International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.281

(03/2005)

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

Digital transmission of television signals

Requirements for multichannel video signal transmission over IP-based fibre network

ITU-T Recommendation J.281

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Requirements for multichannel video signal transmission over IP-based fibre network

Summary

Recent mass deployments of broadband optical access networks allow general consumers to use 100 Mbit/s or more bandwidth at affordable costs. This bandwidth has potential of transmitting high-quality video signals up to HDTV. Internet Protocol is generally employed on the broadband fibre networks. This Recommendation provides the requirements of multichannel video transmission system over IP-based fibre network including cable television networks with high-level architecture.

It is assumed that the television services are provided in the same way as the current CATV system. The unicast based VoD, which involves a unicast session, is not taken into consideration. However, the broadcast based VoD, which has been integrated into the CATV broadcasting system, is taken into account. In this Recommendation, the broadcast based VoD is assumed to be provided by a multicast stream instead of a broadcast signal, and can be treated as a broadcasting service.

Source

ITU-T Recommendation J.281 was approved on 1 March 2005 by ITU-T Study Group 9 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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ITU-T Recommendation J.281

Requirements for multichannel video signal transmission over IP-based fibre network

1 Scope

This Recommendation defines the requirements for a multichannel video signal transmission system over IP-based fibre network. The video service is expected to be the same as the current digital broadcasting service in which high-quality video programmes including HDTV are provided as a part of a set of services, such as data services, conditional access system and electric programme guide.

2 References

2.1 Normative

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 H.222.0 | ISO/IEC 13818-1 (2000), *Information technology – Generic coding of moving pictures and associated audio information: Systems*.

– ITU-T Recommendation G.983.1 (2005), *Broadband optical access systems based on Passive Optical Networks (PON)*.

– ITU-T Recommendation G.983.3 (2001), *A broadband optical access system with increased service capability by wavelength allocation*.

– ITU-T Recommendation G.984.1 (2003), *Gigabit-capable Passive Optical Networks (GPON): General characteristics*.

– ITU-T Recommendation J.183 (2001), *Time-division multiplexing of multiple MPEG-2 transport streams over cable television systems*.

– ITU-T Recommendation J.193 (2004), *Requirements for the next generation of set-top boxes*.

– IEEE Std. 802.3AH (2004), *Technology – Telecommunications and Information Exchange Between Systems – LAN/MAN – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Amendment: Media Access Control Parameters, Physical Layers and Management Parameters for Subscriber Access Networks*.

3 Definitions

This Recommendation defines the following term:

3.1 transport stream (TS): A data structure defined in ITU-T Rec. H.222.0 | ISO/IEC 13818-1.

4 Abbreviations

This Recommendation uses the following abbreviations:

CATV	Cable Television
ECM	Entitlement Control Message
EMM	Entitlement Management Message
EPG	Electronic Programme Guide
FTTH	Fibre to the Home
FTTB	Fibre to the Building
HDTV	High Definition TeleVision
IP	Internet Protocol
MAC	Media Access Control
MPEG	Moving Picture Experts Group
NIT	Network Information Table
OLT	Optical Line Terminal
ONU	Optical Network Unit
PES	Packetized Elementary Stream
PSI	Programme-Specific Information
PHY	Physical Layer
QoS	Quality of Service
RTP	Real-time Transport Protocol
STB	Set-Top Box
TS	Transport Stream
UDP	User Datagram Protocol
VoD	Video on Demand

5 System assumption

To help to understand the requirement of the system described in the following clause, this clause describes the system assumptions and the reference architecture.

The presented system consists of mainly four components: Headend, Core network, Access network and STB. These components are briefly explained in Figure 1.

