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Technical Specification

Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 24: MTA Basic Access ISDN Interface (MTA-ISDN)

Reference

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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access and Terminals (AT).

The present document is part 24 of a multi-part deliverable covering Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services. Full details of the entire series can be found in part 1 [1].

The present document describes the ISDN-enabled Multimedia Terminal Adapter (iMTA) architecture and protocols for Internet Protocol (IP)-based Cable Telephony ISDN services.

Introduction

The cable industry in Europe and across other global regions has already deployed broadband cable television Hybrid Fiber/Coaxial (HFC) data networks running the international cable modem protocol (a.k.a DOCSIS®, see bibliography) or the European adaptation thereof (a.k.a Euro-DOCSIS®, see bibliography). The cable industry is in the rapid stages of deploying IP voice and other time critical multimedia services over these broadband cable television networks.

The cable industry has recognized the urgent need to develop ETSI Technical Specifications aimed at developing interoperable interface specifications and mechanisms for the delivery of end to end advanced real time IP multimedia time critical services over bi-directional broadband cable networks.

IPCablecom is a set of protocols and associated element functional requirements developed to deliver Quality of Service (QoS) enhanced secure IP multimedia time critical communications services using packetized data transmission technology to a consumer's home over the broadband cable television Hybrid Fibre/Coaxial (HFC) data network running the cable modem protocol. IPCablecom utilizes a network superstructure that overlays the two-way data-ready cable television network. While the initial service offerings in the IPCablecom product line are anticipated to be packet voice, the long-term project vision encompasses packet video and a large family of other packet-based services.

The cable industry is a global market and therefore the ETSI standards are developed to align with standards either already developed or under development in other regions. The ETSI Specifications are consistent with the CableLabs/PacketCable™ set of specifications (see bibliography) as published by the SCTE (see bibliography). An agreement has been established between ETSI and SCTE in the US to ensure, where appropriate, that the release of PacketCable™ (see bibliography) and IPCablecom set of specifications are aligned and to avoid unnecessary duplication. The set of IPCablecom ETSI specifications also refers to ITU-T Study Group 9 draft and published recommendations relating to IP cable communication.

The initial effort in IPCablecom has been on supporting analogue, POTS MTA terminals through IPAT V5.2 gateway interfaces (see TS 101 909-23, see bibliography) to support IP Voice (Telephony over IP) and other time critical multimedia services over these broadband networks. However, a need has been identified in TR 101 963 [8] (see clauses 5.3 and 9) to support also legacy ISDN terminal equipment in the wider European market. Consequently in order to support the development of broadband networks and equipment with support for legacy ISDN terminals, the key functions and features of these ISDN-capable MTAs need to be sufficiently defined.

The whole set of multi-part ETSI deliverables to which the present document belongs specify a cable communication Service for the delivery of IP multimedia time critical services over a HFC Broadband Cable Network to the consumers home cable telecom terminal. "IPCablecom" also refers to the ETSI TC AT working group program that shall define and develop these ETSI deliverables.

NOTE: The present document may have impacts upon other deliverables of the ETSI multi-part IPCablecom series; such potential impacts are currently unknown and are for further study. Thus, a need may arise in the future to revise the present document accordingly.

1 Scope

The present set of documents specifies IPCablecom, a set of protocols and associated element functional requirements. These have been developed to deliver Quality of Service (QoS), enhanced secure IP multimedia time critical communication services, using packetized data transmission technology to a consumer's home over a cable television Hybrid Fiber/Coaxial (HFC) data network.

To facilitate maintenance and future enhancements to support other real-time multimedia services the TS 101 909 document series consist of multi-parts as detailed in TS 101 909-1 [1].

The present document is part 24 providing a technical description of this architecture, and where appropriate, identify the portions of the IPCablecom specifications that apply to this architecture and their use. The embedded, ISDN-enabled MTA (iMTA) and its interfaces are described in the present document. The definition and interfaces of a standalone ISDN MTA (S-iMTA) are not described in the present document and remain as for further study.

While the initial service offerings in the IPCablecom product line are anticipated to be packet voice and packet video, the long-term project vision encompasses a large family of packet-based services. This may require in the future, not only careful maintenance control, but also an extension of the present set of documents.

The present document assumes familiarity with the IPCablecom architecture, specifically with DQoS, security and call signalling.

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] ETSI TS 101 909-1: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 1: General".

[2] ETSI TS 101 909-2: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 2: Architectural framework for the delivery of time critical services over cable Television networks using cable modems".

[3] ETSI TS 101 909-4: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 4: Network Call Signalling Protocol".

[4] ETSI TS 101 909-5: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 5: Dynamic Quality of Service for the Provision of Real Time Services over Cable Television Networks using Cable Modems".

[5] ETSI TS 101 909-6: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 6: Media Terminal Adapter (MTA) device provisioning".

[6] ETSI TS 101 909-11: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 11: Security".

[7] ETSI TS 101 909-22: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 22: Management Event Messages".

[8] ETSI TR 101 963: "Access and Terminals (AT); Report on the Requirements of European Cable Industry for Implementation of IPCablecom Technologies; Identification of high level requirements and establishment of priorities".

[9] ETSI TR 101 973-3 (V1.1.1): "Access and Terminals (AT); Public Switched Telephone Network; Support of legacy terminals by BroadBand IP equipment; Listing of the most relevant features and functionalities; Part 3: ISDN terminals".

[10] ETSI ES 201 488-1: "Access and Terminals (AT); Data Over Cable Systems; Part 1: General".

[11] ETSI ES 201 488-2: "Access and Terminals (AT); Data Over Cable Systems; Part 2: Radio Frequency Interface Specification".

[12] ETSI ES 201 488-3: "Access and Terminals (AT); Data Over Cable Systems; Part 3: Baseline Privacy Plus Interface Specification".

[13] ETSI ES 202 488-1: "Access and Terminals (AT); Second Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 1: General".

[14] ETSI ES 202 488-2: "Access and Terminals (AT); Second Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 2: Radio frequency interface specification".

[15] ETSI EN 300 012-1: "Integrated Services Digital Network (ISDN); Basic User-Network Interface (UNI); Part 1: Layer 1 specification".

[16] ETSI ES 202 488-3: "Access and Terminals (AT); Second Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 3: Baseline privacy plus interface specification".

[17] ITU-T Recommendation G.711: "Pulse Code Modulation (PCM) of voice frequencies".

[18] ITU-T Recommendation G.729 annex E Corrigendum 1 (1998): "11.8 kbit/s CS-ACELP speech coding algorithm. Corrigendum 1".

[19] ITU-T Recommendation J.112: "Transmission systems for interactive cable television services".

[20] ITU-T Recommendation Q.921: "ISDN user-network interface - Data link layer specification".

[21] ITU-T Recommendation Q.931: "ISDN user-network interface layer 3 specification for basic call control".

[22] IETF RFC 1350: "The TFTP Protocol (Revision 2)".

[23] IETF RFC 1591: "Domain Name System Structure and Delegation".

[24] IETF RFC 2131: "Dynamic Host Configuration Protocol".

[25] IETF RFC 2327: "SDP: Session Description Protocol".

[26] IETF RFC 2576: "Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework".

[27] IETF RFC 2822: "Internet Message Format".

[28] IETF RFC 2960: "Stream Control Transmission Protocol".

[29] IETF draft-ietf-sigtran-rfc3057bis-00.txt: "ISDN Q.921-User Adaptation Layer".

[30] IETF RFC 3164: "The BSD Syslog Protocol".

[31] IETF RFC 3396: "Encoding Long Options in the Dynamic Host Configuration Protocol (DHCPv4)".

[32] IETF RFC 3410: "Introduction and Applicability Statements for Internet-Standard Management Framework".

[33] IETF RFC 3411: "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks".

[34] IETF RFC 3412: "Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)".

[35] IETF RFC 3414: "User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)".

[36] IETF RFC 3415: "View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)".

[37] IETF RFC 3417: "Transport Mappings for the Simple Network Management Protocol (SNMP)".

[38] IETF RFC 3435: "Media Gateway Control Protocol (MGCP) Version 1.0".

[39] IETF RFC 3495: "Dynamic Host Configuration Protocol (DHCP) Option for CableLabs Client Configuration".

[40] IETF RFC 3660: "Basic Media Gateway Control Protocol (MGCP) Packages".

[41] IETF RFC 3661: "Media Gateway Control Protocol (MGCP) Return Code Usage".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in RFC 3057bis [29] and the following apply:

(IUA)-Application Server (AS): logical entity serving a specific application instance

NOTE: An example of an Application Server (AS) is a CMS handling ITU-T Recommendation Q.931 [21] and call processing for D channels. Practically speaking, an AS is modelled at the iMTA as an ordered list of one or more related Application Server Processes (e.g. primary, secondary, tertiary); see also RFC 3057bis [29]. RFC 3057bis [29] uses the term AS synonymously with an instance of CMS.

(IUA)-Application Server Process (ASP): process instance of an Application Server

NOTE: Examples of Application Server Processes are primary or backup MGC instances; see also RFC 3057bis [29].

(SCTP)-association: association refers to a SCTP association

NOTE: The association will provide the transport for the delivery of Q.921-User protocol data units and IUA adaptation layer peer messages; see also RFC 3057bis [29].

backhaul: iMTA terminates the lower layers of an SCN protocol and backhauls the upper layer(s) to MGC for call processing

NOTE: For the purposes of the present document the iMTA terminates ITU-T Recommendation Q.921 [20] and backhauls ITU-T recommendation Q.931 [21] to MGC; see also RFC 3057bis [29].

Basic Rate Access (BRA): ISDN user-network access arrangement that corresponds to the interface structures composed of two B-channels and one D-channel

NOTE: The bit rate of the D-channel for this type of access is 16 kbit/s (ITU-T Recommendation I.430).

B-channel: this function provides for the bi-directional transmission of independent B-channel signals each having a bit rate of 64 kbit/s

cable modem: layer two termination device that terminates the customer end of the J.112 connection

Customer Premises Equipment (CPE): in the scope of TS 101 909-24 understood being an ISDN terminal as an instantiation of Telecommunications Terminal Equipment (TTE)

D-channel: this function provides for the bi-directional transmission of one D-channel signal at a bit rate of 16 kbit/s for basic rate

endpoint: Terminal, Gateway or MCU

fail-over: capability to re-route signalling traffic as required between related ASPs in the event of failure or unavailability of the currently used ASP (e.g. from primary MGC to back-up MGC)

NOTE: Fail-over also applies upon the return to service of a previously unavailable process; see also RFC 3057bis [29].

Flow [IP Flow]: unidirectional sequence of packets identified by ISO Layer 3 and Layer 4 header information

NOTE: This information includes source/destination IP addresses, source/destination port numbers, protocol ID. Multiple multimedia streams may be carried in a single IP Flow.

Flow [J.112 Flow]: unidirectional sequence of packets associated with a SID (Service Identifier) and a QoS. Multiple multimedia streams may be carried in a single J.112 Flow.

gateway: devices bridging between the IPCablecom IP Voice Communication world and other communication networks (e.g. the PSTN)

NOTE: Examples are the Media Gateway which provides the bearer circuit interfaces to the PSTN and transcodes the media stream, and the Signalling Gateway which sends and receives circuit switched network signalling to the edge of the IPCablecom network.

IPCablecom: ETSI deliverables including an architecture and a series of specifications that enable the delivery of real time services (such as telephony) over the cable television networks using cable modems

(IUA)-Interface: for the purposes of TS 101 909-24 an IUA-interface supports the relevant ISDN signalling channel.

NOTE: This signalling channel may be a 16 kbps D channel for an ISDN BRA.

latency: time, expressed in quantity of symbols, taken for a signal element to pass through a device

(IUA)-interface identifier: the IUA-Interface Identifier identifies the physical interface at the iMTA for which the signalling messages are sent/received

NOTE: The format of the Interface Identifier parameter can be text or integer, the values of which are assigned according to network operator policy. The values used are of local significance only, coordinated between the SG and ASP. Significance is not implied across SGs served by an AS; see also RFC 3057bis [29].

iMTA: this expression is used synonymous for Embedded MTA with ISDN access interface

NOTE 1: A system component that has integrated a Multimedia Terminal Adapter (MTA) providing an ISDN interface to the subscriber side. The CM offers an Ethernet interface towards the subscriber side to connect, data services, e.g. a PC. The Network interface consists of a cable modem interface towards the HFC network (CMTS).

NOTE 2: The iMTA acts as a MGCP-controlled residential Media Gateway (MG) that backhauls DSS1 signalling via SCTP/IUA. Thus, the IUA signalling agent within the iMTA receives/sends SCN native signalling at the edge of the IP network. The IUA signalling function of an iMTA relays ITU-T Recommendation Q.931 [21] signalling. The SG function may also be co-resident with the MG function to process SCN signalling associated with line or trunk terminations controlled by the MG (e.g. signalling backhaul).

ISDN: Integrated Services Digital Network that provides or supports a range of different telecommunications services and provides digital connections between user-network interfaces

proxy: facility that indirectly provides some service or acts as a representative in delivering information there by eliminating a host from having to support the services themselves

Q.921-user: any protocol normally using the services of the ISDN Q.921 (e.g. ITU-T Recommendation Q.931 [21])

NOTE: See RFC 3057bis [29].

(SCTP)-stream: refers to an SCTP stream

NOTE: A uni-directional logical channel established from one SCTP endpoint to another associated SCTP endpoint, within which all user messages are delivered in-sequence except for those submitted to the un-ordered delivery service. See also RFC 3057bis [29].

trunk: analogue or digital connection from a circuit switch which carries user media content and may carry voice signalling (MF, R2, etc.)

