, as shown in Figure F.20.

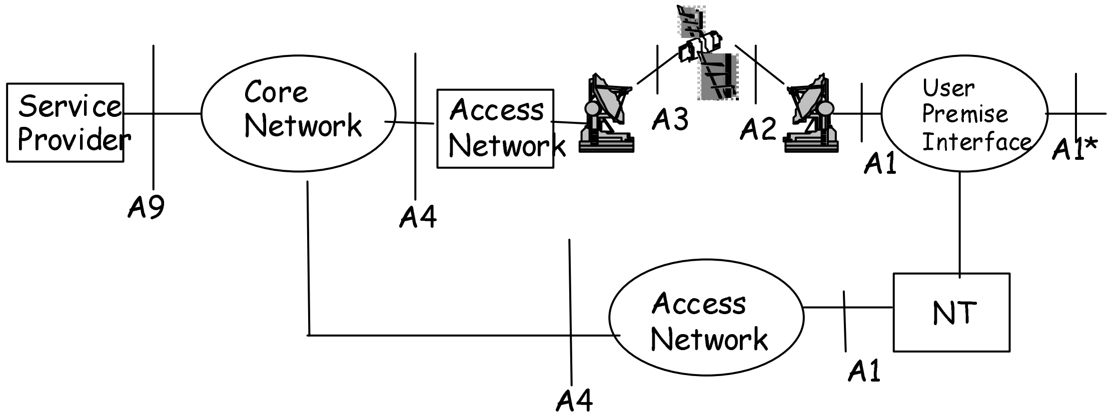


Figure F.20: Satellite Mapping for DAVIC reference points

F.4.2 DAVIC Protocols and Physical Interfaces

The DAVIC protocols and physical interfaces are similar to the FSAN and ATM Forum approaches in that they support IP, UDP and ATM running over the standard core network SDH, PDH, SONET, PSTN, ISDN interfaces. However they also support a 270 Mbit/s DVB interface. A Bit Error Rate of better than 1 in 10^{-9} is specified. Standard recommended media connector is RJ45. For satellite access, QPSK and shortened Reed Solomon encoding is recommended.

F.4.3 DAVIC Network Management Architecture

The DAVIC Network Management Architecture is reasonably open compared to the structured architectures associated with the FSAN and ATM Forum proposals. This is due to that different management scenarios are available to take into account the various issues surrounding where to allocate the network management and intelligence functions in the network. The DAVIC approach is also flexible in that many interfaces have been defined to work with either the TMN based CMIP or SNMP. Plus in the future the DAVIC council may consider the adoption of the new web based and object broker based management architectures such as CORBA.

However all the DAVIC scenarios are based on a common set of "S" management information flows which are used to communicate between the various network elements. The common use of manager to manager communications is also recommended for example between the management system managing the access network and the management system running the core network. This information is referred to in Figure F.21 and Tables F.5 and F.6.

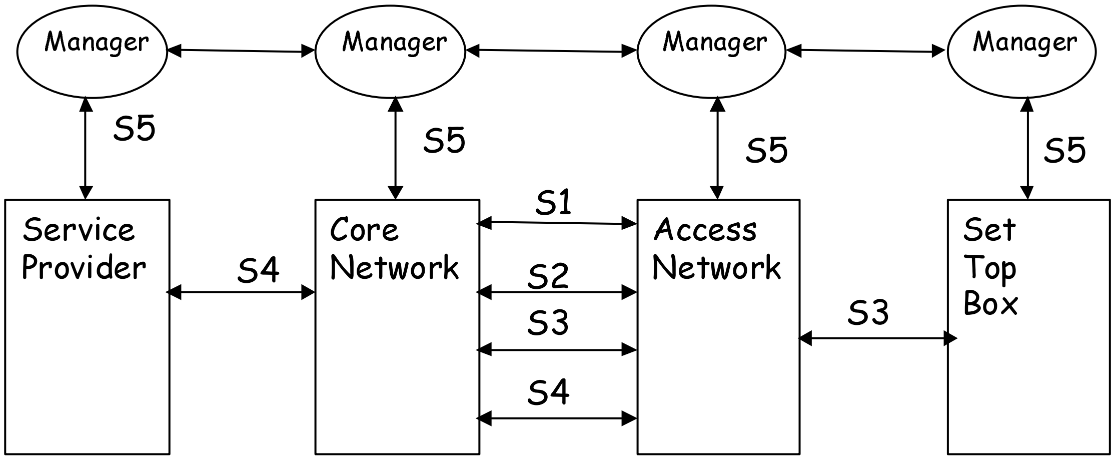


Figure F.21: DAVIC Management Architecture

Table F.5: Management S Flow Descriptions

Management Flow	Description
S1	**Content information**
S2	**Application service layer configuration**
S3	**Session and Transport Service Layer information**
S4	**Network Service Layer Control Information**
S5	**Network Management Information**

Table F.6: Management Interface Implementation Options

Management Interface	Implementation
NMS to Core Network	**CMIP or SNMP**
NMS to Access Network	**CMIP or SNMP**
NMS to Service Provider Server	**SNMP**
NMS to Set Top Box	**SNMP**
Manager to Manager	**CMIP or SNMP**

From Table F.6 it is interesting to note that only SNMP can be used to manage the Set Top Box and the Service Provider Server.

F.4.3.1 Management Scenario 1

This is a scenario in which the end-to-end multimedia system is partitioned into two management domains based on provider boundaries. One management domain contains the Service Provider who owns the server. The second management domain contains the Delivery System provider who owns the Core Network, Access Network and the STB. These two management domains are managed by separate Management Systems to provide reliability in their portion of the end-to-end system. There is peer-to-peer communication between the two Service Management Systems (SMSs).

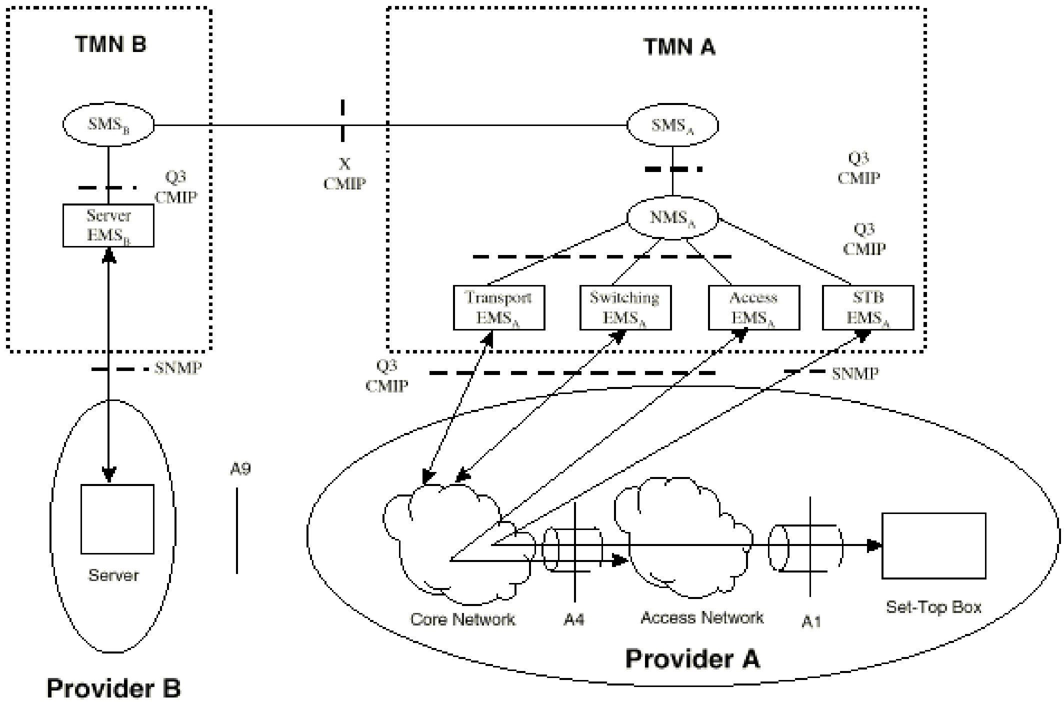


Figure F.22: DAVIC Management Scenario 1

F.4.3.2 Management Scenario 2

This is a scenario in which the end-to-end multimedia system is partitioned into two management domains based on provider boundaries. One management domain contains the Service Provider who owns the server and the STB. The second management domain contains the network provider who owns the Core Network, and the Access Network. The two domains are managed by separate Network Management Systems. There is peer to peer communication between the two SMSs.

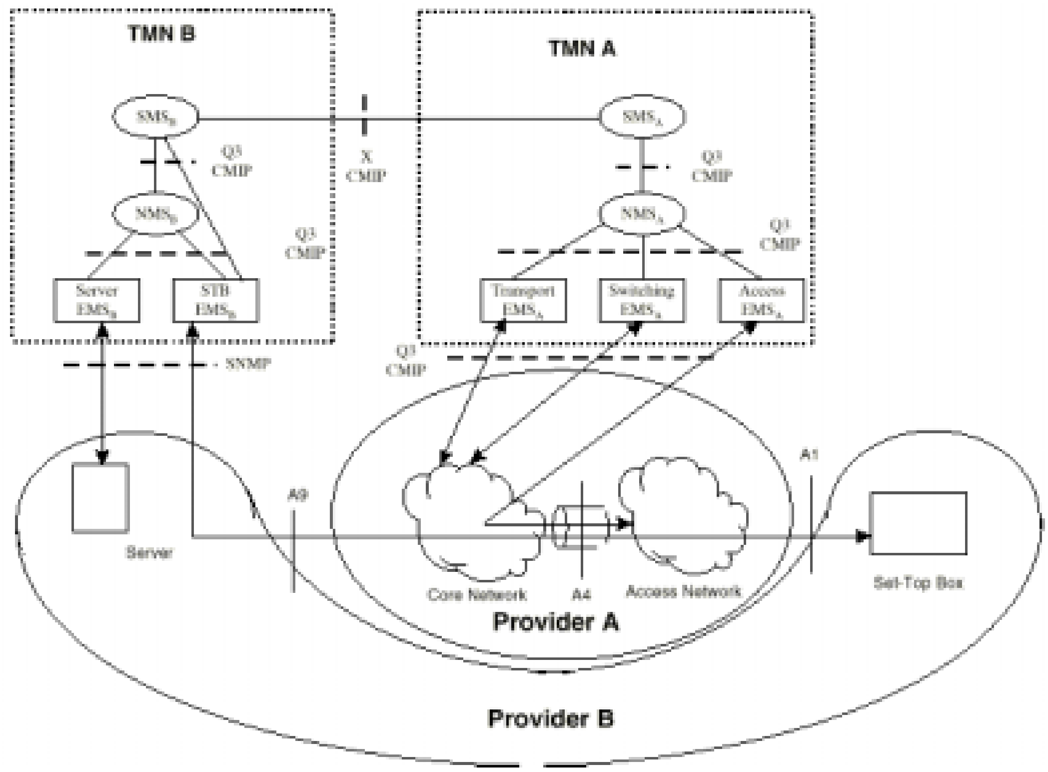


Figure F.23: DAVIC Management Scenario 2

F.4.3.3 Management Scenario 3

This scenario is one in which the STB is owned by an End Consumer. The end-to-end multimedia system without the STB can now be partitioned into management domains based on the ownership of the several components of the system.

