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I.121

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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

General structure – Description of ISDNs

BROADBAND ASPECTS OF ISDN

Reedition of CCITT Recommendation I.121 published in the Blue Book, Fascicle III.7 (1988)

NOTES

1 CCITT Recommendation I.121 was published in Fascicle III.7 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

Recommendation I.121

BROADBAND ASPECTS OF ISDN

(Melbourne, 1988)

Foreword

This Recommendation should be interpreted as a guideline to the objective of providing more detailed Recommendations on all broadband aspects of ISDN (B-ISDN) during the next Study Period (1989-1992).

The Recommendation was elaborated taking into account the following:

– the emerging demand for broadband services;

– the availability of high speed transmission, switching and signal processing technologies;

– the need for covering broadband aspects of ISDN, in CCITT Recommendations,

– the need to integrate both interactive and distribution services;

– the need to integrate both circuit and packet transfer modes into one universal broadband network;

– the need to provide flexibility to both user and operator.

1 Principles and concept

1.1 *Principles of* B-ISDN

The main feature of the ISDN concept is the support of a wide range of audio, video and data applications in the same network. A key element of service integration for an ISDN is the provision of a range of services using a limited set of connection types and multipurpose user-network interfaces.

In the context of this Recommendation, the term B-ISDN is used for convenience in order to refer to and emphasize the broadband aspects of ISDN. The intent, however, is that there be one comprehensive notion of an ISDN which provides broadband and other ISDN services.

B-ISDNs support both switched and non-switched connections. Connections in a B-ISDN support both circuit-mode and packet-mode services.

A B-ISDN will contain intelligence for the purpose of providing service features, maintenance and network management functions. This intelligence may not be sufficient for some new services and may have to be supplemented by either additional intelligence within the network, or possibly compatible intelligence in user terminals.

A layered structure should be used for the specification of the access protocol to a B-ISDN.

It is recognized that ISDNs may be implemented in a variety of configurations according to specific national situations.

1.2 *Evolution of B-ISDN*

1.2.1 *Target transfer mode*

Asynchronous transfer mode (ATM) is the target transfer mode solution for implementing a B-ISDN. It will influence the standardization of digital hierarchies and multiplexing structures, switching and interfaces for broadband signals.

ATM as used in this Recommendation concerns a specific packet-oriented transfer mode using the asynchronous time division multiplexing technique: the multiplexed information flow is organized in fixed size blocks, called cells. A cell consists of a user information field and a header; the primary role of the header is to identify cells belonging to the same virtual channel on an asynchronous time division multiplex. Cells are assigned on demand, depending on the source activity and the available resources. Cell sequence integrity on a virtual channel is preserved by the ATM layer.

ATM is a connection-oriented technique. Header values are assigned to each section of a connection when required and released when no longer needed. The connections identified by the headers remain unchanged during the lifetime of a call. Signalling and user information are carried on separate virtual channels.

ATM will offer a flexible transfer capability common to all services, including connectionless services.

1.2.2 *Evolution steps*

B-ISDN will be based on the concepts developed for ISDN and may evolve by progressively incorporating additional functions and services (e.g. high quality video applications).

The deployment of B-ISDN may require a period of time extending over one or more decades. Thus, arrangements must be developed for the interworking of services on B-ISDN and services on other networks.

In the evolution towards a B-ISDN, digital end-to-end connectivity will be obtained in part via plant and equipment used in existing and planned networks, such as digital transmission and switching. Relevant Recommendations for these constituent elements of a B-ISDN are contained in the appropriate series of Recommendations of CCITT and of CCIR.

In the early stages of the evolution of B-ISDN, some interim user-network arrangements [e.g. combinations of synchronous transfer mode (STM) and ATM techniques] may need to be adopted in certain countries to facilitate early penetration of digital service capabilities.

2 Service aspects of B-ISDN

2.1 *General*

The principles of services supported by an ISDN are described in the I.200-Series Recommendations. The description of B-ISDN services is based on the principles of the existing I-Series Recommendations.

This section describes the classification of broadband services, the definition of those service classes, and gives examples of services in each service class proposed to be supported by the ISDN.

This classification does not take into account the location of the implementation of the functions either in the network or in the terminals. This classification is primarily from the point of view of the network and not from the user point of view.

Depending on their communication functions and applications, the services to be supported by the B-ISDN may be internationally standardized and offered by the Administration as bearer services or teleservices.

2.2 *Service classes*

Depending on the different forms of the broadband communication and their applications, two main service categories have been identified: interactive services and distribution services. The interactive services are subdivided into three classes of services, viz., the conversational services, the messaging services, and the retrieval services. The distribution services are represented by the class of distribution services without user individual presentation control and the class of distribution services with user individual presentation control (see Figure 1/I.121).

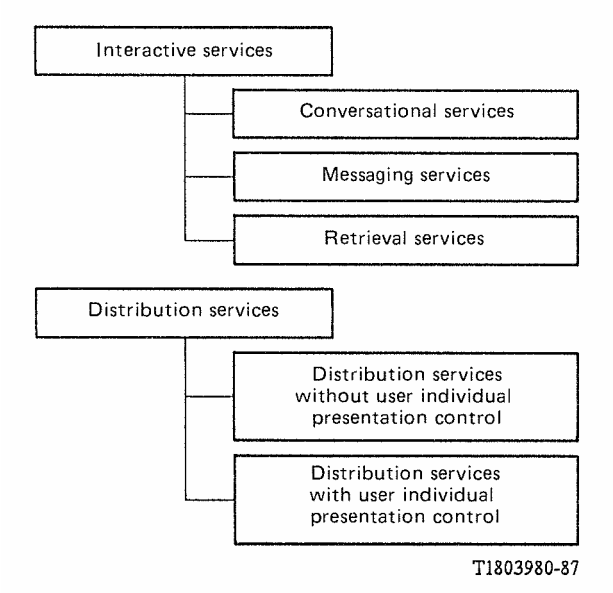


FIGURE 1/I.121
Classification of broadband services

2.3 *Definition of service classes*

2.3.1 **Conversational services**

Conversational services in general provide the means for bidirectional dialogue communication with real-time (no store-and-forward) end-to-end information transfer from user to user or between user and host (e.g. for data processing). The flow of the user information may be bidirectional symmetric, bidirectional asymmetric and in some specific cases (e.g. such as video surveillance), the flow of information may be unidirectional. The information is generated by the sending user or users, and is dedicated to one or more individual communication partners at the receiving site.

Examples of broadband conversational services are videotelephony, video conference and high speed data transmission.

2.3.2 **Messaging services**

Messaging services offer user-to-user communication between individual users via storage units with store-and-forward, mailbox and/or message handling (e.g. information editing, processing and conversion) functions.

Examples of broadband messaging services are message handling services and mail services for moving pictures (films), high resolution images and audio information.

2.3.3 **Retrieval services**

The user of retrieval services can retrieve information stored in information centres and in general provided for public use. This information will be sent to the user on his demand only. The information can be retrieved on an individual basis. Moreover, the time at which an information sequence is to start is under the control of the user.

Examples are broadband retrieval services for film, high resolution image, audio information, and archive information.

2.3.4 **Distribution services without user individual presentation control**

These services include broadcast services. They provide a continuous flow of information which is distributed from a central source to an unlimited number of authorized receivers connected to the network. The user can access this flow of information *without* the ability to determine at which instant the distribution of a string of information will be started. The user cannot control the start and order of the presentation of the broadcast information. Depending on the point of time of the user's access, the information will not be presented from its beginning.

Examples are broadcast services for television and audio-programmes.

2.3.5 **Distribution services with user individual presentation control**

Services of this class also distribute information from a central source to a large number of users. However, the information is provided as a sequence of information entities (e.g. frames) with cyclical repetition. So, the user has the ability of individual access to the cyclical distributed information and can control the start and order of presentation. Due to the cyclical repetition, the information entities selected by the user will always be presented from its beginning.

