INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.111

(03/98)

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

Interactive systems for digital television distribution

Network independent protocols for interactive systems

ITU-T Recommendation J.111

(Previously CCITT Recommendation)

ITU-T J-SERIES RECOMMENDATIONS

TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

General Recommendations	J.1–J.9
General specifications for analogue sound-programme transmission	J.10–J.19
Performance characteristics of analogue sound-programme circuits	J.20–J.29
Equipment and lines used for analogue sound-programme circuits	J.30–J.39
Digital encoders for analogue sound-programme signals	J.40–J.49
Digital transmission of sound-programme signals	J.50–J.59
Circuits for analogue television transmission	J.60–J.69
Analogue television transmission over metallic lines and interconnection with radio-relay links	J.70–J.79
Digital transmission of television signals	J.80–J.89
Ancillary digital services for television transmission	J.90–J.99
Operational requirements and methods for television transmission	J.100–J.109
Interactive systems for digital television distribution	**J.110–J.129**
Transport of MPEG-2 signals on packetised networks	J.130–J.139
Measurement of the quality of service	J.140–J.149
Digital television distribution through local subscriber networks	J.150–J.159

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION J.111

NETWORK INDEPENDENT PROTOCOLS FOR INTERACTIVE SYSTEMS

Summary

This Recommendation describes protocols independent of the underlying physical and transport protocol for the support of interaction services based on digital TV broadcast systems.

Source

ITU-T Recommendation J.111 was prepared by ITU-T Study Group 9 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 18th of March 1998.

Keywords

Digital TV services, Interaction channel, ISDN, PSTN.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The 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 Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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.

INTELLECTUAL PROPERTY RIGHTS

The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The 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, the 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.

CONTENTS

Introduction

This Recommendation is one of a series describing interactive digital TV services. This Recommendation describes protocols independent of the underlying physical and transport protocol for the support of interaction services based on digital TV broadcast systems. Other relevant Recommendations are J.110 which describes the basic principles and J.113 which describes the provision of return channel based on PSTN and ISDN.

Recommendation J.111

NETWORK INDEPENDENT PROTOCOLS FOR INTERACTIVE SYSTEMS

(Geneva, 1998)

1 Scope

This Recommendation describes protocols independent of the underlying physical and transport protocol for the support of interaction services based on digital TV broadcast systems. Other relevant Recommendations are J.110 [1] which describes the basic principles and J.113 [2] which describes the provision of return channel based on PSTN and ISDN.

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; all 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.

2.1 Normative references

[1] ITU-T Recommendation J.110 (1997), *Basic principles for a worldwide common family of systems for the provision of interactive television services*.

[2] ITU-T Recommendation J.113 (1998), *Digital video broadcasting interaction channel through the PSTN/ISDN*.

[3] HEINANEN, (J.): Multiprotocol Encapsulation over ATM Adaptation Layer 5, RFC 1483, 20 July 1993.

[4] LAUBACK, (M.): Classical IP and ARP over ATM, RFC 1577, 20 January 1994.

[5] EN 301 192: Specifications for data broadcasting.

[6] RFC 1332: The PPP Internet protocol control protocol.

[7] RFC 1717 (MP): The PPP Multilink protocol.

[8] ISO/IEC DIS 13818-6, *Information technology – Generic coding of moving pictures and associated audio information – Part 6: Extensions for DSM-CC*.

[9] ETR 211: Guidelines for the implementation and usage of service information.

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

[11] RFC 1661 (PPP): The point-to-point protocol.

[12] RFC 1994 (CHAP): PPP challenge handshake authentication protocol.

[13] RFC 1340: PPP data link layer protocols.

[14] RFC 1662: PPP in HDLC-like framing.

[15] ITU-T Recommendation J.83 (1997), *Digital multi-programme systems for television, sound and data services for cable distribution*.

2.2 Informative references

[16] Davic 1.3: Davic reference model.

3 Definitions

The definitions in Recommendation J.110 [1] apply.

4 Abbreviations

The abbreviations in Recommendation J.110 [1] apply and are listed below.

