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PART I

Recommendations Q.500 to Q.554

DIGITAL LOCAL, COMBINED, TRANSIT
AND INTERNATIONAL EXCHANGES IN INTEGRATED

DIGITAL NETWORKS AND MIXED ANALOGUE-DIGITAL NETWORKS

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SECTION 1

INTRODUCTION AND FIELD OF APPLICATION

Recommendation Q.500

DIGITAL LOCAL, COMBINED, TRANSIT AND INTERNATIONAL EXCHANGES

INTRODUCTION AND FIELD OF APPLICATION

1 Introduction

This series of Recommendations Q.500-554 applies to digital local, combined , transit and international exchanges for telephony in Integrated Digital Networks (IDNs) and mixed analogue/digital networks, and also to local, combined, transit and international exchanges in an Integrated Services Digital Network (ISDN).

The series of Recommendations comprises:

Q.500 Introduction and field of application

Q.511 Exchange interfaces towards other exchanges

Q.512 Exchange interfaces for subscriber access

Q.513 Exchange interfaces for operations, administration and maintenance

Q.521 Exchange functions

Q.522 Digital exchange connections, signalling and ancillary functions

Q.541 Design objectives — General

Q.542 Design objectives — Operations and Maintenance

Q.543 Performance design objectives

Q.544 Exchange measurements

Q.551 Transmission characteristics of digital exchanges

Q.552 Transmission characteristics at 2-wire analogue interfaces

Q.553 Transmission characteristics at 4-wire analogue interfaces

Q.554 Transmission characteristics at digital interfaces.

Considerations have been primarily on exchanges utilizing, at least in part, time division switching techniques. However, these Recommendations are implementation independent, and other system implementations using alternative techniques (e.g., space division switching) may be possible, which would meet the requirements of these Recommendations.

A ‘‘combined’’ digital exchange is one which includes both local exchange and transit exchange functions (see definition 1005 in Recommendation Q.9).

2 Field of application

These Recommendations are intended to be applied as indicated below.

2.1 *Application and evolution to the ISDN*

The selection of features, functions and interfaces to be provided in a digital local, combined, transit or international exchange in a particular network application will be determined by the administration concerned. Reference to a function in these Recommendations, including their diagrams, does not imply that it will necessarily be provided in every exchange type or configuration. Similarly, it is possible that some functions may be provided which are not mentioned.

2.2 *Relationship of design performance requirements to operational performance requirements*

Performance requirements as defined in this series of Recommendations should be considered as design objectives for systems under the conditions stated in the Recommendations. These conditions are defined by such parameters as average circuit occupancy, busy hour call attempts, etc. They should be distinguished from the operational performance requirements which administrations establish for exchanges operating in their particular environment.

Further clarification of this point can be obtained in Recommendation G.102.

3 The Q.500-Series of Recommendations

3.1 *Exchange interfaces (Recommendations Q.511, Q.512 and Q.513)*

The interface functions defined are those necessary for interworking with digital and analogue transmission systems on both circuits to other exchanges and on subscriber lines, and with telecommunications management networks.

3.1.1 *Characteristics of exchange interfaces towards other exchanges (Recommendation Q.511)*

This Recommendation describes the exchange interfaces used to provide transmission facilities towards other exchanges. It applies to digital local, combined, transit and international exchanges for telephony in integrated digital networks (IDN) and mixed (analogue/digital) networks, and also to local, combined, transit and international exchanges in an integrated services digital network (ISDN).

3.1.2 *Characteristics of exchange interfaces for subscriber access (Recommendation Q.512)*

The Recommendation describes the subscriber side interface characteristics. It applies to digital local and combined exchanges for telephony in Integrated Digital Networks (IDN) and mixed (analogue/digital) networks, and also to local and combined exchanges in an integrated digital network (ISDN).

3.1.3 *Exchange interfaces for operations, administration and maintenance (Recommendation Q.513)*

The interfaces defined are those necessary for transmission of messages associated with operations, administration and maintenance of the exchange.

