ETSI TR 102 001 V1.1.1 (2003-04)

Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Systems reference document for TETRA Advanced Packet Service (TAPS)

Reference

DTR/ERM-RM-007

Keywords

data, radio, SRDOC, system, TETRA, UHF

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, send your comment to:
editor@etsi.org

Contents

Intellectual Property Rights

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

1 Scope

The present document defines the requirements for radio frequency usage for TETRA Advanced Packet Service (TAPS).

It includes necessary information to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT), including:

- detailed market information (annex A);
- technical information (annex B);
- expected compatibility issues (annex C).

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

[2] ETSI EN 300 392-3 (all sub-parts): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 3: Interworking at the Inter-System Interface (ISI)".

[3] ETSI ETS 300 392-4 (all sub-parts): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 4: Gateways basic operation".

[4] ETSI EN 300 392-5: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 5: Peripheral Equipment Interface (PEI)".

[5] ETSI EN 300 392-9: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 9: General requirements for supplementary services".

[6] ETSI ETS 300 392-10 (all sub-parts): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 10: Supplementary services stage 1".

[7] ETSI ETS 300 392-11(all sub-parts): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 11: Supplementary services stage 2".

[8] ETSI ETS 300 392-12 (all sub-parts): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 12: Supplementary services stage 3".

[9] ETSI ETS 300 395 (all parts): "Terrestrial Trunked Radio (TETRA); Speech codec for full-rate traffic channel".

[10] ETSI ETS 300 396 (all parts): "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO)".

[11] ETSI TS 101 350: "Digital cellular telecommunications system (Phase 2+) (GSM); General Packet Radio Service (GPRS); Overall description of GPRS radio interface; Stage 2".

[12] ETSI TS 100 573: "Digital cellular telecommunications system (Phase 2+) (GSM); Physical layer on the radio path; General description".

[13] ETSI EN 300 959: "Digital cellular telecommunications system (Phase 2+) (GSM); Modulation".

[14] ETSI EN 300 910: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".

[15] ETSI TS 100 911: "Digital cellular telecommunications system (Phase 2+); Radio subsystem link control".

[16] ETSI TS 100 912: "Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization".

[17] ETSI EN 300 908: "Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path".

[18] ETSI EN 300 909: "Digital cellular telecommunications system (Phase 2+) (GSM); Channel coding".

[19] ETSI TS 101 349: "Digital cellular telecommunications system (Phase 2+) (GSM); General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol".

[20] ETSI TS 101 351: "Digital cellular telecommunications system (Phase 2+) (GSM); General Packet Radio Service (GPRS); Mobile Station - Serving GPRS Support Node (MS-SGSN) Logical Link Control (LLC) layer specification".

[21] ETSI TS 100 297: "Digital cellular telecommunications system (Phase 2+) (GSM); General Packet Radio Service (GPRS); Mobile Station (MS) - Serving GPRS Support Node (SGSN); Subnetwork Dependent Convergence Protocol (SNDCP)".

[22] ETSI TS 101 348: "Digital cellular telecommunications system (Phase 2+) (GSM); General Packet Radio Service (GPRS); Interworking between the Public Land Mobile Network (PLMN) supporting GPRS and Packet Data Networks (PDN)".

[23] ETSI TS 129 002: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Mobile Application Part (MAP) Specification (Release 1999)".

[24] ETSI TS 129 060: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); General Pocket Radio Service (GRPS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp Interface (Release 1999)".

[25] ETSI TS 101 962 (V1.1.1): "Terrestrial Trunked Radio (TETRA); TETRA Advanced Packet Service (TAPS)".

[26] ETSI EN 301 979 (V1.1.1): "Terrestrial Trunked Radio (TETRA); Harmonized EN for TETRA Advanced Packet Service (TAPS) equipment covering essential requirements of article 3.2 of the R&TTE Directive".

[27] ETSI ES 201 962: "Terrestrial Trunked Radio (TETRA); TETRA Advanced Packet Service (TAPS)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Air interface (Um interface): the interface between Mobile Station and TAPS network

Gb interface: the interface between an SGSN and a BSS

Gi interface: the interface between Packet Domain and an external packet data network

Gn interface: the interface between two GSNs within the same PLMN

Gp interface: the interface between two GPRS Support Nodes (GSNs) in different PLMNs

Gr interface: the interface between the Serving GPRS Support Node and the Home Location Register

Ud interface: Direct Mode Air Interface

Um interface: the interface between a GSM MS and GSM BTS

3.2 Abbreviations

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

AI	Air Interface
BCCH	Broadcast Control Channel
BSS	Base Station System
BTS	Base Transceiver Station
CDF	Cumulitive Distribution Function
DMO	Direct Mode Operation
EDGE	Enhanced Data rates for GSM Evolution
EGPRS	EDGE GPRS
(E)GPRS	(Enhanced) General Packet Radio Service (which means both GPRS and EGPRS)
EPT	ETSI Project TETRA
GGSN	Gateway GPRS Support Node
GoS	Grade of Service
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HLR	Home Location Register
HSD	High-Speed Data
IP	Internet Protocol
IPI	IP Interworking
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
L1	Layer 1
L2	Layer 2
LLC	Logical Link Control
MAC	Medium Access Control
MAP	Mobile Access Protocol
MS	Mobile Station
PAMR	Public Access Mobile Radio
PDN	Packet Domain Network
PEI	Peripheral Equipment Interface
PLMN	Public Land Mobile Network
PMR	Private Mobile Radio
PSTN	Public Switched Telephone Network
PTP	Point-to-Point
RF	Radio Frequency
RLC	Radio Link Control
RRC	Radio Response Control
RX	Receiver
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SNDCP	SubNetwork Dependent Convergence Protocol
SRD	Short Range Device
SwMI	Switching and Management Infrastructure
TAPS	Tetra Advanced Packet Service
TETRA	TErrestrial Trunked Radio
ToR	Terms of Reference
TRR	Tactical Radio Relay
TRX	Transmitters/Receivers
UIC	Union International des Chemins de fer
USIM	Universal Mobile Telecommunications System
V+D	Voice plus Data

4 Executive summary

TETRA Advanced Packet Service (TAPS) has been developed in response to user needs and according to a mandate issued by the ETSI Board. The mandate outlined that TAPS should be developed as fast as possible by making maximum reuse from other standardized technologies. TAPS should also provide for Interworking and Roaming to other 2.5 - 3 G technologies.

Further details TAPS can be found in EN 301 979 [26] and TS 101 962 [25].

TAPS adapts (E)GPRS technology to provide an overlay network for TETRA systems. TAPS provides high-speed packet data at speeds approximately ten times that available in existing TETRA, to support multimedia and other high-speed data applications required by existing and future TETRA users. TAPS is also designed to complement the existing V+D services of TETRA.

TAPS together with other parts of TETRA Release 2 will provide users confidence in the technology as an evolving communications tool that enables the users to use applications available from other parts of the market or developed specifically for them. TAPS is not only necessary for TETRA to maintain the market, but it will also help grow the market because it brings the high-speed data capabilities of cellular technologies within the bands of PMR and PAMR users.

TAPS is a packet switching data only system, it does not support circuit switched nor DMO.

The TAPS standard is designed to cover the bands 380 MHz to 400 MHz, 410 MHz to 430 MHz, 450 MHz to 470 MHz, 870 MHz to 876/915 MHz to 921 MHz. These bands are covered by ERC/DEC(96)01 and ERC/DEC(96)04 with uplink in the lower half of the band and downlink in the upper half. The duplex separation is 10 MHz for the 400 MHz bands and 45 MHz for the 800/900 MHz band. Channel numbering has been adapted to allow for a flexible frequency allocation within the boundaries of the frequency bands.

The transmitter characteristic is standardized to the same levels as TETRA V+D in the 400 MHz frequency range although being a 200 kHz channel separation service. This obviously needs careful consideration for frequency allocations close to narrow band services because of the associated noise bandwidth. In the 800/900 MHz band similar characteristics as for (E)GPRS have been standardized. Protection to the GSM BTS RX has been maintained to the same level as in the GSM standard. CEPT ECC SE has determined the guard bands and other mitigation that may be needed in the 400 MHz and the 800/900 MHz bands. The maximum power from an MS is 2 W and the base station power is limited to 30 W at the output of the transmitter to provide a balanced link.