AAL	ATM Adaptation Layer
ACD/ACD	Application Control Data or Application Communication Data
API	Application Programming Interface
ARP	Address Resolution Protocol
ASN.1	Abstract Syntax Notation One
ATM	Asynchronous Transfer Mode
BER	Basic Encoding Rules
CATV	Community Antenna TeleVision
CHAP	Challenge Handshake Authentication Protocol
CPU	Central Processing Unit
DAVIC	Digital Audio VIsual Council
DDC	Data Download Control
DSM-CC	Digital Storage Media – Command and Control
DSM-CC U-N	DSM-CC User-to-Network
DSM-CC U-U	DSM-CC User-to-User
DVB	Digital Video Broadcasting
HDLC	High-level Data Link Control
IEEE	Institute of Electrical and Electronic Engineers (US)
IIOP	Internet Inter-ORB Protocol
IOR	Interoperable Object Reference
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
ISDN	Integrated Services Digital Network
LCP	Link Control Protocol
LLC	Link Layer Control
MAC	Medium Access Control
MATV	Master Antenna TeleVision
MIB	Management Information Base
MMDS	Multipoint Microwave Distribution System
MP	Multilink Point-to-Point Protocol (PPP)
MPEG	Moving Pictures Experts Group
MPEG TS	MPEG Transport Stream

MTU	Multiport Transceiver Unit
NSAP	Network Services Access Point
OSI	Open Systems Interconnection
PAP	Password Authentication Protocol
PPP	Point-to-Point Protocol
PSTN	Public Switched Telephone Network
RFC	Request For Comments
RPC	Remote Procedure Call
RTP	Real Time Protocol
SI	Service Information
SIS	Systems for Interactive Services
SMATV	Satellite Master Antenna TeleVision
SNAP	Sub-Network Attachment Point
SNMP	Simple Network Management Protocol
SRM	Session and Resource Manager
STB	Set Top Box
STU	Set Top Unit
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UNO-CDR	Universal Networked Object – Common Data Representation
UNO-RPC	Universal Networked Object – Remote Procedure Call

5 Protocol stack and system models

5.1 Protocol stack model

The protocol stack model used for the purposes of this Recommendation consists of the following layers.

Physical layer: where all the physical (electrical) transmission parameters are defined – network dependent.

Transport layer: defines all the relevant data structures and communication protocols like data containers, etc. – network dependent.

Application layer: is the interactive application software and runtime environments – network independent. See Figure 1.

This Recommendation describes the network independent protocols only (to layer 4 of the OSI reference model typically). The network dependent protocols within the transport and physical layers are described in other Recommendations, for example the PSTN/ISDN protocols are described in Recommendation J.113 [2].

5.2 System model/overview

Refers to Recommendation J.110 [1].