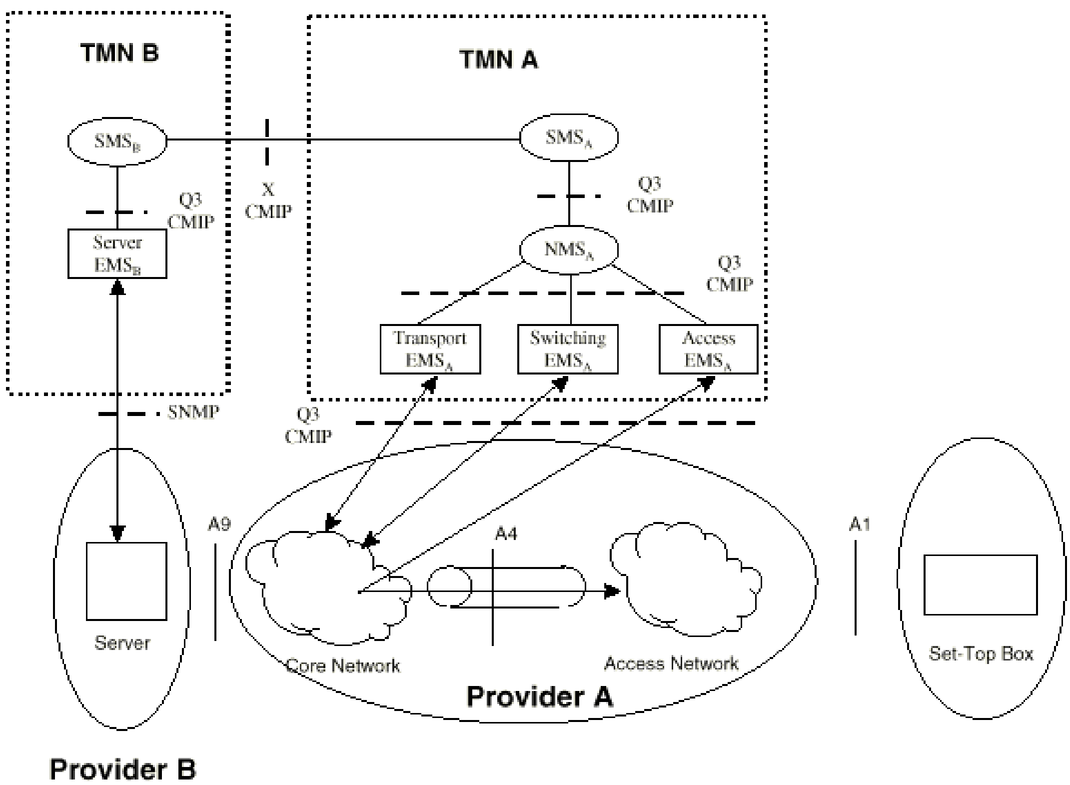


Figure F.24: DAVIC Management Scenario 3

F.4.3.4 Management Scenario 4

This scenario shows a single enterprise scenario in which one provider owns the entire network. In this case, conceptually only one SMS is required to manage the network to provide reliable service. However to decrease complexity, the network can be partitioned into sub-networks to provide distributed management.

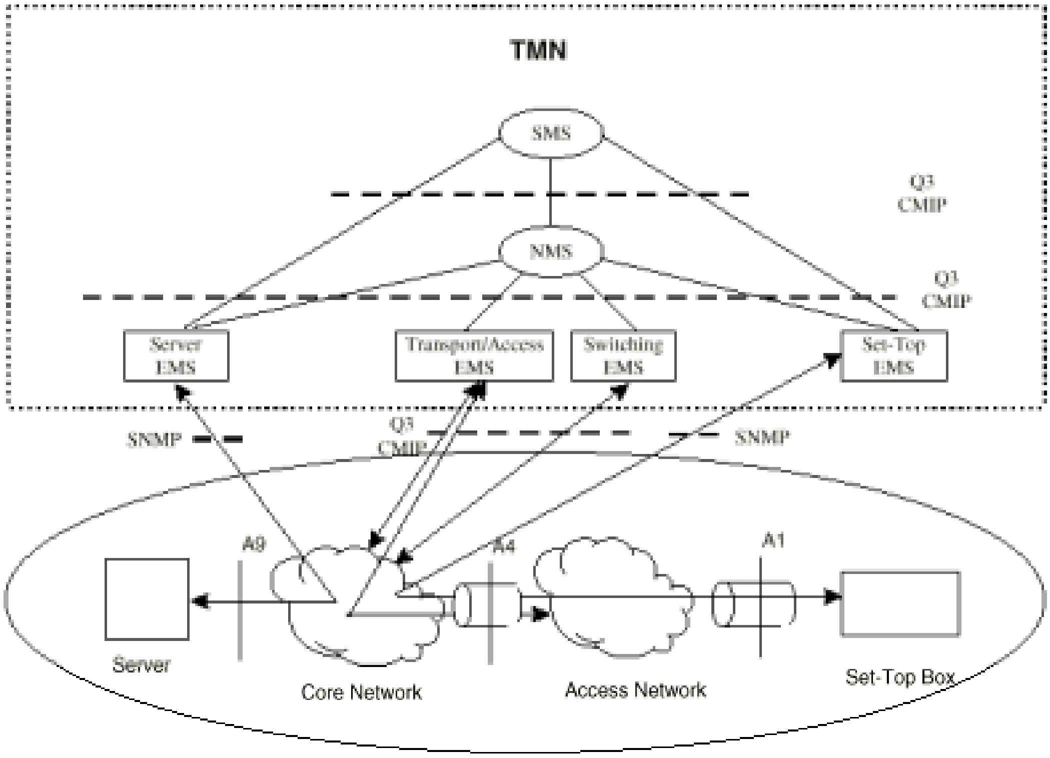


Figure F.25: DAVIC Management Scenario 4

F.4.3.5 Management Scenario 5

In this scenario the Access Network provider also owns the STB. The end-to-end multimedia system can now be partitioned into management domains based on the ownership of the several components of the system as below.

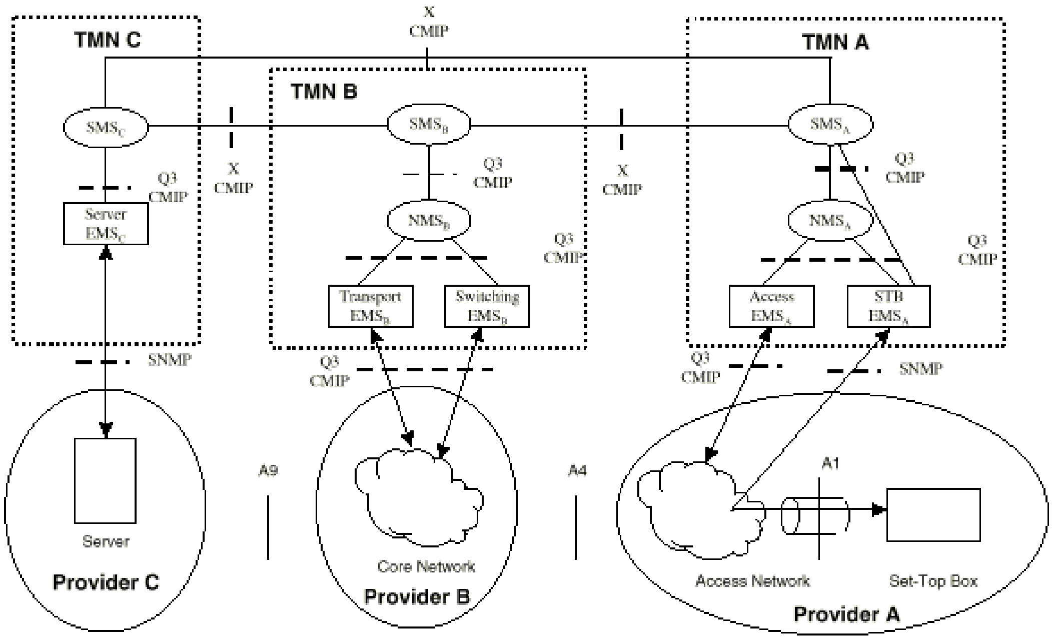


Figure F.26: DAVIC Management Scenario 5

F.4.3.6 Management Scenario 6

In this scenario all resources belong to the network provider, however the network provider is selling capacity to service providers. Interactions, therefore, occur at the service level but all flowing within the DAVIC network are controlled by the network provider.

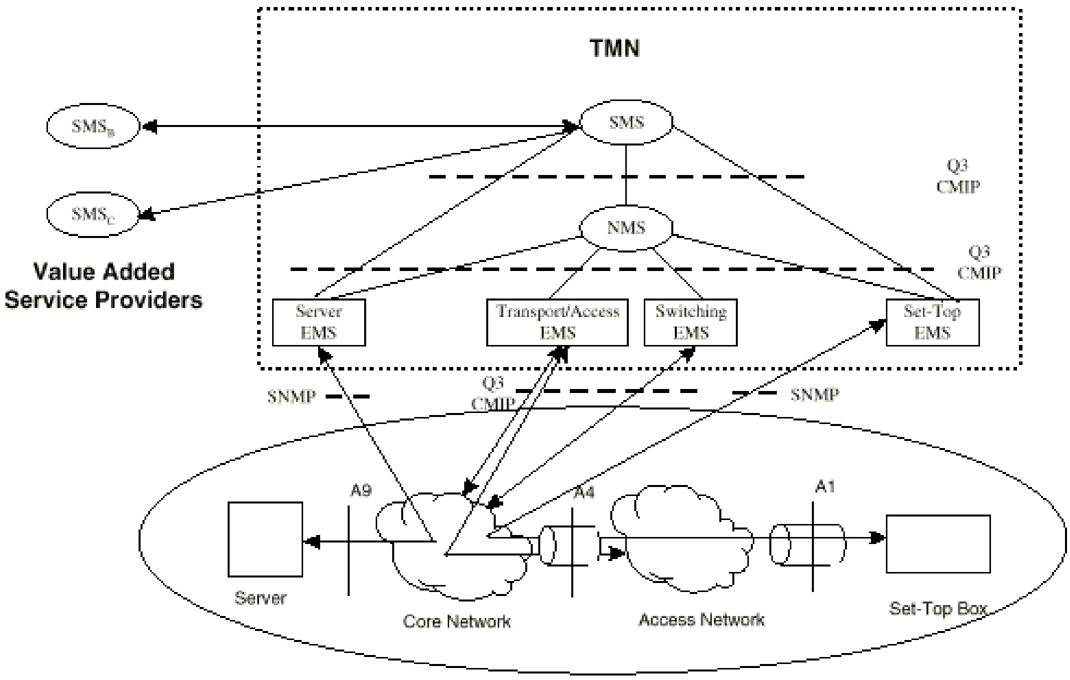


Figure F.27: DAVIC Management Scenario 6

F.5 ITU

The key area of the ITU activity in this subject are based round ITU Recommendations:

- ITU-T Recommendation M.3100 [77] for TMN architecture and implementation.
- ITU-T Recommendation G.967.1 [25] for VB5.1 architecture and implementation.
- ITU-T Recommendation G.967.2 [26] for VB5.2 architecture and implementation.
- ITU-T Recommendation G.902 [24] framework for functional access networks.
- ITU-R Recommendation M.817 [78] IMT 2000 Network Architecture.
- ITU-R Recommendation M.818 [79] Satellite Operations within IMT-2000.
- Performance of ATM via satellite issues draft recommendations.