One example of such a service is full channel broadcast videography.

2.4 *Examples of broadband services*

Table A-1/I.121 contains examples of possible services, their applications and some possible attribute values describing the main characteristics of the services.

Guideline prose definitions, service attributes and attribute values for describing a number of possible broadband services are presented in Annex B. Services described include:

– broadband unrestricted bearer services;

– high quality broadband video telephony:

– high quality broadband video conference;

– existing quality and high definition TV distribution;

– broadband Videotex.

2.5 *User-network interface from the service point of view*

2.5.1 *Need for simultaneous services*

The user-network interface will be required to support a varying mixture of services to broadband network users. The simultaneous services required at the interface will vary between customers, e.g. the requirements for residential customers may differ from those business customers. The capacity of the interface, the mix of simultaneous services, and the bit rate required for each service are all interrelated.

The user-network interface must be able to accommodate at least an H_4 user rate (see Note), (or an equivalent mix of services whose aggregate bit rate may be up to that of an H_4 user rate), plus some additional narrow-band services and signalling. Moreover, there may be a need to carry a greater volume of services and to provide the capability of supporting services whose rates exceed the H_4 user rate.

The study of simultaneous service requirements is important and will impact broadband aspects of ISDN such as bit rates, user interfaces, protocol processing, etc.

Note – The term H_4 user rate is used here to give an indication of the range of bit rates available to the user (see § 5). No implications for channel provision are intended.

2.5.2 *Flexibility of the user-network interface*

Not only will ISDNs in different environments need to support a large variety of customer requirements for different services, but also the access requirements of a given customer may often change from time to time.

For these reasons, it is necessary that the user network interface be flexible and capable of offering dynamic allocation of resources to services.

3 Architecture models

3.1 *Functional architecture*

The general architecture of the ISDN from the functional point of view is described in Recommendation I.324.

3.2 *Basic architectural model*

Figure 2/I.121 shows the main information transfer and signalling functional components of ISDN including broadband aspects:

- local functional capabilities (LFC), i.e. local exchange functions and possibly including remote switching cross-connect muldexes, etc.;
- inter-exchange signalling functional entities;
- 64 kbit/s based functional entities;
- broadband functional entities.

These components need not be provided by distinct networks but may be combined as appropriate for a particular implementation.

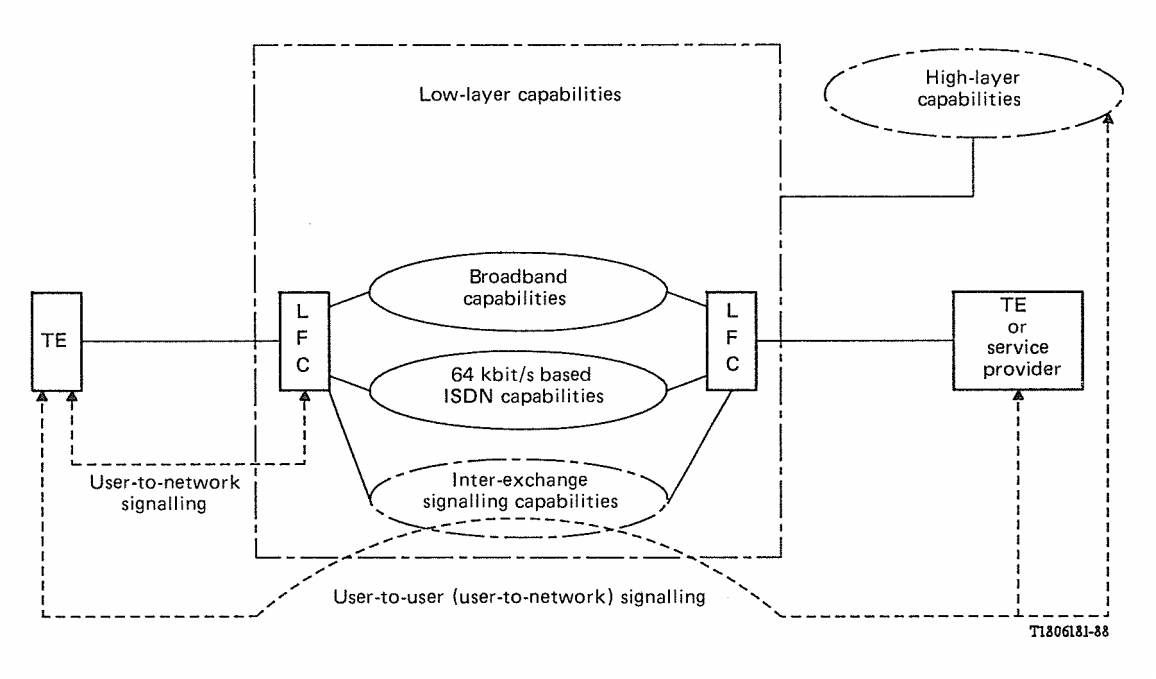


FIGURE 2/I.121

Basic architectural model of ISDN, including broadband aspects

3.3 *Reference configurations*

3.3.1 *Reference configuration for the user-network interface*

The reference configuration defined in Figure 1/I.411 and shown here as Figure 3/I.121 is considered sufficiently general to be applicable not only for a basic access and a primary rate access but also to a broadband access. Both reference points S and T are valid for broadband accesses.

The functions of the NT1 are, in principle, identical for 64 kbit/s based ISDN and B-ISDN. The same applies to the NT2.

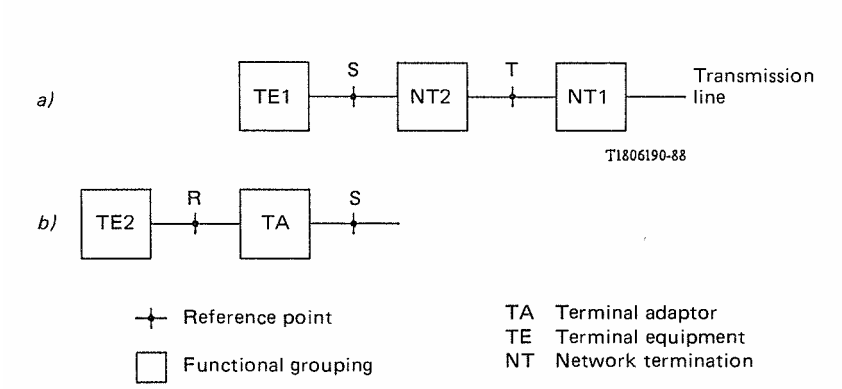


FIGURE 3/I.121

B-ISDN reference configuration

3.3.2 *Physical realization of reference configurations and user-network interfaces*

In order to clearly illustrate the broadband aspects, the notations for reference points and for functional groupings with broadband capabilities are appended with the letter B (e.g. B-NT1, T_B).

Interfaces at reference points S_B and T_B will be standardized. These interfaces will support all ISDN services.

Figure 4/I.121 gives examples of physical configurations illustrating combinations of physical interfaces at various reference points. The examples cover configurations that could possibly the supported by standardized interfaces and reference points S_B and T_B. Other configurations may also be supported.

Configurations *j)* and *k* in Figure 4/I.121 require that the interface specifications for S_B and for T_B have a high degree of commonality. Such commonality is highly desirable. The feasibility of achieving the needed commonality requires further study.

One objective in designing interfaces is to support multiple terminals simultaneously via simplified B-NT2 (e.g. a B-NT2 consisting solely of physical connections).

3.4 *B-ISDN protocol model for ATM*

The B-ISDN protocol model for ATM is shown in Figure 5/I.121. Two specific layers related to the ATM functions are:

– an ATM layer that is common to all services and provides cell transfer capabilities; and

– an adaptation layer that is service dependent.

3.4.1 ATM layer

The boundary between the ATM layer and the service adaptation layer corresponds to the boundary between functions devoted to the header and functions devoted to the information field.