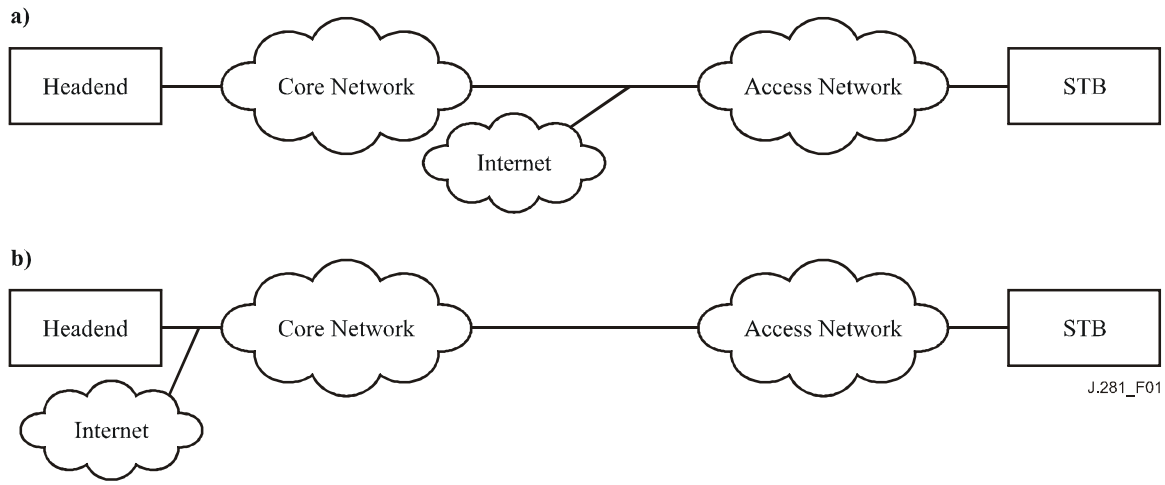

Figure 1/J.281 – Examples of system configuration

5.1 Headend

Headend plays a similar role to CATV's headend. It coordinates video signal and produces transport streams. Encapsulation into IP packets also takes place here. At least one Headend must exist on the system. Two or more Headends on the same system are also possible.

5.2 Core Network

Core Network is responsible for transporting the injected IP packets to each Access Network with sufficient transfer quality. It has appropriate bandwidth, QoS functions and/or network architecture so as to guarantee the quality needed for video transmission services, against the traffic generated by the conventional Internet applications, such as WWW, e-mail.

5.3 Access Network

Access Network connecting STB and Core Network provides sufficient bandwidth for video services. It also provides connectivity between customer premises equipment and the Internet. This Recommendation assumes that the Access Network is an FTTx network. Several FTTx architectures are available, and the similarity among these architectures may cause confusion. This Recommendation focuses on FTTH, which is defined that ONU is installed in/outside the houses, and FTTB, which is defined that ONU is installed in a building.

Figure 2 shows examples of Access Network. Access Network consists of OLT, ONU and Optical Fibre connecting them. In some cases, a splitter may be inserted between ONU and OLT. In some Recommendations or standards, particularly G-series Recommendations of ITU-T such as ITU-T Recs G.983 and G.984, the optical fibre network between OLT and ONU is called the Optical Distribution Network (ODN).

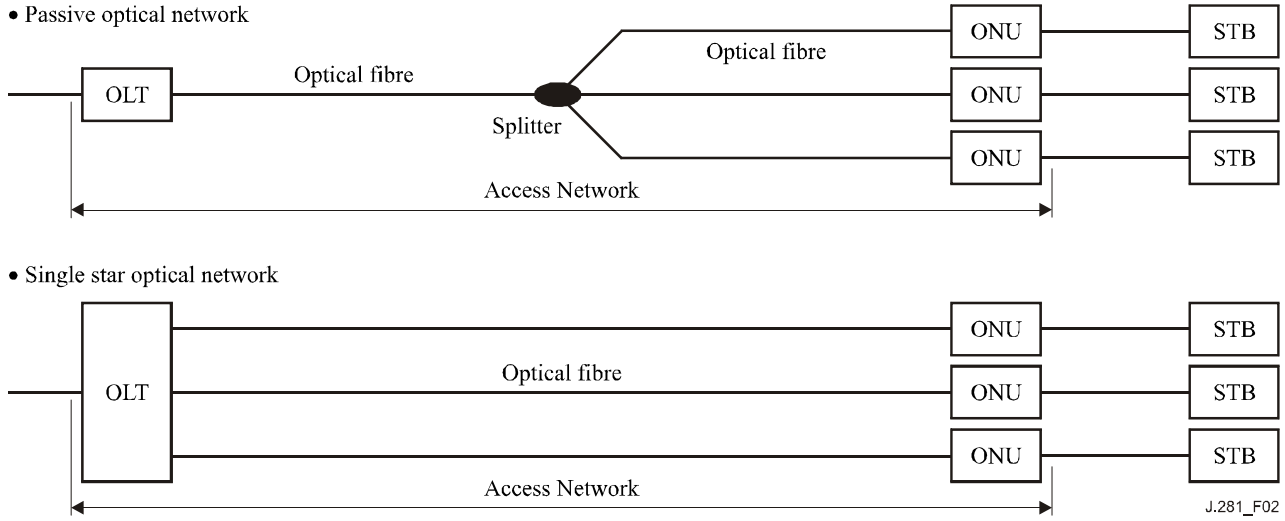

Figure 2/J.281 – Examples of Access Network

A number of optical access network technologies have been developed, and several carriers have deployed some of them. The following are technologies relevant to this Recommendation at the time of publication.

– ITU-T Rec. G.983.1;
– ITU-T Rec. G.983.3;
– ITU-T Rec. G.984.1;
– IEEE Std. 802.3AH.

5.4 Connection with the Internet

Connectivity with the Internet can be provided on this system. Several connecting points can be prepared for Internet services. The connecting point between Access Network and Core Network, as depicted in Figure 1-a, is one example. Locating the connecting point as Figure 1-a makes it easier to maintain the quality of service within Core Network.

A connecting point can be located within Headend or Core Network as depicted in Figure 1-b. In this case, the Core Network should offer a measure that can maintain transmission quality of video services.

5.5 STB

STB is responsible for terminating all network functions in all layers as well as providing conventional STB functions such as video decoding.