The Receiver characteristics have been standardized to be the same as (E)GPRS with the exception of the blocking characteristics, which because of the service being PMR/PAMR, has been made the same as TETRA V+D. This also provides for the flexible frequency arrangement that has been introduced.

In terms of spectrum utilization in the 400 MHz bands, TAPS is capable of a maximum utilization of 2 × 8 MHz of each 2 × 10 MHz band. This has been achieved by limiting the necessary separation between uplink and downlink frequencies to 2 MHz. The position of the separation may be entirely in the down link band, entirely in the up link band or may be spread between the up and downlink bands. The concept used in the 400 MHz bands has been developed to allow for a flexible frequency allocation rather than a maximum utilization. At the 800/900 MHz band a guard band of around 1 MHz is necessary between GSM BTS RX and TAPS in addition to a separation distance or filters. At the border to UIC a 200 kHz guard band is needed. Because TAPS is a GSM technology the spectrum parameters are well known. The differences to the GSM (E)GPRS are given in the annexes.

The capacity of a system with a minimum frequency allocation is best understood by working through an example. EPT has made a calculation of the amount of users that can be served by a system covering the centre of London. Using a 2 × 2,4 MHz allocation and a recognized traffic, GoS and user profile, such a system can provide service to 10 000 users.

Currently the bands allocated to TETRA are limited to narrow band services. FM 38, however, has taken onboard to develop an ECC Decision for wider band services to operate in the bands used in connection with narrow band digital trunked networks.

EPT requests the support of the ECC to enable the users to take advantage of the high-speed data system TAPS within a very short time frame. ECC is expected to support the co-existence studies and the development of a new ECC Decision covering wider band services in the bands of the ERC/DEC(96)01 and 04 as a supplement to PMR and PAMR users. The first utilization of TAPS is expected in the 800/900 MHz band in 2004, followed by the 400 MHz bands in 2005-6.

4.1 Status of the present document

Version 0.0.6 was approved at ERM RM 7 - 10 January 2003 after review of the compatibility studies performed by CEPT SE. These compatibility studies cover all the concerns raised earlier.

Concerns expressed by the GSM community (ETSI TC MSG) were confirmed by the compatibility studies performed by CEPT (see clause C.1). The introduction of TAPS at 915 MHz will require co-ordination between the GSM operator operating just below 915 MHz and the TAPS operator. Also, in some cases filters will be required in the GSM base station receiver.

4.2 Technical issues

The following text is extracted from a TR 101 976: "Guide to TAPS". The guide serves as a quick way to understand what TAPS is about and what it covers.

4.2.1 Service requirements

TETRA Advanced Packet Service (TAPS) provides high-speed packet data at speeds approximately 10 times that available in existing TETRA, to support multimedia and other high-speed data applications required by existing and future TETRA users.

TAPS enables the service subscriber to send and receive data in an end-to-end packet transfer mode, without utilizing network resources in circuit switched mode.

TAPS enables the cost-effective and efficient use of network resources for packet mode data applications, e.g. for applications that exhibit one or more of the following characteristics:

- intermittent, non-periodic (i.e. bursty) data transmissions, where the time between successive transmissions greatly exceeds the average transfer delay;
- frequent transmissions of small volumes of data, for example transactions consisting of less than 500 bytes of data occurring at a rate of up to several transactions per minute;
- infrequent transmission of larger volumes of data, for example, transactions consisting of several k/bytes of data occurring at a rate of up to several transactions per hour.

Within TAPS, two different bearer service types are defined. These are:

- Point-To-Point (PTP), individual call;
- Point-To-Multipoint (PTM), group call.

The requirements for TAPS are stated in TS 101 962 [25].

4.2.2 Overview of standardized interfaces

The existing TETRA standards define a number of interfaces to support mobile services as shown in figure 1. The central component of the standard reference model is the Switching and Management Infrastructure (SwMI) which provides circuit and packet switched telecommunication services to mobile stations (MS).

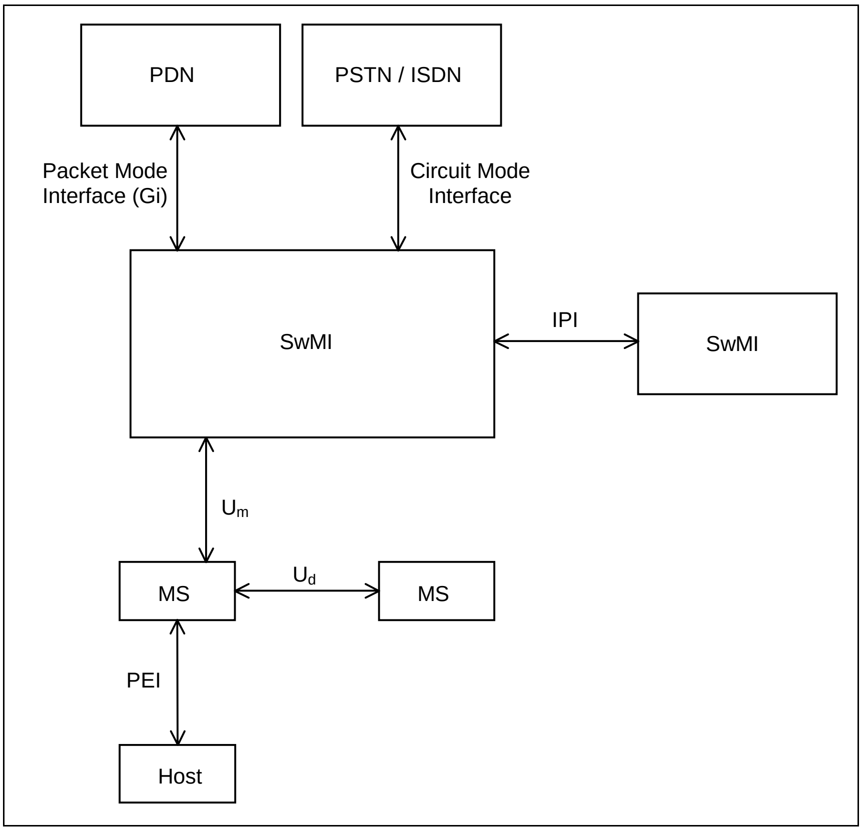

Figure 1: Existing TETRA V+D interfaces

The internal SwMI architecture is not defined by the standard but only the external interfaces between the SwMI and other entities. The standardized interfaces are:

- Trunked Mode Air Interface (Um) EN 300 392-2 [1];
- Direct Mode Air Interface (Ud) ETS 300 396 [10];
- IP Interface (IPI);
- Inter-system Interface (ISI) EN 300 392-3 [2];
- Peripheral Equipment Interface EN 300 392-5 [4];
- PSTN/ISDN Network Interface ETS 300 392-4 [3].

There are also standards related to operation across multiple interfaces such as the speech codec ETS 300 395 [9] and supplementary services EN 300 392-9 [5], ETS 300 392-10 [6], ETS 300 392-11 [7], ETS 300 392-12 [8].

The TETRA TAPS standard described in the present document seeks to enhance the capability of TETRA to support enhanced data rate capability for packet data. In order to achieve this, additional standard interfaces are proposed as shown in figure 2.