3.4.2 Adaptation layer

The adaptation layer supports higher layer functions of the user and control planes and supports connections between ATM and non-ATM interfaces. Information is mapped by the adaptation layer into ATM cells. At the transmitting end, information units (e.g. LAPD frames) are segmented or information units (e.g. PCM voice samples) are collected to be inserted into ATM cells. At the receiving end the information units are reassembled (e.g. LAPD frames) or read-out (e.g. PCM voice samples) from ATM cells. Any adaptation layer specific information (e.g. data field length, time stamps, sequence number) that must be passed between peer adaptation layers is contained in the information field of the ATM cell.

The adaptation layer could be terminated in a Network Termination (NT), Network Adapter (NA), Terminal Adapters (TA), Terminal Equipment (TE) and Exchange Termination (ET) (see Figure 6/I.121). Network adapter functions include those adaptation functions that are necessary between ATM and non-ATM parts of ISDN.

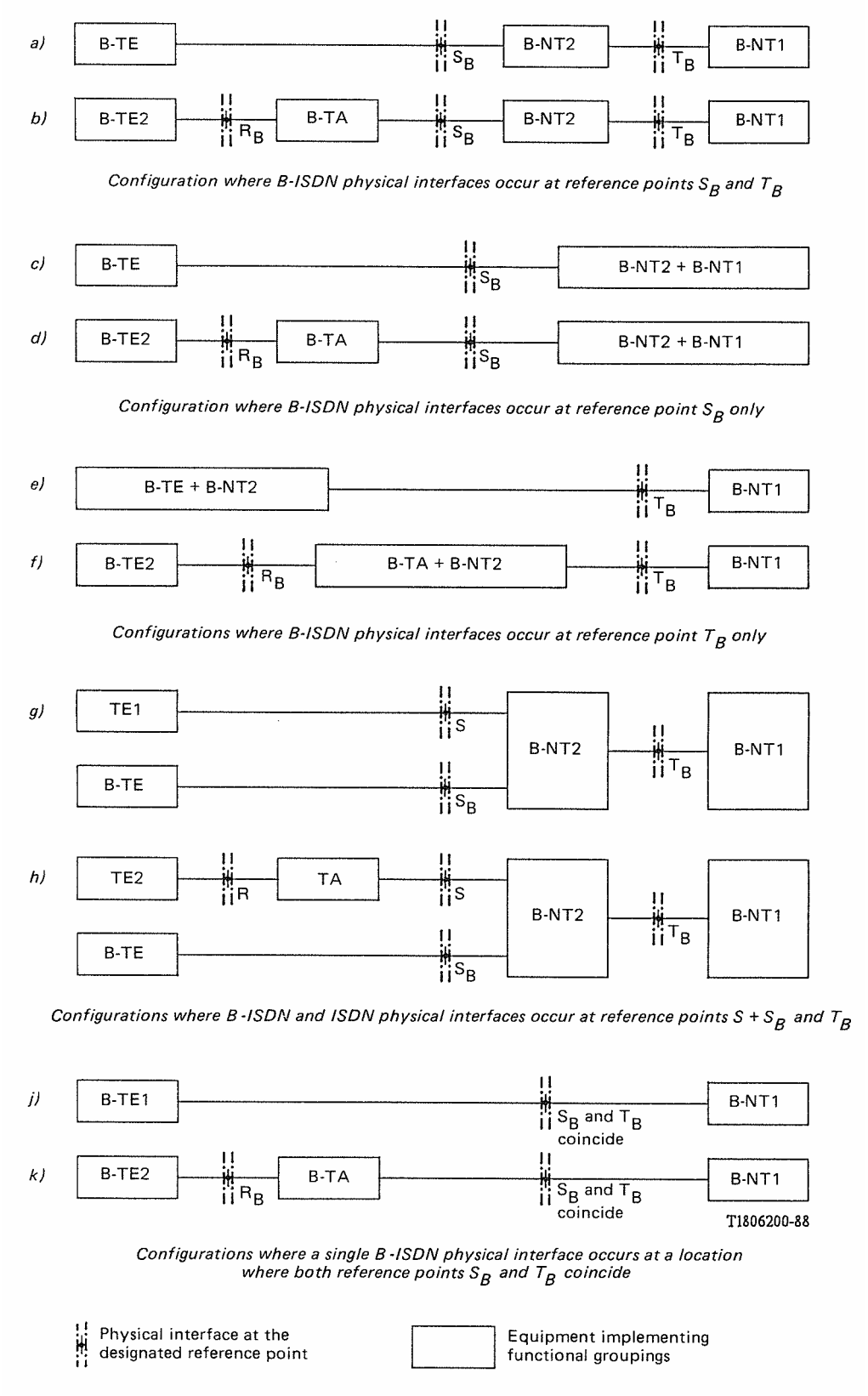


FIGURE 4/I.121

Examples of physical configurations for broadband user applications

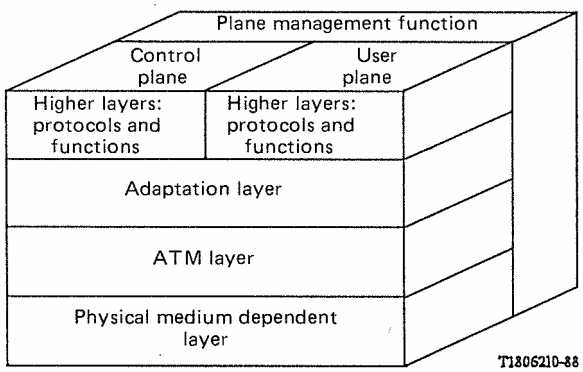
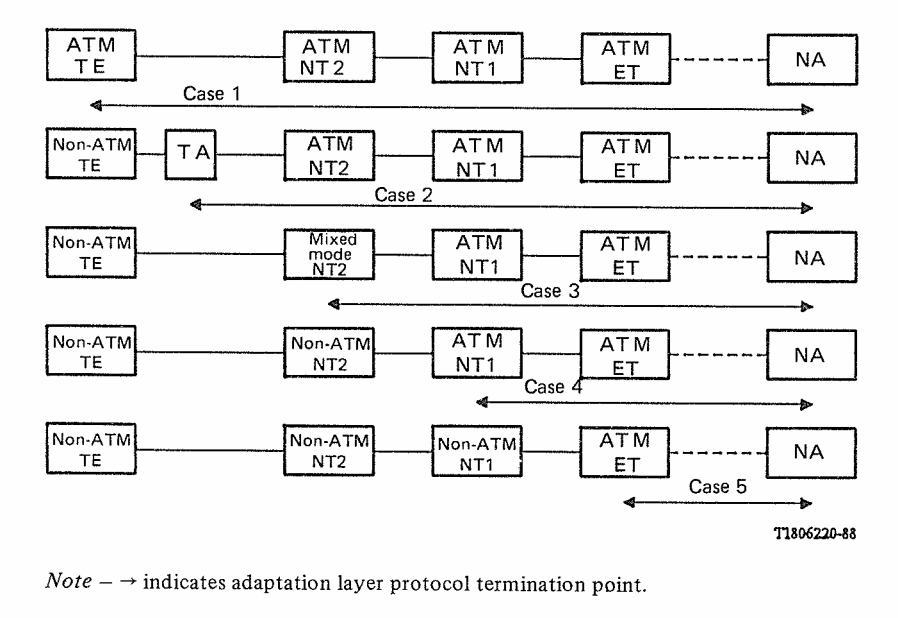


FIGURE 5/I.121

B-ISDN protocol model for ATM



Note – → indicates adaptation layer protocol termination point.

FIGURE 6/I.121

Scope of adaptation layer

3.4.3 Adaptation layer functions

Examples of adaptation functions include Continuous Bit Stream Oriented (CBO) services adaptation functions, existing packet mode services adaptation functions and connectionless services adaptation functions:

– CBO adaptation functions

CBO oriented services are those which involve an uninterrupted flow of digital information; for example; 64 kbit/s PCM voice. The CBO adaptation functions support these services over an ATM network. Within the adaptation layer the following functions may be performed:

1) cell assembly and disassembly;

2) compensation for the variable delay of the ATM network;

3) handling of lost cell conditions;

4) clock recovery. Some alternatives are to synchronize the output bit stream to the network clock or to the source bit stream;

5) mapping of the control signal (e.g. V.35) into the ATM cell stream.

