

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.160

(11/2005)

SERIES J: CABLE NETWORKS AND TRANSMISSION
OF TELEVISION, SOUND PROGRAMME AND OTHER
MULTIMEDIA SIGNALS

IPCablecom

**Architectural framework for the delivery of
time-critical services over cable television
networks using cable modems**

ITU-T Recommendation J.160

ITU-T



Copyright International Telecommunication Union/ITU Telecommunication Sector
Provided by IHS Markit under license with ITU-T
No reproduction or networking permitted without license from IHS

ITU-T Recommendation J.160

Architectural framework for the delivery of time-critical services over cable television networks using cable modems

Summary

This Recommendation provides a high-level reference framework that identifies the functional components and defines the interfaces necessary to provide digital voice and telephony services. A family of Recommendations (ITU-T Recs J.161-J.178) has been developed to implement this architecture.

Source

ITU-T Recommendation J.160 was approved on 29 November 2005 by ITU-T Study Group 9 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

© ITU 2006

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

CONTENTS

Page

1	Scope	1
2	References.....	1
3	Terms and definitions	2
4	Abbreviations and conventions.....	2
4.1	Abbreviations	2
4.2	Conventions.....	4
5	IPCablecom	4
5.1	IPCablecom architecture framework.....	4
5.2	IPCablecom zones and domains.....	5
5.3	IPCablecom Recommendations.....	6
5.4	IPCablecom design considerations.....	7
6	IPCablecom functional components.....	9
6.1	Media Terminal Adapter (MTA).....	10
6.2	Cable Modem (CM)	12
6.3	HFC access network	12
6.4	Cable Modem Terminating System (CMTS)	12
6.5	Call Management Server (CMS).....	12
6.6	PSTN gateway	13
6.7	OSS back-office components	15
6.8	Announcement Server (ANS).....	16
7	Protocol interfaces	17
7.1	Call signalling interfaces	17
7.2	Media streams.....	19
7.3	MTA device provisioning.....	21
7.4	SNMP element management layer interfaces.....	22
7.5	Event messages interfaces	23
7.6	Quality of Service (QoS).....	24
7.7	CMS subscriber provisioning.....	27
7.8	Electronic surveillance	28
7.9	Security.....	29
8	Network design considerations.....	35
8.1	Timekeeping and reporting issues	35
8.2	Timing for playout buffer alignment with coding rate.....	35
8.3	IP addressing	35
8.4	Dynamic IP addressing assignment.....	36
8.5	FQDN assignment	36
8.6	Priority marking of signalling and media stream packets	36
8.7	Fax support	37

	Page
8.8 Analogue modem support.....	37
Appendix I – Glossary of terms	38
I.1 Definitions	38
I.2 Abbreviations	40
BIBLIOGRAPHY	43

iv

ITU-T Recommendation J.160

Architectural framework for the delivery of time-critical services over cable television networks using cable modems

1 Scope

The IPCablecom project defines a family of Recommendations that can be used to develop interoperable equipment capable of providing packet-based voice, video and other high-speed multimedia services over hybrid fibre coax (HFC) cable systems utilizing cable modems per the DOCSIS family of Recommendations. Future work will extend this architecture to include multimedia applications.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-T Recommendation G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.
- ITU-T Recommendation J.83 (1997), *Digital multi-programme systems for television, sound and data services for cable distribution*.
- ITU-T Recommendation J.112 (1998), *Transmission systems for interactive television services*, plus Annex A (2001), *Digital Video Broadcasting: DVB interaction channel for Cable TV (CATV distribution systems)*, Annex B (2004), *Data-over-cable service interface specifications: Radio-frequency interface specification* and Annex C (2002), *Data-over-cable service interface specifications: Radio-frequency interface specification using QAM technique*.
- ITU-T Recommendation J.161 (2001), *Audio codec requirements for the provision of bidirectional audio service over cable television networks using cable modems*.
- ITU-T Recommendation J.162 (2005), *Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems*.
- ITU-T Recommendation J.163 (2005), *Dynamic quality of service for the provision of real-time services over cable television networks using cable modems*.
- ITU-T Recommendation J.164 (2005), *Event message requirements for the support of real-time services over cable television networks using cable modems*.
- ITU-T Recommendation J.166 (2005), *IPCablecom management information base (MIB) framework*.
- ITU-T Recommendation J.167 (2005), *Media terminal adapter (MTA) device provisioning requirements for the delivery of real-time services over cable television networks using cable modems*.
- ITU-T Recommendation J.170 (2005), *IPCablecom security specification*.
- ITU-T Recommendation J.171.0 (2005), *IPCablecom trunking gateway control protocol (TGCP): Profiles overview*.