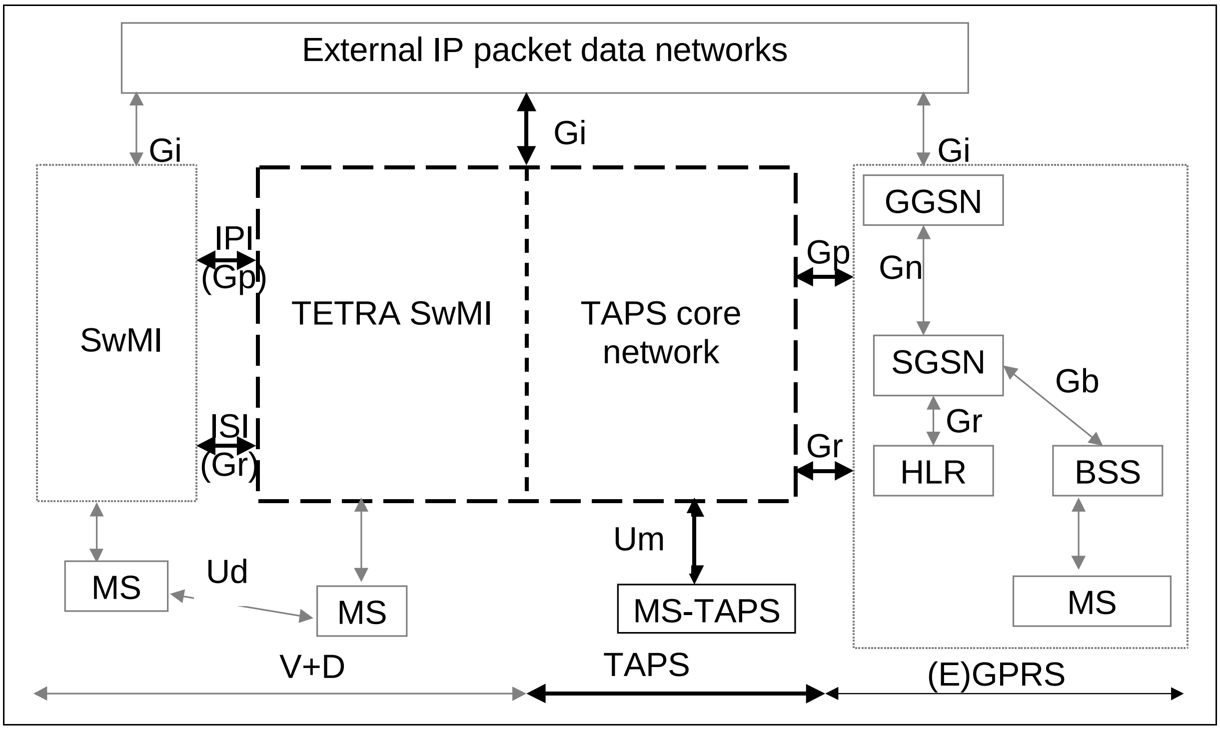

Figure 2: TETRA TAPS standard interfaces

Subsequent clauses in the present document outline each of the interfaces to be standardized for high-speed data operation.

The four interfaces within the scope of the TETRA TAPS standard are:

- Air Interface (Um);
- Packet Data Network Interface (Gi);
- TETRA-GSM Inter-network Interfaces (Gp and Gr).

Future standardization will be driven by the needs of service integration, and that this may result in the incorporation of additional core network interfaces from (E)GPRS.

4.2.3 Air interface

In order to add high-speed packet data services to the TETRA standard, a new air interface is added between the MS and network. This interface is referred to as U_m with a protocol stack as shown in figure 3. The components of the protocol stack re-use, as far as possible, the (E)GPRS standards drafted by ETSI for GSM systems. An overview of the (E)GPRS air interface is covered by TS 101 350 [11].

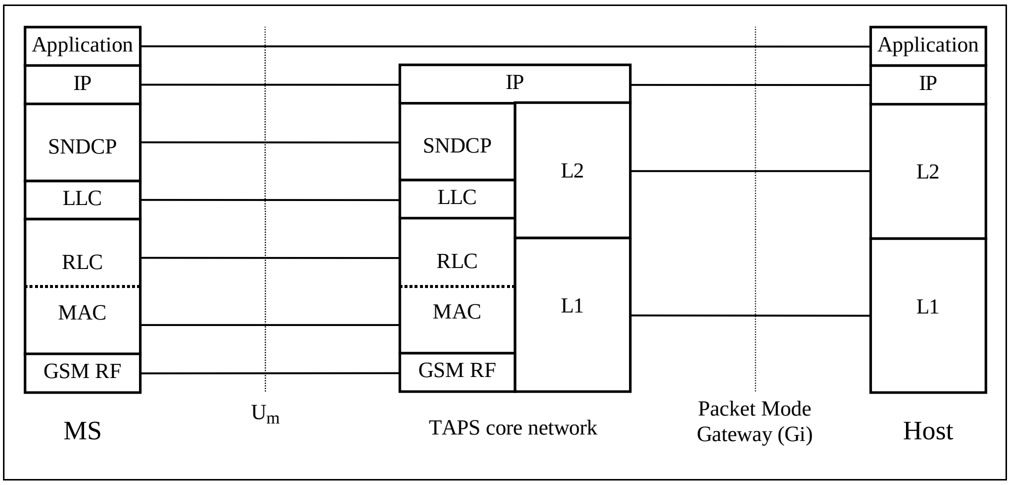

Figure 3: TETRA TAPS air interface protocol stack

An overview of the air interface protocol can be found in TS 101 350 [11]. Each layer of the protocol stack is described by GSM standard documents as follows:

- Physical Layer (RF parameters and modulation) TS 100 573 [12], EN 300 908 [17], EN 300 909 [18], EN 300 959 [13], EN 300 910 [14], TS 100 911 [15], TS 100 912 [16]
- MAC Layer:
  - channel coding EN 300 909 [18];
  - slot and frame structure EN 300 908 [17];
  - protocol aspects TS 101 349 [19];
- LLC Layer TS 101 351 [20];
- SNDCP (mobility and data transfer) TS 101 297 [21].

For the purposes of the present document, it is assumed that the packet mode gateway interface for TETRA is the same as the Gi interface for (E)GPRS.

TAPS applies to TETRA TAPS MS and TETRA TAPS network. TAPS covers the variations to the core GSM standards for TETRA TAPS operation.

4.2.3.1 Classes of terminal

Class-C mode is the only GSM MS mode of operation supported, since all circuit switched channels, including speech channel, are outside the scope of TAPS. In class C mode, the MS is exclusively attached to the GPRS network.

4.2.3.2 Service interaction

Service interaction with circuit switched channels is outside the scope of TAPS.

4.2.3.3 GSM standard references and deltas

The basis for TAPS is the following:

- The specifications from 3GPP Release 1999, are used as the basis;
- 77 specifications are wholly applicable;
- 19 specifications are applicable in part, where some clauses are omitted;
- 10 specifications contain modifications to individual clauses;
- The technical changes fall into two main categories:
  a) Changes necessary to exclude circuit-switched connections from the scope of TAPS;
  b) Changes necessary to make the specifications apply to the applicable frequency bands.

4.2.3.3.1 Physical layer

(E)GPRS Transposition to TETRA environment

The following text describes in general the adaptations to the physical layer for TAPS.

Frequency bands and channel arrangement

The TAPS standard is designed to cover the bands 380 MHz to 400 MHz, 410 MHz to 430 MHz, 450 MHz to 470 MHz, 870 MHz to 876/915 MHz to 921 MHz. These bands are covered by ERC/DEC(96)01 and ERC/DEC(96)04 with uplink in the lower half of the band and downlink in the upper half. The duplex separation is 10 MHz for the 400 MHz bands and 45 MHz for the 800/900 MHz band. Channel numbering has been adapted to allow for a flexible frequency allocation within the boundaries of the frequency bands.

Transmitter characteristics

The transmitter characteristic is standardized to the same levels as TETRA V+D in the 400 MHz frequency range although being a 200 kHz channel separation service. This obviously needs careful consideration for frequency allocations close to narrow band services because of the associated noise bandwidth. In the 800/900 MHz band similar characteristics as for (E)GPRS have been standardized. Protection to the GSM BTS RX has been maintained to the same level as in the GSM standard. CEPT ECC SE will determine the guard bands necessary for both the 400 MHz and the 800/900 MHz bands.