– Existing packet mode services adaptation functions

Existing packet mode services (e.g. LAPD) can be supported by the CBO adaptation functions. This does not take advantage of the idle periods between data transmission. The packet mode adaptation layer provides bandwidth savings by taking advantage of the bursty nature of packet services. Operations that may be carried out by the packet mode adaptation functions include:

1) detection of information blocks from the higher layer;

2) dividing information blocks into ATM cells;

3) handling of partially filled cells;

4) reassembling information blocks from received ATM cells;

5) sending information blocks to the higher layer;

6) rate adaptation;

7) action on loss of cells.

– Adaptation functions may be defined for connectionless services.

4 Asynchronous transfer mode characteristics

4.1 *General considerations*

The information field is transported transparently by the ATM layer; no processing (e.g. error control) is performed on the information field at the ATM layer.

The header and the information field each consist of a fixed integer number of octets at a given reference point. The information field length is the same for all connections at all reference points where the ATM technique is applied.

4.2 *Header functions*

The header contains just the information required to transfer the information field through the ATM network. Application-oriented or service-oriented information does not appear inside the header.

The three following functions are mandatory:

– virtual channel identification (VCI);

– error detection on the header;

– unassigned cell indication.

The need for additional functions supported by the header is for further study. The following candidates have been identified:

– error correction on the header;

– Quality of Service identification (e.g. delay or loss priority);

– payload type (e.g. virtual circuit test cells);

– cell loss detection;

– access control at the user-network interface (UNI);

– cell sequence numbering;

– terminal identifier;

– virtual path identification;

– line equipment identification.

4.3 *Header format*

VCI and error control are supported by explicit fields. Whether identified functions are explicitly (by fields) or implicitly (by VCI) supported is for further study.

4.4 *Header size*

The size of the header should be chosen in the range of 3 to 8 octets. To determine the appropriate size, urgent study on the header functions mentioned in § 4.2 and on the capacity for future and additional uses is recommended. As an objective, the header size should be the same at all reference points. The feasibility of this is for further study.

4.5 *Information field size*

The size of the information field should be chosen in the range of 32 to 120 octets. To determine the appropriate size, the two following items need urgent study:

– end-to-end Quality of Service covering acceptable end-to-end delay and loss of information;

– transmission efficiency: the information field size-to-header size ratio should allow all existing and envisaged services to be efficiently supported on the transmission media.

5 Broadband channel rates

In this section channels refer to virtual channels with appropriate transmission channel bit rates. In addition to B, H_o and H_1 channels, B-ISDN will support broadband channels H_2 and H_4 having the following bit rates:

1) H_{21} broadband channel: 32 768 kbit/s;

2) H_{22} broadband channel:

– in the approximate range of 43 to 45 Mbit/s;

– an integer multiple of 64 kbit/s;

– not greater than the payload of existing third level asynchronous transmission systems of the 1.5 Mbit/s based hierarchy.

Consistent with these three requirements, one objective is to maximize the bit rate of the H_{22} broadband channel.

3) H_4 broadband channel:

– in the range of 132 to 138.240 Mbit/s;

– an integer multiple of 64 kbit/s.

When subsequently defining the exact bit rate, the following factors will be taken into account:

– the ATM basis of the 150 Mbit/s user network interface;

– the possible need, during an interim period, to use STM techniques to carry the bit stream of this channel in transmission systems based on the existing and the new digital hierarchy;

– the possible need to support a television signal multiplex as specified by the CMTT.

The final specification of H_{22} and H_4 broadband channel rates should be such that:

$$4 \times H_{21} \text{ rate } H_4 \text{ rate}$$

$$3 \times H_{22} \text{ rate } H_4 \text{ rate}$$

Additional broadband channels may be defined if necessary.

6 User-network interface (UNI)

6.1 *General*

This section defines some structural, physical and functional characteristics of broadband user-network interfaces. The characteristics discussed apply to interfaces at the T_B and at the S_B reference points. The commonality between the interface of T_B and at S_B reference points is a matter of further study.

B-ISDN user-network interfaces will be standardized at two bit rates. One of these will be at approximately 150 Mbit/s and the other will be at approximately 600 Mbit/s. The broadband UNI need not be symmetrical. Each of these interfaces must be capable of supporting broadband services as well as 64 kbit/s based ISDN services.

As an objective, the target solution for both B-ISDN user-network interfaces is based on ATM.

Other interface capabilities such as maintenance are not considered in this section.

6.2 *Structure of 150 Mbit/s UNI*

The structure of 150 Mbit/s UNI will be unique and will be based on one of the following alternatives:

1) ATM

This structure shown in case *a)* and case *b)* of Figure 7/I.121 uses only labelled multiplexing with cell interleaving. This category has two possible alternatives:

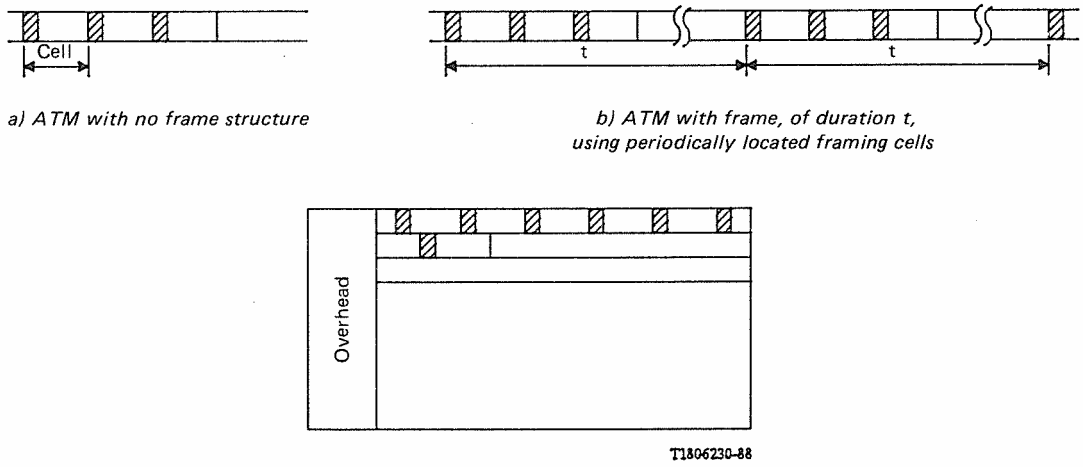
a) no frame structure is imposed on this interface;

b) all cells are aligned in a frame structure constructed by periodically located synchronization cells.

2) ATM within a non-ATM frame

This structure, shown in case *c)* of Figure 7/I.121, places ATM cells in the payload of a frame constructed by using overhead not based on ATM cells.

Note – In the evolution to B-ISDN, a frame structure similar to case *e)* of Figure 8/I.121 may also be considered as one alternative.