3.2 Abbreviations

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

AC	Alternating Current
AS	Application Server (see IUA-AS)
ASP	Application Server Process (see IUA-ASP)
BA	Basic vote Access
BRA	Basic Rate Access (used synonymously as BRI)
BRI	Basic Rate Interface
CA	Call Agent
CM	Cable Modem
CMS	Call Management Server
CMTS	Cable Modem Termination System (used synonymously also as AN)
CPE	Customer Premises Equipment (used synonymously as TTE)
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DOCSIS™	Data-Over-Cable Service Interface Specifications
DQoS	Dynamic Quality of Service
DSS1	Digital Subscriber Signalling No. 1 (UNI Signalling)
DTMF	Dual Tone Multi Frequency
eMTA	Embedded MTA
HDLC	High-level Data Link Control
HFC	Hybrid Fiber/Coaxial
HW	HardWare
IETF	Internet Engineering Task Force
iMTA	ISDN-capable embedded MTA
IP	Internet Protocol
IPAT-LCS	Internet Protocol Access Terminal - Line Control Signalling
IPR	Intellectual Property Rights
IPSEC	Internet Protocol Security
ISDN	Integrated Services Digital Network
ITU	International Telecommunications Union
IUA	ISDN User Adaptation
IUA-AS	IUA Application Server (CMS)
IUA-ASP	IUA AS Process
KDC	Key Distribution Center
L3	ISDN Layer 3
LE	Local Exchange
MG	Media Gateway
MGC	Media Gateway Controller
MGCP	Media Gateway Control Protocol
MIB	Management Information Base
MTA	Multimedia Terminal Adapter
NCS	Network Control Signalling
NIF	Nodal Interworking Function
NT	Network Termination
NTE	Network Terminating Equipment
NTFY	Notify (see MGCP)

OSS	Operational Support System
PHY	PHYsical Layer
PKINIT	Public-Key INITial authentication
PL-EV	Primary Line EVent
POTS	Plain Old Telephone Service
PRA	Primary Rate Access (used synonymously as PRI)
PRI	Primary Rate Interface
PSTN	Public Switched Telephone Network
ptmp	Point-to-Multipoint
ptp	Point-to-Point
QoS	Quality of Service
REQ	REQuest
RFC	Request for Comment
RKS	Record Keeping Server
RQNT	Notification Request (see MGCP)
RTCP	Realtime Transport Control Protocol
RTP	Realtime Transport Protocol
SAPI	Service Access Point Identifier
SCN	Switched Circuit Network
SCTE	Society of Cable Telecommunications Engineers
SCTP	Stream Control Transmission Protocol
SDP	Session Description Protocol
SG	Signalling Gateway
S-iMTA	Standalone ISDN-capable MTA
SNMP	Simple Network Management Protocol
SW	SoftWare
TE	Terminal Equipment (see also CPE, TTE)
TEI	Terminal Endpoint Identifier
TFTP	Trivial File Transfer Protocol
TGT	Ticket Granting Ticket
TTE	Telecommunications Terminal Equipment (used synonymously as CPE and TE)
UDP	User Datagram Protocol
UNI	User-Network Interface
USB	Universal Serial Bus
USM	User-based Security Model
VACM	View-based Access Control Model
WLAN	Wireless Local Area Network

4 Conventions

If the present document is implemented, the key words "MUST" and "SHALL" as well as "REQUIRED" are to be interpreted as indicating a mandatory aspect of the present document.

The key words indicating a certain level of significance of a particular requirements that are used throughout the present document are summarized in the table below:

"MUST"	This word or the adjective "REQUIRED" means that the item is an absolute requirement of the present document.
"MUST NOT"	This phrase means that the item is an absolute prohibition of the present document.
"SHOULD"	This word or the adjective "RECOMMENDED" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behaviour is acceptable or event useful, but the full implications should be understood and the case carefully weighted before implementing any behaviour described with this label.
"MAY"	This word or the adjective "OPTIONAL" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

5 System architecture

The DSS1 signalling of ISDN Subscribers is transported to the CMS via the backhaul mechanism of SCTP and IUA. The iMTA is treated like a residential media gateway where the bearer is controlled via MGCP/NCS.

The iMTA specified in the present document supports the following ISDN services and applications:

- circuit-mode 64 kbit/s unrestricted;
- circuit-mode 3,1 kHz audio;
- circuit-mode speech;
- telephony 3,1 kHz;
- telephony 7 kHz;
- facsimile group 4 class 1;
- facsimile group 3.

The iMTA does not support any of the following ISDN services and applications:

- packet-mode (X.31 base B) B- and D-channel;
- teletex;
- syntax-based videotex;
- videotelephony;
- primary Rate Access/Interface (PRI/PRA).

The supported interface types are:

- basic Rate Interface (BRI):
  - Point-to-Point (ptp);
  - Point-to-Multipoint (ptmp).

Figure 1 shows the network architecture for an iMTA.

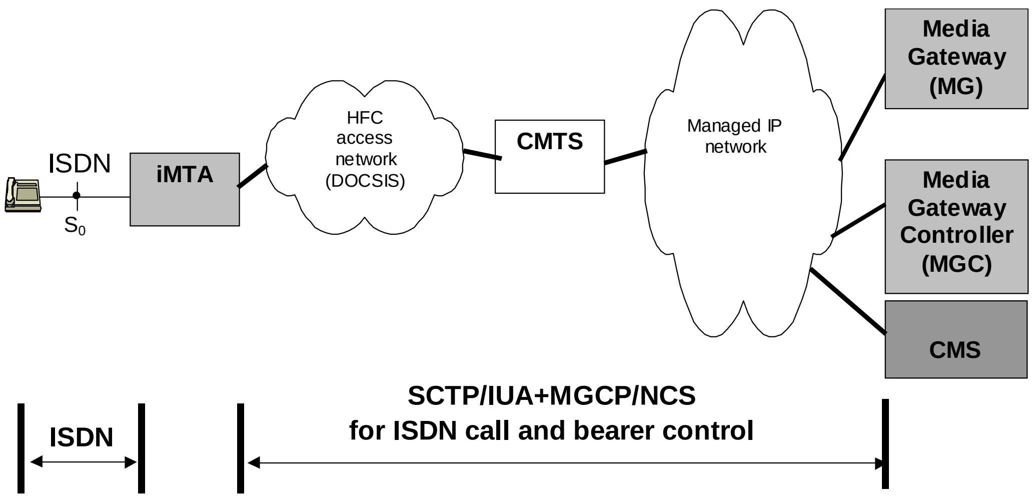

Figure 1: Network architecture for iMTA

5.1 User interfaces

The iMTA MUST offer ISDN as user side interface for voice service:

- ISDN BA ptp and ptmp, DSS1 signalling.

5.2 Network interfaces

Towards the network side a cable modem interface (see ES 201 488-1 [10], ES 201 488-2 [11] and ES 201 488-3 [12]) or ES 202 488-1 [13], ES 202 488-2 [14] and ES 202 488-3 [16]) MUST be provided:

- Cable modem with QoS support.

5.3 Call control interfaces

For ISDN the iMTA MUST provide SCTP (IUA (DSS.1)) as network call control interface:

- SCTP (IUA (DSS1));
- NCS deploying MGCP, DTMF, RTP;
- maintenance functions MUST be controlled via MGCP (with AuditEndpoint and RestartInProgress) commands.

5.4 Management and provisioning interfaces

An iMTA MUST provide DHCP (RFC 2131 [24], RFC 3495 [39]), TFTP (RFC 1350 [22]), DNS (RFC 1591 [23], RFC 3396 [31]), SNMPv3 and SYSLOG (RFC 3164 [30]) for the purpose of management and provisioning (see TS 101 909-6 [5]).

The iMTA MUST deploy SNMPv3 (see RFC 3417 [37], RFC 3412 [34] and RFC 3414 [35]). A more detailed introduction to the current SNMP Management Framework can be found in RFC 3410 [32], an overall architecture is described in RFC 3411 [33]. User-based Security Model (USM) RFC 3414 [35] and View-based Access Control Model (VACM) (RFC 3415 [36]) are supported to allow the cable operator to implement management policy for access to specified MIBs. The concept of management views was introduced with SNMPv3, and is defined in RFC 3410 [32] through RFC 3415 [36] and RFC 2576 [26]. It is a method for specifying what user(s) is/are allowed to access which MIB object(s). View-based Access Control Model (VACM) MUST be employed as defined by RFC 3415 [36].

5.5 Protocol interfaces

The Q.921 layer from the terminal equipment is terminated in the iMTA and converted to SCTP (IUA (DSS.1)), see figure 2. The ITU-T Recommendation Q.931 [21] protocol is relayed transparently through the iMTA. The bearer traffic is controlled via MGCP/NCS and transported in RTP sessions.

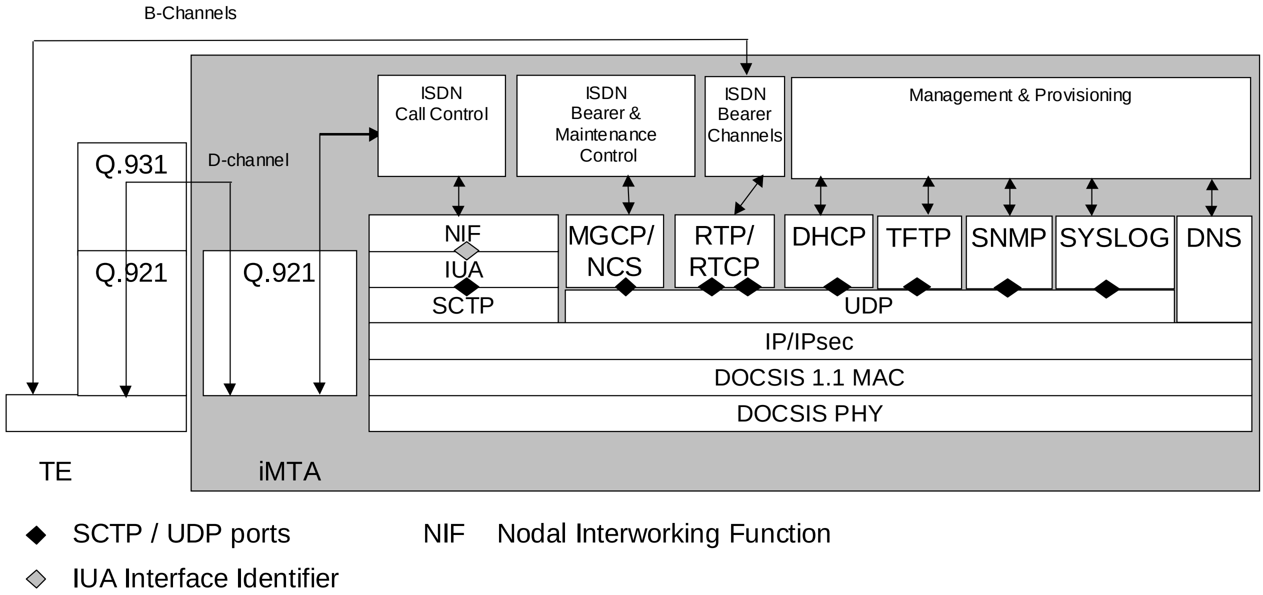

Figure 2: iMTA protocol stack overview

The iMTA MUST offer ISDN as user side interface for voice services ISDN. The iMTA MUST support the transport of voice and data traffic in different Service Classes (see ES 202 488-2 [14]).

For ISDN the iMTA MUST provide as network call control interface SCTP (IUA (DSS.1)). The maintenance control is performed via MGCP/NCS.

5.6 HDLC/Q.921 interface

The iMTA terminates the Q.921 layer and converts it into SCTP (IUA) towards the CMS. The iMTA MUST maintain the status of the SAPI/TEI; and optionally the CMS MAY maintain that status. For this reason it MUST be possible to configure the ISDN layer 2 service in the iMTA:

- Point-to-Point/Point-to-Multipoint scenario;
- permanent/non-permanent active layer 2;
- timer value (TL2out) for periodically layer 2 re-establishment in case of permanent layer 2, (between 4 s and 60 s, default is 7 s);
- TEI Management procedures:
    - For point-to-multipoint and non-permanent layer 2 application, the iMTA MUST be able to dynamically assign the TEI values in the range of 64 to 126.
    - In the case of point-to-point and permanent layer 2 application the iMTA MUST be able to accept a pre-assigned TEI value in the range of 0 to 63 from an ISDN terminal.
    - The iMTA MUST ignore pre-assigned TEI value received from ISDN Terminal for Point-to-Multipoint line.

5.7 L3 ISDN interface

TR 101 973-3 [9] describes the features and functionality including some flow scenarios of an ISDN terminal in the context of an IPCablecom environment. An iMTA as a broadband NTE backhauls any ISDN layer 3 signalling (see ITU-T Recommendation Q.931 [21]) through IUA over SCTP transport towards the CA of the CMS where the call control function is located.

6 System components

6.1 Embedded ISDN MTA (iMTA)

An embedded MTA (eMTA) is a hardware device that incorporates a cable modem (see ES 201 488-1 [10], ES 201 488-2 [11] and ES 201 488-3 [12] or ES 202 488-1 [13], ES 202 488-2 [14] and ES 202 488-3 [16]) as well as an IPCablecom multi-media terminal adapter component. Following this, the iMTA is an eMTA that has two logical parts, which are physically combined into one device (see note): a Cable Modem (CM), and an ISDN Multi-media Terminal Adapter (MTA). Every home using IPCablecom services has at least one such device. On the subscriber side, it supports ISDN, and optionally includes a local 10BaseT or 100BaseT port for high-speed data access. On the network side it supports the IPCablecom/cable modem/HFC network requirements.

The cable modem is a modulator that provides data transmission over the cable network using the cable modem protocol (see ES 201 488-1 [10], ES 201 488-2 [11] and ES 201 488-3 [12] or ES 202 488-1 [13], ES 202 488-2 [14] and ES 202 488-3 [16]). In IPCablecom, the CM plays a key role in handling the media stream and provides services such as classification of traffic into service flows, rate shaping and prioritized queuing.