Receiver characteristics

The receiver characteristics have been standardized to be the same as (E)GPRS with the exception of the blocking characteristics which because of the service being PMR/PAMR has been made the same as TETRA V+D. This also provides for the flexible frequency arrangement that has been introduced.

Transmitter and receiver performance

The performance of the transmitter and the receiver are generally similar to that of (E)GPRS. The changes introduced are solely concerned with the matching of the frequency bands and the introduction of flexibility in frequency assignment in the 400 MHz bands.

Spectrum characteristics

In terms of spectrum utilization in the 400 MHz bands TAPS is capable of a maximum utilization of 2 × 8 MHz. This has been achieved by limiting the necessary separation between uplink and downlink frequencies to 2 MHz. The position of the separation may be entirely in the downlink band, entirely in the uplink band or may be spread between the up and downlink bands. At the 800/900 MHz band it is anticipated, subject to confirmation from CEPT ECC SE, that a guard band of 1 MHz may be necessary between GSM BTS RX and TAPS if allocated uncoordinated, similar to the border with UIC where a 200 kHz to 600 kHz guard band is anticipated. Same approach should be applied to uncoordinated SRDs; for further information, please refer to ECC Reports as indicated in clause C.1.

Environmental condition

Environmental requirements are the same as for GSM equipment.

Repeater characteristics

Repeater characteristics are the same as for GSM equipment.

4.2.3.3.2 Data link layer

The requirements are the same as for (E)GPRS.

4.2.3.3.3 RRC/RLC/MAC layer

The requirements are the same as for (E)GPRS, except that requirements associated with circuit-switched connections are deleted.

4.2.3.3.4 Mobility management and GPRS session management

The requirements are the same as for (E)GPRS, except that requirements associated with circuit-switched connections are deleted and that the Mobile Station Classmark and Mobile Station Radio Access Capability information elements are extended to address access to TAPS networks.

4.2.4 Interface to packet data networks

The Packet Domain can operate IPv4 or IPv6. The interworking point is the Gi interface. The Gi Reference point is the interface between the Packet Domain and an external packet data network.

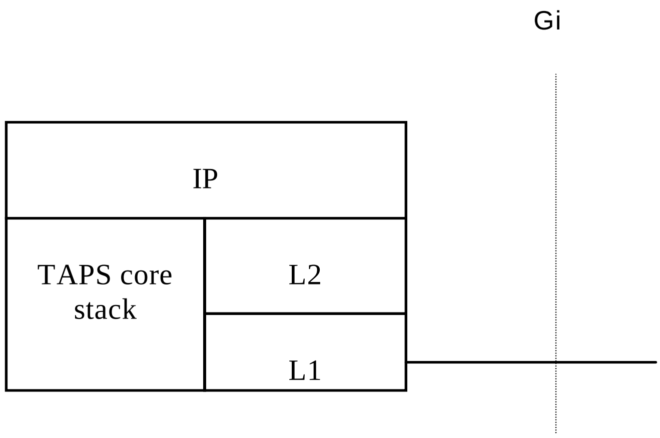

Figure 4: The protocol stacks for the IP/Gi reference point

Typically in the IP networks, the interworking with subnetworks is done via IP routers. The Gi reference point is between the TAPS core and the external IP network. From the external IP network's point of view, the TAPS core is seen as a normal IP router. The L2 and L1 layers are operator specific.

It is out of the scope of the present document to standardize the router functions and the used protocols in the Gi reference point.

Interworking with ISPs and private/public IP networks is subject to interconnect agreements between the network operators.

Access to the Internet and intranets may involve specific functions such as user authentication, user's authorization, end-to-end encryption between MS and Intranet/ISP, allocation of dynamic addresses belonging to the TETRA Network/Intranet/ISP addressing space, high-level mobility management. There are multiple options for higher layer interworking to Internet and intranets. These options are not different from those described in TS 101 348 [22]. Additional options such as those described in further evolution of the TS 101 348 [22] specifications are also possible (e.g. mobile IP).

4.2.5 Roaming between TETRA TAPS and TETRA V+D

This is outside the scope of TETRA TAPS at this time.

4.2.6 Roaming with GSM networks

This clause describes the basis for roaming/migration between TETRA TAPS and (E)GPRS networks.

The high-speed packet data overlay allows a TETRA TAPS MS to obtain high-speed packet data services from a TETRA TAPS network. Given that this service is provided using (E)GPRS technology, it is desirable to facilitate interworking and roaming between TETRA TAPS high speed data networks and (E)GPRS networks. Such interworking can be enabled by supporting network interfaces between a TETRA TAPS network and (E)GPRS network as shown in figure 5.

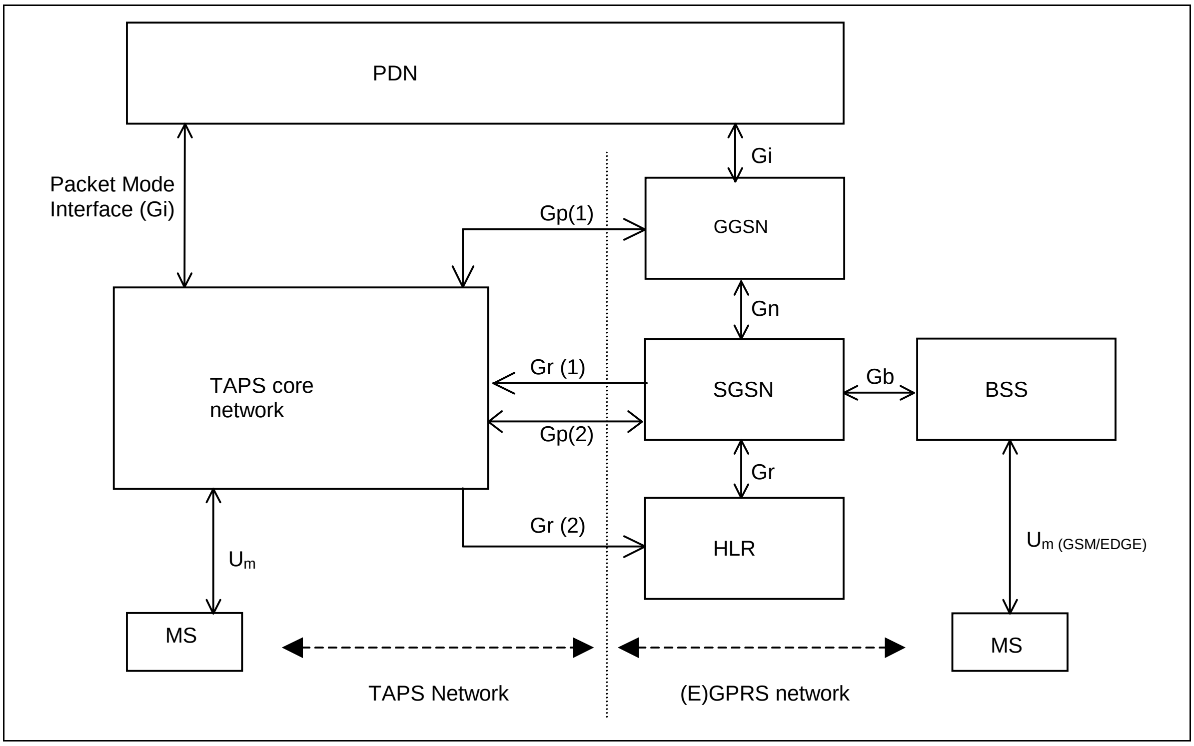

Figure 5: Interfaces between TETRA TAPS and (E)GPRS

The interworking between (E)GPRS and TETRA TAPS is defined by two interface specifications:

- Mobility management, Gr interface (defined within GSM MAP specification TS 129 002 [23])
- Data transfer and call control, Gp interface (defined along with Gn interface in TS 129 060 [24]).