These interfaces include OAM interfaces between the exchange and the following: OAM systems, mediation devices, user workstations, and other network elements.

3.1.4 *Interfaces to non-voice handling facilities*

The need for the Recommendation of interfaces between digital transit, local and combined exchanges and non-voice handling facilities remains for further study. (An example of such a non-voice facility is a packet switched data node.) Attention is drawn to Recommendation X.300 which describes the general principles for interworking between public data networks and also to the I.400/I.500-Series Recommendations for interworking between ISDN and other dedicated networks.

3.2 *Exchange functions (Recommendation Q.521)*

This Recommendation covers the definition of the principal exchange functions to support services and includes a description of an exchange functional model.

3.3 *Exchange connections, signalling and ancillary functions (Recommendation Q.522)*

This Recommendation covers the following functions:

a) *Connections through an exchange*

This section includes the switch block(s), the characteristics associated with connections through exchanges and a set of diagrams showing typical types of connection.

A connection through an exchange may include one or more stages of time and/or space division switching, providing a path for transmission through the exchange.

b) *Signalling*

Signalling includes reception of call-related and other information, interaction with the call control function and transfer of information to subscribers and network(s) as required.

Signalling may involve common channel and/or channel associated signalling.

c) *Control and call handling*

Control and call handling includes initiation, supervision and termination of most actions in the exchange.

Commands are initiated and information passed/received to/from the other functions within the exchange.

Control functions may be contained in one block or distributed throughout the exchange.

d) *Ancillaries*

Examples of such functions are:

— recorded announcements;

— tone generation;

— conferencing facilities.

Their location is dependent on the function itself and the exchange configuration.

3.4 *Exchange design objectives (Recommendations Q.541, Q.542, Q.543 and Q.544)*

3.4.1 *General design objectives (Recommendation Q.541)*

This includes the general design objective principles, availability and hardware design objectives as well as the design objectives associated with the operation of an exchange in an Integrated Digital Network. The latter encompasses timing and synchronization design objectives.

Timing comprises the generation and distribution of timing signals and includes timing of outgoing signals. It enables those parts of the exchange which form the switched path of a connection to operate synchronously. Synchronization will depend on the national synchronization plan and exchange timing arrangements.

Exchanges will usually extract synchronizing information from one or more incoming bit streams or a separate synchronization network and use this to adjust the timing signals generated in the distribution within the exchange.

3.4.2 *Operations and maintenance design objectives (Recommendation Q.542)*

This covers the operations and maintenance design objectives including network management controls, alarm handling and subscriber line maintenance and testing.

3.4.3 *Performance design objectives (Recommendation Q.543)*

Exchange performance design objectives are defined for guiding system design and for comparing the capabilities of different systems. (Recommendations relating to provisioning and operational performance of exchanges in the network are covered in the E.500-E.543 Series.)

3.4.4 *Exchange measurements (Recommendation Q.544)*

Measurements that may be used for planning, operation, maintenance and network management of exchanges and their associated networks are described. The measurement data consists primarily of event counts and traffic intensity levels experienced by the various traffic handling elements of the exchange.

3.5 *Transmission characteristics (Recommendations Q.551 to Q.554)*

3.5.1 *Transmission characteristics of digital exchanges (Recommendation Q.551)*

This includes the general definitions associated with Recommendations Q.551 to Q.554, and transmission parameters from a total exchange perspective such as absolute group delay and the transfer function for jitter and wander. These Recommendations define, for any connection which may be set up by a local, combined, transit or international exchange, the necessary levels of transmission performance to conform with overall objectives for the complete user-to-user connections in which the exchange may be involved.

3.5.2 *Transmission characteristics at 2-wire interfaces (Recommendation Q.552), 4-wire interfaces (Recommendation Q.553) and digital interfaces (Recommendation Q.554)*

These cover the detailed transmission characteristics of the various types of interface that may be provided on a digital exchange.