The iMTA is an IPCablecom client device that contains a subscriber side interface to the subscriber's ISDN terminal (e.g. ISDN telephone) and a network side voice and signalling interface to elements in the network. iMTA basically handles the two-way translation of voice to IP packets, and two-way ISDN to IP based signalling conversion. iMTA provides codecs and all signalling and encapsulation functions required for media transport and call signalling. IPCablecom iMTAs are REQUIRED to support the Network Call Signalling (NCS) protocol.

The iMTA MAY optionally provide a high speed "data port" that MAY be of a type IEEE 802.3 Ethernet (10/100 baseT, RJ-45) and/or USB or other access technology (IEEE 802.11 WLAN, Bluetooth etc). The choice of which type is offered in a given iMTA is market driven. The present document does not cover the high speed "data ports".

NOTE: Presence of a high-speed "data port" raises the need for QoS assurance mechanisms (see clause 7.3 "DQoS").

Figure 3 gives an overview of the typical functional blocks of the iMTA.

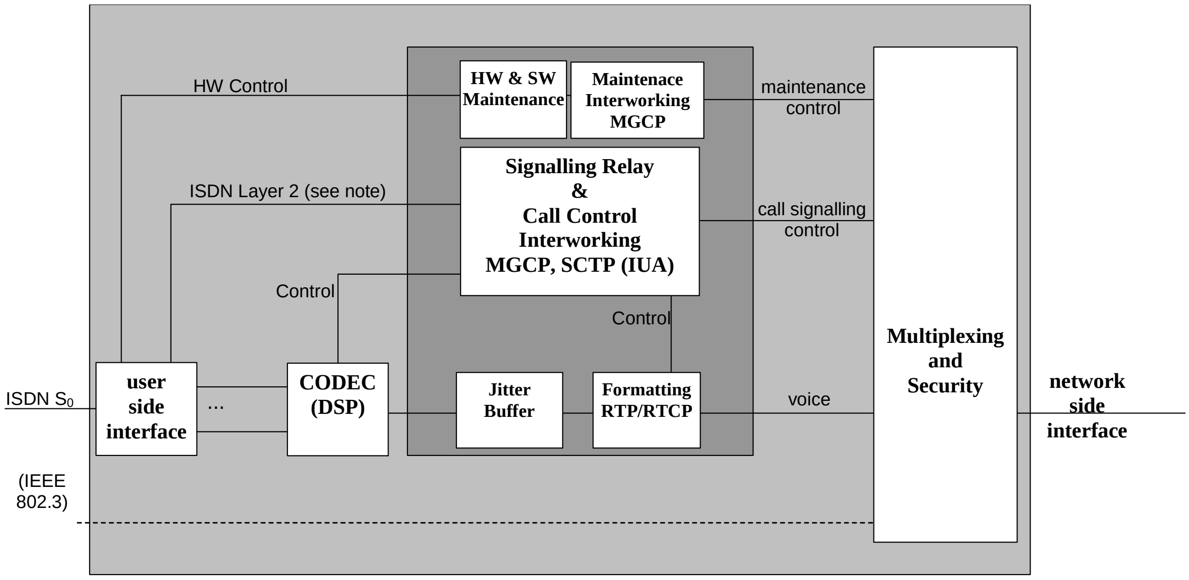

Figure 3: iMTA functional blocks overview

NOTE: The present document does only address an embedded iMTA, a standalone iMTA (S-iMTA) is out of scope of the present document.

6.2 Fail-over, robustness and reliability

iMTA users would expect a similar availability in an IPCablecom environment than they are used to from the circuit-switched PSTN/ISDN. For this reason iMTA has to address appropriate measures to provide sufficient robustness and reliability. To meet the ISDN signalling reliability and performance requirements for carrier-grade IP networks, network operators SHOULD ensure that there is no single point of failure of their CMS.

The following architecture enables cable service operators to deploy multiple redundant CMS systems with active and standby call agents to meet the required reliability needs. There MUST at least be one active call agent for MGCP/SCTP/IUA communication and one or more standby call agents. The standby call agents are maintained only for backup purposes and will come into play just when the active call agent failed.

At startup, the iMTA knows the set of call agents (e.g. through configuration or network management). Using DNS, the iMTA is able to resolve the configured symbolic names of the call agents.

In case the iMTA cannot reach one call agent, a switchover procedure to another standby call agent will be executed. The iMTA will then send its messages to the new active call agent.

Figure 4 shows an example with two redundant CMS each on different hosts. Each CMS features an MGC that has established a MGCP/SCTP/IUA link towards the iMTA. One of those links becomes active while the other one is kept for backup reasons.

The CMS on both hosts MAY share their state (e.g. by shared memories) or MAY communicate state information through some protocol means; such means are outside the scope of the present document. For example, such communication means are necessary to transfer context, call and security state from one system to another in case of fail-over.

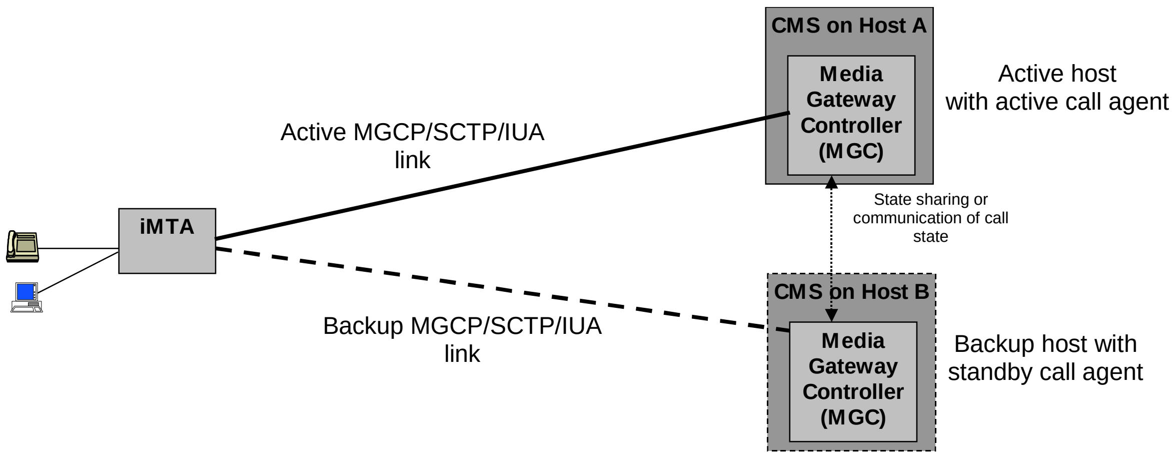

Figure 4: Redundant call agents

6.2.1 MGCP

The iMTA MUST adhere to the MGCP specification as given in RFC 3435 [38] and RFC 3661 [41]. RFC 3435 [38] takes precedence in case of conflicts with NCS part 4.

It is recommended that the iMTA follows the guidelines and procedures RFC 3435 [38] for handling failover, robustness and reliability. In particular, see section 4 "States, Failover and Race Conditions" and subsections 4.1 "Failover Assumptions and Highlights" and 4.4.6 "Fighting the Restart Avalanche".

6.2.2 SCTP

If ISDN ports are located on the iMTA the active and the standby call agent initiate an SCTP association with the iMTA and setup their IUA connection with "ASP Up"/"ASP Up Ack" message. Only the active call agent sends an "ASP Active" message to the iMTA to allow the exchange of IUA messages; see annex A:

- Both call agents establish an own SCTP association with the iMTA. In the associations for each D-channel a separate SCTP stream is set up; i.e. for an iMTA with 4 S_0 ports, 4 SCTP streams per SCTP association are required. The number of streams cannot be changed during the lifetime of an association and MUST be configurable.

- After the SCTP association is setup with SCTP streams in both directions, IUA communication between iMTA and both call agents starts: Both call agents announce themselves with "ASP Up" messages and expect acknowledgements from their peers on the iMTA. In the header of the outgoing messages the call agents use the IP-Address of the iMTA and the "well-known" destination SCTP port address 9900 together with the own IP-Address and any free unused SCTP port address.

- When the active call agent receives the "ASP Up Ack" message from the iMTA it announces itself as the active partner with an "ASP Active" message. With the reception of the "ASP Active Ack" message the IUA is now ready to transport ITU-T Recommendation Q.931 [21] primitives between call agent and iMTA.

- After the SCTP Association has been established both iMTA and call agent (both active and standby) start supervising the association status by sending periodic heartbeat messages to each other.

6.2.3 Q.921

The iMTA terminates the Q.921 layer and maps it into IUA. Depending on the layer 2 status configuration the iMTA MUST perform the following actions:

- **Permanent layer 2:** The iMTA is responsible for layer 2 establishment. Each time the layer 2 towards the terminal equipment breaks down the iMTA has to perform the following actions:

  1) Layer 2 outage:

     - try to re-establish layer 2 connection to terminal equipment and send IUA establish indication to call agent in case of successful layer 2 re-establishment;

     - send IUA Release indication in case the layer 2 can not be built up successfully after T200 elapsed N200 times (see ITU-T Recommendation Q.921 [20]). The iMTA MUST continue periodically (interval TL2out, configurable timer) to re-establish the layer 2 towards the terminal and inform the call agent after successful re-establishment with IUA Establish indication.

  2) Switch-over of SCTP association: after the outage of the active SCTP association and the switch-over to the standby SCTP association the iMTA MUST check whether the layer 2 towards the terminal equipment is still active, if:

     - Yes: send an IUA Establish indication on the new active SCTP association.

     - No: try to re-establish the layer 2 and act as described above under 1.

- **Non-permanent layer 2:** Normally the iMTA indicates a layer 2 establishment (initiated by the terminal equipment during call setup) to the CMS. However, also the CMS may request a layer 2 establishment. If the iMTA receives an IUA Establish request message from the call agent it MUST check whether the layer 2 towards the terminal equipment is still active. If:

  - Yes: send an IUA Establish confirmation to the call agent.

  - No: try to re-establish the layer 2 towards the terminal and inform the call agent after the layer 2 is re-established with IUA Establish confirmation. In case the layer 2 can no longer be activated the iMTA MUST inform the call agent after T200 elapsed N200 times (see ITU-T Recommendation Q.921 [20]) with IUA Release indication message.

The iMTA assigns the TEI values. The iMTA MUST maintain the status of the TEIs, and CMS MAY maintain the status of the TEIs. The status of the TEIs MAY be queried and/or indicated (but MUST NOT be changed) via the IUA management messages; see section 3.3.3.3 "TEI Status Messages" and section 3.3.3.4 "TEI Query Messages" of RFC 3057bis [29].

7 iMTA power, physical and electrical characteristics

This clause provides information on the physical and electrical characteristics of an iMTA including aspects of power.

The iMTA is a device that is situated in two distinct networks: HFC and ISDN. As such the iMTA MUST comply with the physical and electrical characteristics of either network type:

a) The ISDN side of the iMTA acts as an ISDN Network Termination (NT) towards the CPE (TE). For this case, the iMTA MUST comply with the Basic User-Network Interface (UNI) Layer1 specification (see EN 300 012-1 [15]). In particular, clause 9 of EN 300 012-1 [15] yields the electrical characteristics, clause 10 of EN 300 012-1 [15] addresses power feeding and clause 11 of EN 300 012-1 [15] specifies the interface connector contacts. The iMTA does not support ISDN power feeding towards the TE (see EN 300 012-1 [15] clauses 6.1.7, 6.3.1 and 10) in the event of failure.

b) The HFC side of the iMTA acts as a cable modem. For this case, the iMTA MUST comply with the ES 201 488-2 [11] or with the ES 202 488-2 [14] physical and electrical characteristics.

The iMTA MAY have two sources of input power; the HFC Network and the local premises AC Utility.

7.1 HFC network powering

The HFC network is typically powered by distributed power nodes.

Powering of the iMTA by the HFC Network is for further study. In all the cases the powering MUST comply with the appropriate harmonized safety standards or appropriate national safety standards.

7.2 Premises powering

This is the method of providing local AC utility power directly to the iMTA from a receptacle at the premises.

7.2.1 Mechanical interface

The vendor MUST supply an appropriate AC mains line cord compliant with the appropriate harmonized safety standards or appropriate national safety standards.

7.2.2 Input voltage

The device SHOULD operate at the normal AC Supply voltage tolerance ranges.

7.2.3 Telephony service availability considerations

The delivery of a highly available Telephony service to the users is directly impacted by the reliability of the local AC utility provider. Some administrations and/or network operators require to provide alternate power to bridge across AC utility power loss.

The most common method of providing alternate power for the AC utility over relatively short periods of time is to provide a battery backup system.

The following requirements assume a battery backup system is employed. These requirements are not intended to dictate any specific implementation architecture or method as long as the functional goal of the backup system is achieved.

The implementation of a battery backup system is NOT REQUIRED by the present document but MAY be subject to national regulation.

7.2.3.1 Up power interruptions

7.2.3.1.1 AC utility to back up supply

The iMTA transition from AC utility power (power loss) to a back up power source (battery) MUST maintain all established voice and data connections.

7.2.3.1.2 Back up supply to AC utility

The iMTA transition from a back up power source (battery) to the AC utility power (power restoration) MUST maintain all established voice and data connections.

7.2.3.2 Automatic operation

The switching from AC utility power to battery back up MUST operate without service personnel or user intervention.

The switching from battery back up to AC utility power MUST operate without service personnel or user intervention.

If the battery is capable of being re-charged (e.g. secondary cell type), the battery charger operation (e.g. starting battery charge, ending battery charge, etc.) MUST operate without service personnel or user intervention.

7.2.3.3 Operation without battery

The iMTA MUST maintain all connection services if the battery is removed for service or replacement.

The iMTA MUST maintain all connection services if the battery is determined as requiring replacement, see clause 6.2.3.7.2.2.

7.2.3.4 Service limitations

During operation on backup power, data connections MAY optionally be disabled.

Upon return of AC utility power, data connections MUST be enabled.

7.2.3.5 Battery run time

Battery run time is dependent on the iMTA design, the back up system efficiency and the size and type of back up battery. These parameters represent various trade off considerations to meet specific run time goals per local administration requirements and product costs.