An example of protocol stack is shown in Figure 3. The protocol stack is divided into two parts:

1) the group of layers below RTP layer, that is primarily responsible for transmission;
2) the group of layers above MPEG-2 TS layer that is primarily responsible for services.

These two groups of layers are not closely related; therefore, the service operation and the network operation are expected to be less dependent of each other.

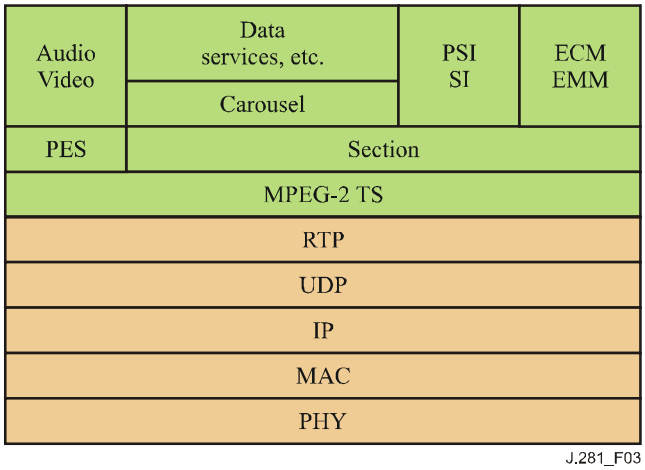

Figure 3/J.281 – An example of protocol stack

The following are the assumptions regarding the protocol structure:

- Services are operated over MPEG-2 TS system.
- Multiple programmes are provided. Several hundreds of programmes may be provided.
- IP multicast is employed for distribution of video contents.

6 Requirements

6.1 Transmission and service

The following are the requirements regarding the transmission and service:

- IP network should rigidly control the distribution area.
- If multiple broadcasters provide TSs independently, each TS should retain its independence.
- IP network should eliminate or reduce the jitter caused in the network.
- High transmission efficiency should be realized.
- TS that has been transmitted through networks must be compliant with ITU-T Rec. H.222.0 | IEC/ISO 13818-1.

IP network should minimize transmission latency.

NOTE – Future Recommendations will define a tolerable value of transmission latency for FTTx-based IP video services. Although transmission latency is for further study, hundreds of milliseconds is suggested as an appropriate value for latency in some documents.

6.2 Packet format

The following are the requirements regarding the packet format:

- Error protection encoding that is performed on either MPEG-2 TS packets or RTP packets should work against IP-level packet-loss while keeping the transmission latency low enough as described in 6.1.
- Packet header should enable STB to recognize the sequence of transmitted IP packets.

6.3 Multiplexing and programme selection

The following are the requirements regarding the multiplexing and programme selection issues:

- Programmes should be received on transport stream basis.
- The information regarding the multiplexing should be provided by PSI, which is defined in ITU-T Rec. H.222.0 | IEC/ISO 13818-1.
- NIT should contain the sufficient information to specify the logical location of programmes.
- The multiplexing scheme defined in ITU-T Rec. J.183 should be employed.
- STB should minimize the programme selection time, which is desired to be the same degree as a conventional cable television STB.

6.4 Network QoS and bandwidth

The following are the requirements regarding the network QoS and bandwidth issues:

- Core Network should provide sufficient bandwidth to enable all programmes to be distributed simultaneously.
- Access Network must provide sufficient bandwidth that enables to distribute at least one programme for each user.
- Quality classification should be defined for Core Network and Access Network.

NOTE – It is necessary to consider the allocation of bandwidth and priority to other services as a total network management policy. Priority of a video service over a telephone service, for example, is up to the operator and the broadcaster. This Recommendation does not define total network management issues while the quality of video service is maintained.

6.5 STB

The following are the requirements regarding STB:

- IP address should be assigned automatically.
- STB should support services based on additional information attached to MPEG-2 TS.
- STB should provide copy control.
- Headend and/or IP network should prevent unauthorized STB from receiving any programme.
- STB should meet requirements defined in ITU-T Rec. J.193 except definitions regarding physical layer and analogue video/audio services.

NOTE – ITU-T Rec. J.193 defines functional requirements for the Next Generation STB. Some requirements can be applied to the STB of this Recommendation, although requirements associated with physical layer and analogue video/audio services should not be applied.

6.6 Security

The following are the requirements regarding the security:

- Headend and/or IP network should provide a means of preventing unauthorized persons from accessing to the Headend equipment.
- Server and STB should withstand denial of service attacks, which disrupt or deteriorate video services.
- Headend and/or IP network should prevent illegal wiretapping and spoofing.

6.7 Coordination with other services and technologies

The following are the requirements regarding the coordination with other telecommunication services:

- If an IP transmission path in Access Network and Core Network is shared with other telecommunication services, the quality of video transmission should be immune from failure or breakdown of other services.
- The quality of service should be independent of the structure of optical fibre network.
- IP network should anticipate an expansion of bandwidth to meet demands of future contents.
- STB should coordinate with home network technologies (for example, LAN).

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Printed in Switzerland
Geneva, 2005