The Gr interface allows the TETRA TAPS network to retrieve packet data service parameters for a GSM subscriber that has migrated to a TETRA TAPS network (Gr (2) in figure 5) and for a TETRA TAPS subscriber that has migrated to a (E)GPRS PLMN (Gr (1) in figure 5). The Gp interface in figure 5 provides a tunnel for data transfer between the GSM and TETRA TAPS networks. When the GSM subscriber migrates to a TETRA TAPS network, the TETRA TAPS network uses the Gp (2) interface to inform the GSM network that packet data for that subscriber should be tunnelled to the TETRA TAPS network for delivery to the subscriber. Similarly, the converse is true for a TETRA TAPS subscriber migrating to a (E)GPRS PLMN using the Gp (1) interface.

4.2.7 Implementation examples

Since TAPS references GSM (E)GPRS standards, there are various possible implementations that take advantage of (E)GPRS core network components and internal interfaces. Figure 6 shows one such implementation possibility which shows how TAPS may be implemented using such components.

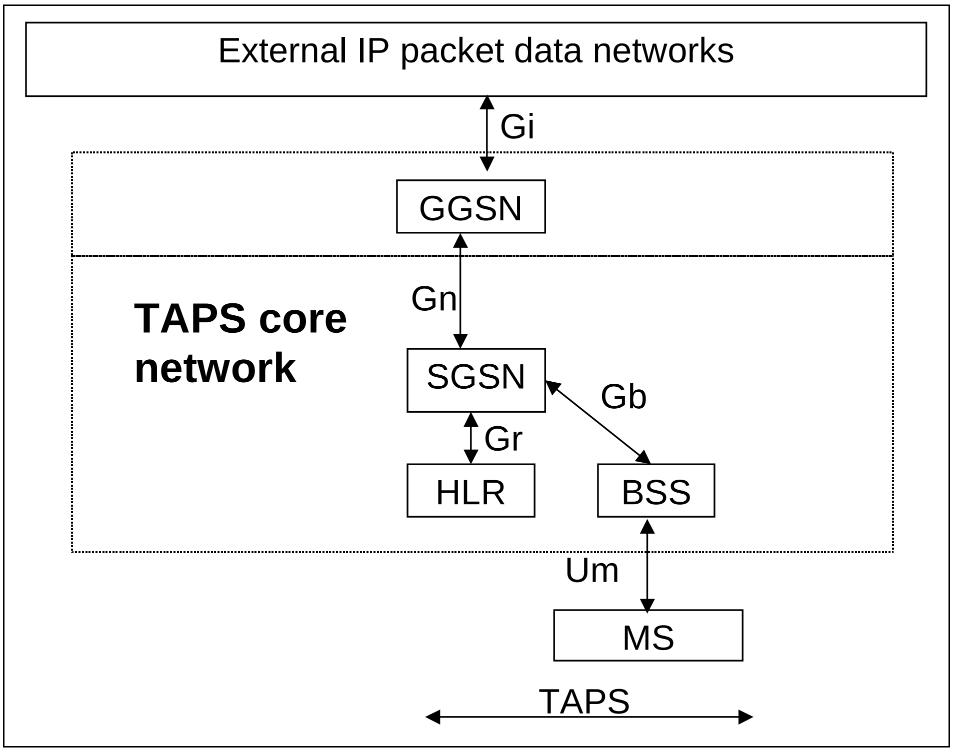

Figure 6: Possible TAPS implementation

Since TAPS is an overlay on the already standardized TETRA V+D SwMI, it may not be evident how it may interwork with packet data provided by the already existing TETRA V+D standard. Figures 7 and 8 show two possible implementations that provide a common interface point using Gi (i.e. IP) or Gn (GPRS Tunnelling Protocol (GTP)). These figures provide examples of possible levels of integration between TETRA V+D packet data and TAPS.

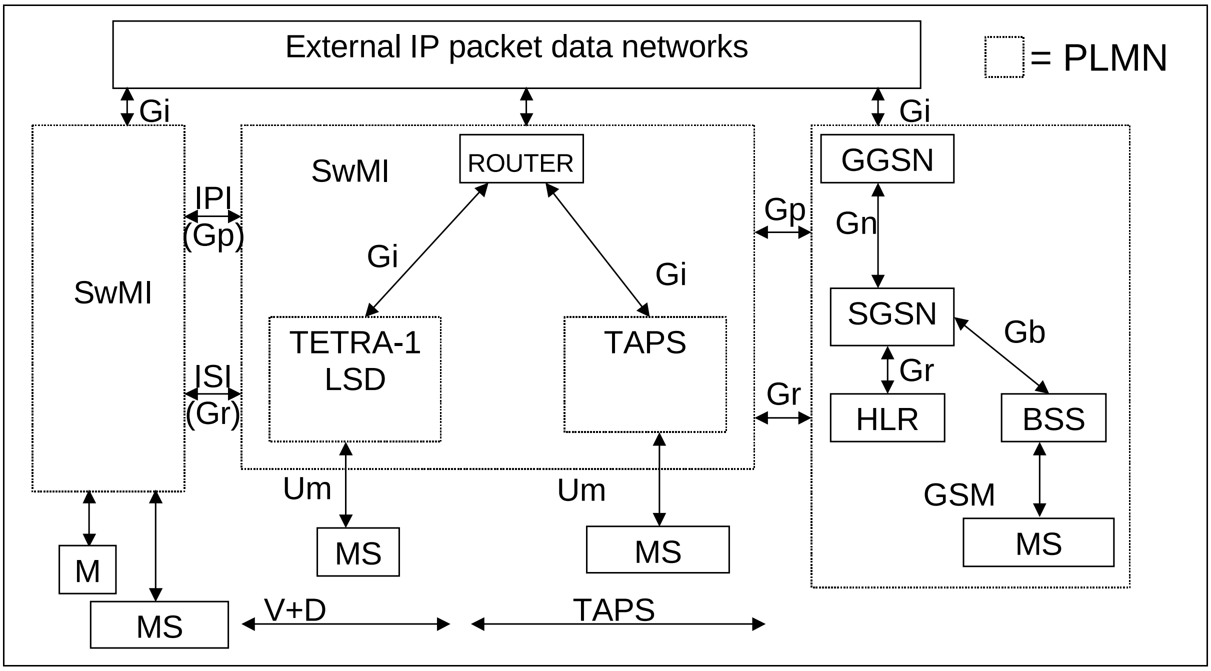

Figure 7: Possible interworking implementation based on Gi

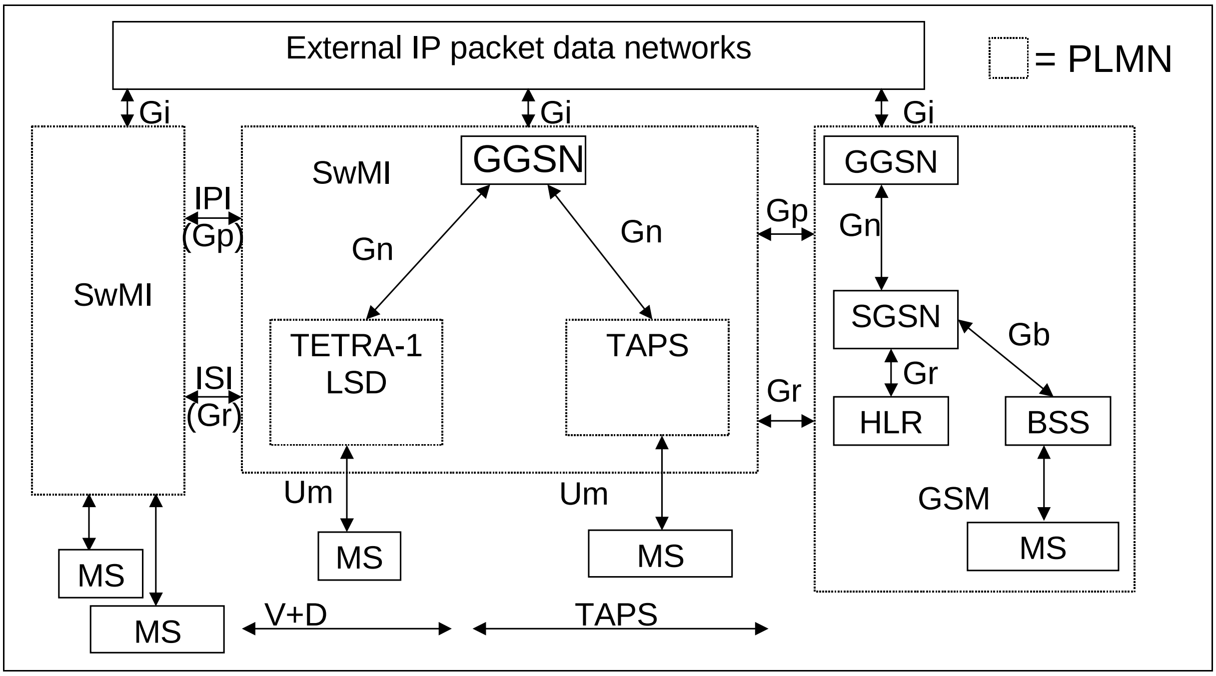

Figure 8: Possible interworking implementation based on Gn

Note that the interfaces to GSM networks shown in figures 7 and 8 are expected to evolve so that these interfaces will also provide connectivity to UMTS networks.