It is not possible to define any specific run times across all administrations therefore; the present document leaves specific run time goals to national regulation.

The vendor MUST specify the expected run time of the iMTA assuming a battery in good condition with a full charge for a representative sample of modes of iMTA operation in accordance with national regulations or based on operators specification where there is no national regulation. Since vendor equipment MAY be configured with different types and quantities of interfaces, it is the vendor obligation to provide the appropriate combinations of port states and modes as appropriate for the equipment being offered.

The minimum modes that MUST be specified:

1) Idle run time - the iMTA is supporting the required protocol overhead, one telephony port is provisioned, all other telephone and data ports are disabled (not provisioned) and there is no active telephony connection on the provisioned telephony port. At the end of the Idle Run Time the iMTA MUST still originate a single, 3 min telephony connection without any other connection activity.

2) Provisioned Run Time - The iMTA is supporting the required protocol overhead, all telephony and data ports are provisioned, and there are no active telephony or data connections. At the end of the Provisioned Run Time the iMTA MUST still originate a single, 3 min Telephony Connection without any other connection activity.

3) Data Run Time - The iMTA is supporting protocol overhead, all telephony ports are disabled (not provisioned), all data ports are provisioned, and with a full data rate connection active, unless disabled per clause 6.2.3.4.5.

4) Talk Run Time - the time the iMTA can support the required protocol overhead, all telephony and data ports are provisioned, and there is one continuous telephony connection and no data connections.

5) Full Load Run Time - the time the iMTA can support the required protocol overhead with all of the Telephony connections active and a full rate data connection, unless disabled per clause 6.2.3.4.

7.2.3.6 Battery recharge time

If the battery is capable of being re-charged (e.g. secondary cell type), the vendor MUST specify the time to recharge the back up battery to at least 80 % of its capacity after the return of the AC utility power assuming the battery was fully discharged.

7.2.3.7 Back up telemetry

In order to maintain the high availability provided by the back up battery the iMTA MUST monitor various AC utility and battery states and report them to the OSS system so that the operator can replace aged or defective back up systems.

7.2.3.7.1 Operations Support System (OSS) event reporting

The iMTA MUST support the event and alarm reporting mechanism as defined in TS 101 909-22 [7]. This mechanism is used to configure the line events on the iMTA. This mechanism is also used to report the Line Events in a local log or to send these events to an OSS back office system via SNMP or SYSLOG.

All Line Events MUST be defined as a matched pair of "set" and "cleared" events. Eight Line Events are programmable events and therefore MAY be redefined to support a meaning other than the battery-related meanings defined in the present document. If these Line Events are redefined, then the definition of the new meaning and any coordination between systems to support this new meaning is out of the scope of IPCablecom.

The "set" and "clear" events for the four alarm signals are defined below.

7.2.3.7.2 Telemetry signals

7.2.3.7.2.1 Telemetry signal 1 - AC fail

The active alarm state of this signal indicates an "AC Fail" condition, which means the Back Up Supply, has detected a failure of the utility AC power and is operating off its battery.

The inactive alarm state of this signal indicates an "AC Restored" condition that means the Back Up Supply has detected the presence of utility AC power and is no longer operating off its battery:

- PL-EV-1: active alarm state of telemetry signal 1; default meaning "AC Fail" and default severity MINOR.
- PL-EV-2: inactive alarm state of telemetry signal 1, default meaning "AC Restored"; PL-EV-2 always clears PL-EV-1.

7.2.3.7.2.2 Telemetry Signal 2 - Replace Battery

The active alarm state of this signal indicates a "Replace Battery" condition which means the Back Up Supply, via internal test mechanisms outside the scope of the present document, has determined that the battery can no longer maintain a charge sufficient enough to provide the designed amount of battery run time and thus is failing and MUST be replaced with a new battery.

The inactive alarm state of this signal indicates a "Battery Good" condition:

- PL-EV-3: active alarm state of telemetry signal 2; default meaning "Replace Battery" and default severity MINOR.
- PL-EV-4: inactive alarm state of telemetry signal 2; default meaning "Battery Good"; PL-EV-4 always clears PL-EV-3.

7.2.3.7.2.3 Telemetry Signal 3 - Battery Missing

The active alarm state of this signal indicates a "Battery Missing" condition, which means the Back Up Supply has detected that a battery is not present and a battery MUST be installed to support the Back Up Supply.

The inactive alarm state of this signal indicates a "Battery Present" condition:

- PL-EV-5: active alarm state of telemetry signal 3; default meaning "Battery Missing" and default severity MINOR.
- PL-EV-6: inactive alarm state of telemetry signal 3; default meaning "Battery Present"; PL-EV-6 always clears PL-EV-5.

7.2.3.7.2.4 Telemetry Signal 4 - Battery Low

The active alarm state of this signal indicates a "Battery Low" condition. This condition is defined to mean that battery has sufficiently discharged (e.g. approximately 75 % to 80 % discharged) to the point where a power source can only be maintained for a short while longer.

The inactive alarm state of this signal indicates a "Battery Not Low" condition. This condition means that the battery has a charge capacity above the "battery low" threshold (e.g. at least 20 % to 25 % of full capacity):

- PL-EV-7: active alarm state of telemetry signal 4; default meaning "Battery Low" and default severity MINOR.
- PL-EV-8: inactive alarm state of telemetry signal 4; default meaning "Battery Not Low"; PL-EV-8 always clears PL-EV-7.

8 System interfaces

Protocol specifications have been or are currently being defined for most component interfaces within the IPCablecom architecture. An overview of these component interfaces is provided in the IPCablecom architecture framework Technical Report (see TS 101 909-1 [1]). The individual IPCablecom protocol specifications SHOULD be consulted for complete requirements of each component interface.

New interfaces pertaining to the support iMTA have been added to the IPCablecom architecture. These will be detailed in the following clauses. Existing IPCablecom interfaces are not always shown unless they are directly related to the iMTA.

There are no event messages interfaces for iMTA.

8.1 Physical and data link layer interfaces

Table 1 summarizes the physical interfaces of an iMTA.

The cable modem data link interfaces from the iMTA towards the HFC network MAY be ES 201 488-1 [10], ES 201 488-2 [11], ES 201 488-3 [12] or MAY be ES 202 488-1 [13], ES 202 488-2 [14] and ES 202 488-3 [16].

The iMTA MAY optionally provide a high speed "data port" that MAY be of a type IEEE 802.3 Ethernet (10/100 baseT, RJ-45) and/or USB or other access technology (IEEE 802.11.x WLAN, Bluetooth etc). The choice of which type is offered in a given iMTA is market driven. The present document does not cover the high speed "data ports".

Table 1: Physical Interfaces

COMPONENT INTERFACE	PHYSICAL INTERFACE
iMTA-to-HFC Network (AN)	ES 201 488-1 [10], ES 201 488-2 [11] and ES 201 488-3 [12] or ES 202 488-1 [13], ES 202 488-2 [14] and ES 202 488-3 [16])
iMTA-to-CPE	ISDN S_0 (IEEE 802.3, USB, or other high-speed data port OPTIONAL)
iMTA-to-CMS/MGC	no direct physical interface

8.2 Call signalling interfaces

Figure 5 identifies the call signalling interfaces for an iMTA when used in an IPCablecom architecture; see also the interface description in table 2. Interface Pkt-c11 is a new IPCablecom interface specific to an iMTA between an iMTA and CMS.

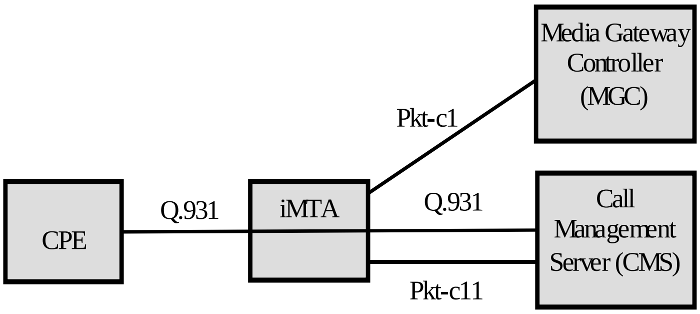

Figure 5: Call signalling interfaces

Table 2: Call signalling interfaces

Component Interface	IPCablecom Functional Components	Description
Pkt-c1	iMTA-MGC	Call signalling messages for ISDN bearer and maintenance control exchanged between the MTA and MGC using the NCS protocol, which is profile of MGCP.
Pkt-c11 (new)	iMTA-CMS	ISDN Call control signalling messages exchanged between the MTA and the CMS using the IUA over SCTP protocol.
ITU-T Recommendation Q.931 [21]	CPE-CMS	ISDN User-network signalling.

8.2.1 SCTP interface

The Stream Control Transmission Protocol (SCTP) is a new IP transport protocol, existing at an equivalent level with UDP and TCP, which currently provide transport layer functions to many Internet applications. SCTP has been approved by the IETF as a Proposed Standard, and is specified in RFC 2960 [28].

Like TCP, SCTP provides a reliable transport service, ensuring that data is transported across the network without error and in sequence. Like TCP, SCTP is a session-oriented mechanism, meaning that a relationship is created between the endpoints of an SCTP association prior to data being transmitted, and this relationship is maintained until all data transmission has been successfully completed.

The SCTP Implementors Guide (see bibliography) captures technical corrections to RFC 2960 [28] and MUST take precedence over RFC 2960 [28].

SCTP is used for transport of IUA messages from the iMTA to the CMS.

The iMTA MUST support the SCTP protocol according RFC 2960 [28] and the IUA protocol according RFC 3057bis [29].

For ISDN subscribers the call control signalling MUST be performed via SCTP (IUA (DSS.1)) signalling backhaul.

Within the SCTP (IUA) service some data (e.g. retransmission timers, etc.) need to be configured.

8.2.2 IUA interface

IUA (see RFC 3057bis [29]) defines a protocol for backhauling of ISDN Q.921-user messages (e.g. ITU-T Recommendation Q.931 [21] messages) over IP using the Stream Control Protocol (SCTP). IUA provides the capability to transport ITU-T Recommendations Q.921/Q.931 boundary primitives.

This IUA protocol MUST be used between the iMTA and the CMS for ISDN call control signalling. It is assumed that the iMTA receives ISDN signalling over a standard ISDN user interface. IUA supports as well point-to-point as point-to-multipoint communication mode.

The iMTA has to terminate the ITU-T Recommendation Q.921 [20] protocol towards the ISDN interface and convert the received Q.921-user messages into IUA message format towards CMS.

Between iMTA and CMS one SCTP association MUST be established. The SCTP association MUST be established with iMTA start-up. The CMS MUST act as a SCTP client and MUST establish the SCTP associations to the iMTAs. Inside this SCTP association a number of SCTP streams, e.g. one SCTP stream per D-channel MUST be assigned. The number of SCTP streams MUST be configurable. The SCTP streams are unidirectional channels; i.e. in the iMTA per ISDN port one outbound SCTP stream is assigned and one inbound stream MUST be accepted.

In the iMTA a further SCTP stream for maintenance and status information exchange MUST be assigned.

The IUA message header contains an interface identifier field. For a given interface the iMTA MUST be able to identify the associated signalling channel.

The iMTA MUST perform a dynamic assignment of D-channel messages onto a physical interface. For this reason the iMTA must maintain a map of the IUA interface identifier to a physical interface on the iMTA. The IUA interface identifier MUST correspond 1:1 to the iMTA BA port number, beginning with one (IID1 ↔ BA1).

If the IUA layer becomes inactive due to a CMS failure the iMTA MUST inform the Q.921 layer to e.g. perform some actions on ITU-T Recommendation Q.921 [20] basis:

- IUA protocol functions on CMS:
    - Each SCTP association is subdivided into several streams which represent the ports connected (i.e. D-channels). The SCTP streams are unidirectional channels.
- IUA protocol functions on iMTA:
    - On the iMTA the IUA receives ISDN signalling via a standard S_0 interface.
    - Between iMTA and CMS one SCTP association MUST be established. The SCTP association is established by the CMS.
    - Inside this SCTP association one SCTP stream per D-channel is assigned. The SCTP streams are unidirectional channels, i.e. in the iMTA per ISDN port one outbound SCTP stream is assigned and one inbound stream MUST be accepted. In the iMTA a further SCTP stream for maintenance and status information exchange MUST be assigned (stream0).
    - For a given interface the iMTA MUST be able to identify the associated signalling channel. The iMTA MUST perform a dynamic assignment of D-channel messages onto a physical interface. For this reason the IUA in the iMTA MUST maintain a map of the interface identifier to an association and stream represented by a physical interface on the iMTA.
    - The TEI values are assigned in the iMTA. The iMTA has to maintain the status of the TEIs, and CMS MAY maintain the status of the TEIs. The status of the TEIs MAY be queried and/or indicated (but MUST NOT be changed) via the IUA management messages; see section 3.3.3.3 "TEI Status Messages" and section 3.3.3.4 "TEI Query Messages" of RFC 3057bis [29].

8.2.3 MGCP interface

The iMTA MUST adhere to the MGCP specification as given in RFC 3435 [38] and RFC 3661 [41]. RFC 3435 [38] takes precedence in case of conflicts with NCS part 4. Support of SDP (RFC 2327 [25]) is required by RFC 3435 [38] implicitly.

8.2.3.1 ISDN access line endpoint identifiers/names

Embedded clients MUST have at least one endpoint and MAY have more than one endpoints (e.g. one for each RJ11 jack) associated with them, and each of the endpoints is identified by a separate local endpoint name.
Embedded clients will support the following endpoint-type.

Endpoints in iMTA clients MUST support the additional naming conventions specified in this clause:

- Basic Access ISDN: The ISDN telephone is represented as an ISDN access line (ialn). This is basically the equivalent of an ISDN telephone line as known in the PSTN.

- Endpoint names MUST comply with the format as defined by clause 6.1.1 of TS 101 909-4 [3]; see also RFC 2822 [27] section 3.4.1.