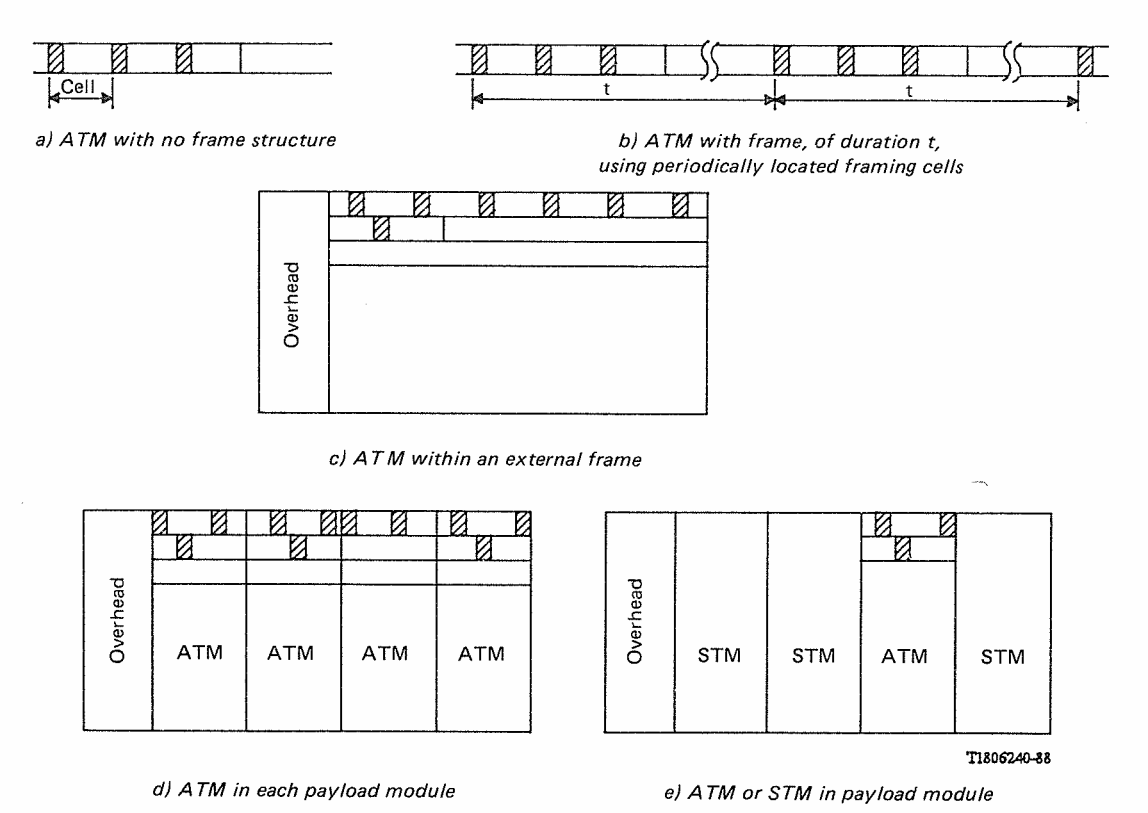
a) ATM with no frame structure

b) ATM with frame, of duration t, using periodically located framing cells

c) UNI structure with ATM within an external frame

FIGURE 7/I.121

Structures for 150 Mbit/s user-network interface (UNI)



a) ATM with no frame structure

b) ATM with frame, of duration t, using periodically located framing cells

c) ATM within an external frame

d) ATM in each payload module

e) ATM or STM in payload module

Note – These diagrams are illustrative only; the actual multiplexing methods are to be defined.

FIGURE 8/I.121

Structures for 600 Mbit/s user-network interface (UNI)

6.3 *Structure of 600 Mbit/s UNI*

Five candidate structures as shown in Figure 8/I.121 have been identified for the 600 Mbit/s UNI. Structures shown in cases *a), b)* and *c)* of Figure 8/I.121 are identical to cases *a), b)* and *c)* of Figure 7/I.121. Structures shown in cases *d)* and *e)* of Figure 8/I.121 have the payload partitioned into payload modules, where case *e)* shows some of these in STM, for possible use in an interim period.

The 600 Mbit/s UNI may be constructed as if derived by (bit, byte, cell) interleaving of four 150 Mbit/s structures and in this case, the gross bit rate of the 600 Mbit/s UNI will be four times the gross bit rate of the 150 Mbit/s UNI.

The structure of the 600 Mbit/s interface may need to provide for the capability of supporting services whose rates exceed the rate of the H_4 broadband channel. This item requires further study.

6.4 *Physical and functional characteristics*

6.4.1 *Physical characteristics*

Layer 1 of the broadband UNI requires electrical or optical transmission capable of supporting the requisite rate.

As an objective, the interfaces should allow for the support of point-to-multipoint configurations.

6.4.2 *Functional characteristics*

The channel mix need not be the same in both directions of transmission.

6.4.3 *Timing characteristics*

The NT1 will derive bit timing information from the aggregate bit stream received from the network.

In case *a)* of Figure 7/I.121 and of Figure 8/I.121, no frame timing is provided. Only cell delineation is provided using randomly located synchronization cells.

In case *b)* of Figure 7/I.121 and of Figure 8/I.121, frame timing is provided using periodically located synchronization cells.

In case *c)* of Figure 7/I.121 and cases *c), d)* and *e)* of Figure 8/I.121, frame timing is provided from the overhead information. The ATM stream within the payload or a payload module may be self delineated, i.e. cells are delineated by inserting synchronization cells randomly or periodically. Alternatively, cell delineation can be achieved by using the periodic structure of the payload.

In all cases the exact method for cell delineation is for further study.

7 Network aspects

7.1 *Generalities*

UNI will be defined according to user needs. Maximum commonality between UNI and the network node interfaces is aimed for.

7.2 *Transmission of ATM*

ATM can be supported by any digital transmission hierarchy or system (e.g. existing hierarchies of Rec. G.702, the proposed synchronous hierarchy of Rec. G.707, G.708, G.709 and any future hierarchy that may be defined). The transfer of information by means of a stream of cells is the basic concept of ATM. It is desirable to be able to perform this process at the highest practical bit rate. Standardization of a broadband digital transmission hierarchy has to accommodate these principles.

7.3 *Synchronization*

The need for synchronization in the ATM network requires further study.

7.4 *Signalling*

In B-ISDN, signalling and user information are carried on separate ATM virtual channels. A user may have multiple signalling entities connected to the network connection control management via separate ATM virtual channels. Enhanced or extended I.441 and I.451 access protocols will be used in B-ISDN to accommodate the additional B-ISDN capabilities.

7.5 *Traffic management and usage monitoring*

7.5.1 *Source characterization*

Two types of service sources can be classified according to the traffic patterns they produce:

– constant traffic sources. Constant traffic sources produce a fixed rate of information, e.g. PCM encoded speech;

– variable traffic sources. Variable traffic sources produce a variable rate of information, e.g. bursty data sources.

7.5.2 *Source indication at call establishment*

The signalling messages sent by a user to establish a call may include the following type of information:

– source traffic characteristics, e.g. burstiness;

– required network transport capabilities, e.g. Quality of Service parameters.

7.5.3 *Network resource management at call establishment*

In response to the source indication the network may manage resources in several ways, such as:

– dedicate resources to a given connection;

– share resources among multiple connections;

– share resources among a class of connections (e.g. connections supporting bursty data sources).

For each of the above-mentioned alternatives, networks may manage resources according to the following examples:

– *Case A*

In this case sufficient resources are provided to accommodate the expected maximum source bit rate. It could be used for continuous bit stream oriented services, as well as other services.

– *Case B*

In this case resources are provided at a level somewhere between the expected peak and average source bit rate. This strategy could be applied to bursty sources.

Other ways of managing resources may also be envisaged.

7.5.4 *Usage monitoring*

In ATM a user could attempt to send traffic exceeding the characteristic negotiated at call establishment. ATM networks will provide usage monitoring to detect such situations. When the negotiated capacity is being exceeded, appropriate action is taken by the network to protect the Quality of Service provided to other network users.

7.5.5 *Flow control*

For further study.

7.5.6 *Congestion handling*

For further study.

8 Adaptation between ATM and non-ATM parts of the ISDN

Interworking is envisaged between ATM based and 64 kbit/s based networks and terminals. For that purpose, network adaptations and terminal adaptations will be defined, for example:

– to connect a terminal according to standardized interfaces (I-Series Recommendations) to the ATM network;

– to provide internetworking between ATM and 64 kbit/s based parts of the ISDN.

This item requires further study.

ANNEX A

(to Recommendation I.121)

Examples of broadband services

Table A-1/I.121 contains examples of possible services, their applications and some possible attribute values describing the main characteristics of the services.