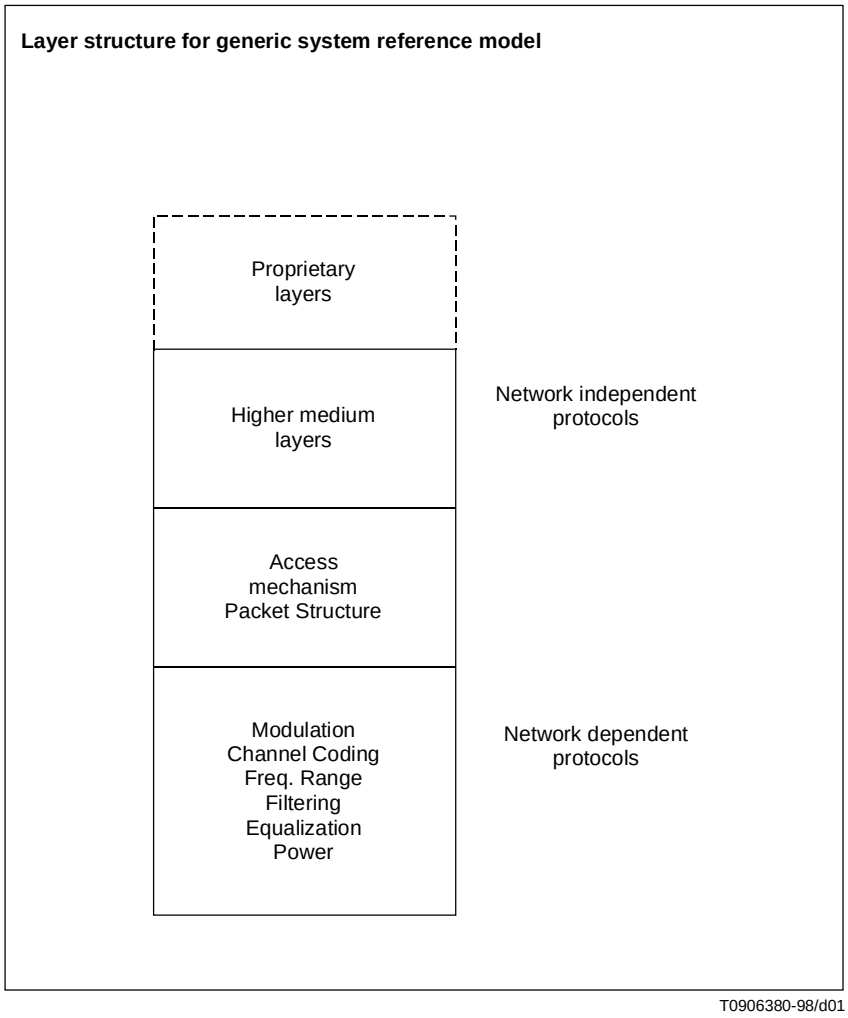

Figure 1/J.111 – Layer structure for generic system reference model

5.3 Logical model

The broadcast channel carries content from the broadcast service provider and, in some instances, from the interactive service provider to the user. The broadcast channel may also carry embedded ACD/ACD and/or DDC from the interactive service provider to the user, possibly for controlling an application for which broadcast programme associated data is being supplied by the interactive service provider.

Figure 2 shows the mapping of logical channels onto the system model.

The interaction channel carries content from the interactive service provider to the user, and may also carry user contribution content back to the interactive service provider. The interaction channel also carries ACD/ACD to and from the user, and may also carry DDC to the user.

The interactive service provider may also need to send content, either to the broadcast service provider, or to the broadcast network adapter. The latter will require the interactive service provider to send ACD/ACD and/or DDC to the broadcast network adapter for embedding in the broadcast channel. A bidirectional application control and communication channel will also be required between the broadcast service provider and the interactive service provider for synchronization purposes.

The network independent protocol stacks are derived from the logical channel terminology specified by DAVIC, i.e. S1 to S5 flows. This terminology is explained in Davic 1.3 [16].

The following basic realizations of mapping logical streams S1, S2 onto the system model are possible as illustrated in Figure 2:

a) Broadcast channel carries S1 from broadcast service provider or from interactive service provider to the user;

   Broadcast channel carries S2 (ACD/ACD and/or DDC) forward to the user;

   Interaction channel carries S2 backward (ACD/ACD).

b) Broadcast channel carries S1 as in a);

   Interaction channel carries S2 forward (ACD/ACD and/or DDC) and S2 backward (ACD/ACD).

c) Interaction channel carries S1 from interactive service provider to the user;

   Interaction channel carries S2 as in b).

d) Interaction channel carries S1 (user contribution content) from the user back to the interactive service provider or to the broadcast service provider;

   Interaction channel carries S2 as in b).

e) Store and forward return mode where real time interactivity is not possible.

The SIS protocol stacks provide a generic solution for communication between a STB and a network. In the case where a direct connection between a STB and an interactive service provider exists, the SIS protocol stacks provide a solution for the STB and the server. Where there is not a direct connection to an interactive service provider (e.g. in traversing multiple networks), the protocol stack at the server end may be different to the STB stack for the mapping between the IP layer and the underlying physical layer (an example of this is a point-to-point connection from the STB to the first point of presence in the network, with an X.25 connection from the network to the interactive service provider).