In addition to the naming conventions specified above, local endpoint names for endpoints of type "ISDN access line" (`ialn`) for embedded clients MUST adhere to the following:

- Local endpoint names contain at least one and, at most, three terms:
  - Term1 MUST be the term "`ialn`" or a wildcard character. It should be noted that the use of a wildcard character for term1 could refer to any or all endpoint-types in the embedded client regardless of their type. Use of this feature is generally expected to be for administrative purposes, e.g. auditing or restart.
  - Term2 MUST identify the ISDN type (BRA) and a logical number from one to the number of ISDN access lines supported by the embedded iMTA client in question. The number identifies a specific ISDN access line on the iMTA. Term2 MAY identify the username of some ISDN endpoint/port.
  - Term3 MUST identify the specific B-Channel being logical number one or two in case of BRA. Term3 MAY identify the ISDN port name as the local endpoint name of some ISDN endpoint.
- If a local endpoint name is composed of only one term, that term will be term1.
- If term1 *is not* a wildcard character, the wildcard character dollar sign (referring to "any one") is then assumed for term2, i.e. "`ialn`" is equivalent to "`ialn/$`".
- If term1 *is* a wildcard character, the wildcard character asterisk (referring to "all") is then assumed for term2, i.e. "`*`" and "`$`" is equivalent to respectively "`*/*`" and "`$/*`".

EXAMPLES:

`ialn/BA8/B1`	First B-channel for ISDN basic access line No. 8.
`ialn/BA46/*`	Any B-channel for ISDN basic access line No. 46.
`ialn/BA*/*`	Any B-channel for any ISDN basic access line.
`ialn/*/*`	Any B-channel for either ISDN BRA.
`ialn/username/B1@home.de`	ISDN equipment of username on ISDN port B1 in the home.de domain.
`ialn/username/*`	ISDN equipment of username on any ISDN port in any domain.
`*/*/*`	Any endpoint (regardless of endpoint-type) on the iMTA client in question.
`*`	Any endpoint (regardless of endpoint-type) on the iMTA client in question.

The provisioning/(auto)configuration process is responsible for obtaining and providing information about how many endpoints an embedded client has, as well as the endpoint-type of each endpoint. Although they are logically different, it should be noted that the *endpoint-type* can be derived from the local portion of the endpoint name.

8.2.3.2 Tone/DTMF

DTMF digit transport is controlled via MGCP, i.e. MGCP will request from the iMTA to activate or deactivate DTMF detection with MGCP RQNT messages. According to the current condition the iMTA shall either send DTMF digits via MGCP (e.g. the dialled digits) or transport them in the bearer channel inside the RTP stream. To guarantee a transparent transport of the DTMF digits and tones a non-compressing codec ITU-T Recommendation G.711 [17] is required. When a compressing codec, e.g. ITU-T Recommendation G.723 (see bibliography) is used for a connection, the transparent transport of DTMF digits is not guaranteed, therefore in this case the MGC request from iMTA to detect DTMF digits and signal them to the MGC via NTFY. The MGC sends then the digits with RQNT to the other side of the connection, where the corresponding tone must be applied.

RFC 3660 [40] provides the specification of the DTMF package (see section 2.2 "DTMF Package").

8.3 QoS interfaces

IPCablecom Dynamic QoS (DQoS) uses the call signalling information at the time that the call is made to dynamically authorize resources for the call. Dynamic QoS prevents various thefts of service attack types by integrating QoS messaging with other protocols and network elements. The network elements that are necessary for iMTA in an Dynamic QoS control Architecture are described in TS 101 909-5 [4].

8.4 Media interfaces

iMTA deploys the same media interfaces as described in the IPCablecom architecture part 2 clause 6.2; see TS 101 909-2 [2].

8.5 Announcement service interfaces

See TS 101 909-2 [2] clause 6.7 for announcement service interfaces.

8.6 iMTA device provisioning interfaces

See TS 101 909-2 [2] clause 6.3 for device provisioning interfaces.

8.7 Security interfaces

The present document inherits the same security interfaces as defined by the IPCablecom security architecture in TS 101 909-11 [6] as appropriate; any other security interfaces that are not directly related to the iMTA are not shown in figure 6.

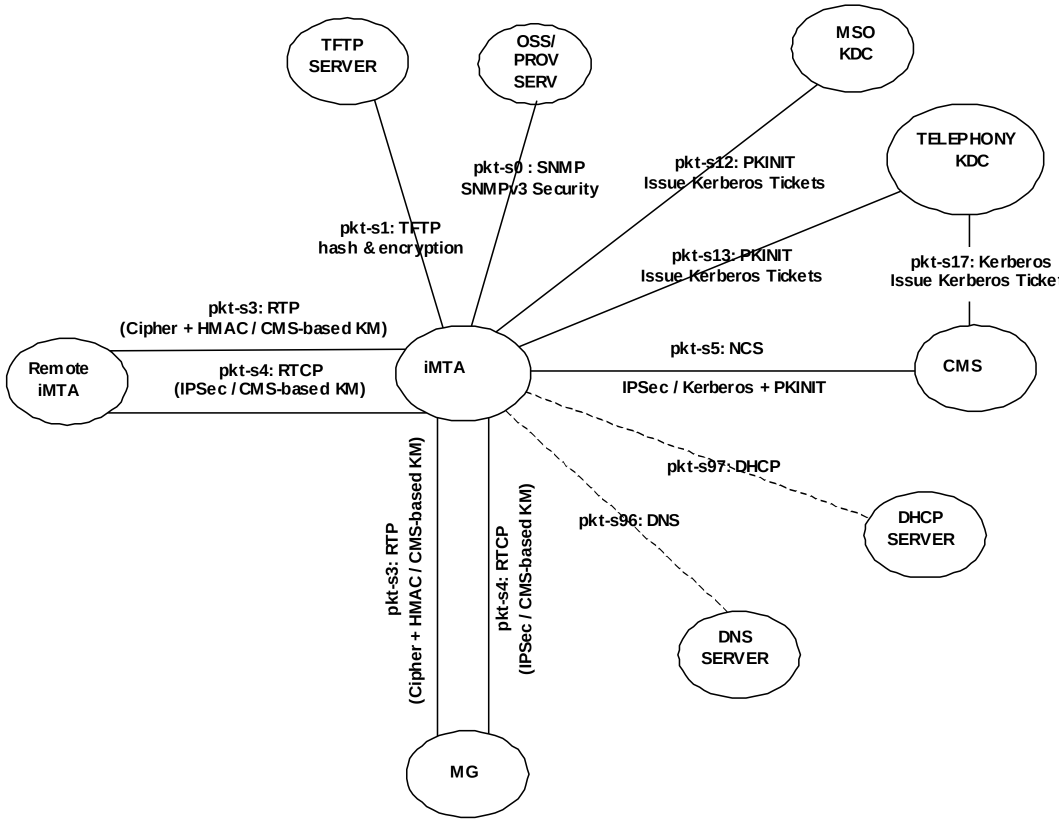

Figure 6: iMTA security interfaces

Table 3: iMTA security interfaces

Component interface	IPCablecom functional components	Description
pkt-s0	iMTA - PS/OSS	Immediately after the DHCP sequence, the iMTA performs Kerberos-based key management with the Provisioning Server to establish SNMPv3 keys. All SNMP messages are authenticated with privacy being optional.
pkt-s1	iMTA - TFTP	iMTA Configuration file download. When the Provisioning Server sends an SNMP Set command to the iMTA, it includes both the configuration name and the hash of the file. Later, when the iMTA downloads the file, it authenticates the configuration file using the hash value. The configuration file may be optionally encrypted.
pkt-s3	iMTA - iMTA iMTA - MG	**RTP:** End-to-end media packets between two iMTAs, or between iMTA and MG. RTP packets are encrypted directly with the chosen cipher. Message integrity is optionally provided by an HMAC MMH. Keys are randomly generated and exchanged by the two endpoints inside the signalling messages via the CMS.
pkt-s4	iMTA - iMTA iMTA - MG	**TCP:** RTCP control protocol for RTP. Message integrity and encrypted by selected cipher. The RTCP keys are derived using the same secret negotiated during the RTP key management. No additional key management messages are needed or utilized.
pkt-s5	iMTA - CMS	**NCS:** Message integrity and privacy via IPSec for the NCS and IUA/SCTP protocols Key management is with Kerberos with PKINIT (public key initial authentication) extension.
pkt-s12	iMTA - MSO KDC	**PKINIT:** An AS-REQ message is sent to the KDC with public key cryptography used for authentication. The KDC verifies the certificate and issues either a service ticket or a Ticket Granting Ticket (TGT), depending on the contents of the AS Request. The AS Reply returned by the KDC contains a certificate chain and a digital signature that are used by the iMTA to authenticate this message. In the case that the KDC returns a TGT, the iMTA then sends a TGS Request to the KDC to which the KDC replies with a TGS Reply containing a service ticket. The TGS Request/Reply messages are authenticated using a symmetric key inside the TGT.
pkt-s13	iMTA - Tel KDC	**PKINIT:** See pkt-s12 above.
pkt-s96	iMTA - DNS	**DNS:** Used by the iMTA to obtain IP addresses for KDC and TFTP servers. Cryptographic methods are not specified on this interface for all IPCablecom architectures. Securing this interface is at the discretion of the system operator.
pkt-s97	iMTA - DHCP	**DHCP:** used by the various network elements to obtain an IP address. Cryptographic methods are not specified on this interface for all IPCablecom architectures. Securing this interface is at the discretion of the system operator.

NOTE: The present document does not define any particular security interface between the iMTA and the CPE on the ISDN link. Typically, those parts of under the security control of the user and do not need particular security measures. In those rare cases where very-high security needs are of concern, ISDN crypto boxes between iMTA and CPE may be deployed for that purpose.

8.8 IPAT-LCS interface

The iMTA network architecture (see figure 1) is compliant with the Line Control Signalling (LCS) architecture as described in TS 101 909-23 (see bibliography). The Internet Protocol Access Terminal (IPAT) together with the Local Exchange (LE) provides the functionality of the MGC, MG, CMS and of SG, RKS and Announcement Server.

The IPAT terminates the NCS/MGCP, SCTP and ITU-T Recommendations Q.921/Q.931/IUA signalling protocols to/from the iMTA.

Annex A (informative): Example message flows

The following figures show example message flows for call setup between iMTAs including CMS/MGC for various scenarios and applications. The CMS/MGC is shown as two functionally separate entities, but omit any internal communication between MGC and CMS.

NOTE: The message flow illustrate MGCP/NCS and ISDN call signalling, but omit any details on QoS/Cable Modem and other IPCablecom protocols.

The messages are numbered sequentially, but some unrelated messages are not shown and gaps in the sequence numbers result. It is to be noted, that the message flows show a particular protocol instantiation, slightly different timing orderings may be observed in practice with a particular implementation.

The MGCP messages show only the most important parameters (e.g. MGCP callID field - when present - is shown as C: without given the actual value); but often omit any details; equally SCTP and IUA message are just indicated yet lack any further detail. The MGCP I: ConnectionId is shown as a symbolic value rather than a numeric value.

A.1 Example: Outgoing call ISDN, gateway B release

Figures A1 and A.2 illustrate a scenario where iMTA-A calls the B-side through a gateway. Thus, the present document's signalling occurs only between iMTA-A and MGC, CMS; the actual terminating endpoint beyond the gateway at the B-side is not shown.