- ITU-T Recommendation J.178 (2005), *IPcablecom CMS to CMS signalling*.
- ITU-T Recommendation Q.704 (1996), *Signalling network functions and messages*.
- ITU-T Recommendation T.38 (2005), *Procedures for real-time Group 3 facsimile communication over IP networks*.
- IETF RFC 1305 (1992), *Network Time Protocol (Version 3) Specification, Implementation and Analysis*.
- IETF RFC 1119 (1989), *Network Time Protocol*.
- IETF RFC 1889 (1996), *RTP: A Transport Protocol for Real-Time Applications*.
- IETF RFC 1890 (1996), *RTP Profile for Audio and Video Conferences with Minimal Control*.
- IETF RFC 2474 (1998), *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*.
- IETF RFC 3168 (2001), *The Addition of Explicit Congestion Notification (ECN) to IP*.
- IETF RFC 3260 (2002), *New Terminology and Clarifications for Diffserv*.
- IETF RFC 3261 (2002), *SIP: Session Initiation Protocol*.
- IETF RFC 3414 (2002), *User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)*.
- IETF RFC 3415 (2002), *View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*.
- IETF RFC 3611 (2003), *RTP Control Protocol Extended Reports (RTCP XR)*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 IPcablecom: An ITU-T project that includes an architecture and a series of Recommendations that enable the delivery of real-time services over the cable television networks using cable modems.

3.2 cable modem: A cable modem is a layer two termination device that terminates the customer end of the DOCSIS connection.

3.3 managed IP network: An IP network, managed by a single entity for the purpose of transporting IPcablecom signalling and media packets.

3.4 managed IP backbone: A Managed IP network that is used for interconnecting IPcablecom domains.

4 Abbreviations and conventions

4.1 Abbreviations

This Recommendation uses the following abbreviations:

ANC	Announcement Controller
ANP	Announcement Player
ANS	Announcement Server
CM	Cable Modem

CMS	Call Management Server
CPE	Customer Premises Equipment
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DTMF	Dual Tone Multi-Frequency
FQDN	Fully Qualified Domain Name
GC	Gate Controller
HFC	Hybrid Fibre/Coax
HTTP	HyperText Transfer Protocol
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPsec	IP security
ISTP	Internet Signalling Transport Protocol
ISUP	Integrated Services Digital Network User Part
MAC	Media Access Control
MF	Multi-Frequency
MG	Media Gateway
MGC	Media Gateway Controller
MIB	Management Information Base
MMH	Multilinear Modular Hash
MTA	Media Terminal Adapter
MTP	Message Transfer Part
NAT	Network Address Translator
NCS	Network-Based Call Signalling
OSS	Operations Support System
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RKS	Record Keeping Server
RTP	Real-Time Transfer Protocol
SA	Source Address
SCCP	Signalling Connection Control Part
SG	Signalling Gateway
SID	System IDentification number
SNMP	Simple Network Management Protocol
TCAP	Transaction Capabilities Application Part
TFTP	Trivial File Transfer Protocol

TGCP Trunking Gateway Control Protocol
TGS Ticket Granting Server
ToS Type of Service
UDP User Datagram Protocol

4.2 Conventions

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

The keywords indicating a certain level of significance of particular requirements that are used throughout this Recommendation are summarized.

"MUST"	This word or the adjective "REQUIRED" means that the item is an absolute requirement of this Recommendation.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this Recommendation.
"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 valid reasons may exist in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior 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 IP_Cablecom