TABLE A-1/I.121

Possible broadband services in ISDN [a]

Service classes	Type of information	Examples of broadband services	Applications	Some possible attribute values [g], [h]
Conversational services	Moving pictures (video) and sound	Broadband [b], [c] video-telephony	Communication for the transfer of voice (sound), moving pictures, and video scanned still images and documents between two locations (person-to-person) [c] – Tele-education – Tele-shopping – Tele-advertising	– Demand/reserved/permanent – Point-to-point/multipoint – Bidirectional symmetric/bidirectional asymmetric – (Value for information transfer rate is under study)
		Broadband [b], [c] videoconference	Multipoint communication for the transfer of voice (sound), moving pictures, and video scanned still images and documents between two or more locations (personne-to-group, group-to-group [c] – Tele-education – Tele-shopping – Tele-advertising	– Demand/reserved/permanent – Point-to-point/multipoint – Bidirectional symmetric/bidirectional asymmetric
		Video-surveillance	– Building security – Traffic monitoring	– Demand/reserved/permanent – Point-to-point/multipoint – Bidirectional symmetric/unidirectional
		Video/audio information transmission service	– TV signal transfer – Video/audio dialogue – Contribution of information	– Demand/reserved/permanent – Point-to-point/multipoint – Bidirectional symmetric/bidirectional asymmetric
	Sound	Multiple sound-programme signals	– Multilingual commentary channels – Multiple programme transfers	– Demand/reserved/permanent – Point-to-point/multipoint – Bidirectional symmetric/bidirectional asymmetric

	Data	High speed unrestricted digital information transmission service	– High speed data transfer
			  – LAN (local area network) interconnection
			  – Computer-computer interconnection
			– Transfer of video and other information types
			– Still image transfer
			– Multi-site interactive CAD/CAM
				– Demand/reserved/permanent
				– Point-to-point/multipoint
				– Bidirectional symmetric/bidirectional asymmetric

		High volume file transfer service	– Data file transfer	– Demand – Point-to-point/multipoint – Bidirectional symmetric/bidirectional asymmetric

TABLE A-1/I.121 (*continued*)

Service classes	Type of information	Examples of broadband services	Applications	Some possible attribute values [g), h)]
Conversational services *(continued)*	Data *(continued)*	High speed teleaction	– Realtime control – Telemetry – Alarms	
	Document	High speed Telefax	User-to-user transfer of text, images, drawings, etc.	– Demand – Point-to-point/multipoint – Bidirectional symmetric/bi-directional asymmetric
		High resolution image communication service	– Professional images – Medical images – Remote games and game networks	
		Document communication service	User-to-user transfer of mixed documents [d)]	– Demand – Point-to-point/multipoint – Bidirectional symmetric/bi-directional asymmetric
Messaging services	Moving pictures (video) and sound	Video mail service	Electronic mailbox service for the transfer of moving pictures and accompanying sound	– Demand – Point-to-point/multipoint – Bidirectional symmetric/uni directional (for further study)
	Document	Document mail service	Electronic mailbox service for mixed documents [d)]	– Demand – Point-to-point/multipoint – Bidirectional symmetric/uni directional (for further study)
Retrieval services	Text, data, graphics, sound, still images, moving pictures	Broadband videotex	– Videotex including moving pictures – Remote education and training – Telesoftware – Tele-shopping – Tele-advertising – News retrieval	– Demand – Point-to-point – Bidirectional asymmetric
		Video retrieval service	– Entertainment purposes – Remote education and training	– Demand/reserved – Point-to-point/multipoint [f)] – Bidirectional asymmetric
		High resolution image retrieval service	– Entertainment purposes – Remote education and training – Professional image communications – Medical image communications	– Demand/reserved – Point-to-point/multipoint [f)] – Bidirectional asymmetric
		Document retrieval service	"Mixed documents" retrieval from information centres, archives, etc. [d), e)]	– Demand – Point-to-point/multipoint [f)] – Bidirectional asymmetric
		Data retrieval service	Telesoftware	

TABLE A-1/I.121 (*continued*)

Service classes	Type of information	Examples of broadband services	Applications	Some possible attribute values [g), h)]
Distribution services without user individual presentation control	Video	Existing quality TV distribution service (PAL, SECAM, NTSC)	TV programme distribution	– Demand (selection)/permanent – Broadcast – Bidirectional asymmetric/unidirectional
		Extended quality TV distribution service – Enchanced definition TV distribution service – High quality TV	TV programme distribution	– Demand (selection)/permanent – Broadcast – Bidirectional asymmetric/unidirectional
		High definition TV distribution service	TV programme distribution	– Demand (selection)/permanent – Broadcast – Bidirectional asymmetric/unidirectional
		Pay-TV (pay-per-view, pay-per-channel)	TV programme distribution	– Demand (selection)/permanent – Broadcast/multipoint – Bidirectional asymmetric/unidirectional
	Text, graphics, still images	Document distribution service	– Electronic newspaper – Electronic publishing	– Demand (selection/permanent – Broadcast/multipoint [f)] – Bidirectional asymmetric/unidirectional
	Data	High speed unrestricted digital information distribution service	– Distribution of unrestricted data	– Permanent – Broadcast – Unidirectional
	Moving pictures and sound	Video information distribution service	– Distribution of video/audio signals	– Permanent – Broadcast – Unidirectional
Distribution services with user individual presentation control	Text, graphics, sound, still images	Full channel broadcast videography	– Remote education and training – Tele-advertising – News retrieval – Telesoftware	– Permanent – Broadcast – Unidirectional

Notes to Table A-1/I.121:

a) In this table only those broadband services are considered which may require higher transfer capacity than that of the H_1 capacity. Services for sound retrieval, main sound applications and visual services with reduced or highly reduced resolutions are not listed.

b) This terminology indicates that a re-definition regarding existing terms has taken place. The new terms may or may not exist for a transition period.

c) The realization of the different applications may require the definition of different quality classes.

d) "Mixed document" means that a document may contain text, graphic, still and moving picture information as well as voice annotation.

e) Special high layer functions are necessary if post-processing after retrieval is required.

f) Further study is required to indicate whether the point-to-multipoint connection represents in this case a main application.

g) At present, the packet mode is dedicated to non-realtime applications. Depending on the final definition of the packet transfer mode, further applications may appear. The application of this attribute value requires further study.

h) For the moment this column merely highlights some possible attribute values to give a general indication of the characteristics of these services. The full specification of these services will require a listing of all values which will be defined for broadband services in Recommendations of the I.200-Series.

ANNEX B

(to Recommendation I.121)

Definitions of possible broadband service families and their attribute values

B.1 broadband unrestricted bearer services

B.1.1 *Definition*

Bearer services which provide unrestricted end-to-end transfer of digital information without alteration between S_B/T_B reference points and require broadband channel rates. User information is transferred over standardized broadband channels for STM (circuit) services or a virtual channel of defined capacity for ATM based services; signalling is provided over a signalling channel.

B.1.2 *Attribute description*

See Table B-1/I.121.

B.2 high quality broadband videotelephony services

B.2.1 *Definition*

High quality broadband videotelephony services are symmetrical real-time, bi-directional audio-visual services which provide person-to-person communication for the transfer of high quality voice (sound), moving pictures, and optionally video-scanned still images between two locations.

B.2.2 *Attribute description*

See Table B-2/I.121.