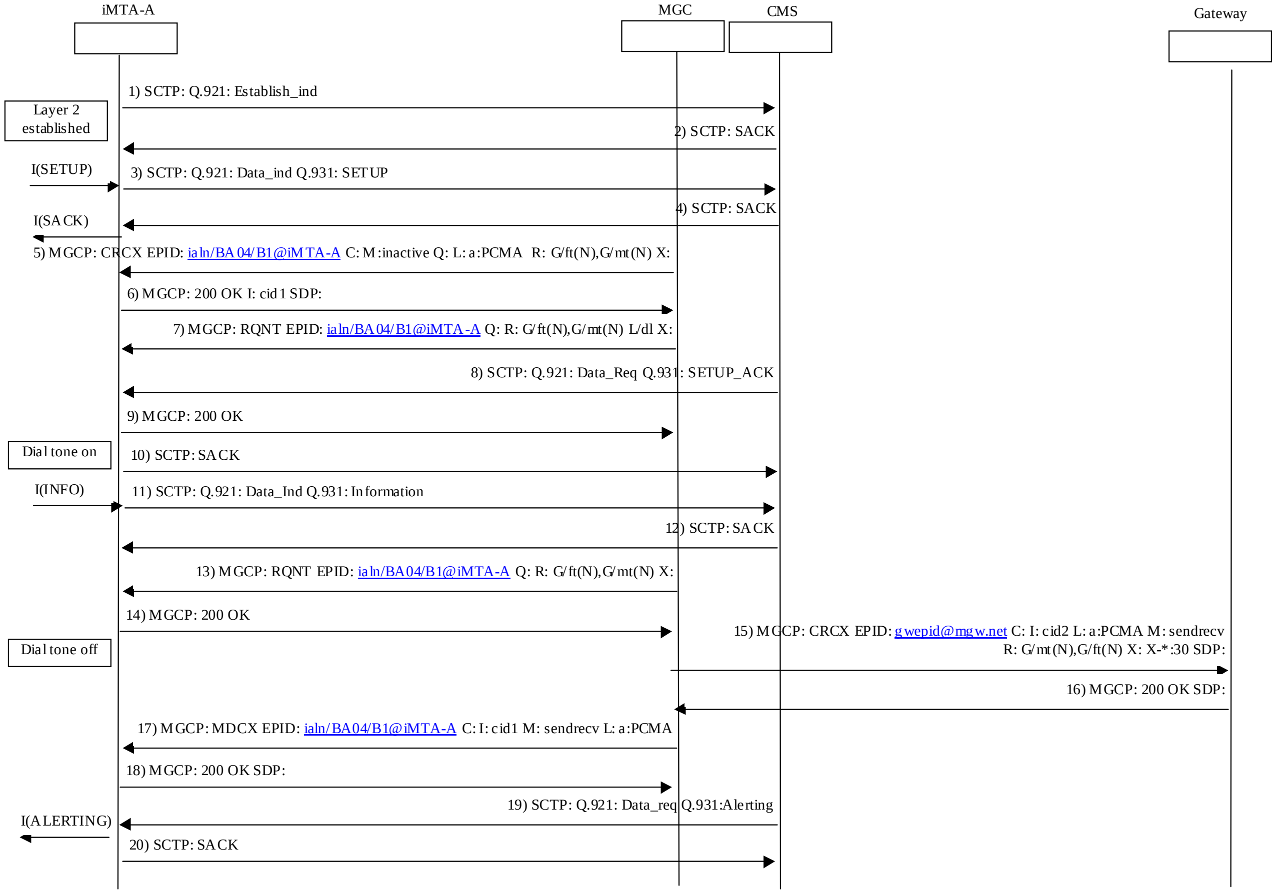

Figure A.1

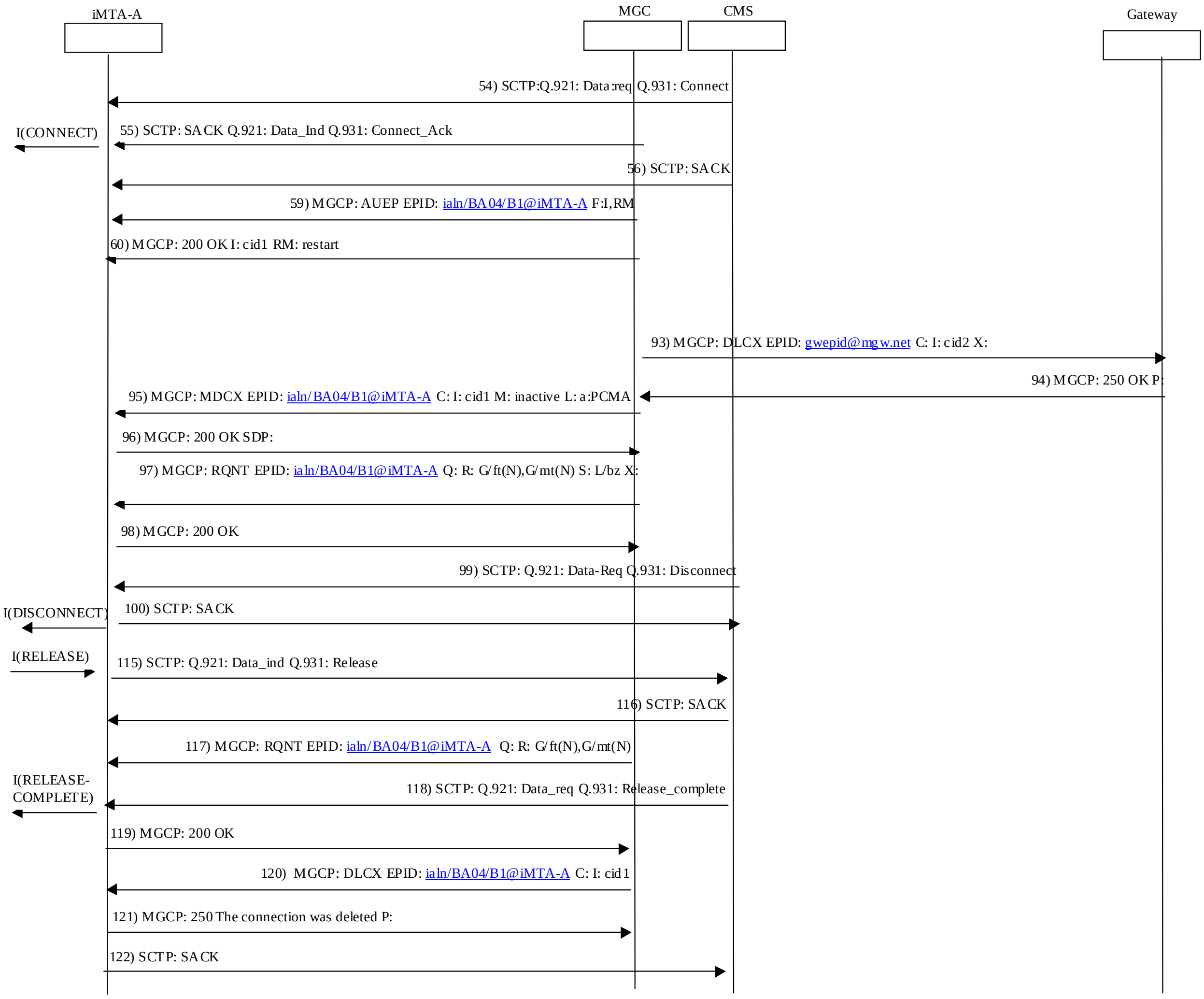
iMTA-A
MGC
CMS
Gateway
54) SCTP:Q.921: Data:req Q.931: Connect
I(CONNECT)
55) SCTP: SACK Q.921: Data_Ind Q.931: Connect_Ack
56) SCTP: SACK
59) MGCP: AUEP EPID: ialn/BA04/B1@iMTA-A F:I,RM
60) MGCP: 200 OK I: cid1 RM: restart
93) MGCP: DLCX EPID: gwepid@mgw.net C: I: cid2 X:
94) MGCP: 250 OK P:
95) MGCP: MDCX EPID: ialn/BA04/B1@iMTA-A C: I: cid1 M: inactive L: a:PCMA
96) MGCP: 200 OK SDP:
97) MGCP: RQNT EPID: ialn/BA04/B1@iMTA-A Q: R: G/ft(N),G/mt(N) S: L/bz X:
98) MGCP: 200 OK
99) SCTP: Q.921: Data-Req Q.931: Disconnect
I(DISCONNECT)
100) SCTP: SACK
I(RELEASE)
115) SCTP: Q.921: Data_ind Q.931: Release
116) SCTP: SACK
117) MGCP: RQNT EPID: ialn/BA04/B1@iMTA-A Q: R: G/ft(N),G/mt(N)
I(RELEASE-COMPLETE)
118) SCTP: Q.921: Data_req Q.931: Release_complete
119) MGCP: 200 OK
120) MGCP: DLCX EPID: ialn/BA04/B1@iMTA-A C: I: cid1
121) MGCP: 250 The connection was deleted P:
122) SCTP: SACK

Figure A.2

A.2 Example: Two sides ISDN, iMTA-A release

Figures A.3 and A.4 illustrate how iMTA-A sets up an ISDN call to iMTA-B; iMTA-A releases the call then.

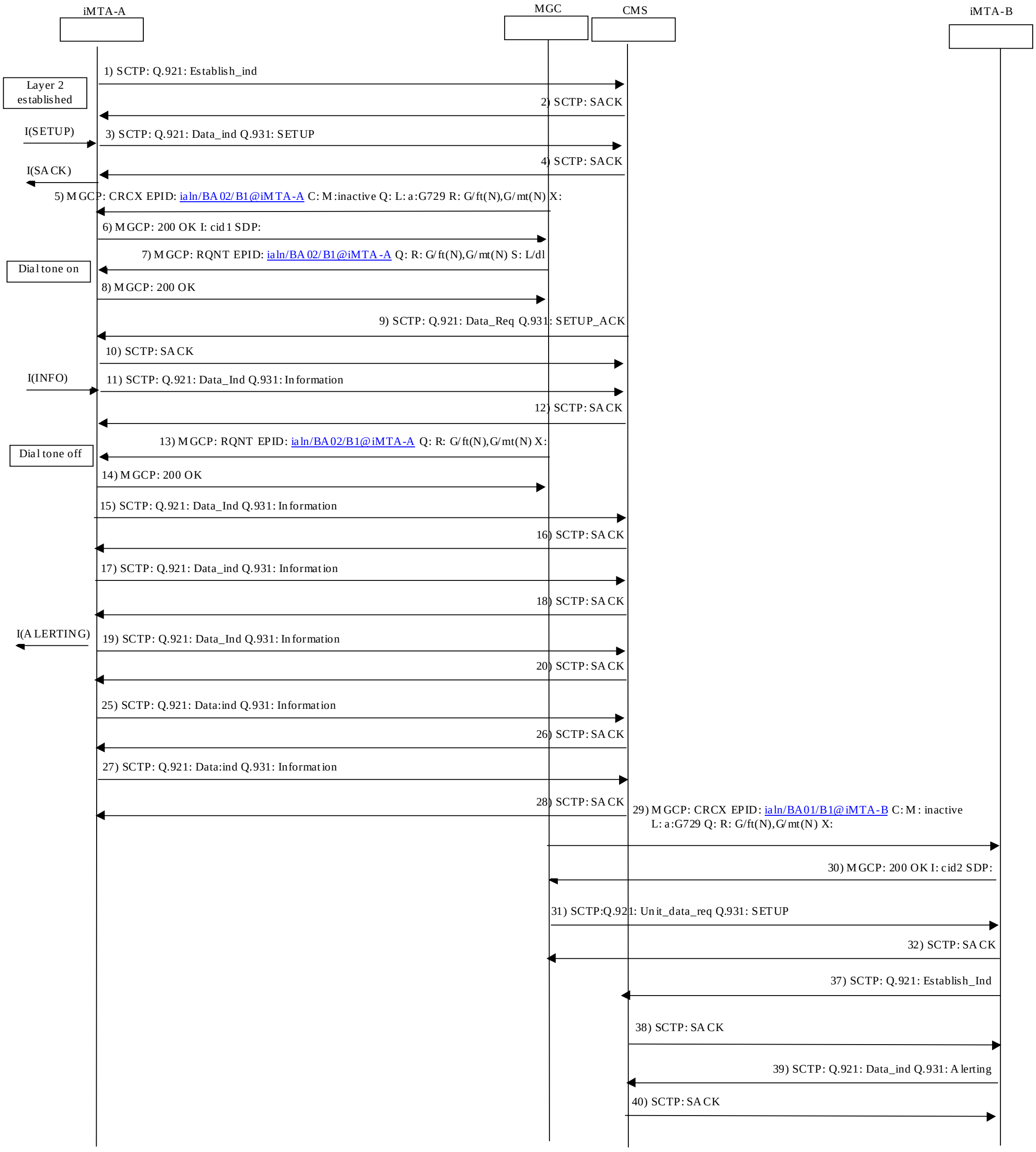

Figure A.3

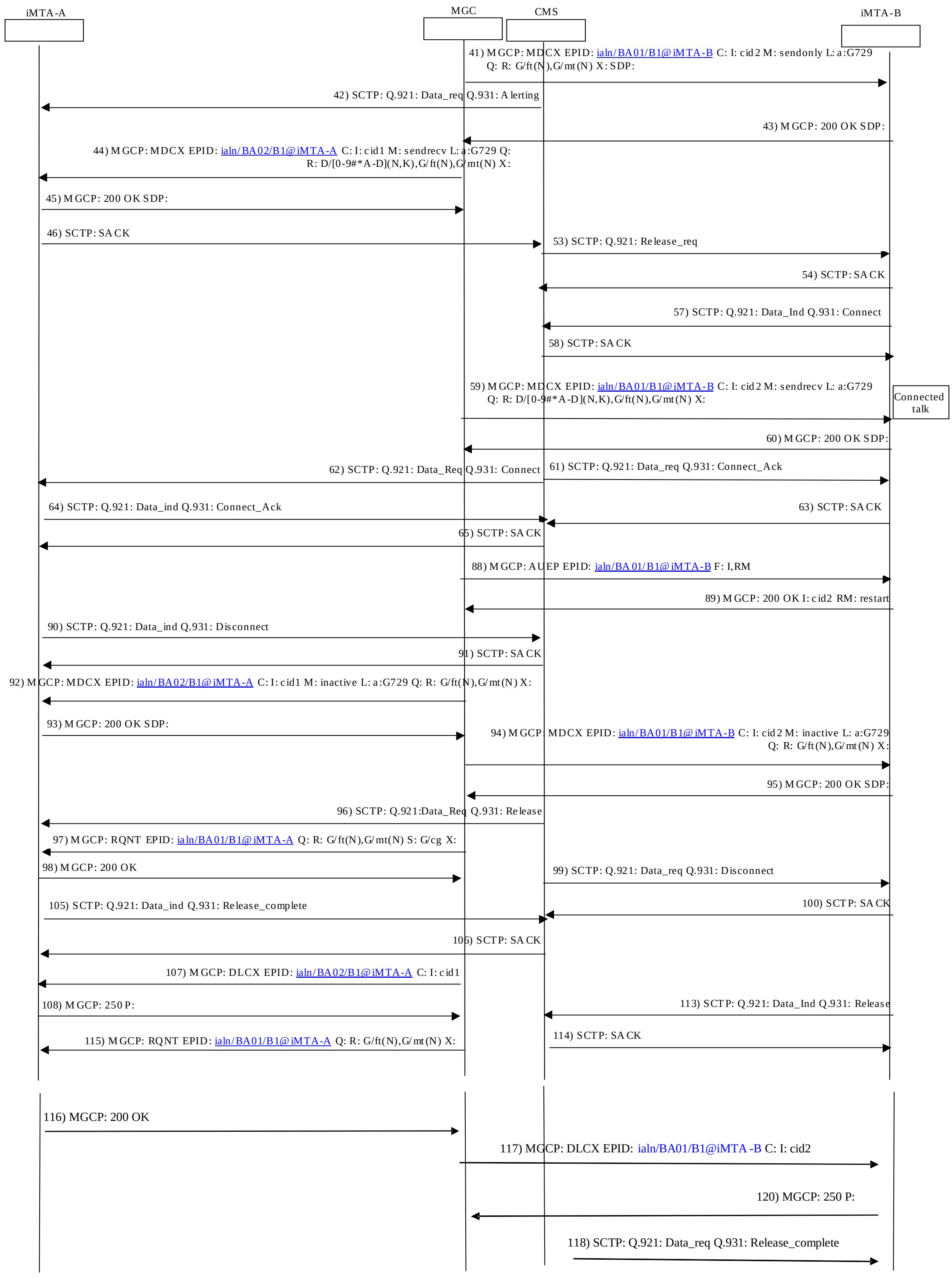
iMTA-A
MGC
CMS
iMTA-B
41) MGCP: MDCX EPID: ialn/BA01/B1@iMTA-B C: I: cid2 M: sendonly L: a:G729 Q: R: G/ft(N),G/mt(N) X: SDP:
42) SCTP: Q.921: Data_req Q.931: Alerting
43) MGCP: 200 OK SDP:
44) MGCP: MDCX EPID: ialn/BA02/B1@iMTA-A C: I: cid1 M: sendrecv L: a:G729 Q: R: D/[0-9#*A-D](N,K),G/ft(N),G/mt(N) X:
45) MGCP: 200 OK SDP:
46) SCTP: SACK
53) SCTP: Q.921: Release_req
54) SCTP: SACK
57) SCTP: Q.921: Data_Ind Q.931: Connect
58) SCTP: SACK
59) MGCP: MDCX EPID: ialn/BA01/B1@iMTA-B C: I: cid2 M: sendrecv L: a:G729 Q: R: D/[0-9#*A-D](N,K),G/ft(N),G/mt(N) X:
Connected talk
60) MGCP: 200 OK SDP:
62) SCTP: Q.921: Data_Req Q.931: Connect
61) SCTP: Q.921: Data_req Q.931: Connect_Ack
64) SCTP: Q.921: Data_ind Q.931: Connect_Ack
63) SCTP: SACK
65) SCTP: SACK
88) MGCP: AUEP EPID: ialn/BA01/B1@iMTA-B F: I,RM
89) MGCP: 200 OK I: cid2 RM: restart
90) SCTP: Q.921: Data_ind Q.931: Disconnect
91) SCTP: SACK
92) MGCP: MDCX EPID: ialn/BA02/B1@iMTA-A C: I: cid1 M: inactive L: a:G729 Q: R: G/ft(N),G/mt(N) X:
93) MGCP: 200 OK SDP:
94) MGCP: MDCX EPID: ialn/BA01/B1@iMTA-B C: I: cid2 M: inactive L: a:G729 Q: R: G/ft(N),G/mt(N) X:
95) MGCP: 200 OK SDP:
96) SCTP: Q.921:Data_Req Q.931: Release
97) MGCP: RQNT EPID: ialn/BA01/B1@iMTA-A Q: R: G/ft(N),G/mt(N) S: G/cg X:
98) MGCP: 200 OK
99) SCTP: Q.921: Data_req Q.931: Disconnect
105) SCTP: Q.921: Data_ind Q.931: Release_complete
100) SCTP: SACK
106) SCTP: SACK
107) MGCP: DLCX EPID: ialn/BA02/B1@iMTA-A C: I: cid1
108) MGCP: 250 P:
113) SCTP: Q.921: Data_Ind Q.931: Release
114) SCTP: SACK
115) MGCP: RQNT EPID: ialn/BA01/B1@iMTA-A Q: R: G/ft(N),G/mt(N) X:
116) MGCP: 200 OK
117) MGCP: DLCX EPID: ialn/BA01/B1@iMTA-B C: I: cid2
120) MGCP: 250 P:
118) SCTP: Q.921: Data_req Q.931: Release_complete