4.3 Short background information

For completeness the output press release following the Board decision has been included. Further information is available on the ETSI Web Site under Board Meeting 28.

New Terms of Reference for Release 2 of TETRA Approved by ETSI Board 28

The 28th ETSI Board meeting approved additional Terms of Reference (ToR) for the ETSI Project TETRA to enable Release 2 of the standard. The purpose of this additional ToR is to ensure that TETRA will be an appropriate technology, well in to the next decade by making substantial enhancements to the existing standard. The items that will be addressed for TETRA Release 2 include:

a) Evolution of TETRA to provide higher-speed packet data in support of multimedia and other high-speed data applications required by existing and future TETRA users within existing frequency bands assigned for TETRA as part of the ERC/DEC(96) Decisions.

b) Selection and standardization (as appropriate) of an additional speech codec (or set of codecs) for TETRA, to enable intercommunication between TETRA and other 3G networks without transcoding, and to provide enhanced voice quality for TETRA by using the latest low bit rate voice codec technology.

c) Further enhancements of the TETRA air interface standard in order to provide increased benefits and optimization in terms of spectrum efficiency, network subscriber capacity, system performance, quality of service, size and cost of terminals, battery life, etc.

d) Production and/or adoption of standards to provide improved interworking and roaming between TETRA and public mobile networks such as GSM, GPRS and UMTS, and other 3G/IP networks.

e) Evolution of the TETRA SIM, with the aim of convergence with the Universal SIM (USIM), to meet the needs for TETRA specific services while gaining the benefits of interworking and roaming with public mobile networks such as GSM, GPRS and UMTS.

f) Extension of the operating range of TETRA, to provide increased coverage and low cost deployment for applications such as airborne public safety, maritime, rural telephony and "linear utilities" (e.g. railways and pipelines).

g) Provision of new ETSI deliverables in order to support further user/market driven requirements that may be identified during study work in the early stages of the EP TETRA Release 2 work programme.

h) Ensure full backward compatibility and integration of the new services with the existing TETRA suite of standards, in order to future proof existing and future investments by TETRA users.

This is extremely good news for TETRA, demonstrating the ongoing commitment from ETSI to the TETRA standard. The decision will ensure that the investments made by manufacturers, network operators and users will be protected for many years to come, and that the TETRA standard will have its place alongside future 3G technologies.

4.4 Short market information

EPT has carried out market survey to identify what enhancements the users wanted for TETRA Release 2.

Figure 9 shows the relative weighted importance of the new requirements:

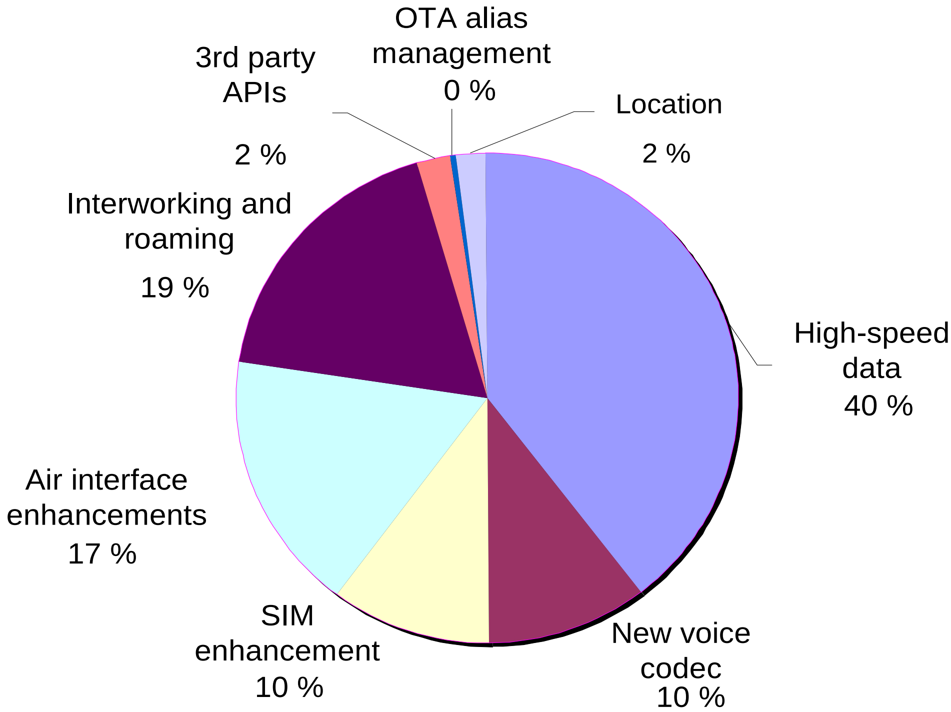

Figure 9: Data interworking requirements

It is obvious that the users ultimate most important enhancement is high-speed data. Infigure 10 it can be seen that there is a great deal of variation between the needs of different market sectors. Only the Military has not put a high importance on high-speed data this may be because they have other means of providing data.

Figure 10 shows that there is a high variation of the prioritization across the market segments:

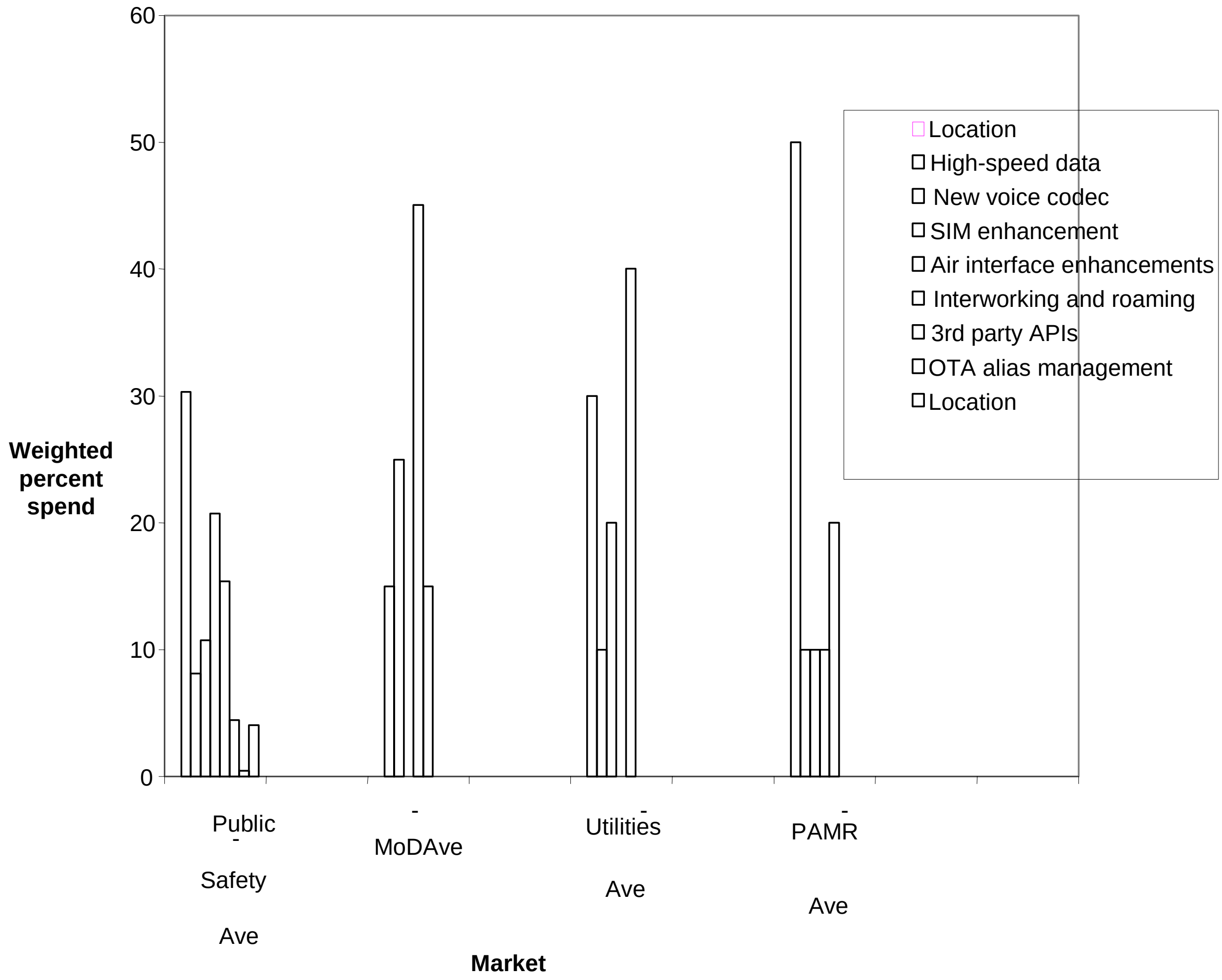

Figure 10: Importance of data interworkings per market

5 Main conclusions

From the market information collected from the users it is clear that the most needed facility is high-speed data to complement the existing V+D services of TETRA. This is not a surprise because of all the applications becoming available from IT and the cellular market. The modern user is not prepared to carry several communications devices around and a number of users want a grade of service that can only be guarantied if they are in control of the network.

The market survey also gave a clear indication that there is an immediate need for this service. Indications from some of the manufacturers promise equipment according to the TAPS standard to become available by the end of 2003 with deployment during 2004.

EPT requests the support of the ECC to enable the users to take advantage of the high-speed data system TAPS within a very short time frame. The ECC is expected to support the co-existence studies and the development of a new ECC Decision covering wider band services in the bands of the ERC/DEC(96)01 and 04 as a supplement to PMR and PAMR users. The first utilization of TAPS is expected in the 800/900 MHz band in 2004 followed by the 400 MHz bands in 2005-6.

Annex A: Detailed market information

A.1 Range of applications

HSD applications and net data rates to support non-voice applications

The net data rates to support non-voice applications on HSD are listed in table A.1. For ease of understanding requirements, the table has been sorted in order of net data rates. It is important to note that these HSD applications were derived solely from the Interim TETRA Release 2 Questionnaire HSD Analysis Report and did not take into consideration the needs of other TETRA and PMR users' organizations who did not participate in the questionnaire.

Table A.1: Net data rates to support non-voice applications

Applications	2005 Voice % impact	K/Bytes	K/Bits	Seconds	kbps (Net)	Application group
Location Services	-2 %	0,1	0,8	1	1	Real time short data
Telemetry (real time transfer)	0 %	0,2	1,6	0,5	3	Real time short data
Operation and control	0 %	0,2	1,6	0,5	3	Real time short data
Biodynamic registrations, EKG incl.	0 %	5	40	10	4	Real time short data
Online forms (1 k/bytes)	0 %	1	8	1	8	Database Interaction
Web browsing	0 %	10	80	10	8	Office Application
People & Vehicles (1 k/bytes)	-2 %	1	8	1	8	Real time short data
Database access (5 k/bytes)	-1 %	5	40	1	40	Database Interaction
Work Management (5 K/bytes)	-5 %	5	40	1	40	Database Interaction
Additional Database access	-1 %	5	40	1	40	Database Interaction
Data tasking e.g. command and control	-5 %	5	40	1	40	Database Interaction
Image transmission / video	0 %	50	200	5	40	Image Transfer
Image Transfer (100 k/bytes compressed JPEG)	0 %	100	800	20	40	Image Transfer
Image incl. Fingerprints, crime marks	0 %	100	800	20	40	Image Transfer
Email (5 k/bytes)	-1 %	5	40	1	40	Office Application
Telemetry (Real time - 5 k/bytes)	0 %	5	40	1	40	Real time short data
e-mails incl. Attachments 2 M/bytes	0 %	2 000	16 000	300	53	File Transfer
e-mails incl. Attachments 2 M/bytes	2 %	2 000	16 000	300	53	Office Application
Connect to hospitals and national health comm. network	0 %	100	800	10	80	File Transfer
Content Push (10 K/bytes)	1 %	10	80	1	80	File Transfer
Interagency Communications (10 k/bytes)	0 %	10	80	1	80	File Transfer
Intranet (10 k/bytes)	0 %	10	80	1	80	Office Application
Database inquiries 10 - 100 k/bytes	0 %	12,5	100	1	100	Database Interaction

Applications	2005 Voice % impact	K/Bytes	K/Bits	Seconds	kbps (Net)	Application group
Internet incl. web browsing 10 - 100 k/bytes	0 %	100	100	1	100	Office Application
Mobile computing - office applications	0 %	100	100	1	100	Office Application
Video Conferencing 64 - 128 k/bytes	0 %	16	128	1	128	Video Transfer
WAP	0 %	25	200	1	200	Database Interaction
Image transfer (image JPEG ±50 k/bytes)	0 %	50	400	1	400	Image Transfer
Picture and video	0 %	50	400	1	400	Image Transfer
Connect to hospitals and national health comm. network	1 %	50	400	1	400	Office Application
Image transmission / video	0 %	50	400	1	400	Video Transfer
Video transfer	0 %	50	400	1	400	Video Transfer
Picture and video	0 %	50	400	1	400	Video Transfer
Video Streaming (50 k/bytes)	0 %	50	400	1	400	Video Transfer
Slow scan video (higher resolution/frame rate cf Release 1)	0 %	50	400	1	400	Video Transfer
Video	0 %	50	400	1	400	Video Transfer
Graphics, maps, location 100 k/bytes - 1 M/bytes	-1 %	125	1 000	2	500	Image Transfer
Fingerprint data (Finger 1 M/bytes, Palm 16 M/bytes)	0 %	1 600	12 800	10	1280	File Transfer
Video clips 1 - 2 M/bytes	0 %	2 000	16 000	7	2286	Video Transfer

From table 1 it can be seen that net data rates in support of non-voice applications for the required GoS range from 1 kbps up to 2 286 kbps. From the table it can be seen that a significant percentage of applications can be supported with net data rates of 80 kbps and below. Similarly, the table indicates that a significant number of applications could be met with net data rates of 400 kbps.

Although the information provided on this table is useful, it is important to note that the mix of applications supported on a network and the amount of non voice traffic is complex and vary considerably between different users.

It is also important to note that the applications listed could be rationalized further within categories. However, as the GoS requirements vary between the identical applications, their individuality has been retained.

A.2 Market size and value

It is obviously not possible to get any manufacturer to reveal their business plans. The TETRA MoU however has made a common view. It is expected that TETRA services will attract businesses in excess of 10 Billion Euros by 2005. This figure has not taken into account China's recent acceptance of the TETRA standard because the impact is still unknown.

By 2006 the number of terminals in Europe will have grown to 2,8 million and installed base stations will have exceeded 17 000.

The number of terminals in Europe that include high-speed data will by 2006 be around 63 % of all terminals.