5.1 IP_Cablecom architecture framework

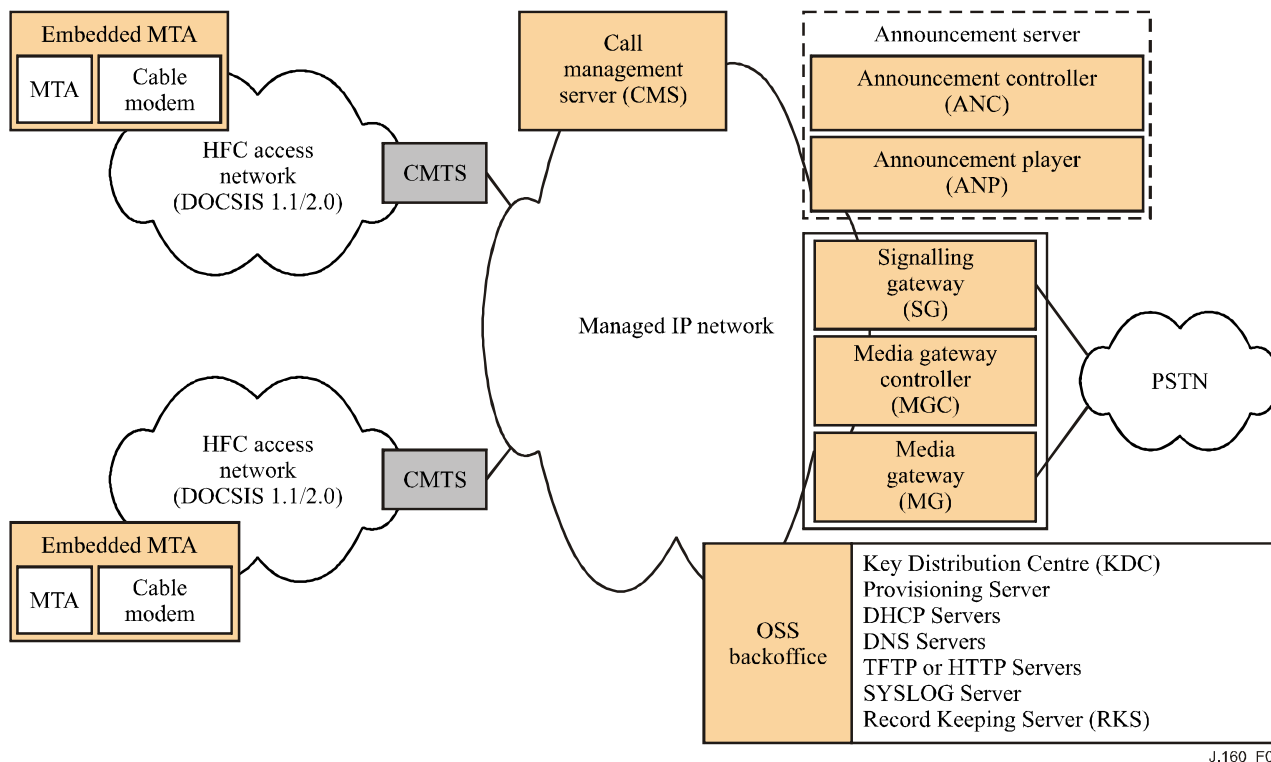
At a very high level, the IP_Cablecom architecture contains three networks: the "DOCSIS HFC access network", the "Managed IP network" and the PSTN. The Cable Modem Termination System (CMTS) provides connectivity between the "DOCSIS HFC access network" and the "Managed IP network". Both the Signalling Gateway (SG) and the Media Gateway (MG) provide connectivity between the "Managed IP network" and the PSTN. The reference architecture for IP_Cablecom is shown in Figure 1.

The DOCSIS HFC access network provides high-speed, reliable, and secure transport between the customer premise and the cable headend. This access network provides all DOCSIS capabilities including Quality of Service. The DOCSIS HFC access network includes the following functional components: the Cable Modem (CM), the Multimedia Terminal Adapter (MTA), and the Cable Modem Termination System (CMTS).

The Managed IP network serves several functions. First, it provides interconnection between the basic IP_Cablecom functional components responsible for signalling, media, provisioning, and the establishment of quality of service on the access network. In addition, the managed IP network provides long-haul IP connectivity between other Managed IP and DOCSIS HFC networks. The Managed IP network includes the following functional components: Call Management

Server (CMS), several Operations Support System (OSS) back-office servers, Signalling Gateway (SG), Media Gateway (MG), and Media Gateway Controller (MGC).

The individual network components that are shown in Figure 1 are described in detail in clause 6.



J.160_F01

Figure 1/J.160 – IPCablecom reference architecture

5.2 IPCablecom zones and domains

An IPCablecom zone consists of the set of MTAs in one or more DOCSIS HFC access networks that are managed by a single functional CMS as shown in Figure 2. Interfaces between functional components within a single zone and between zones (e.g., CMS ↔ CMS) are defined in the IPCablecom Recommendations.