The key issues from the above recommendations have been incorporated into the FSAN clause of the present document.

F.6 ETSI

The key area of the ITU activity in this subject are based round ETSI Recommendations:

- The VB5.1 architecture and implementation (EN 301 005-1 [80]).
- The VB5.2 architecture and implementation (EN 301 217-1 [82]).
- The VB5 TMN interfaces (EN 301 271 [57] V1.1).

The key issues from the above recommendations have been incorporated into the FSAN and ATM Forum clause of the present document.

F.7 Telecommunications Industry Association

The Telecommunications Industry Association (TIA) is also active in the area of broadband multimedia systems and has issued a standard TSB94 highlighting their recommended satellite ATM network guidelines. Key issues addressed within the present document are:

- Aspects associated with satellite handovers;
- Aspects associated with satellite routing;
- ATM architectures for transparent satellites;
- ATM architectures for satellites with OBP.

F.7.1 Satellite Handovers

TSB94 has identified that there are three key handover situations for satellite systems as shown in Table F.7.

Table F.7: Satellite Handover Types

Handover type	Initiated by	Performed by	System
Intra-satellite	End User	Satellite (beam switching)	GEO/MEO/LEO
Inter-hub	Fixed Earth Station	Fixed Earth Station	LEO/MEO
Inter-satellite	End user, Fixed Earth Station or Satellite	Fixed Earth Station or Satellite	LEO/MEO

From Table F.7 it can be concluded that for inter-hub and inter-satellite handovers a terrestrial ATM based network may be needed between the ground based fixed earth stations. Also the rate of handover changes will vary dependent on the constellation used.

F.7.2 Satellite Routing

TSB94 discusses that routing for bent pipe ATM via satellite solutions is achieved by forwarding all the cells from the receiver module to the downlink transmitter module, i.e. there are no changes to the data format. However in contrast the OBP satellite ATM switch will be required to perform ATM VC, VP and P-NNI routing along with resolving media access issues dependent on the satellite configuration (point to point, mesh or interconnect). The OBP ATM switch will also be expected to perform traffic management issues such as connection admission and control, usage parameter control, cell discarding and traffic shaping.

F.7.3 Transparent Satellite Architectures

The TIA TSB94 standard has put forward three typical ATM network architectures for so called bent-pipe satellites. Since the satellites are transparent no processing above the physical layer is carried out on the satellite.

- ATM network access to fixed terminals and interconnect between two fixed networks. Within this architecture it is assumed that the gateway earth station acts as a multiplexer and is connected to the ATM network by a NNI interface such as the ATM Forum's PNNI. If the satellite access network is used to interconnect two private ATM networks, the interface between the access points and the ATM networks can be PNNI. If the satellite access network is used to interconnect two public ATM networks the interface between the access points can be the ATM Forum BISDN Inter Carrier Interface (B-ICI). If the satellite access network is used to interconnect a private and a public ATM network the interface point can be a public UNI. The interface between the ATM user equipment and the satellite access network can be a public or private UNI.

- Mobile ATM Network Access to provide ATM networks between moving and portable end devices. With this scenario the interface between the ATM user equipment and the satellite access network is a UNI with mobility support. The gateway earth station will need to be connected to a terrestrial ATM network via a NNI interface.

- Mobile ATM Network Interconnect to provide interconnection between a mobile network and a fixed network or two mobile networks. In this scenario all interfaces need to be NNI with mobility support.

F.7.4 OBP Satellite Architectures

Regarding OBP Satellite ATM architectures the TIA standards recommend the following approaches:

- For ATM network access architectures the use of UNI signalling between the access node and the satellite. NNI signalling between the satellite and hub ground earth station.

- For ATM network interconnect architectures the use of NNI signalling between satellite and neighbouring ground ATM switches.

- For Full Mesh ATM networks the use of UNI for direct ATM access and NNI for inter-satellite to fixed ATM switch communications.

F.8 Common Elements and Key Differences

After reviewing all the relevant standards and initiative it is clear that the following issues are common and hence should be considered for adoption in any future broadband satellite system proposal:

- The use of the ETSI/ITU VB5 architecture at the SNI.

- The use of the ATM Forum UNI, NNI and PNNI architectures at the UNI interface.

- The use of TMN based manager to manager communications for end to end service management.

- The use of some form of RTMC, B-BCC and Q2931 signalling.
- The common use of physical interfaces and service sets.
- The common use of asymmetric and symmetrical services.

The above issues are shown schematically in Figures F.28 and F.29 which show all the domains and reference points for the various initiatives mapped onto a satellite access network.

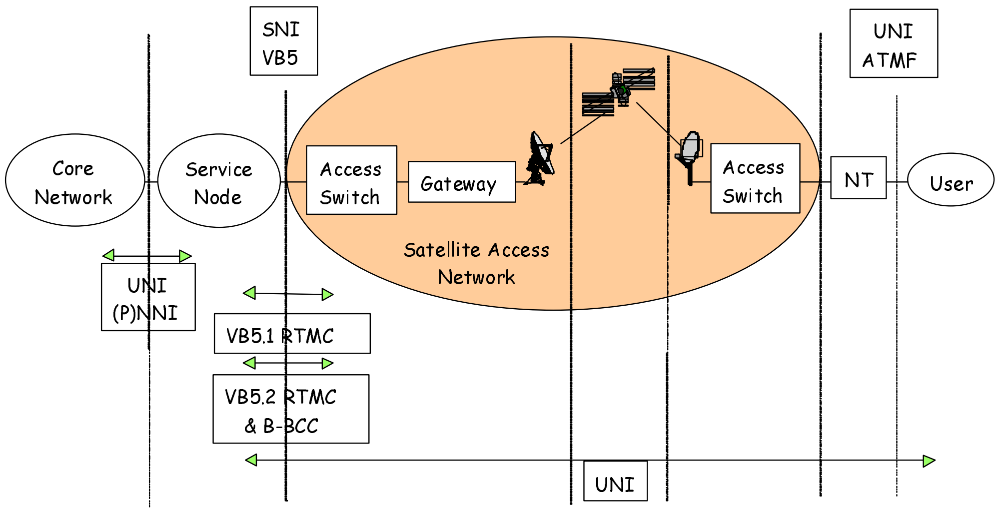


Figure F.28: Common Interface Domains

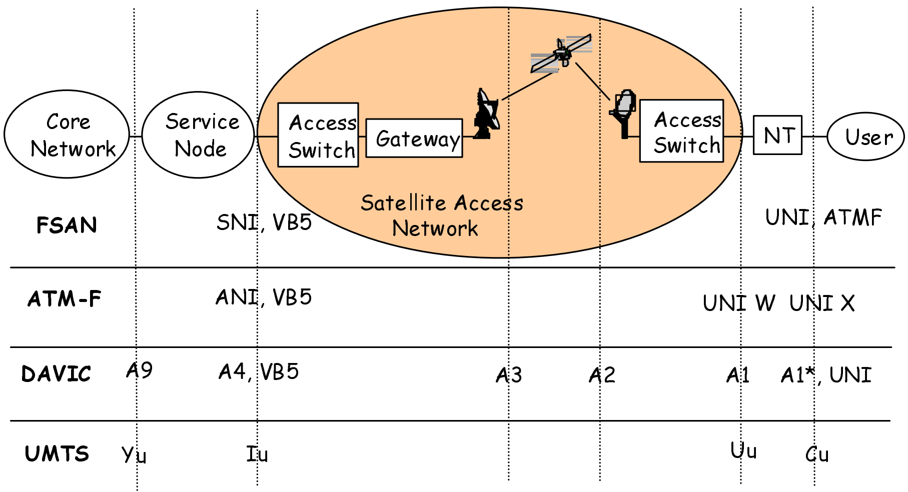


Figure F.29: Cross Interface Signalling

However the following differences exist across the various standards and initiatives:

- The FSAN approach is based on transparent signalling and no intelligence in the access network. This maps ideally onto present day transparent bent pipe satellite systems, but may raise issues with OBP satellite system since this could be argued to include some intelligence. The FSAN architecture is also based on management from the core network, which is again ideal for satellite applications since it reduces the intelligence needed on board the satellite.
- The ATM Forum approach is based on active signalling and ATM layer processing within the access network, which may map onto future broadband systems using OBP but is incompatible with present day transparent systems. However the use of signalling proxy agents may be able resolve this issue by moving the intelligence back to the core network.

- The TIA activities have identified that a different ATM interface will be required at the satellite to gateway, satellite to satellite and satellite to remote terminal interfaces depending on the network configuration e.g. ATM interconnect or full mesh architecture and connection between public or private networks.
- The DAVIC specification also highlights the issue of where to locate the network management and intelligence boundaries, e.g. who manages the user terminal equipment etc.
- Finally there is the issue of running the VB5 RTMC and B-BCC over a satellite access link, i.e. will the round trip access delay effect their operation.

F.9 Conclusions

In conclusion it is recommended that future broadband satellite systems should at the minimum evaluate the use of the ITU/ETSI VB5 and ATM Forum UNI interfaces at the Service Node and Access Node Interfaces of their networks since these architectures are common across all the various standards.

Areas identified for further investigation by ETSI are:

1) The effects of running the VB5 RTMC and B-BCC protocols over a satellite access network.
2) The advantages and disadvantages to be obtained from placing ATM layer and network management intelligence/processing on board future satellite systems and the associated mappings to the ATM and FSAN approaches. For example are there any advances of putting connection admission control and access based signalling on board as proposed by the ATM forum or maintain this functionality at the core network as proposed by the FSAN architecture.
3) The identification of what different ATM interfaces are required at the satellite to gateway earth station, satellite to satellite and satellite to remote terminal interfaces for different network configurations e.g. ATM interconnect or full mesh architecture and connection between public or private networks.
4) The development of TMN based X Co-operative interfaces between satellite operators, network providers and service provides to provide seamless network and service management capabilities. As well as identifying the network and service management boundaries in a broadband satellite multimedia environment, for example who manages the user terminal equipment.

Annex G (informative): DVB-RCS Details

The scope of the baseline specification is for the provision of the interaction channel for GEO satellite interactive networks with fixed return channel satellite terminals (RCST). The solutions provided are a part of a wider set of alternatives to implement interactive services for Digital Video Broadcasting (DVB) systems. For the purposes of this specification, the following informative reference applies:

- DVB Commercial Requirements for Satellite Interactive Terminals (DVB-CM141).

G.1 Reference Models

G.1.1 Protocol Stack Model

For asymmetric interactive services supporting broadcast to the user with narrowband return channel, a simple communications model consists of the following layers:

- **physical layer:** Where all the physical (electrical) transmission parameters are defined.
- **transport layer:** Defines all the relevant data structures and communication protocols like data containers, etc.
- **application layer:** Is the interactive application software and runtime environments (e.g. home shopping application, script interpreter, etc.).