Note that an exception to the use of PPP is acceptable as an option, in the case of a cable return channel, where IP may be carried over ATM. In this case, LLC/SNAP as defined in RFC 1483 [3] shall be used for encapsulating the IP over AAL5. The default MTU size shall be 9180 bytes as defined in RFC 1577 [4]. If another case arises where a PPP link is not used, then an equivalent encapsulation method will be specified as part of the network dependent protocol stack.

In order to facilitate lower cost implementations where a fully-featured system is not required, the feature set can be adapted to the requirements of the specific application.

6 Protocol stacks

The protocol stacks specified comply with the references as listed in this Recommendation. The protocol stacks and their use are explained in Davic 1.3 [16].

It is recognized that this Recommendation may be extended to allow other lower level protocols in the future.

6.1 S1 – broadcast or narrowcast content – audio, video, data

Broadcast channel: Two categories are provided:

i) J.83 transmission system;

ii) transmission system with UDP/IP or TCP/IP with an interaction channel return flow. See Table 1.

The mechanism for transmitting IP within MPEG-2 private sections (DSM-CC sections) will be as defined in EN 301 192 [5].

Where TCP/IP is carried over the broadcast channel, an interaction channel shall be established for the flow of return acknowledgements.

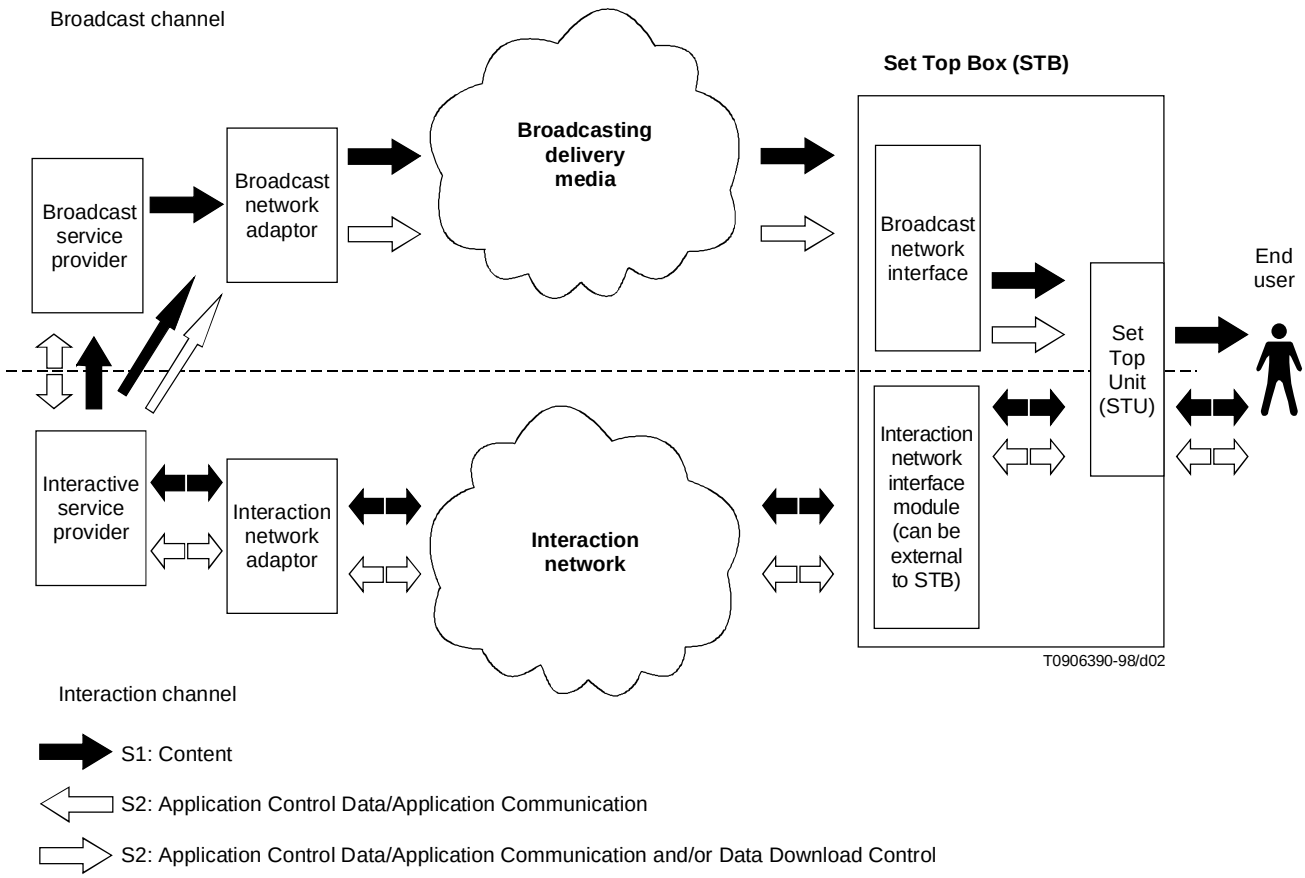

Figure 2/J.111 – Logical model

Table 1/J.111 – UDP/IP or TCP/IP via broadcast channel

UDP	TCP
IP	
MPEG-2 private section (DSM-CC section)	
MPEG-2 TS	

Interaction channel: This allows for the exchange of both time sensitive (synchronized) and non-time sensitive (non-synchronized) content information and application data via the interaction channel. Time sensitive content information consists of streams which have to be delivered in real time. Non-time sensitive content information consists of files whose delivery does not need to be in real time.

i) Synchronized data: see Table 2.

Table 2/J.111 – Synchronized data via interaction channel

UDP
IP
PPP(MP)