Figure A.4

A.3 Example: Restart ISDN

Figure A.5 illustrates a scenario where the restart procedure is invoked once the IUA layer of iMTA-A drops out.

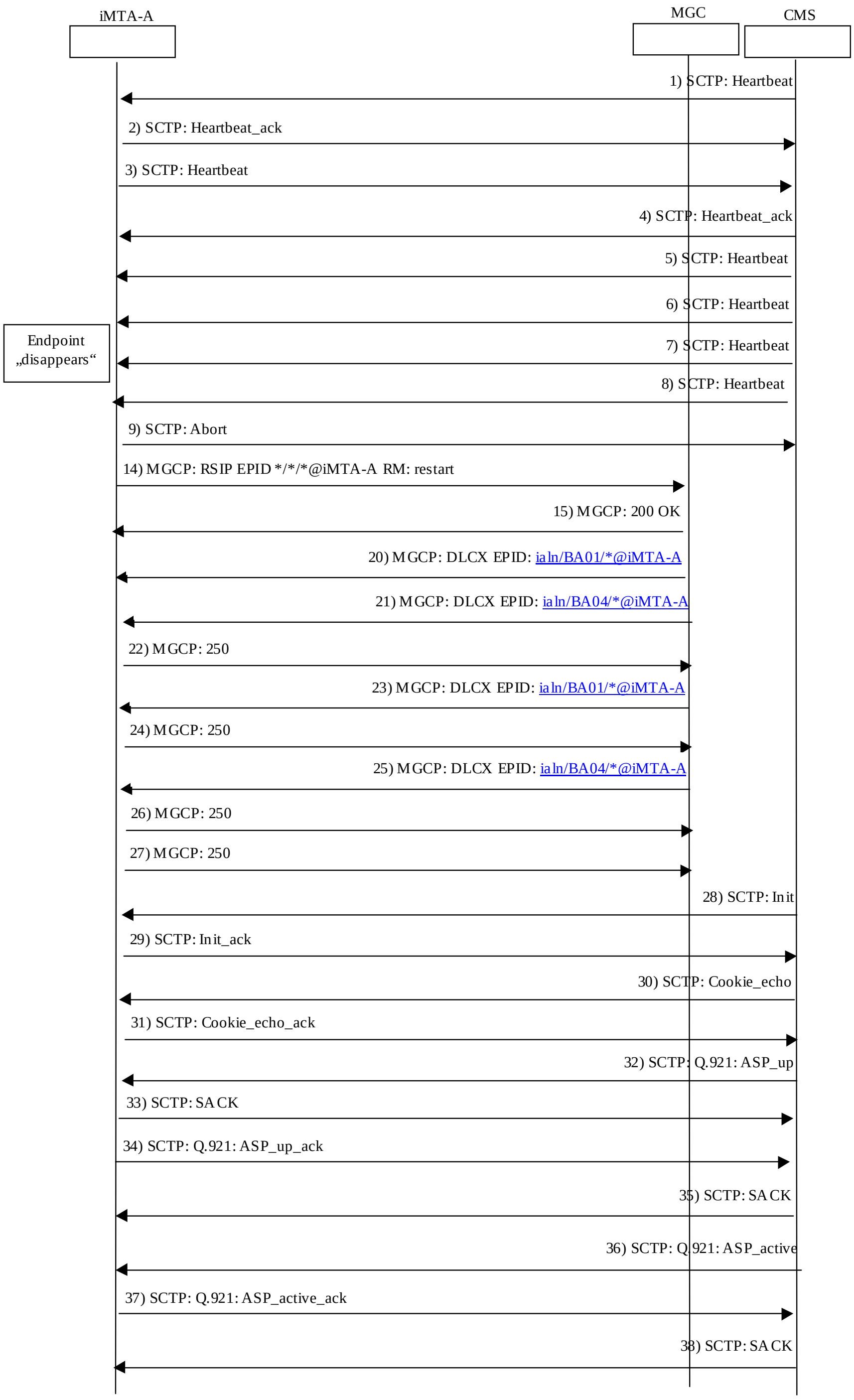

Figure A.5

A.4 Example: DTMF Transmission G.723

Figures A.6 and A.7 illustrate a scenario where iMTA-B calls MTA-A using an ITU-T Recommendation G.723.1 (see bibliography) codec.

Figure A.6

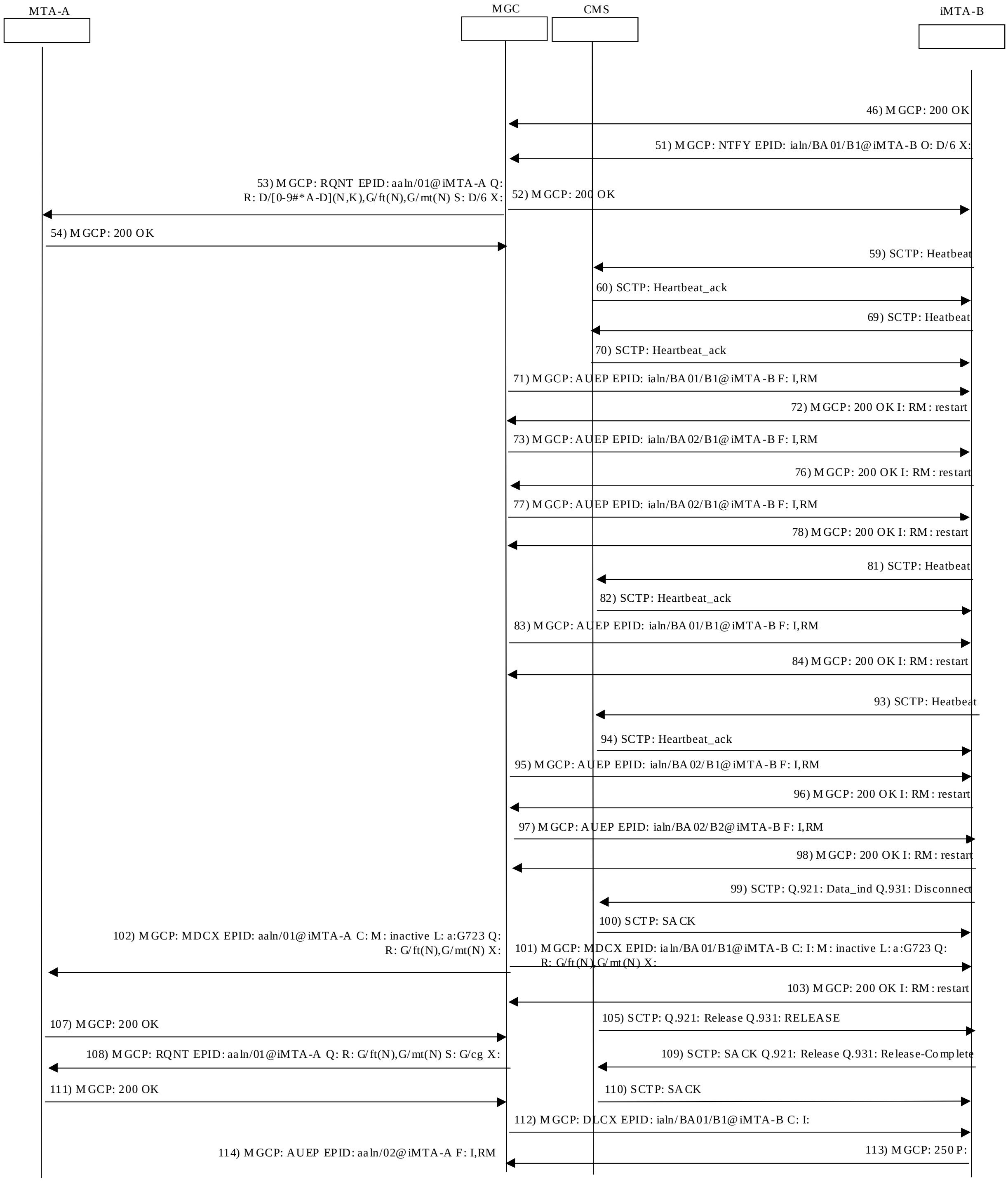

Figure A.7

A.5 Example: FAX call from ISDN to analog

iMTA-B calls MTA A that is an analogue FAX. The endpoints communicate initially with each other using ITU-T Recommendation G.729 [18] a codec. Once the FAX tone has been detected, switch-over to ITU-T Recommendation G.711 [17] takes place.