A simplified model of the OSI layers was adopted to facilitate the production of specifications for these layers. The figure below points out the lower layers of the simplified model and identifies some of the key parameters for the lower two layers. Following the user requirements for interactive services, no attempt will be made to consider higher layers in this specification.

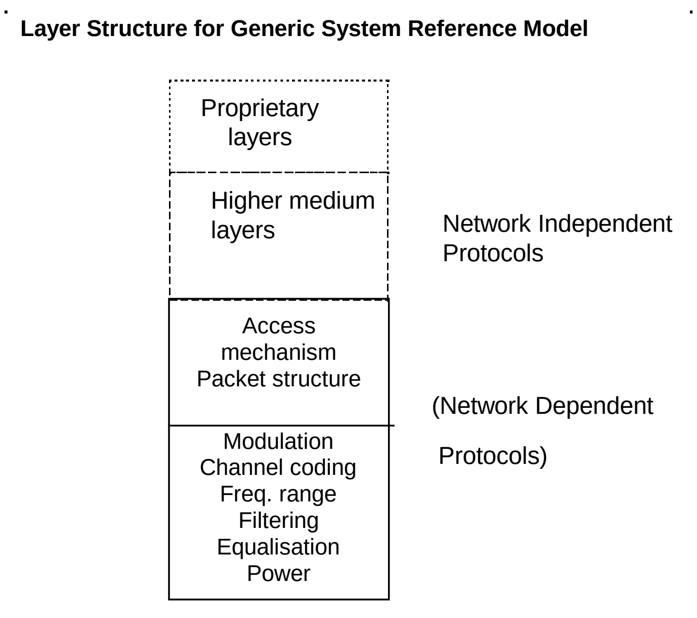


Figure G.1: Layer structure for generic system reference model

G.1.2 System Model

The figure above shows the system model that is to be used for interactive services. In the system model, two channels are established between the Service Provider and the User:

- **Broadcast channel (BC)**: A unidirectional broadband Broadcast Channel including video, audio and data. BC is established from the service provider to the users. It may include the Forward Interaction path.
- **Interaction channel (IC)**: A Bi-directional Interaction Channel is established between the service provider and the user for interaction purposes. It is formed by.
- **Return Interaction path** (Return Channel): From the User to the Service Provider. It is used to make requests to the service provider, to answer questions or to transfer data. It is a narrowband channel. Also commonly known as return channel.
- **Forward Interaction path**: From the service provider to the user. It is used to provide some sort of information by the service provider to the user and any other required communication for the interactive service provision. It may be embedded into the broadcast channel. It is possible that this channel is not required in some simple implementations that make use of the Broadcast Channel for the carriage of data to the user.

The RCST is formed by the Network Interface Unit (NIU) (consisting of the Broadcast Interface Module (BIM) and the Interactive Interface Module (IIM)) and the Set Top Unit (STU). The RCST provides interface for both broadcast and interaction channels. The interface between the RCST and the interaction network is via the Interactive Interface Module.

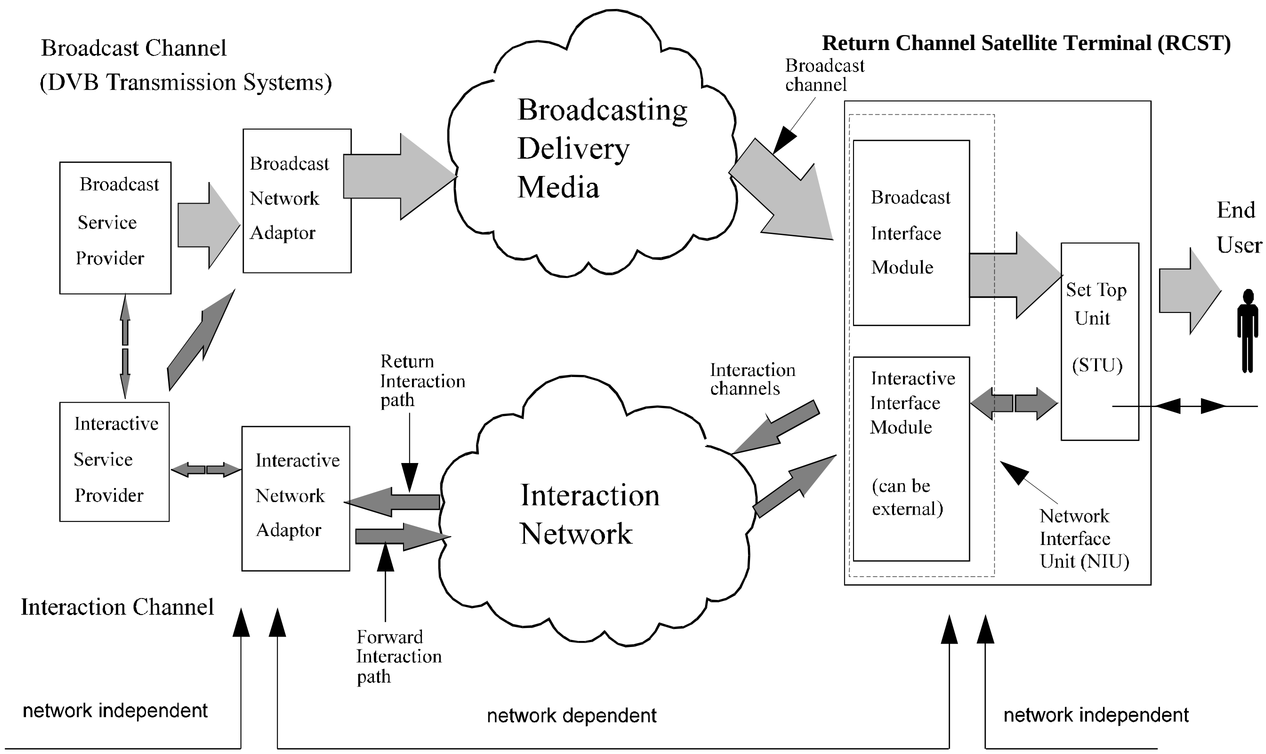


Figure G.2: A generic system Reference Model for Interactive Systems

G.1.3 Reference Model of the Satellite Interactive Network

An RCST is e.g. a SIT or a SUT An overall Satellite Interactive Network, within which a large number of Return Channel Satellite Terminal (RCST) will operate, will comprise the following functional blocks:

- **Network Control Centre:** A NCC provides monitoring and control functions. It generates control and timing signals for the operation of the Satellite Interactive Network to be transmitted by one or several Feeder Stations.

- **Traffic Gateway:** A Traffic Gateway receives the RCST return signals, provides accounting functions, interactive services and/or connections to external public, proprietary and private service providers (data bases, pay-per-view TV or video sources, software download, tele-shopping, tele-banking, financial services, stock market access, interactive games etc.) and networks (Internet, ISDN, PSTN etc.).
- **Feeder:** A Feeder transmits the forward link signal, which is a standard satellite digital video broadcast (DVB-S) uplink, onto which are multiplexed the user data and/or the control and timing signals needed for the operation of the Satellite Interactive Network.

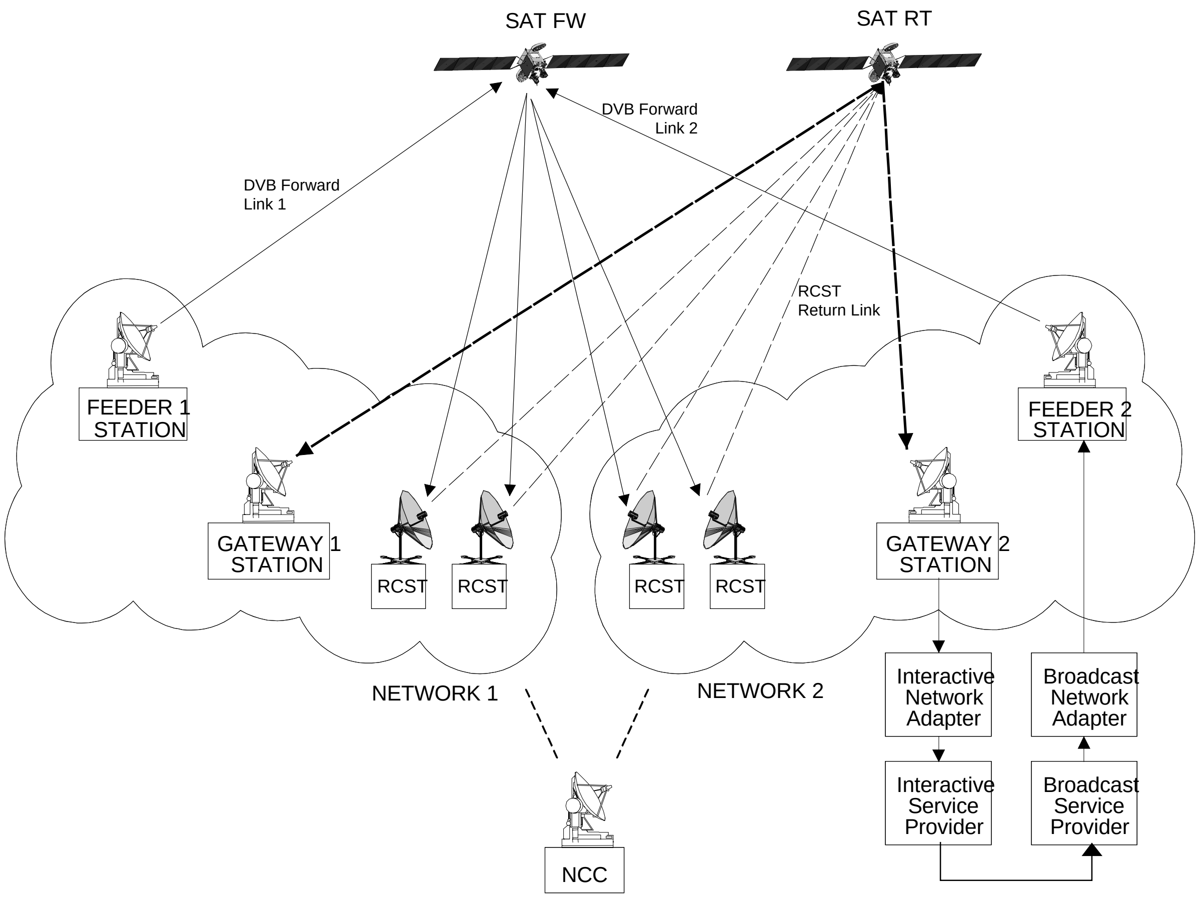


Figure G.3: Reference Model for the Satellite Interactive Network

The forward link carries user traffic and signalling from the NCC to RCSTs. The signalling from the NCC to RCSTs that is necessary to operate the return link system is called "Forward Link Signalling" in the following. Both the user traffic and forward link signalling can be carried over different forward link signals. Several RCST configurations are possible depending on the number of forward link demodulators present on the RCST:

- 1: standard;
- 2: enhanced;
- more than 2: universal.