RTP may optionally be used above UDP for critical real time communication. RTP provides information about the coding scheme used in the payload and time stamps to enable receivers to regenerate sender timing. Control messages are also used to monitor connection quality and to identify participants in a multi-user session. Note that RTP relies on software decompression which requires significant CPU resources.

ii) Non-synchronized data: see Table 3.

Table 3/J.111 – Non-synchronized data via interaction channel

TCP
IP
PPP(MP)

Standard TCP is adequate for delivery of content up to 150 kbit/s, but if it is required to deliver data at a higher rate, via a long delay network, then extensions to TCP exist which can be implemented. These implementations will be backwards compatible with standard TCP implementations. If this option is used, then the extensions of TCP shall be according to RFC 1332 [6].

6.2 S2 – ACD/ACD and DDC between server and STB

Broadcast channel: Two categories are provided:

i) Download of data across the broadcast channel: see Table 4.

Table 4/J.111 – DDC via broadcast channel

DSM-CC data carousel
MPEG-2 private section (DSM-CC section)
MPEG-2 TS

ii) ACD/ACD – User-to-user interaction across the broadcast channel: see Table 5.

Table 5/J.111 – ACD/ACD via broadcast channel

DSM-CC U-U
DSM-CC object carousel
DSM-CC data carousel
MPEG-2 private section (DSM-CC section)
MPEG-2 TS

In Table 5 above, DSM-CC U-U is only used for the API. The DSM-CC object carousel specification describes the transportation of the U-U objects (and their attributes) in the broadcast channel. The objects within the object carousel can either be broadcast in the object carousel itself or can be located at an interactive server. If necessary, the identification of the interactive server (e.g. PSTN/ISDN telephone number) can be communicated to STB by including the ServiceLocationComponent structure (defined in DSM-CC U-U) in the IOR of the object. The ServiceLocationComponent shall contain a 20 bytes E.164 NSAP address which conveys the identification information, as defined in EN 301 192 [5].

Interaction channel: Two categories are provided:

i) Download of data across the interaction channel: see Table 6.

Table 6/J.111 – DDC via interaction channel

DSM-CC download
TCP
IP
PPP(MP)

ii) ACD/ACD – User-to-user interactions across the interaction channel: see Table 7.