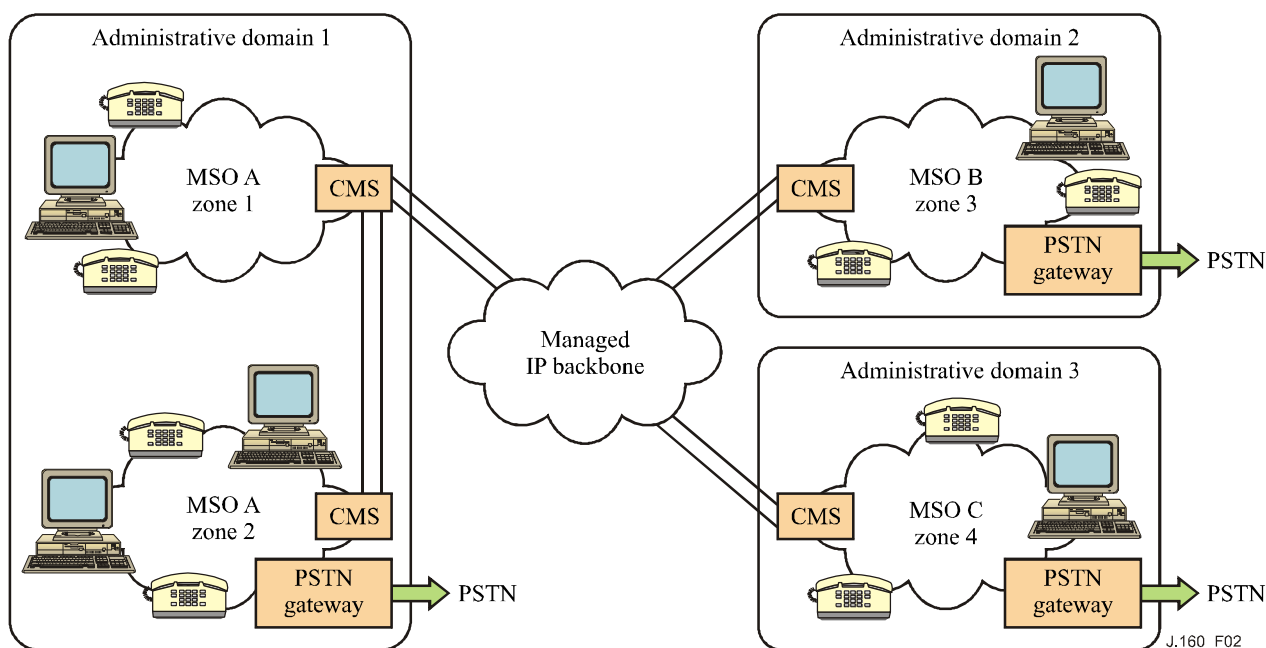


Figure 2/J.160 – Zones and administrative domains

An IPCablecom domain is made up of one or more IPCablecom zones that are operated and managed by a single administrative entity. An IPCablecom domain may also be referred to as an administrative domain.

5.3 IPCablecom Recommendations

Table 1/J.160 – IPCablecom Recommendations

J.160	Architectural framework for the delivery of time-critical services over cable television networks using cable modems
J.161	Audio codec requirements for the provision of bidirectional audio service over cable television networks using cable modems
J.162	Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems
J.163	Dynamic quality of service for the provision of real-time services over cable television networks using cable modems
J.164	Event message requirements for the support of real-time services over cable television networks using cable modems
J.165	IPCablecom Internet signalling transport protocol (ISTP)
J.166	IPCablecom management information base (MIB) framework
J.167	Media Terminal Adapter (MTA) device provisioning requirements for the delivery of real-time services over cable television networks using cable modems
J.168	Vacant-Incorporated as Annex E/J.166
J.169	Vacant-Incorporated as Annex C/J.166
J.170	IPCablecom security specification
J.171.1	IPCablecom trunking gateway control protocol (TGCP): Profile 1
J.171.2	IPCablecom trunking gateway control protocol (TGCP): Profile 2
J.172	IPCablecom management event mechanism

Table 1/J.160 – IPCablecom Recommendations

J.173	IPCablecom embedded MTA primary line support
J.174	IPCablecom interdomain quality of service
J.175	Audio server protocol
J.176	Vacant-Incorporated as Annex D/J.166
J.177	IPCablecom CMS subscriber provisioning specification
J.178	IPCablecom CMS to CMS signalling
J.179	IPCablecom support for multimedia

5.4 IPCablecom design considerations

In order to enable real-time multimedia communications across the cable network infrastructure, IPCablecom Recommendations define protocols in the following areas:

- Call Signalling;
- Quality of Service;
- Media Stream Transport and Encoding;
- Device Provisioning;
- Event Messaging;
- Security;
- Electronic Surveillance;
- Operational Support Systems.