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SECTION 2

EXCHANGE INTERFACES, FUNCTIONS AND CONNECTIONS

Recommendation Q.511

EXCHANGE INTERFACES TOWARDS OTHER EXCHANGES

1 General

This Recommendation applies to digital local, combined, transit and international exchanges for telephony in Integrated Digital Networks (IDN) and mixed (analogue/digital) networks, and also to local, combined, transit and international exchanges in an Integrated Services Digital Network (ISDN).

The field of application of this Recommendation is more fully defined in Recommendation Q.500.

2 Scope of Recommendation

This Recommendation is not intended to define any systems or equipment in or connected to, a digital exchange via these interfaces. Therefore only the characteristics of the interfaces are described.

The exchange interfaces described in this Recommendation are used to connect these exchanges to transmission facilities towards other exchanges.

All interfaces that have been studied in detail are described, and illustrated in Figure 1/Q.511 but it is not intended to specify every interface. Other interfaces are for further study (e.g., those for broadband facilities).

3 Characteristics of digital interfaces towards other exchanges

3.1 *Interface A*

3.1.1 *General*

Interface A is a digital interface to allow interconnection at the first level of a digital transmission hierarchy towards other exchanges.

3.1.2 *Electrical characteristics*

The electrical characteristics of interface A are described in Recommendation G.703.

The frame structure at interface A should be identical to that of the first order multiplexes described in Recommendations G.704 and G.705.

Timing in the transmitting direction will be derived within the digital exchange.

Figure 1/Q.511, p.1

3.1.3 *Channel types, channel allocation and signalling* :

— number of channel timeslots per frame: 32B/F24, numbered 0-31B/F1-24;

— additional channel timeslots may be utilized for common channel signalling when more signalling capacity is required between exchanges. For 2048 kbitB/Fs systems, they should be selected from the channel timeslots allocated in PCM multiplexes for data purposes according to Recommendation G.735. When no such channel timeslots are allocated or available, additional channel timeslots may be selected from channel timeslots allocated for voice channels.

For 2048 kbit/s systems:

— channel timeslot 16 is primarily intended for signalling but should be switchable. On systems between exchanges (not involving PCM primary muldex) when channel 16 is not assigned to carry signalling it may be allocated to speech or other srvices;

— channel timeslot 0 is used for frame alignment, alarm indication, network synchronization and other purposes;

— although no specific application is at present foreseen for switching timeslot 0, it is recommended that the possibility of read and write access to this timeslot should be retained as a safeguard for future requirements. Such access would allow processing of some or all of the information contained in this timeslot, in particular those bits reserved for national and international use. The need to switch channel timeslot 0 as a normal channel, without special access, requires further study. In any case the incoming frame alignment signal will not be passed through the exchange to an outgoing system.

3.1.4 *Functional characteristics*

The use of the Cyclic Redundancy Check (CRC) procedures described in Recommendation G.704 is recommended for interfaces which carry ISDN traffic and optional for other applications. The frame alignment, CRC multiframe alignment and CRC monitoring functions are in accordance with Recommendation G.706.

3.2 *Interface B*

3.2.1 *General*

Interface B is a digital interface to allow interconnection at the second level of a digital transmission hierarchy towards other exchanges.

3.2.2 *Electrical characteristics*

The electrical characteristics of interface B are described in Recommendation G.703.

The frame structure at interface B should be identical to that of the second order multiplexes described in Recommendations G.704 and G.705.

Timing in the transmitting direction will be derived within the digital exchange.

3.2.3 *Channel types, channel allocation and signalling* :

— number of channels: 132/98 numbered 0-131/1-98.

For 8448 kbit/s systems:

— where signalling capacity is required between exchanges, timeslots 67, 68, 69 and 70 can be utilized for signalling in this order of descending priority. Those channels not used for signalling can be used for speech or other purposes. If a channel timeslot is reserved for service purposes within the switch, it shall be channel timeslot 1;

— it is left for mutual agreement whether or not channel timeslot 1 will carry traffic;

— 128 of the channel timeslots may carry traffic through the exchange.