Table 7/J.111 – ACD/ACD via interaction channel

DSM-CC U-U
UNO-CDR, UNO-RPC
TCP
IP
PPP(MP)

The UNO-RPC consists of the Internet Inter-ORB Protocol (IIOP) as specified in RFC 1717 (MP) [7].

6.3 S3 – Session control signalling

Session control protocols are not normally required in STBs for interactive services. If as an option it is required to allow for services using session control, then the protocols used shall be as listed in Table 8. As resource allocation is not normally required for the point-to-point connection, resource descriptors in session set-up messages are not normally needed.

Table 8/J.111 – Session control via interaction channel (optional)

DSM-CC U-N subset
UDP
IP
PPP(MP)

The subset of messages required is as follows:

Session Setup Sequence:
ClientSessionSetupRequest/ClientSessionSetupConfirm

Client Initiated Session Release Sequence:
ClientReleaseRequest/ClientReleaseConfirm

Server Initiated Release Sequence:
ClientReleaseIndication/ClientReleaseResponse

Status Inquiry Sequence:
ClientStatusIndication/ClientStatusResponse

Connection Reset Sequence:
ClientResetRequest/ClientResetIndication

For implementation of session control signalling, see clause 9.

An exception to the above is in the case where session control is used on the interaction channel and IP data is carried within the MPEG-2 stream through the broadcast channel [see 6.1 ii)]. In this case, resource descriptors may optionally be used. When the STB opens the service which uses IP over the MPEG-2 TS, a session is established on the interaction channel. The STB then receives the required signalling parameters via the interaction channel using the resource descriptors as specified below as part of the ClientSessionSetUpConfirm message.

The IP packets are carried in the MPEG-2 TS using the specified datagram_section as defined in EN 301 192 [5]. The parameters required for locating the stream where the packets are carried can be signalled on the interaction channel by using either a MpegProgram descriptor as specified in ISO/IEC 13818-6 [8], which defines the physical parameters directly, or by using the service component descriptor which uses the SI data indirection mechanisms (see ETR 211 [9] and ETS 300 802 [10]) to provide a physical network independent location mechanism. A MAC address descriptor can also be used for assigning a MAC address to the STB that it will use for filtering the packets. If the MAC address is allocated statically for each client or is provisioned through some other mechanism, this descriptor is not used.

7 PPP data-link set-up

After the STB has been connected through the interaction network to the server, the PPP configuration process is initiated. This configuration process consists of the following phases:

1) Link Control Protocol (LCP, see RFC 1661 [11]) is used to establish the data link connection;

2) IPCP (RFC 1332 [6]) is used to configure IP and the type of compression.

In phases 1) and 2), both "Configure-Request" and "Configure-Ack" packets are sent and received. In phase 2), the STB sends a Configure-Request packet that includes the IP address configuration fields at the beginning. In this case, PPP facilitates the transfer of an IP address from the interactive service provider during the initialization phase of PPP.

Optionally, authentication of the STB can be done using the Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP), both as specified in RFC 1994 [12]. For compression of the IP address and control fields (see RFC 1332 [6]), the following protocols shall be supported in the PPP data link layer (see RFC 1340 [13]):

– 002l Internet protocol;

– 002d Van Jacobson Compressed TCP/IP;

– 002f Van Jacobson Uncompressed TCP/IP.

For the PPP link, the following configuration shall be supported as recommended for PSTN type links (Appendix A to RFC 1662 [14]):

– Async Control Character Map;

– Magic Number;

– Address and Control Field Compression;

– Protocol Field Compression.

8 Network congestion control

Where a large number of (near) simultaneous transactions may be generated by a popular broadcast, a means of avoiding network congestion shall be provided in the interactive application. Guidance on implementation of network congestion control is given in Davic 1.3 [16].

9 Session control in interactive services

9.1 Introduction

End-to-end session control is needed for certain services and network configurations. If a session control protocol is used, the protocol stack shall be as defined in 6.3. A subset of DSM-CC user-to-network protocol is used. The syntax of the user-to-network messages is defined in clause 4 of ISO/IEC 13818-6 [8].