G.2 Forward Link

The RCST shall be able to receive digital multimedia broadcast signals conforming to:

- EN 300 421 [9];
- ETS 300 802 [10];

- ETS 300 468 [11];
- EN 301 192 [13];
- EN 301 459 [17];
- ETR 154 [5].

G.3 Return Link

G.3.1 Base-band Physical Layer and Multiple Access

Specifications for the base-band physical layer are given. The figure below represents an example of the digital signal processing to be performed at the RCST transmitter side, from the energy dispersal of the serial information bit-stream, to the QPSK modulation representing the digital to analogue conversion.

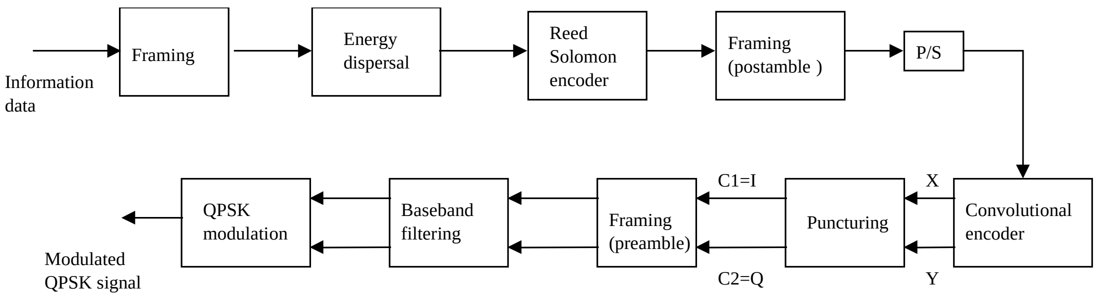


Figure G.4: Baseband signal processing with traffic burst framing as example

RCST synchronization includes definition of:

- Timing Control;
- Carrier synchronization;
- Burst synchronization;
- Symbol clock synchronization;
- Burst start time.

There are four types of bursts: traffic (TRF), acquisition (ACQ), synchronization (SYNC) and common signalling (CSC). Any slot can contain any kind of burst, at the discretion of the operator or service provider. An illustration of valid combinations of slots is shown below.

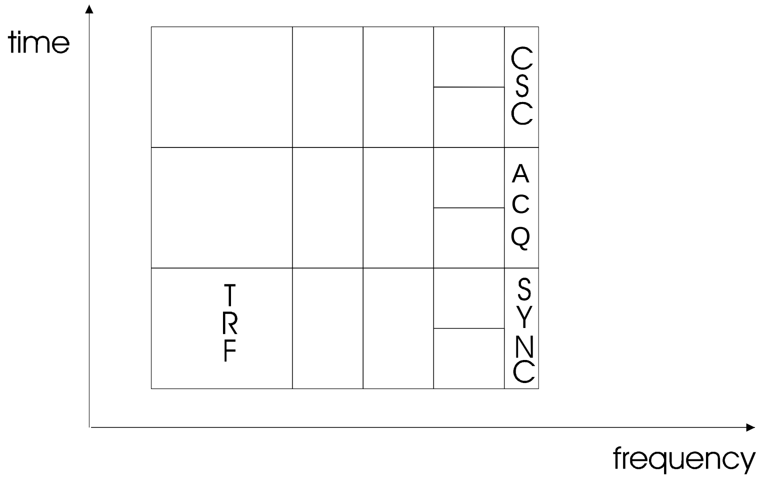


Figure G.5: Examples of valid combinations of slots

The burst formats, etc., are detailed under the following headings.

- Traffic burst format;
- Synchronization and acquisition burst formats;
- Satellite Access Control header;
- Common Signalling Channel burst format;
- Bit numbering and Interpretation;
- Transmission Order.

G.3.2 Randomization for energy dispersal

The return link data stream shall be organized in fixed length bursts. In order to comply with ITU Radio Regulations and to ensure adequate binary transitions, serial data bit stream in a burst shall be randomized. The polynomial of the Pseudo Random Binary Sequence (PRBS) shall be as the one of EN 300 421 [9], i.e. $1+x^{14}+x^{15}$.

G.3.3 Coding

Coding for channel error protection is applied to traffic and control data only. The coding scheme allows, but does not impose, serial concatenation of two codes. The outer code is a by-passable Reed-Solomon (RS) code, whereas the inner code can be either the non-systematic convolutional code of EN 300 421 [9] or a Turbo code. The selected inner code is signalled by the NCC on the forward link. A bypassable CRC can also be applied on the bursts in order to allow error detection at the NCC. Details are given under the following headings.

- CRC error detection code;
- Outer coding (RS);
- Inner coding (convolutional code);
- Inner coding (Turbo code).

G.3.4 Modulation

The signal shall be modulated using QPSK, with roll-off factor of 35%. The specification will also include details on:

- Bit mapping to QPSK constellation;
- Baseband shaping and quadrature modulation;
- Output power control;
- Guard Time.

G.3.5 Capacity Request Mechanisms

All methods described below can be used by RCSTs for capacity requests. One or more of the methods may be employed in a Satellite Interactive Network. For the particular implementation, the RCSTs would be configured at the time of commissioning and/or during operation.

- **Prefix Method**: This mechanism is based on a prefix (N= 0 to 7 Bytes, N configurable) attached to all traffic bursts. If N is non-zero, it carries control and management information from the RCSTs to the NCC, mainly composed of capacity requests.
- **Data Unit Labelling Method**: This mechanism is based on pre-assigned values of the Data Unit Header to identify Data Units carrying control and management information from the RCSTs to the NCC. This method shall be consistent with the possible use of the Data Unit Header for routing/switching user information.
- **Mini-slot Method**: This mechanism is based on a periodic assignment to all logged-on RCSTs of slots smaller than traffic slots. It carries control and management information from the RCSTs to the NCC and is used also for maintaining RCST synchronization.
- **Contention based Mini-slot Method**: As per Method "3", but the mini-slot can be accessed by a group of RCSTs on a contention basis.

The multiple-access capability is either fixed or dynamic slot MF-TDMA. The specification defines both a Frame and Super-frame format.

G.4 Protocol and Sequences

Procedures to allow a RCST to log-on to the satellite interactive network and for operations with the NCC and the gateways are defined. This includes an identification of the calling RCST, an optional ranging process to adjust timing, frequency, and power of the RCST, and a log-on procedure which gives an identification to the RCST that can be used to transmit meta-signalling to request traffic connections. The following subclauses explain into more details each one of these procedures, and the requirements for NCC elements.

G.4.1 Initial Synchronization

Following the power-up, the RCST acquires forward downlink (receiver) synchronization and proceeds as detailed below:

- The RCST acquires coarse return link synchronization using the PCR that is transmitted by the NCC on the forward link.
- The RCST continues to receive the PCR after initial synchronization. In the event that PCR synchronization is lost, the RCST shall cease transmission and re-initiate the synchronization procedure.
- The RCST receives the burst time plan transmitted by the NCC at regular intervals. The BTP is contained in the Forward link Signalling.

G.4.2 Network Entry

Network entry defines:

- Overall Events Sequencing;
- Logon Procedure;
- Acquisition Procedure (Optional);
- Synchronization Maintenance Procedures (Optional);
- Signalling Messages.

G.4.3 Log-off Procedure

The log-off procedure defines three classes:

- General;
- Normal;
- Abnormal.

G.5 Service support

The slot allocation process shall support four capacity categories:

- Continuous Rate Assignment;
- Rate Based Dynamic Capacity;
- Volume Based Dynamic Capacity;
- Free Capacity Assignment.

Details are given for each.

G.6 Network management

The specification defines the messages to allow a RCST to log-on to the satellite interactive network. These will be used to co-ordinate an identification of the calling RCST, a process to adjust the power of the RCST, and a log-on procedure which gives an identification to the RCST that can be used to transmit meta-signalling to request traffic connections. As a minimum set of requirements the RCST must comply with the Control and Monitoring Functions specified in an EN. Among others, the present document requires that the RCST is only allowed to transmit when it receives its control correctly.

G.6.1 Protocol stack

The protocol stack is based on the DVB/MPEG2-TS standard in the forward link and is based on ATM cells or MPEG2-TS Packets mapped onto TDMA bursts in the return link. There are two types:

- RCST Type A (IP Only);
- RCST Type B (ATM).

G.6.2 Mesh networks

To be studied later.

G.6.3 RCST Addressing

On the Forward Link, RCSTs shall be uniquely identified by a physical MAC address and a logical address.

The *MAC address* is a physical address stored in non-volatile memory. It corresponds to a unique RCST physical identifier. It shall follow the IEEE 802.3 [81] standard and shall consist of 48 bits. The value 0xFFFFFFFFFFFF shall be reserved for broadcasting to all RCSTs. This MAC address will be used to address MAC signalling between the NCC and the NIU. It will also be used to encapsulate IP datagrams into MPEG2-TS frames.

The logical address is composed of two fields, the Group_ID and Logon_ID which are assigned to each RCST during logon. They are used for addressing individual RCSTs until logoff. (The Group_ID is probably, therefore, the same after the next logon.).

- The Group_ID corresponds to a group of logged-on RCSTs. It shall consist of 8 bits. The value 0xFF shall be reserved for system use (contention mode on the return link).
- The Logon_ID uniquely identifies the RCST within a group identified with the Group_ID. The Logon_ID shall consist of 16 bits. The value 0xFFFF shall be reserved for system use (contention mode on the return link).

For a Type A RCST any data (user traffic) that is destined to a specific RCST shall be transmitted using the RCST MAC address. Any data (user traffic) that is destined to all Type A RCSTs shall be transmitted using the broadcast MAC address (0xFFFFFFFFFFFF).

Independently, each protocol used at higher layers may impose its own addressing scheme, e.g. IP addresses, etc.

G.6.4 Forward Link Signalling

DVB defines a set of tables built upon the MPEG PSI tables to provide detailed information regarding the broadcast network. Such DVB tables are referred as the Service Information (SI) tables. In a two-way Satellite Interactive Network, consisting of a forward and return link via satellite, medium access control information and other signalling are communicated through the forward link and shall be transmitted in a DVB compliant manner. Thus, the specifications for Service Information (SI) in DVB systems shall apply. The forward link signalling consists of general SI tables, carrying information about the structure of the satellite interactive network, and RCST specific messages sent to individual RCSTs, private data fields defined for standard DVB-SI tables, special Transport Stream packets (PCR Insertion) and descriptors, including private descriptors for standard DVB-SI tables. It is recommended that the transmission interval for the relatively static tables be set to between 5 and 10 seconds as a reasonable compromise between signalling overhead and logon speed.

The figure below gives an overview of the protocol stack for forward link signalling. The specifications also defines:

- PCR Insertion TS Packet.
- Repetition Rates.