TABLE B-1/I.121

Broadband unrestricted bearer services

Attributes	Values		
Information transfer attributes 1. Information transfer mode [a]	STM (circuit)	ATM	
		Deterministic [b]	Statistical [b]
2. Information transfer rate (Mbit/s)	H_{21}, H_{22} or H_4 channel bit-rate		
2.1 Peak bit rate (throughput)		H_{21}, H_{22} or H_4 channel or other bit rate	H_{21}, H_{22} or H_4 channel or other bit rate
2.2 Average bit rate [c]		As peak bit rate	Under study
3. Information transfer capability	Unrestricted	Unrestricted	
4. Structure	Unstructured or 8 kHz integrity [d]	For further study	
5. Etablishment of communication	Demand/reserved/permanent	Demand/reserved/permanent	
6. Communication configuration	Point-to-point/multipoint/broadcast	Point-to-point/multipoint/broadcast	
7. Symmetry	Bidirectional symmetric/bidirectional asymmetric/unidirectional	Bidirectional symmetric/bidirectional asymmetric/unidirectional	
Access attributes 8. Access channel and rate (kbit/s) 8.1 User information	H_{21}, H_{22} or H_4 for user information	Virtual channel with H_{21}, H_{22} or H_4 channel or other bit rates	
8.2 Signalling/selecting	Signalling channel for signalling and OAM [e] – under study	Signalling channel for signalling and OAM [e] – under study	
9. Access protocols Signalling access Protocols 9.1 Layer 1 9.2 Layer 2 9.3 Layer 3 Information access protocols 9.4 Layer 1 9.5 Layer 2 9.6 Layer 3	To be defined I.440/441, I.450/451 } Need additions for broadband communication To be defined – [f] – [f]	To be defined I.440/441, I.450/451 } Need additions for broadband communication To be defined – [f] – [f]	
General attributes 10. Supplementary services provided	For further study	For further study	
11. Quality of service – End-to-end transfer delay – Delay jitter (cell jitter) – Error characteristics – Information loss probability	For further study	For further study	

TABLE B-1/I.121 (*continued*)

Attributes	Values	
12. Interworking possibilities	For further study	For further study
13. Operational and commercial	For further study. This study should include maintenance facilities.	For further study. This study should include maintenance facilities.

a) The values for the information transfer mode attribute need further study. For example, the distinction between the STM (circuit) and the ATM (deterministic) values needs to be investigated.

b) In the ATM deterministic mode a transfer capacity of the peak bit rate will be provided to the user all the time (average bit rate = peak bit rate). In the ATM statistical mode a transfer capacity of only the average gross bit rate (i.e. the average net bit rate plus cell headers) will be provided to the user (depending on the throughput class).

c) Average over, for example, 100 ms.

d) Further study is needed.

e) For reserved/permanent service the operational, administrative and maintenance messages (OAM) related to this service may be conveyed over the signalling channel.

f) User defined.

TABLE B-2/I.121

High quality broadband videotelephony services[a)]

Attributes	Values		
Information transfer attributes 1. Information transfer mode [b)]	STM (circuit)	ATM	
		Deterministic [c)]	Statistical [c)]
2. Information transfer rate [d)] (Mbit/s)	H_{21}, H_{22} or H_4 channel bit-rate		
2.1 Peak bit rate (throughput)		H_{21}, H_{22} or H_4 channel or other bit rate	H_{21}, H_{22} or H_4 channel or other bit rate
2.2 Average bit rate [e)]		As peak bit rate	Under study
3. Information transfer capability	High quality video + 15 kHz audio + user-to-user messages	High quality video + 15 kHz audio + User-to-user messages	
4. Structure	Unstructured	For further study	
5. Establishment of communication	Demand/reserved/permanent	Demand/reserved/permanent	
6. Communication configuration	Point-to-point/multipoint	Point-to-point/multipoint	
7. Symmetry	Bidirectional symmetric	Bidirectional symmetric	
Access attributes 8. Access channel and rate	H_2 or H_4 (bit rates under study) for user information		
8.1 User information		Virtual channel with H_{21}, H_{22} or H_4 channel or other bit rate	Virtual channel with H_{21}, H_{22} or H_4 channel or other bit rate
8.2 Signalling	Signalling channel for signalling and OAM-under study	Signalling channel under study	
9. Access protocols Signalling access protocols 9.1 Layer 1 9.2 Layer 2 9.3 Layer 3	To be defined I.440/441, I.450/451: Need additions for broadband communication	To be defined I.440/441, I.450/451: Need additions for broadband communication	
Information access protocols 9.4 Layer 1 9.5 Layer 2 9.6 Layer 3	To be defined Under study	To be defined Under study	
High layer attributes 10. Type of user information	Moving pictures + sound + user-to-user messages		
11. Transport (layer 4) functions/protocol	Under study		
12. Session (layer 5) functions/protocol	Under study		

TABLE B-2/I.121 (*continued*)

Attributes	Values	
13. Presentation (layer 6) functions/protocol 13.1 Video 13.2 Audio 13.3 Auxiliary 13.4 User-to-user messages	Under study. This study should include video, sound, auxiliary information such as text, facsimile, etc., and user-to-user control messages	
14. Application (layer 7) function/protocol 14.1 Video 14.2 Audio 14.3 Auxiliary 14.4 User-to-user messages	Under study	
General attributes 15. Supplementary services provided	As for telephony; others under study	
16. Quality of service 16.1 Video	Equal to or higher than existing TV	
16.2 Audio	15 kHz stereo [f]	
– End-to-end transfer delay – Delay jitter (call jitter) – Error characteristics – Information loss probability	Under study	Under study
17. Interworking possibilities	With other videotelephone, telephone, and video-conference services	
18. Operational and commercial	For further study. This study should include maintenance facilities	

a) The attribute values characterize a videoconference service providing high video quality equal or higher than existing TV standards. Until now only coding mechanisms for those video qualities have been available which require transfer bit rates equal to or higher than, the H_{21}-channel bit rate. Due to future development in research of coding algorithms and techniques, the transfer bit rates necessary for those video qualities may decrease.

b) The values for the information transfer mode attribute need further study. For example, the distinction between the STM (circuit) and the ATM (deterministic) values needs to be investigated.

c) In the ATM deterministic mode a transfer capability of the peak bit rate will be provided to the user all the time (average bit rate = peak bit rate). In the ATM statistical mode a transfer capacity of only the average gross bit rate (i.e. the average net bit rate plus cell headers) will be provided to the user (depending on the throughput class).

d) The broadband network is free to process the bit-stream (e.g. compression, conversion to analogue etc.) as long as end-to-end service quality requirements are satisfied.

e) Average over, for example, 100 ms.

f) This value may be restricted to 7 kHz only at the electro-acoustic interface at the TE due to possible echo cancellation problems in case of band-free application.

B.3 high quality broadband videoconference services

B.3.1 *Definition*

High Quality Broadband Videoconference services provide person-to-person or group-to-group capability for the transfer of different high quality information types primarily including voice (sound), full motion video, moving

pictures, and, optionally, video-scanned still images, documents and other video information, to support conferencing between two or more locations.

B.3.2 *Attribute description*

See Table B-3/I.121.

B.4 high definition TV and existing quality TV distribution services

B.4.1 *Definition*

High definition TV (HDTV)/existing quality TV distribution services provide the capability of distributing TV programmes with the quality of HDTV/existing quality TV as appropriate.

B.4.2 *Attribute description*

See Table B-4/I.121.

B.5 broadband videotex services

B.5.1 *Definition*

Broadband Videotex services are interactive services which provide, through appropriate access by standardized procedures, for users of broadband videotex terminals to communicate with data bases via telecommunications networks.