In the DSM-CC reference model, the client and the server use the user-to-network protocol to communicate with a session and resource manager (DSM-CC SRM). In a simple service environment, the session and resource manager can be integrated with the server because only the session management is needed.

9.2 Session establishment

After setting up the connection, the STB establishes an end-to-end session to the server using the DSM-CC U-N session set-up sequence (Figure 3). The object reference to the service root directory is returned with the confirm message.

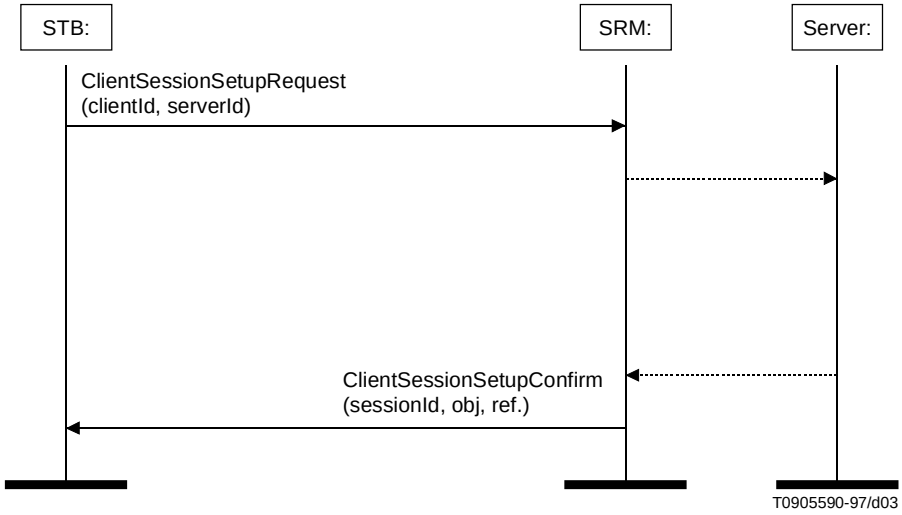

Figure 3/J.111 – Session set-up sequence

9.3 Session release

When the STB wants to close the session, it uses the client-initiated session release sequence (Figure 4). After that, the connection can be closed.

When the server receives the session release message, it can close all objects related to the session and shut down the service for the session.

If the server wants to close a session, it can use the server-initiated session release sequence (Figure 5).

9.4 Status inquiry

The SRM can check if the client is still connected by sending a status indication message and checking the response of the client (Figure 6).