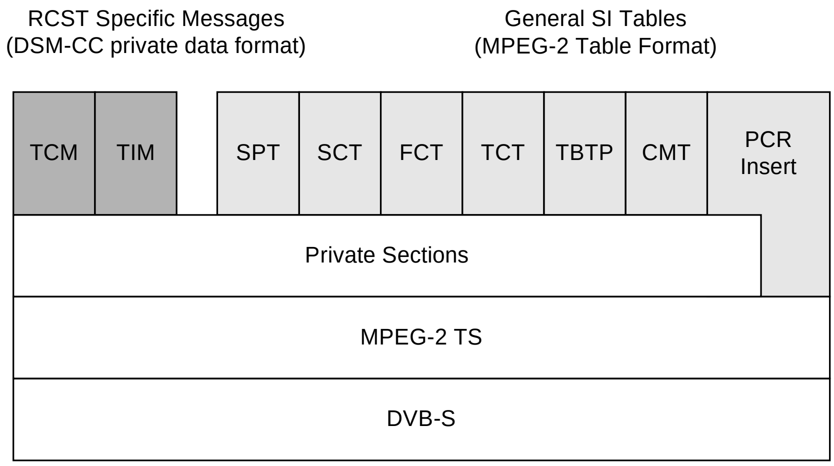


Figure G.6: Protocol Stack for Forward Signalling

G.6.5 Return Link Signalling

- RCST synchronization and Identification messages.
- Configuration parameters between RCST and NCC.
- Other Messages for Network Management.
- Burst Time Plan Exchange.

G.6.6 Coding of SI for Forward Link Signalling

- SI Table Mechanism.
- DSM-CC Section Mechanism.
- Coding of PID and table_id fields.

G.7 Security, Identity, Encryption

Security is intended to protect the user identity including its exact location, the signalling traffic to and from the user, the data traffic to and from the user and the operator/user against use of the network without appropriate authority and subscription. Three levels of security can be applied to the different layers:

- DVB common scrambling in the forward link (could be required by the service provider).
- Satellite interactive network individual user scrambling in the forward and return link.
- IP or higher layer security mechanisms (could be used by the service provider and content provider).

Although the user/service provider could use his own security systems above the data link layer, it may be desirable to provide a security system at the data link layer so that the system is inherently secure on the satellite section without recourse to additional measures. Also, since the satellite interactive network forward link is based on the DVB/MPEG-TS Standard, the DVB common scrambling mechanism could be applied, but is not necessary (it would just add an additional protection to the entire control stream for non-subscribers). This concept is shown in below.

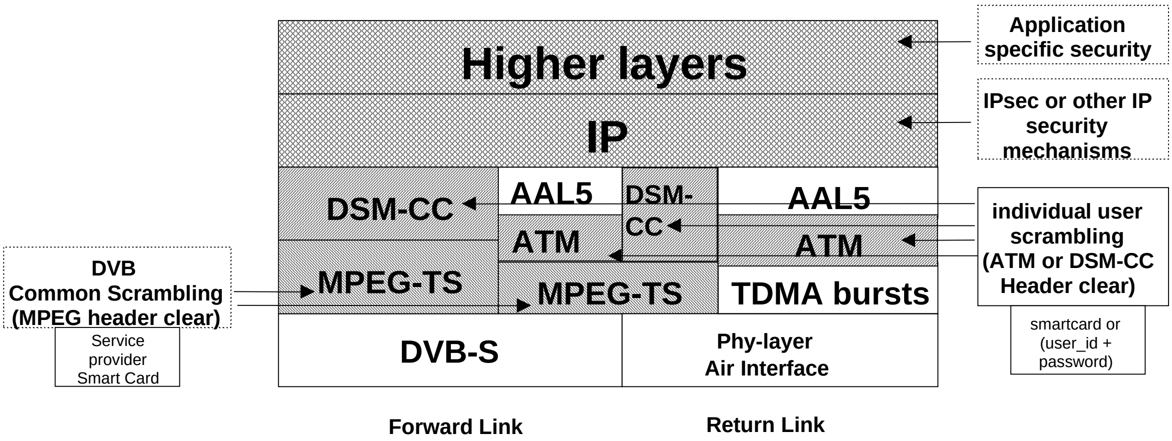


Figure G.7: Security layers for satellite interactive network

There can be more than one user per RCST and that such users will have security in their own right. Security is thus defined at a level higher than the individual RCST. On a user basis, an authentication algorithm may either check for user name and password on the client device or may use a Smart Card within the RCST. All data and control to and from each user may be scrambled on an individual user basis. Each user will have a control word for the return and the forward Link that does not allow anybody other than the NCC or the user himself to descramble the data, except for lawful interceptors such as country authorities.

G.7.1 Authentication

Authentication may be implemented by request for a user name or password on the client device. In the case of a PC used as the client device, the RCST does not need to carry any special implementation. However, if the RCST contains a proxy client, then the proxy may be able to authenticate itself to the NCC. This means that an authentication server may be implemented at the NCC, which manages the authentication of each user. Authentication could also be replaced by a Smart Card on the RCST, also used for the link layer individual control word encryption.

G.7.2 Forward Link

- DVB Common Scrambling could be required in the Forward Link.
- Individual scrambling may be implemented at the section level, but the MAC address of the user may remain in the clear, since the RCST uses the MAC address to filter messages.

G.7.3 Return Link

- The client device may handle IPsec, so the router at the NCC may be able to handle IPsec.
- Individual layer 2 scrambling may also be implemented, with the header of ATM cells scrambled as well. This signifies that the BTP may be used at the NCC in order to know the originating RCST for each burst, which allows to individually descramble each message accordingly.
- Return link scrambling for RCSTs sending MPEG2-TS packets.

Annex H (informative): System design issues and performance considerations for broadband satellite-ATM networks

NOTE: This contribution has been prepared to assist the ETSI STF126 for the study on Broadband Satellite Multimedia. In the first four paragraphs an overview of some of the design issues involved in a broadband satellite network is given, followed by some initial thoughts on the possible standardization issues.

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H.1 Satellite constellation

The choice of the satellite constellation has a great impact on a broadband satellite-ATM system design. On the one hand systems that use GEO satellites (placed at about 36,000 km of altitude) give an almost static user behavior resulting in negligible handover probabilities and no need for virtual channel re-arrangement. On the other hand, systems using Low Earth Orbiting (LEO) satellites (placed at altitudes ranging from 500 km to 2 000 km) require a sophisticated handover algorithm and a methodology for accepting new calls, without affecting the quality of service requirements of all the active connections.

The use of multi-beam non-geostationary (non-GEO) satellites with advanced on-board processing capabilities in future multimedia satellite communications networks is a great challenge [H1]. Non-GEO satellites can provide global coverage with higher elevation angles, satellite diversity and offer lower propagation delays with respect to GEO satellites [H2]. Smaller, high data rate user terminals can be used with an increased level of mobility/portability. Connection admission control is one of the main areas of concern in any network that needs to provide GoS/QoS guarantees. In non-GEO satellite networks after the call establishment phase, service interruption due to unsuccessful inter-spot-beam or inter-satellite handoff could always happen.

Medium Earth Orbit (MEO) satellite networks seem to be a good compromise [H3] between the high orbital distances of the GEO systems (with no extra complexity for handoff) and the low earth orbital distances (with the very high handover rates due to the satellite movement). Systems that use MEO satellites provide large coverage areas and require a much smaller number of satellites to cover the whole earth than any LEO satellite system with global coverage. In addition, each satellite can stay in view for over 1 hour before a user must switch to the next satellite.

The number of satellites that are visible any time from any particular User Terminal (UT) or GTW stations depends on the satellite constellation design in particular the satellite diversity. It is assumed that during the call set-up phase the UT selects the strongest signal among all the available frequencies that is usually transmitted by the highest satellite in the sky at that particular moment.

H.2 Ground Network Infrastructure

Another parameter that influences the selection of the satellite network architecture, is the dependency on the terrestrial network infrastructure. The satellite links are essential for inter-station signalling, when there is no terrestrial infrastructure deployed. For example, most GEO systems do not need ground station interconnection through terrestrial links, whereas non-GEO systems require only a few satellite links to the LESs, when ISLs are used; otherwise they highly depend on a fast backbone network. In GEO systems ISLs mainly handle the traffic between different regions of the earth and bypass the terrestrial links, whereas in most non-GEO constellations ISLs are essential in order to reduce the number of LESs.

H.3 Satellite Access Interface and Protocol Stacks

Two main scenarios for the satellite access network protocol can be envisaged [H4]. The first one uses ATM cell encapsulation and satellite specific protocols for establishing and managing a connection, whereas the second one provides a highly integrated solution with the ATM protocol stack and aims towards the definition of a new Satellite-ATM (S-ATM) protocol layer.

The ATM protocol extensions over the air interface and the on-board processing capabilities are different for each protocol platform. As a result, there are still a lot of open issues for investigation before a final decision can be reached. A more general satellite packet switching approach increases the system flexibility to accommodate any future protocol standards without being restricted by adopting an ATM satellite switching solution. However, the second approach provides a highly optimized protocol architecture, especially if ATM is adopted as the transport mechanism for the future broadband communication systems.

H.3.1 ATM Protocol Encapsulation

Protocol encapsulation is a simple and easy to implement technique for passing arbitrary protocol information through the network entities that could not otherwise interpret specific information. In this scenario, the satellite protocol platform is designed to transparently support different user terminal standards through a proprietary, satellite specific, interface. The satellite access protocols are terminated at the gateway stations and are thus not seen by any external network. Therefore, no modifications to the existing protocol standards are necessary.

This approach appears to be very attractive in systems that need to accommodate several different types of user terminals with a variety of protocol standards, when the ATM protocol is not the dominant transport mechanism. Circuit switching, packet switching, or even hybrid solutions for the on-board satellite processor, can be implemented for networks that use this type of protocol platform. However, in this approach it is very difficult to offer optimum performance to any particular protocol standard, resulting in protocol inefficiencies (related to the increased packet overheads).

H.3.2 S-ATM access interface

In a highly integrated satellite and ATM network scenario the protocol stack inside the satellite network boundaries is very similar to the standard ATM. However, the satellite components use the Satellite-ATM (S-ATM) layer, which replaces the standard ATM layer, in addition to the Medium Access Control (MAC) and the radio physical layers. Signalling for call control is based on the ITU-T Recommendation Q.2931 [73] protocol standard and is terminated at the Network Control Station (NCS). In the case of mobile or portable terminals future versions of B-ISDN signalling and standards can be supported in a highly integrated network environment.

H.3.2.1 LLC layer protocol

The use of an HDLC (High Data Link Control) protocol layer below the S-ATM layer complicates the protocol stack due to the size of the S-ATM cells. The use of a protocol similar to SSCOP (Service Specific Connection Oriented Protocol) with a single ATM cell payload per S-ATM packet requires very large buffers at both the gateway and the terminal sides. Furthermore, it adds considerably on the packet overheads and increases the complexity of both the transmitter and the receiver due to implementation of protocol timers, acknowledgments and re-transmissions. On the other hand, by moving a protocol such as SSCOP above the S-ATM layer a frame size that is larger than one ATM cell can be used (that improves the radio throughput at certain BERs) but this approach also complicates the protocol stack. SSCOP is an end-to-end protocol and has to be terminated at the GTW. As a result, the use of an LLC (Logical Link Control) layer is not so attractive for ATM support over a satellite network in the presence of powerful channel coding and interleaving.