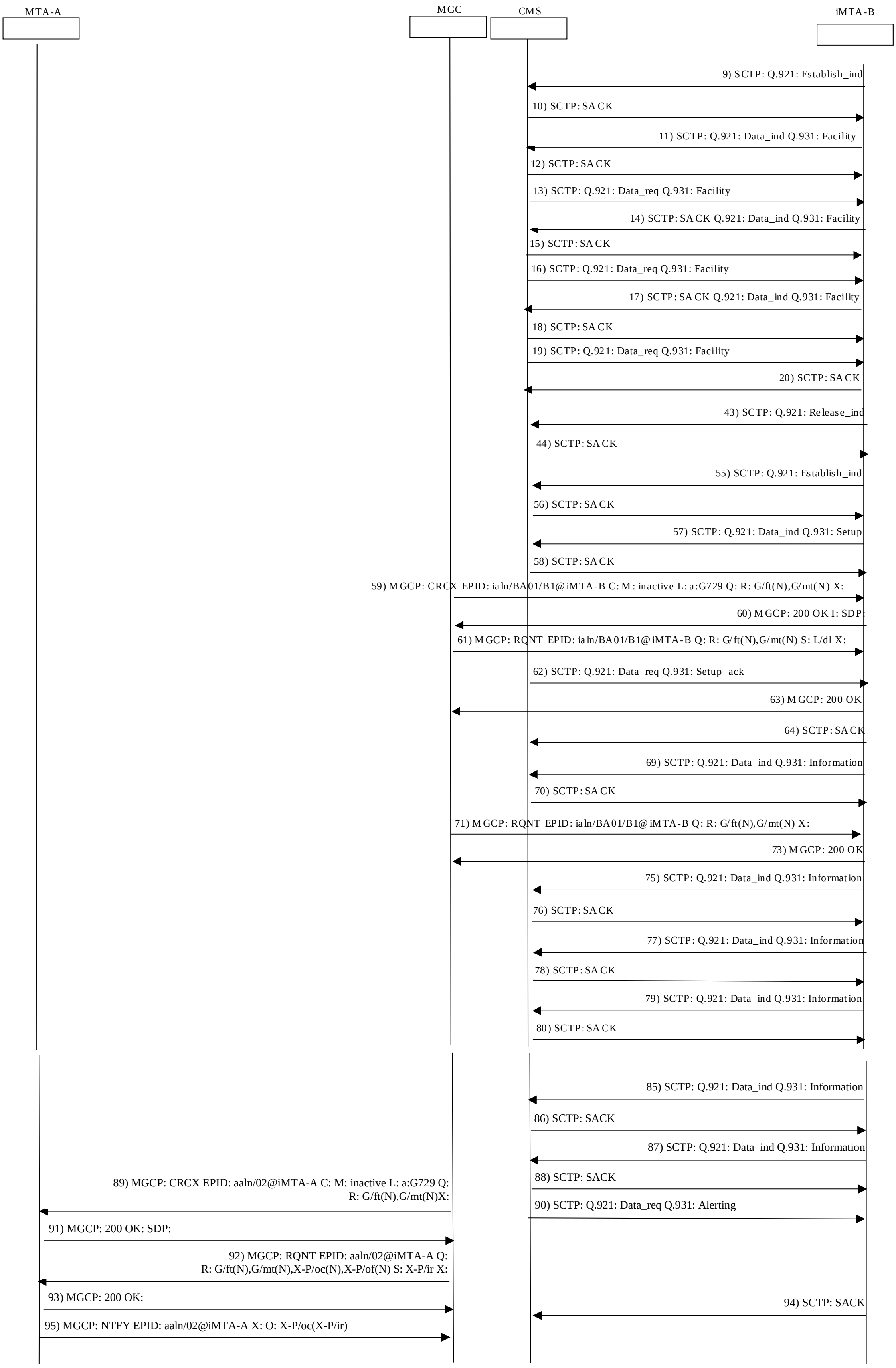
MTA-A
MGC
CMS
iMTA-B
9) SCTP: Q.921: Establish_ind
10) SCTP: SACK
11) SCTP: Q.921: Data_ind Q.931: Facility
12) SCTP: SACK
13) SCTP: Q.921: Data_req Q.931: Facility
14) SCTP: SACK Q.921: Data_ind Q.931: Facility
15) SCTP: SACK
16) SCTP: Q.921: Data_req Q.931: Facility
17) SCTP: SACK Q.921: Data_ind Q.931: Facility
18) SCTP: SACK
19) SCTP: Q.921: Data_req Q.931: Facility
20) SCTP: SACK
43) SCTP: Q.921: Release_ind
44) SCTP: SACK
55) SCTP: Q.921: Establish_ind
56) SCTP: SACK
57) SCTP: Q.921: Data_ind Q.931: Setup
58) SCTP: SACK
59) MGCP: CRCX EPID: ialn/BA01/B1@iMTA-B C: M: inactive L: a:G729 Q: R: G/ft(N),G/mt(N) X:
60) MGCP: 200 OK I: SDP:
61) MGCP: RQNT EPID: ialn/BA01/B1@iMTA-B Q: R: G/ft(N),G/mt(N) S: L/dl X:
62) SCTP: Q.921: Data_req Q.931: Setup_ack
63) MGCP: 200 OK
64) SCTP: SACK
69) SCTP: Q.921: Data_ind Q.931: Information
70) SCTP: SACK
71) MGCP: RQNT EPID: ialn/BA01/B1@iMTA-B Q: R: G/ft(N),G/mt(N) X:
73) MGCP: 200 OK
75) SCTP: Q.921: Data_ind Q.931: Information
76) SCTP: SACK
77) SCTP: Q.921: Data_ind Q.931: Information
78) SCTP: SACK
79) SCTP: Q.921: Data_ind Q.931: Information
80) SCTP: SACK
85) SCTP: Q.921: Data_ind Q.931: Information
86) SCTP: SACK
87) SCTP: Q.921: Data_ind Q.931: Information
88) SCTP: SACK
89) MGCP: CRCX EPID: aaln/02@iMTA-A C: M: inactive L: a:G729 Q: R: G/ft(N),G/mt(N)X:
90) SCTP: Q.921: Data_req Q.931: Alerting
91) MGCP: 200 OK: SDP:
92) MGCP: RQNT EPID: aaln/02@iMTA-A Q: R: G/ft(N),G/mt(N),X-P/oc(N),X-P/of(N) S: X-P/ir X:
93) MGCP: 200 OK:
94) SCTP: SACK
95) MGCP: NTFY EPID: aaln/02@iMTA-A X: O: X-P/oc(X-P/ir)

Figure A.8


MTA-A
MGC
CMS
iMTA-B
96) MGCP: 200 OK
97) MGCP: MDCX EPID: aaln/02@iMTA-A C: I: M:sendonly L: Q: R: S: X: SDP:
98) MGCP: MDCX EPID: ialn/BA01/B1@iMTA-B C: I: M:sendonly L: Q: R: X: SDP:
99) SCTP: Q.921: Data_req Q.931: Progress
101) MGCP: 200 OK
100) MGCP: 200 OK
102) SCTP: SACK
103) MGCP: RQNT EPID: aaln/02@iMTA-A Q: S: X
104) MGCP: 200 OK
105) MGCP: NTFY EPID: aaln/02@iMTA-A O: L/oc(L/adsi)
106) MGCP: 200 OK
115) MGCP: RQNT EPID: aaln/02@iMTA-A Q: R: G/ft(N),G/mt(N)
S: L/rg,G/rt@cid1 X
Off-hook
116) MGCP: 200 OK
119) MGCP: NTFY EPID: aaln/02@iMTA-A X: O: L/hd
120) MGCP: 200 OK
121) MGCP: MDCX EPID: aaln/02@iMTA-A C: M: sendrecv L: a:G729 Q:
R: D/[0-9#*A-D](N,K),G/ft(N),G/mt(N) X
122) MGCP: 200 OK
123) MGCP: RQNT EPID: aaln/02@iMTA-A Q:
R: D/[0-9#*A-D](N,K),L/hf(N,K),G/ft(N),G/mt(N) X
124) SCTP: Q.921: Data_req Q.931: Connect
125) MGCP: 200 OK
126) SCTP: SACK
FAX tone
detection
Switch to
G.711
127) MGCP: NTFY EPID: aaln/02@iMTA-A X O: G/ft
128) MGCP: 200 OK
129) MGCP: MDCX EPID: aaln/02@iMTA-A C: I: M: sendrecv L: a:PCMA X-*: 100 SDP:
130) MGCP: MDCX EPID: ialn/BA01/B1@iMTA-B C: I: M: sendrecv L: a:PCMA X-*: 100 SDP:
132) MGCP: 200 OK SDP:
131) MGCP: 200 OK
142) MGCP: 200 OK I: RM: restart
151) SCTP: Q.921: Data_ind Q.931: Facility
152) SCTP: SACK
153) SCTP: Q.921: Data_req Q.931: Facility
154) SCTP: SACK Q.921: Data_ind Q.931: Facility
155) SCTP: SACK
156) SCTP: Q.921: Data_req Q.931: Facility
157) SCTP: SACK Q.921: Data_ind Q.931: Facility
158) SCTP: SACK
159) SCTP: Q.921: Data_req Q.931: Facility
160) SCTP: SACK
171) MGCP: AUEP EPID: aaln/01@iMTA-A F: I,RM
172) MGCP: 200 OK I: RM: restart
212) SCTP: Q.921: Data_ind Q.931: Disconnect
215) SCTP: SACK

Figure A.9

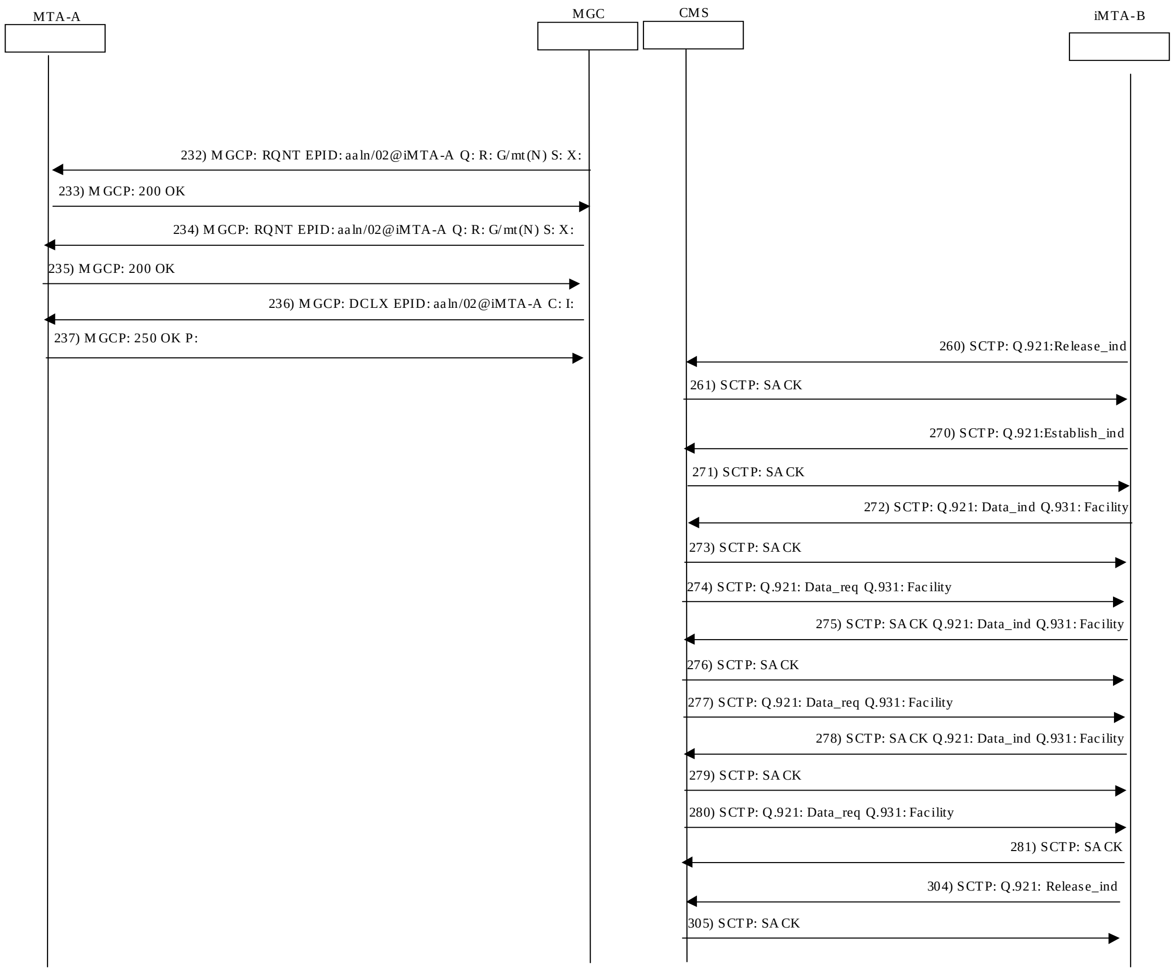
MTA-A
MGC
CMS
iMTA-B
232) MGCP: RQNT EPID: aaln/02@iMTA-A Q: R: G/mt(N) S: X:
233) MGCP: 200 OK
234) MGCP: RQNT EPID: aaln/02@iMTA-A Q: R: G/mt(N) S: X:
235) MGCP: 200 OK
236) MGCP: DCLX EPID: aaln/02@iMTA-A C: I:
237) MGCP: 250 OK P:
260) SCTP: Q.921:Release_ind
261) SCTP: SACK
270) SCTP: Q.921:Establish_ind
271) SCTP: SACK
272) SCTP: Q.921: Data_ind Q.931: Facility
273) SCTP: SACK
274) SCTP: Q.921: Data_req Q.931: Facility
275) SCTP: SACK Q.921: Data_ind Q.931: Facility
276) SCTP: SACK
277) SCTP: Q.921: Data_req Q.931: Facility
278) SCTP: SACK Q.921: Data_ind Q.931: Facility
279) SCTP: SACK
280) SCTP: Q.921: Data_req Q.931: Facility
281) SCTP: SACK
304) SCTP: Q.921: Release_ind
305) SCTP: SACK

Figure A.10

Annex B (informative): iMTA configuration parameters

This annex provides information on the configurable parameters in the iMTA. The shown default parameters are understood to be typical example values; other appropriate values instead MAY be configured too.

B.1 Q.921 parameters

Table B.1: Q.921 Parameters

Parameter	Default value	Example
Layer 2 status	non-permanent	permanent/non-permanent
Layer 2 configuration	point-to-multipoint	point-to-point/point-to-multipoint
TL2out	7 s	Timer for periodically layer 2 re-establishment attempts in case of permanent layer 2 (timer between 4 s and 60 s).

B.2 SCTP/IUA parameters

Table B.2: SCTP/IUA Parameters

Parameter	Default value	Purpose
RtoInitial	3 000 ms	Initial round trip timeout
RtoMin	1 000 ms	Initial minimum round trip timeout
RtoMax	60 000 ms	Initial maximum round trip timeout
ValidCookieLife	60 000 ms	Lifetime of a cookie
AssocMaxRetransmits	10	Maximum retransmissions per association
PathMaxRetransmits	8	Maximum retransmissions per path
MaxInitRetransmits	8	Maximum initial retransmissions
MyRwnd	28 000	Number of bytes queued in rcv queue
Delay	200 ms	According RFC 2960 [28] MUST NOT be > 500 ms
MaxSendQueue	20	Number of chunks in send and retransmission queue
MaxRecvQueue	0	Number of chunks in rcv queue: - 0: only number of bytes will be supervised; - > 0: then a_rwnd will be set to 0 if noOfChunksInReceptionQueue ≥ maxRecvQueue
MaxMessagesInFlight	0	Limits the number of chunks sent to the peer without acknowledgement
NoOfInStreams	9	Number of streams per association from the different peers
NoOfOutStreams	9	Number of streams per association to the different peers
NoOfAssociations	2	Maximum number of associations

B.3 Tones

Values for vendor/country-specific tones SHOULD be configurable.

Annex C (informative): Bibliography

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History

Document history		
V1.1.1	May 2004	Publication