This clause provides an overview of the high-level design goals and concepts used in developing the Recommendations that define the IPCablecom reference architecture. Individual IPCablecom Recommendations should be consulted to obtain detailed protocol requirements for each of these areas.

5.4.1 General architectural goals

- Enable voice quality capabilities similar to or better than the PSTN as perceived by the end-user.
- Provide a network architecture that is scalable and capable of supporting millions of subscribers.
- Ensure the one-way delay for local IP access and IP egress (i.e., excluding the IP backbone network) is less than 45 ms.
- Leverage existing standards. IPCablecom strives to specify open, approved industry standards that have been widely adopted in commercial communication networks. This includes standards approved by the ITU, IETF, IEEE, and other communications standards organizations.
- Leverage and build upon the data transport and Quality of Service capabilities enabled by the J.112 infrastructure.
- Define an architecture that allows multiple vendors to rapidly develop low-cost interoperable solutions to meet time-to-market requirements.
- Ensure that the probability of blocking a call can be engineered to be less than 1% during the High Day Busy Hour (HDBH).
- Ensure that call cut-offs and call defects can be engineered to be less than 1 per 10 000 completed calls.

- Support modems (up to V.90 56 kbit/s) and fax (up to 14.4 kbit/s).
- Ensure that frame slips due to unsynchronized sampling clocks or due to lost packets occur less than 0.25 per minute Call Signalling.

5.4.2 Call Signalling

- Define a network-based signalling architecture.
- Provide end-to-end call signalling for the following call models:
 - calls that originate from the PSTN and terminate on the cable network;
 - calls that originate on the cable network and terminate on the cable network;
 - calls that originate from the cable network and terminate on the PSTN;
 - calls that traverse zones (intradomain) and domains (interdomain).
- Provide signalling to support calling features such as:
 - Call Waiting;
 - Cancel Call Waiting;
 - Call Forwarding (no-answer, busy, variable);
 - Three-way Calling;
 - Voice mail Message Waiting Indicator;
 - Calling Number Delivery;
 - Calling Name Delivery;
 - Calling Identity Delivery On Call Waiting;
 - Calling Identity Delivery Blocking;
 - Anonymous Call Rejection;
 - Automatic Callback;
 - Automatic Recall;
 - Distinctive Ringing/Call Waiting;
 - Customer-Originated Trace.
- Support signalling consistent with existing IP telephony standards for use within a cable operator's IPCablecom network and when connecting to the PSTN.
- Ability to direct dial any domestic or international telephone number (ITU-T Rec. E.164 address).
- Ability to receive a call from any domestic or international telephone number supported by the PSTN.
- Ensure that a new subscriber is able to retain current phone number via Local Number Portability (LNP).
- Ability to use the carrier of choice for long distance calls. This includes pre-subscription and per call selection.
- Support Call Blocking/Call Blocking Toll restrictions (e.g., blocking calls to specific prefixes).

5.4.3 Quality of Service

- Provide a rich set of policy mechanisms to enable and manage QoS for IPCablecom services over the access network.
- Provide admission control mechanisms for both upstream and downstream directions.
- Allow dynamic changes in QoS in the middle of IPCablecom calls.

- Minimize and prevent abusive QoS usage including theft-of-service and denial-of-service attacks. Ensure QoS policy is set and enforced by trusted IPCablecom network elements.
- Provide a priority mechanism for emergency and other priority-based signalling services.

5.4.4 Codec and media stream

- Minimize the effects that delay, packet loss, and jitter have on voice quality in the IP telephony environment.
- Define a minimum set of audio codecs that must be supported on all IPCablecom endpoint devices (MTAs and MGs). Evaluation criteria for mandatory codecs are selected as those most efficient with respect to voice quality, bandwidth utilization, and implementation complexity.
- Accommodate evolving narrow-band and wideband codec technologies.
- Specify echo cancellation and voice activity detection mechanisms.
- Support for transparent, error-free DTMF transmission and detection via both inband transmission and DTMF relay.
- Support terminal devices for the deaf and hearing impaired.
- Provide mechanisms for codec switching when fax and modem services are required.
- Support fax relay for reliable transmission of fax over IP networks.
- Support calculation and reporting of VoIP Metrics to monitor voice quality.

5.4.5 Device provisioning and OSS

- Support dynamic and static provisioning of customer premises equipment (MTA and CM).
- Common provisioning changes should not require reboot of MTA.
- Allow dynamic assignment and management of IP addresses for subscriber devices.
- Ensure that real-time provisioning and configuration of MTA software does not adversely affect subscriber service.
- Define MIB modules for managing customer premises equipment (MTA) using the IETF Simple Network Management Protocol (SNMP).