H.3.2.2 Retransmission mechanism based on Partial Packet Discard

A more ATM oriented solution has been considered in [H4], assuming that retransmission of corrupted or lost data is performed end-to-end by high layer PDUs (Protocol Data Units). Assuming that the erroneous cells can be detected at the satellite switch, these cells and consecutive ones that belong to the same higher layer PDU can be dropped and hence reduce the traffic on the TDM (Time Division Multiplexing) downlinks and the fixed network. The increase in the complexity of this approach, when compared to the LLC case, is lower since no additional processing power is required and less overhead is employed per ATM cell. Only an indication of the last ATM cell of a higher layer PDU is required in the ATM cell header and an additional state per Virtual Channel (VC). However, such a mechanism reduces the throughput on the radio due to unnecessary retransmissions of the correctly received ATM cells within a corrupted higher layer PDU. From this point of view, the throughput on the radio link is equivalent to the "selective retransmission protocol", when a LLC protocol is used and to the "go back N" protocol, when end to end retransmissions are performed (N is the number of ATM cells per higher layer PDU). This mechanism has been proposed in [H5] as Partial Packet Discard (PPD).

H.4 Resource management and control functions

Special attention is needed to the problem of evaluating the performance of multi-rate, multimedia calls with different GoS/QoS requirements. The satellite is assumed to accommodate a regenerative payload, with multi-spot beam antennas and on-board "ATM-like" switching and queuing capabilities. Many broadband satellite systems have proposed advanced on-board satellite switching in order to make full use of the advantages that ATM technology can offer. However, due to the space segment constraints, a full ATM switch on-board satellite is not foreseen. Some of the resource management and control functions are placed on the ground segment; i.e the connection admission control and call control functions.

As a result, the on-board satellite processing requirements are reduced only to the ATM traffic management and, where applicable, the uplink resource allocation. In a satellite-ATM network most of the supported ATM traffic classes such as Constant Bit Rate (CBR), rt-VBR (real-time Variable Bit Rate), nrt-VBR (non real-time Variable Bit Rate) operate on a fixed bandwidth allocation basis. The resources are allocated during the connection establishment phase and remain the same for the call duration. Available Bit Rate (ABR) has been defined in such a way that allows a dynamic rate adaptation according to the network conditions. A number of very interesting studies such as the ERICA and ERICA+ [H6,H7] have been reported that target towards the efficient traffic management in ATM networks and discuss the problem of ABR service support as part of a congestion control (or congestion avoidance) function, mainly for the terrestrial segment.

An investigation that focuses on the ABR capacity estimation in a S-ATM system and the Connection Admission Control (CAC) strategy that needs to be adopted is given in [H8,H9]. An additional parameter has been taken into consideration for the calculation of the ABR available capacity; i.e. MAC uplink resource constraints that is not present in a terrestrial ATM network. Congestion control should only be invoked when the CAC function fails to effectively provide the requested QoS guarantees. By taking into account the resource utilization statistics of traffic models that handle the high priority traffic flows (i.e CBR rt-VBR and nrt-VBR), a new methodology for a two stage adaptive CAC has been developed. Simulation and/or analytical methods can be used for the performance evaluation of the ABR service in an S-ATM environment. Finally, the ATM buffer dimensioning rules for all the supported services are investigated and simulation results that demonstrate the resource availability for the ABR service are provided under different mixed traffic scenarios.

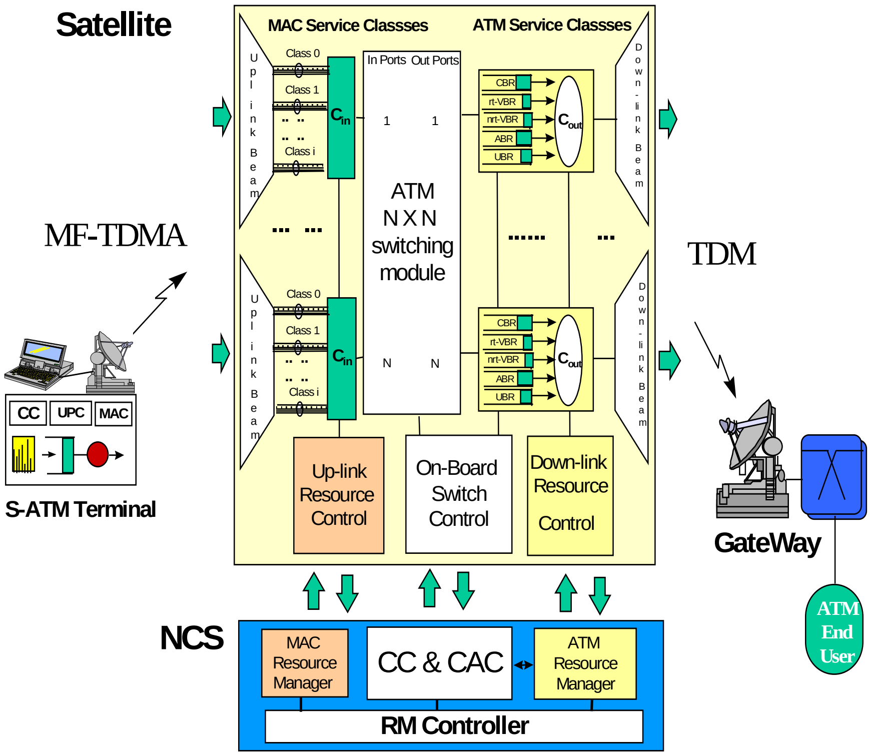

Figure H.1: Resource management and control functional block diagram of a S-ATM

As shown in Figure H.1, the resource management and control functions are distributed between the space and the ground segment. The on-board satellite switch is responsible for providing full connectivity from any uplink to any downlink spot beam and it is controlled by the switch control unit and the Call Control (CC) and the CAC units.

The physical location of the blocks that implement the CC and the CAC functions can be on the ground in order to reduce the on-board processing requirements. In such a way, all the UNI signalling overhead and the call state machine implementation can be directed to the NCS on the ground. Depending on the switch implementation and the information carried within the S-ATM cells, frequent routing table updates such on a per call basis could be avoided. As a result, the on-board switch control processing requirements are minimized. The uplink and downlink resource control units are responsible for the incoming and outgoing traffic management and control the input and the output ports of the ATM switch respectively. The overall network resource management is performed by the Resource Management (RM) controller which supervises the operation of the MAC and the ATM resource managers at the NCS. The RM controller dynamically measures the network performance criteria (GoS, QoS for all service classes) and instructs accordingly the MAC and ATM resource managers.

At the S-ATM terminal side, the control plane protocols are responsible for establishing and maintaining each connection. The bandwidth on the air interface is controlled by the MAC layer and is shared among all active users terminals. The usage parameter control (UPC) is a control function that could be placed either at an UNI or NNI (in such a case is referred as NPC) interface in order to monitor the conformance of existing traffic contracts. Although such a monitoring algorithm is quite essential in networks where traffic contract violations could happen by having misbehaving traffic sources that could transmit cells in excess of the negotiated cell rates, in a S-ATM network the incoming traffic is regulated by the allocated MAC bandwidth units. A MF-TDMA access for the uplink and TDM for the downlink is considered for the satellite-ATM terminals. Gateways and other high data rate terminals that play the role of traffic concentration units and Time Division Multiplex (TDM) access is selected to be most efficient for both the uplink and the downlink. As a result, the existence of UPC or NPC at the Gateway side is more essential.

H.4.1 MAC

As in any other wireless system, MAC regulates the incoming traffic at the satellite network access points. Several studies [H10, H11, H12, H13, H14] based on Demand Assignment Multiple Access (DAMA) [H15] or DAMA-variants [H16] using a combination of random access and reservation based schemes have been conducted. One of the most important designing targets for a MAC scheme is to maximize the resource utilization while maintaining low delay guarantees. In addition, the protocol stability and low complexity of the control algorithm need to be considered. However, a large class of MAC protocols is not applicable for satellite communications [H17]. The reason is that, when comparing the performance of various MAC schemes for GEO satellite networks with multi-class service support, there is not a single winner. Their performance depends on the network topology, the traffic demand and type (i.e. symmetrical, asymmetrical, aggregation level, burstiness etc.) and the complexity of implementing the control algorithm. Keeping in mind that in a broadband satellite-ATM network various types of traffic need to be supported and the ATM on-board switch will route traffic coming from single user terminal up to high data rate multi-user terminals that need to share the same MAC control protocol, a tradeoff in performance versus complexity needs to be made.

H.4.2 Mapping ATM service classes into the air interface

Five distinct service categories have been specified by the ATM Forum to accommodate all the different applications: CBR, rt-VBR, nrt-VBR, ABR and UBR. It is assumed that all service classes except the UBR can share the same pool of uplink resources. In order to guarantee fairness and a fixed GoS for the other services, the UBR resources in the air interface should be taken by another pool of resources with the use of a moving boundary. Since there are no minimum rate guarantees for the UBR service or any strict delay requirements, a hybrid approach which combines both random access and reservation based resource allocation at the air interface could be used. In this way, some level of multiplexing at the MAC layer can be achieved for a large number of bursty sources, as long as the system remains in a stable state and there is enough buffering space in the network [H18]. At the ATM layer, an effective CAC algorithm should take into account all these requirements in order to provide certain levels of QoS to all services classes that share the same downlink.

During the call set-up phase, the CBR, rt-VBR and nrt-VBR services are assigned a fixed number of uplink slots, which remain constant for the duration of the call. Therefore, some multiplexing gain can be achieved only at the ATM layer by limiting the available resources at the ATM switch output queues.

For the ABR service, a more flexible access scheme is assumed since it does not have delay requirements as strict as the rt-VBR. An ABR call is accepted or blocked at the MAC layer according to its Initial Cell Rate (ICR), or Minimum Cell Rate (MCR) requirements. After the call is accepted, all the slots that remain free in the uplink direction can be shared among all ABR users in order to satisfy the instantaneous requirements for increased bandwidth. If we want to maintain certain call blocking rates for all the supported service classes at the MAC layer, the available slots which are shared among all ABR services should be used in such away, as not to affect the new call blocking rate of any service type.

One of the most recent arguments within the ATM Forum study groups concerning the required congestion control scheme for the ABR service was the selection between rate-based and credit-based control loop. Furthermore, a third proposal that is reported in [H19] suggests the integration of both rate and credit based proposals to coexist in order to make use of the advantages of each method in certain network topologies. The rate-based scheme that has been selected by the ATM forum seems to adapt better in WANs with large propagation delays and therefore seems a more appropriate scheme for satellite communications.

H.4.3 Virtual connection tree concept in non-GEO networks

In the last years, a few proposals appeared in the literature suggesting possible ways to overcome the user/terminal mobility problems in wireless ATM networks. A comparison among some of the most recent re-routing and virtual path re-establishment algorithms that can support handoffs in wireless ATM networks can be found in [H20]. However, the mobility issues related to satellite-ATM networks, are not fully covered yet. In a dynamic satellite-ATM network, the "virtual connection tree" concept [H21] can be applied as suggested in [H22]. This idea was also supported in [H23] where a new adaptive routing algorithm applicable in LEO networks with inter-satellite links is presented.