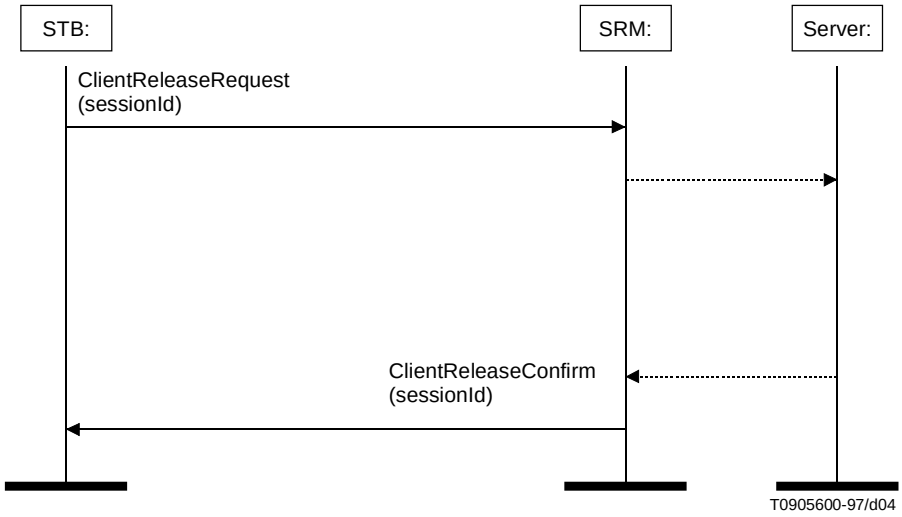

Figure 4/J.111 – Client-initiated session release sequence

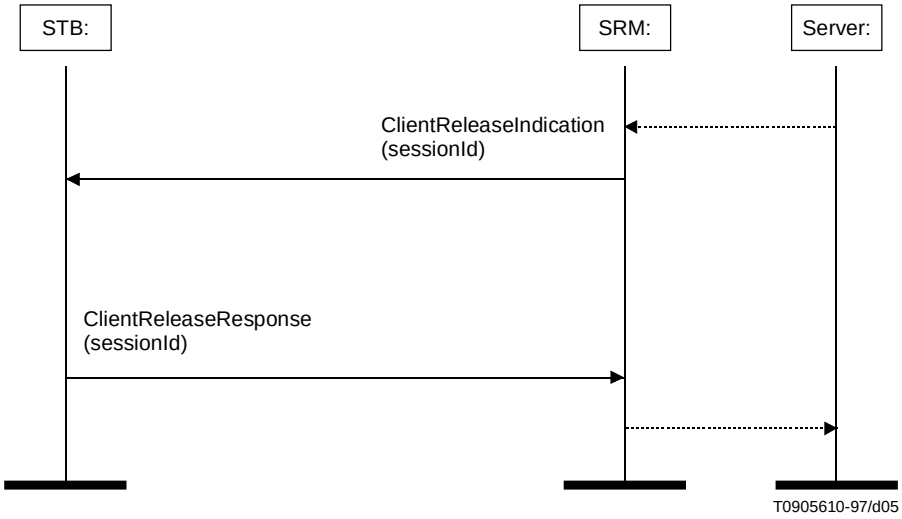

Figure 5/J.111 – Server-initiated session release sequence

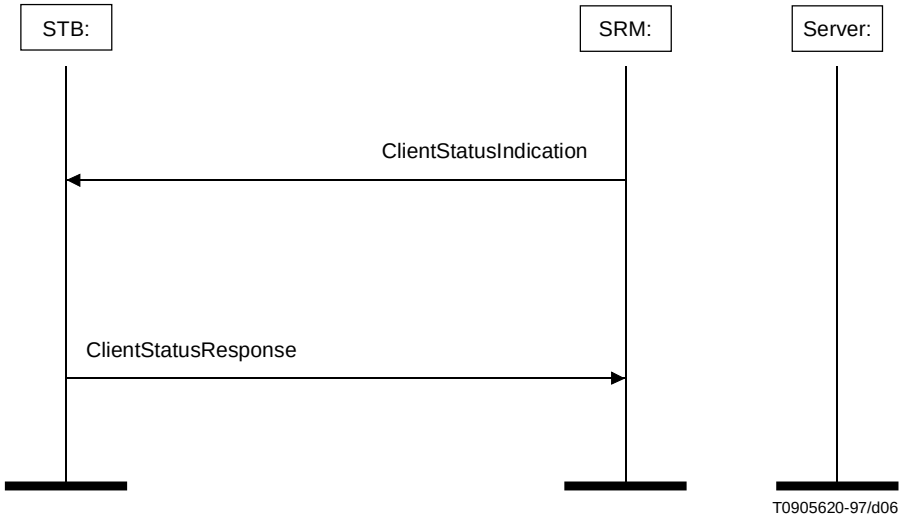

Figure 6/J.111 – Status inquiry sequence

9.5 Connection reset

In an abnormal situation, the client can close all the sessions and reset the connection by sending a ClientResetRequest message to the SRM. Normally, the sessions should be closed with the session release sequence. The reset message should be used only in extraordinary situations such as if the client has an open session but has somehow lost the sessionId.

The SRM can also close all the sessions for a client by sending a ClientResetIndication. This shall also be used only in abnormal situations.

ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	**Transmission of television, sound programme and other multimedia signals**
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communication
Series Y	Global information infrastructure
Series Z	Programming languages