TABLE B-3/I.121

High quality broadband videoconference services [a]

Attributes	Values		
Information transfer attributes 1. Information transfer mode [b]	STM (circuit)	ATM	
		Deterministic [c]	Statistical [c]
2. Information transfer rate [d] (Mbit/s)	H_{21}, H_{22} or H_4 channel bit-rate		
2.1 Peak bit rate (throughput)		H_{21}, H_{22} or H_4 channel or other bit rate	H_{21}, H_{22} or H_4 channel or other bit rate
2.2 average bit rate [e]		As peak bit rate	Under study
3. Information transfer capability	High quality video + 15 kHz audio + user-to-user messages	High quality video + 15 kHz audio stereo + user-to-user messages	
4. Structure	Unstructured	For further study	
5. Establishment of communication	Demand/reserved/permanent	Demand/reserved/permanent	
6. Communication configuration	Multipoint/point-to-point	Multipoint/point-to-point	
7. Symmetry	Bidirectional symmetric/bidirectional asymmetric/others for further study	Bidirectional symmetric/bidirectional asymmetric/others for further study	
Access attributes 8. Access channel and rate	H_2 or H_4 for user information (multipoint communication)		
8.1 User information		Virtual channel with H_2 or H_4 channel bit rate	Virtual channel with H_4 channel bit rate
8.2 Signalling	Signalling channel for signalling and OAM – under study	Signalling channel under study	
9. Access protocols Signalling access protocols 9.1 Layer 1 9.2 Layer 2 9.3 Layer 3 Information access protocols 9.4 Layer 1 9.5 Layer 2 9.6 Layer 3	To be defined I.440/441, I.450/451 } Need supplements for broadband communication To be defined Under study	To be defined I.440/441, I.450/451 } Need supplements for broadband communication To be defined Under study	
High layer attributes 10. Type of user information	Moving pictures + sound + user-to-user messages		
11. Transport (layer 4) functions/protocol	Under study		
12. Session (layer 5) functions/protocol	Under study		

TABLE B-3/I.121 (*continued*)

Attributes	Values	
13. Presentation (layer 6) functions/protocol 13.1 Video 13.2 Audio 13.3 Auxiliary 13.4 User-to-user messages	Under study. This study should include video, sound auxiliary information such as text, facsimile, etc., and user-to-user control messages	
14. Application (layer 7) function/protocol 14.1 Video 14.2 Audio 14.3 Auxiliary 14.4 User-to-user messages	Under study	
General attributes 15. Supplementary services provided	As for telephony; others under study	
16. Quality of service 16.1 Video	Equal to or higher than existing TV	
16.2 Audio	15 kHz stereo [f]	
– End-to-end transfer delay – Delay jitter (cell jitter) – Error characteristics – Information loss probability	Under study	Under study
17. Interworking possibilities	With other videoconference, videotelephone, and telephone services	
18. Operational and commercial	For further study. This study should include maintenance facilities	

a) The attribute values characterize a videoconference service providing high video quality equal to, or higher than, existing TV standards. Until now only coding mechanisms for those video qualities have been available which require transfer bit rates equal to, or higher than, the H_{21}-channel bit rate. Due to future development in research of coding algorithms and techniques, the transfer bit rates necessary for those video qualities may decrease.

b) The values for the information transfert mode attribute need further study. For example, the distinction between the STM (circuit) and the ATM (deterministic) values needs to be investigated.

c) In the ATM deterministic mode a transfer capability of the peak bit rate will be provided to the user all the time (average bit rate = peak bit rate). In the ATM statistical mode a transfer capacity of only the average gross bit rate (i.e. the average net bit rate plus cell headers) will be provided to the user (depending on the throughput class).

d) The broadband network is free to process the bit-stream (e.g. compression, conversion to analogue etc.) as long as end-to-end service quality requirements are satisfied.

e) Average over, for example, 100 ms.

f) This value may be restricted to 7 kHz only at the electro-acoustic interface at the TE due to possible echo cancellation problems in case of band-free application.

TABLE B-4/I.121

High definition TV (HDTV) distribution services and existing quality TV distribution services

Attributes	Existing quality TV distribution service [a) b)]			HDTV distribution service	
	Values			Values	
Information transfer attributes 1. Information transfer mode [c)]	STM (circuit)	ATM		STM (circuit)	ATM
		Deterministic [d)]	Statistical [d)]		Deterministic [d)]
2. Information transfer rate (Mbit/s)	H_{21}, H_{22} or H_4-channel bit-rate			H_4-channel bit rate or greater	
2.1 Peak bit rate (throughput)		H_{21}, H_{22} or H_4 channel or other bit rate		n/a	H_4-channel bit rate or greater
2.2 Average bit rate [e)]		As peak bit rate	Under study	n/a	As peak bit rate
3. Information transfer capability	High quality video + 15 kHz audio stereo	High quality video + 15 kHz audio stereo		HDTV quality video + 15 kHz audio stereo	
4. Structure	Unstructured	Service data unit integrity		Unstructured	For further study
5. Establishment of communication	Demand/reserved	Demand/reserved		Demand/reserved	Demand/reserved
6. Communication configuration	Broadcast (other values for further study)	Broadcast (other values for further study)		Broadcast (other values for further study)	Broadcast (other values for further study)
7. Symmetry	Unidirectional	Unidirectional		Unidirectional	Unidirectional
Access attributes 8. Access channel and rate 8.1 User information	H_2 or H_4 (bits rates under study) for user information	Virtual channel with H_{21}, H_{22} or H_4 channel or other bit rate	Virtual channel with H_{21}, H_{22} or H_4 channel or other bit rate	Virtual channel dependent on the necessary information transfer rate	
8.2 Signalling/selecting	D channel or a special channel for distribution service signalling	D channel or special channel (under study)			D channel or special channel (under study)

TABLE B-4/I.121 (*continued*)

Attributes	Existing quality TV distribution service [a) b)]		HDTV distribution service	
	Values		Values	
9. Access protocols Signalling access protocols 9.1 Layer 1 9.2 Layer 2 9.3 Layer 3	To be defined I.440/441, I.450/451 } Need supplements for broadband communication	To be defined I.440/441, I.450/451 } Need supplements for broadband communication	To be defined I.440/441, I.450/451 } Need supplements for broadband communication	To be defined
Information access protocols 9.4 Layer 1 9.5 Layer 2 9.6 Layer 3	To be defined Under study	To be defined Under study	To be defined Under study	To be defined Under study
High layer attributes 10. Type of user information	Moving picture + sound + data	Moving picture + sound + data	Moving picture + sound + data	
11. Transfer (layer 4) function/protocol	For further study	For further study	For further study	
12. Session (layer 5) function/protocol	For further study	For further study	For further study	
13. Presentation (layer 6) function/protocol 13.1 Video 13.2 Audio 13.3 Auxiliary 13.4 User-to-user messages	For further study, awaiting suitable coding schemes	For further study, awaiting suitable coding schemes	For further study, awaiting suitable coding schemes	
14. Application (layer 7) function/protocol 14.1 Video 14.2 Audio 14.3 Auxiliary 14.4 User-to-user messages	For further study	For further study	For further study	
General attributes 15. Supplementary services provided	For further study	For further study	For further study	

TABLE B-4/I.121 (*continued*)

Attributes	Existing quality TV distribution service [a) b)]		HDTV distribution service	
	Values		Values	
16. Quality of service 16.1 Video	Equal to existing TV	Equal to existing TV (or better)	HDTV quality	
16.2 Audio	Equal to existing high fidelity stereo standards (or better)	Equal to existing high fidelity stereo standards (or better)	Equal to existing high fidelity stereo standards (or better)	
– End-to-end transfer delay – Delay jitter (cell jitter) – Error characteristics – Information loss probability	Under study	Under study	Under study	Under study
17. Interworking possibilities	For further study	For further study	For further study	For further study
18. Operational and commercial	For further study	For further study	For further study	For further study

a) The attribute values characterize a TV distribution service providing high video quality equal to, or higher than, existing TV standards. Until now only coding mechanisms for those video qualities have been available which require transfer bit rates equal to, or higher than, the H_{21}-channel bit rate. Due to future development in research of coding algorithms and techniques, the transfer bit rates necessary for those video qualities may decrease.

b) Preliminary name.

c) The values for the information transfer mode attribute need further study. For example, the distinction between the STM (circuit) and the ATM (deterministic) values needs to be investigated.

d) In the ATM deterministic mode a transfer capacity of the peak bit rate will be provided to the user all the time (average bit rate = peak bit rate). In the ATM statistical mode a transfer capacity of only the average gross bit rate (i.e. the average net bit rate plus cell headers) will be provided to the user (depending on the throughput class).

e) Average over, for example, 100 ms.

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