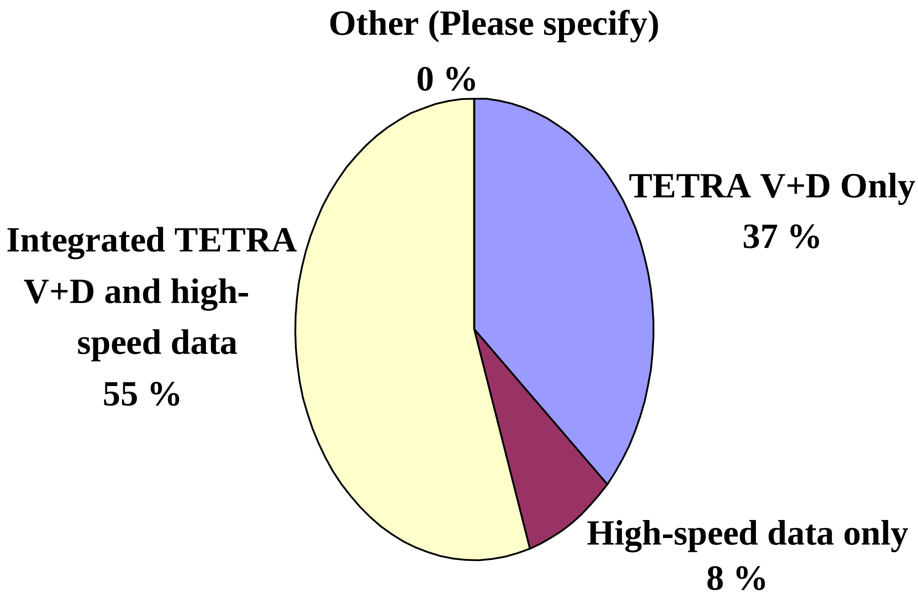

Figure A.1: Terminal type

A.3 Traffic evaluation

The following is an example that estimates how many high-speed data users can be supported in a hypothetical area of Central London and using a minimal frequency allocation. Let us assume that we are deploying TAPS based on a classic 4:12 reuse pattern and we are using for simplicity a uniform inter-site spacing.

Using the following Network assumptions:

- Inter-site spacing: 1 km.
- Surface area in Central London: 25 square km.
- Number of sectors: 86 sectors.
- Spectrum allocation: 2,4 MHz.
- TRX per sector: 1.
- Data throughput per TRX: 210 kbps.

NOTE 1: The data throughput per TRX can be derived from a publicly available study done by Ericsson, Third Generation TDMA, Christofer Linheimer, Sara Mazur, Johan Molno and Magnus Waleij, which was presented at TETRA WG4, contribution WG4HSD00027v2. Results are based on dynamic Monte Carlo simulation done for EDGE. Figure 11 of the document, the Cumulative Distribution Function (CDF) of user throughput per timeslot for Classic 4/12 frequency reuse pattern with 5, 45, 60 and 70 users per sector is particularly useful. For example, it shows that the median user throughput per timeslot (CDF = 50 %) will go down from 37 kbps with 5 users per sector, to 27 kbps with 70 users. This supports the assumption made that TAPS average user throughput is estimated to be 30 kbps per timeslot, or 210 kbps per TRX, as 1 timeslot is reserved for BCCH.

- User requirement for downlink @ peak hour: 325 k/bytes.

NOTE 2: Data applications for a user using nomadic PC laptop will typically generate 65 M/bytes/month on the down link this is based on a study from Arthur D Little the result is based on 10% usage in busy hour and 20 business days per month.

NOTE 3: Choi, H. and Limb, J.A. *A Behavioral Model of Web Traffic*, International Conference of Networking Protocol 99, ICNP99, Sep 1999.

- Average main object size (i.e. HTML page): 10,7 k/bytes (Lognormal);
- Average number of in-line objects (e.g. jpg): 5,5 (Gamma);
- Average size of in-line objects: 7,7 k/bytes (Lognormal);
- Average viewing time: 40 seconds (Weibull);
- Average Web-requests per session: 12,58.

Assuming the session activity follows a Poisson Distribution and a blocking rate of 10 %, the hypothetical area would support around 10 000 users.

A packet call should not last more than 8-10 seconds in average, and the average size of a web page is estimated to be 53 k/bytes. Therefore, a TRX can only support 4 simultaneous packet calls. A session is composed of an average of 12,58 packet call. During a session, viewing time (IDLE) represents 80 % of time. Based on our user requirements, we can make the simplistic assumption that a user has a 53 % probability of establishing a session during peak hour. Therefore we can model the Web traffic as a 10 second event (packet call) where a user generates in average: $0,48 \times 12,58 = 6,1$ packet call per busy hour. Using Erlang B table and N=4, we find that a TRX can support 2,05 data Erlang. A user generating 0,0172 data Erlang, a TRX would support 120 users.

Annex B: Technical information

B.1 Detailed technical description

The detailed technical description of TAPS can be found in ES 201 962 [27] and TS 101 962 [25].

B.2 System description

To facilitate the processes in CEPT the necessary technical information has been included. This information is contained in the CHS for TAPS and the supporting TS "Test Purposes". The TS "Test Purposes" contains the parameters where TAPS is different to (E)GPRS. Because the (E)GPRS standard requires circuit switched mode to be supported for testing purposes and because circuit switched mode is not covered by TAPS the physical layer testing that are mandated by the CHS is included in the TS.

B.3 Information on current version of relevant ETSI standard

The TAPS standard reference is:

ES 201 962 [27]. This standard will be revised to take into account that the responsibility of the technical specification of TAPS has been moved to 3GPP TSG GERAN as an extension of the frequency ranges for standard GSM under the name of GSM T. In particular it should be noted that spurious emissions are specified in TS 145 005.

Annex C: Expected compatibility issues

C.1 Co-existence studies (if any)

The co-existence studies required by the received concern about possible impact on GSM at 915 MHz, UIC DMO at 876 MHz and SRD at below 870 MHz have all been finished. The reports from the studies have been approved as ECC Reports no. 5, 13 and 14 respectively. Some restrictions have been identified in these reports.

C.2 Current ITU allocations

Not relevant.

C.3 Sharing issues

DSI Phase III proposed the 870 - 876/915 - 921 MHz band as a harmonized band for Military Tactical Radio Relays subject to successful sharing between TETRA and Military Tactical Radio Relays. CEPT ECC SE PT27 has been studying the proposed sharing and it is clear that the band cannot be used as a harmonized band. This because co-ordination between the use of Military Tactical Radio Relays and TETRA is required and there is also a need for either frequency or geographical separation distance for the two systems to operate without interference. The required separation may be reduced by the use of mitigation techniques but cannot entirely be avoided. This has been recognized by the Civil/Military meeting in Stockholm 28th to 30th October 2002 and the band is no longer proposed for harmonized use by the military. The band may be used especially for border crossing activities by the military based on national agreements.

The sharing study for TAPS vs. TRRs will take place in SE7 if the mandate is upheld after the outcome of the Civil/Military meeting. In any way the outcome of such a study is not expected to give significantly different results because the TRR's parameters in all cases were the predominant source of interference both for TETRA and for the TRRs.

Annex D: Bibliography

- ERC/DEC(96)01: "ERC Decision of 7 March 1996 on the harmonised frequency band to be designated for the introduction of the Digital Land Mobile System for the Emergency Services".
- ERC/DEC(96)04: "ERC Decision of 7 March 1996 on the frequency bands for the introduction of the Trans European Trunked Radio System (TETRA)".
- ETSI TR 101 976: "Terrestrial Trunked Radio (TETRA); Guide to TETRA Advanced Packet Service (TAPS)".
- ECC Report no. 5: "Adjacent band compatibility between GSM and TETRA Mobile Services at 915 MHz".
- ECC Report no. 13: "Adjacent band compatibility between Short Range Devices and TETRA TAPS mobile services at 870 MHz".
- ECC Report no. 14: "Adjacent band compatibility of UIC Direct mode with TETRA Advanced Packet Data Service (TAPS)".
- ETSI TS 145 005: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".

History

Document history		
V1.1.1	April 2003	Publication