H.5 Standardization Issues

A few studies that have been submitted to the ATM forum concentrate on the WATM issues for the satellite segment. In [H24] an overview of the standardization activities mainly within ITU-R is given focusing on the ATM performance objectives for a satellite link. An introduction to the working plans of the Infrastructure and Satellite Access Sub Group is given in [H25] that includes the list of some initial activities. In [H26] the requirements in mobile airborne platforms are given. The present document can be used as a reference for discussion since it includes a list of WATM requirements at different protocol layers. Another study concentrates on the existing techniques for ATM multicast over highly assymetric satellite links [H27].

It is important to mention that one of the very first tasks of a study is to define certain performance objectives for each service class that it is supported through a broadband satellite system.

H.5.1 Areas of study

Some of the possible areas for discussion by the ETSI working groups are:

- Network architecture and communications interfaces (includes ground network and inter-station signalling);
- Service classes and performance objectives;
- Medium Access Control schemes;
- Air Interface - transmission rates - rate granularity - coding scheme;
- Mapping service classes into the air interface;
- Traffic management and QoS provisioning;
- Signalling and connection establishment issues;
- On-board satellite buffering and routing;
- Addressing issues;
- Multicasting.

Interworking between protocol standards such as ATM, IP, N-ISDN, Frame-Relay etc.

One of the most important areas for discussion is the possibility to provide a common standard (or maximum two) for the air interface. Most of the planned broadband satellite systems consider the use of a common fixed-size packet for the air interface that accommodates one or more ATM cells. An optimum satellite packet length for all the supported service rates and terminals is not envisaged, however at least two possible frame structures can be standardized to be used by different terminal types.

Another area of study is the MAC scheme and the provision of bandwidth on demand. Recent studies that give a comparison of widely known MAC schemes seem to support the idea of a simple DAMA based algorithm [H17, H28]. Implicit reservation is used to (i.e content in a slotted Aloha channel) for the first bandwidth request since it is the most appropriate scheme for a large number of terminals.

The next important area for discussion is the signalling and higher layer protocols. The adoption of a common signalling standard for the satellite segment will be beneficial even when several different standards for the air interface exist. Having specified a certain number of service classes that can be supported over the air interface the same performance objectives can be standardized per service class.

The service mapping, the QoS provisioning and traffic management are network specific functions that could be excluded from the standardization process. However, extensive studies on these areas will provide the means for network dimensioning and reference models for performance evaluation.

Finally the interworking between any future broadband satellite multimedia standard and the existing protocol standards needs to be carefully considered.

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Annex I (informative): Example of Satellite ATM Network Architectural Model

The figure below illustrates the network architecture of an ATM network with user access by satellite. It is from a paper by the Univ. of Surrey (Protocol Architectures for Satellite ATM Broadband Networks, by Ioannis Mertzanis, Georgios Sfikas, Rahim Tafazolli, and Barry G. Evans, University of Surrey [44]). The entities and interfaces identified are also relevant in general i.e. for non-ATM-based satellite networks.

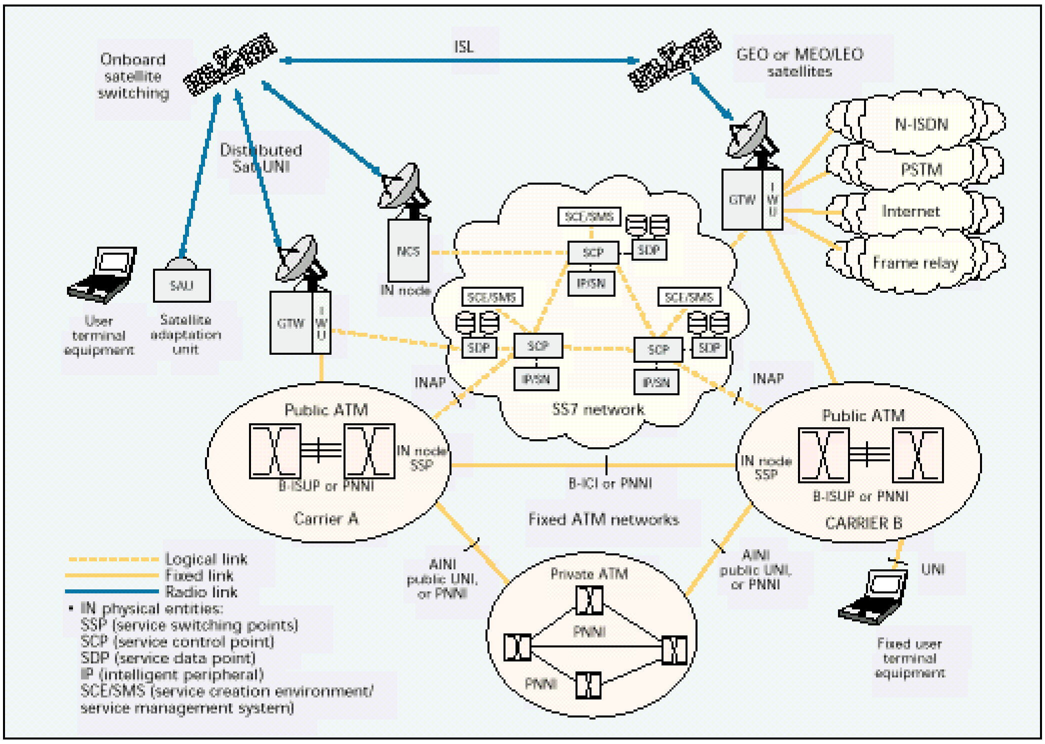

Figure I.1: Satellite ATM reference network configuration

Most of the future broadband satellite systems share common characteristics with the satellite network architecture, onboard satellite processing and switching capabilities, user terminals, supported protocol standards, the access scheme, and interconnection to terrestrial networks. Therefore, in a typical broadband satellite system the following network entities are considered:

User Terminals (UT) - UTs might support several different protocol standards such as: ATM User Network Inter-face (ATM-UNI), Frame Relay UNI (FR-UNI), Narrowband Integrated Services Digital Network (N-ISDN) Basic Rate Interface (BRI), N-ISDN Primary Rate Interfaces (PRI), Transmission Control Protocol/Internet Protocol (TCP/IP). UTs are connected to the satellite adaptation unit (SAU) through one of the supported standard interfaces.

Satellite Adaptation Unit - This is in general a specially designed unit, responsible for providing access to the satellite network. It performs all the necessary user terminal protocol adaptations to the satellite protocol platform. The SAU also includes all physical layer functionalities such as channel coding, modulation/demodulation, the radio frequency parts, and the antenna section. A set of various types of terminals, with a variety of transmission capabilities, is usually offered by a satellite network. Starting from minimum transmission rates of 8 or 16 kb/s, they can cope with maximum transmission rates of 144 kb/s (or 384 kb/s for personal type user terminals), or 2048 kb/s and higher for fixed type terminals with larger antennas. All of the supported terminals share the same access scheme and protocol stacks.

Payload (P/L) - Full onboard satellite signal regeneration is assumed in most of the future broadband satellite systems. The onboard satellite processing units perform multiplexing, demultiplexing, channel coding/decoding, and fast packet switching using a multispot beam configuration. In some onboard proposals, "ATM-like" switching is suggested. These switching units are experimental or currently under development and include only part of the functionalities that a ground ATM switch would perform. Most of the power hungry processing operations such as call setup signalling termination or connection admission control (CAC) are performed on the ground.

Gateway Stations (GTW) - These are the land Earth stations that provide connectivity to the external networks. In geostationary Earth orbit (GEO) systems the placement and number of GTWs on the ground segment depend mainly on the traffic demand. A large number of gateways is expected in geographical areas where the traffic demand is high and these gateways are always connected using the same satellite(s). However, in non-GEO systems the number and placement of the gateway stations depends on some additional system design characteristics such as: constellation design, use (or not) of intersatellite links (ISLs), and the overall end-to-end system delay budgets. For example, in a global medium Earth orbit (MEO) system with no ISLs, a total number of less than 10 gateways can provide full connectivity to the land masses most of the time. A low Earth orbit (LEO) system will require tens to hundreds of gateways, but this number can be reduced with the use of ISLs.

Network Control Station (NCS) - This is a central entity, used in a GEO satellite system (usually one per satellite) that provides overall control of satellite network resources and operations. This node is responsible for allocating radio resources to the GTWs according to a long-term resource planning scheme. The NCS is responsible for performing call routing and call management functions such as location update, handoff (when applicable), authentication, registration, "deregistration", and billing. In non-GEO systems these operations are usually performed in more than one GTWs in a distributed manner.

The above model is also very much in line with ITU-R considerations, as evidenced by the following excerpt from a Report of the Eleventh Meeting of ITU-R Working Party 4B (Geneva, Switzerland 26 - 30 April 1999) ITU-R Working Party 4B:

The satellite network is represented by a ground segment, a space segment, and a network control center. The ground segment consists of ATM networks that may be further connected to other legacy networks. The network control center (NCC) performs various management and resource allocation functions for the satellite media. Inter-satellite links (ISL) in the space segment provide seamless global connectivity to the satellite constellation. The network allows the transmission of ATM cells over satellite, multiplexes and demultiplexes ATM cell streams from uplinks and downlinks, and maintains the QoS objectives of the various connection types. The satellite-ATM network also includes a satellite-ATM interface device connecting the ATM network to the satellite system. The interface device transports ATM cells over the frame based satellite network, and demultiplexes ATM cells from the satellite frames. The device typically uses a DAMA technique to obtain media access to the satellite physical layer. The interface unit is also responsible for forward error correction techniques to reduce the error rates of the satellite link. The unit must maintain ATM quality of service parameters at the entrance to the satellite network. As a result, it translates the ATM QoS requirements into corresponding requirements for the satellite network. This interface is thus responsible for resource allocation, error control, and traffic control.

This architectural model presents several design options for the satellite and ground network segments. These options include:

1) No on-board processing or switching.

2) On-board processing with ground ATM switching.

3) On-board processing and ATM switching.

More than half of the planned Ka-band satellite networks propose to use on-board ATM like fast packet switching a simple satellite model without on-board processing or switching, minimal on-board buffering is required. However, if on-board processing is performed, then on-board buffering is needed to achieve the multiplexing gains provided by ATM. On-board processing can be used for resource allocation and media access control (MAC). MAC options include TDMA, FDMA, and CDMA and can use contention based, reservation based, or fixed media access control. Demand Assignment Multiple Access (DAMA) can be used with any of the MAC options. If on-board processing is not performed, DAMA must be done by the NCC. On-board DAMA decreases the response time of the media access policy by half because link access requests need not travel to the NCC on the ground any more. In addition to media access control, ABR explicit rate allocation or EFCI control, and UBR/GFR buffer management can also be performed on-board the satellite. On-board switching may be used for efficient use of the network by implementing adaptive routing/switching algorithms. Trade-offs must be made with respect to the complexity, power and weight requirements for providing on-board buffering, switching and processing features to the satellite network. In addition, on-board buffering and switching will introduce some additional delays within the space segment of the network. For fast packet or cell switched satellite networks, the switching delay is negligible compared to the propagation delay, but the buffering delay can be significant.

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