5.4.6 Security

- Enable residential voice capabilities with the same or higher level of perceived privacy as in the PSTN.
- Provide protection against attacks on the MTA.
- Protect the cable operator from various denial-of-service, network disruption and theft-of-service attacks.
- Design considerations include confidentiality, authentication, integrity and access control.

5.4.7 Electronic surveillance

- Support ability to perform electronic surveillance by reporting call data and call content.

6 IPCablecom functional components

This clause describes the functional components present in an IPCablecom network (see Figure 3). Component descriptions are not intended to define or imply product implementation requirements but instead to describe the functional role of each of these components in the reference architecture. Note that specific product implementations may combine functional components as needed. Not all components are required to be present in an IPCablecom network.

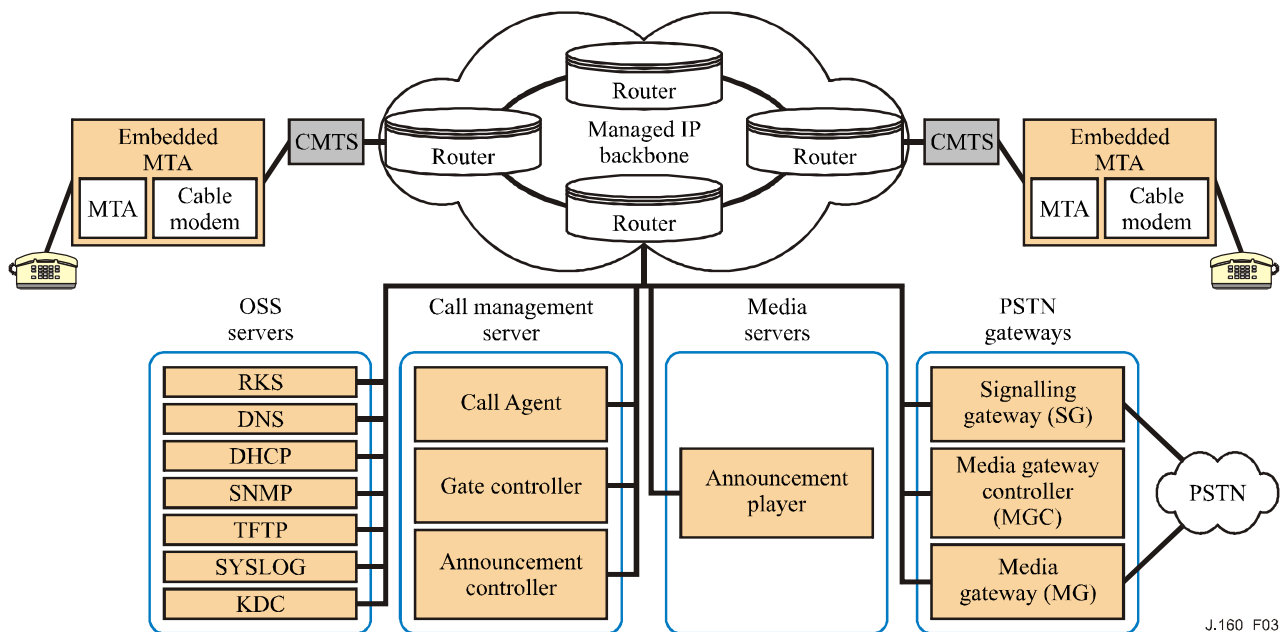


Figure 3/J.160 – IPCablecom component reference model

The IPCablecom architecture contains trusted and untrusted network elements. Trusted network elements are typically located within a Cable Operator's managed backbone network. Untrusted network elements, such as the CM and MTA, are typically located within the subscriber's home and outside of the Cable Operator's facility.

6.1 Media Terminal Adapter (MTA)

An MTA is an IPCablecom client device that contains a subscriber-side interface to the subscriber's CPE (e.g., telephone) and a network-side signalling interface to call control elements in the network. An MTA provides codecs and all signalling and encapsulation functions required for media transport and call signalling.

MTAs reside at the customer site and are connected to other IPCablecom network elements via the HFC access network (ITU-T Rec. J.112). IPCablecom MTAs are required to support the Network Call Signalling (NCS) protocol (ITU-T Rec. J.162).

An embedded MTA (E-MTA) is a single hardware device that incorporates a cable modem as well as an IPCablecom MTA component. Figure 4 shows a representative functional diagram of an E-MTA.