For 6312 kbit/s systems:

— the multiplex structure contains 5 bits and 98 channel timeslots, numbered 1-98, each of 64 kbit/s, of which 96 may carry traffic through the exchange;

— five bits per frame are assigned for a frame alignment signal and for other signals. Timeslots 97 and 98 are assigned to signalling between exchanges.

3.2.4 *Functional characteristics*

The use of the Cyclic Redundancy Check (CRC) procedures described in Recommendation G.704, is recommended for interfaces which carry ISDN traffic and optional for other applications. The frame alignment, CRC multiframe alignment and CRC monitoring functions are in accordance with Recommendation G.706.

4 Characteristics of analogue interfaces towards other exchanges

4.1 *Interface C*

4.1.1 *General*

Interface C is a 2-wire or a 4-wire analogue interface, used where direct interconnection analogue facilities is required. This implies that a PCM codec, associated with this interface, is incorporated in the digital exchange. The equipment on the exchange side of interface C may include a muldex within the exchange termination functions. Differences in circuit configurations with respect to transmission parameters are likely to result in the need to specify a number of different C interfaces, depending on the application environment. This is likely to reduce the flexibility in interconnection possibilities. These C interfaces are specified in Recommendation Q.551. The transmission characteristics of 2-wire interface C2 are described in Recommendation Q.552 and of 4-wire interface C1 in Recommendation Q.553.

4.1.2 *Channel types, channel allocation and signalling*

The signalling characteristics of interface C vary considerably from country to country, and therefore it is not intended that this interface should be the subject of CCITT Recommendations beyond those aspects covered in Recommendations Q.552 and Q.553.

Recommendation Q.512

EXCHANGE INTERFACES FOR SUBSCRIBER ACCESS

1 General

This Recommendation applies to digital local and combined exchanges for telephony in Integrated Digital Networks (IDN) and mixed (analogue/digital) networks, and also to local and combined exchanges in Integrated Services

Digital Networks (ISDN). The field of application of this Recommendation is more fully defined in Recommendation Q.500.

2 Scope of Recommendation

Exchange interfaces for subscriber access that have been considered are described, and illustrated in Figure 1/Q.512 and Table 1/Q.512, but it is not intended to specify every interface. Other interfaces are for further study (e.g., those for dynamic multiplexed basic rate access, broadband access, etc.).

Figure 1/Q.512, p.2

H.T. [T1.512]
TABLE 1/Q.512
Interface references

Access type	Interface/reference points	Paragraph	Related physical Recs.	Related OAM Recs.	Application to connect
Basic access digital section	V 1	3.2	(Note 1)	G.960 (Note 1) I.603	ISDN basic access (2B + D)
Generic digital section Digital network equipment, supporting any combination of access types }	V 2	3.3	None	{	
{ Generic subscriber access (Note 2) digital section }	V 3	3.4	G.703 G.704 G.705	G.706 I.604 (Note 3)	Digital subscriber equipment
{ Digital access link (Static multiplex) } A multiple of ISDN basic accesses }	V 4	3.5	G.706 I.605	{	
{ Generic analogue subscriber access }	Z	4.1	None (Note 4)	None	Analogue subscriber lines

Note 1 — Recommendation G.961 specifies the characteristics of a digital transmission system on metallic local lines which may form part of the basic access digital selection.

Note 2 — In the case of ISDN access this is the primary rate access digital section.

Note 3 — Only in the case of ISDN application, G.706 and I.604 are recommended.

Note 4 — Characteristics other than those defined in Recommendations Q.551 to Q.554 are not subject of CCITT Recommendation.

Table 1/Q.512 [T1.512], p.3

This Recommendation is not intended to define any transmission system, network or subscriber equipment in or connected to, a digital exchange via these interfaces. Therefore only the characteristics of the interfaces are described.

Digital exchange interfaces for subscriber access are defined at the V reference point which is the boundary between the ET and the digital access section or link. These interfaces are designated interface V and are defined to allow flexibility of implementation for different exchange and transmission equipment realizations. However, a physical interface will not be specified for all subscriber access types identified (see Figure 1/Q.512).

In this Recommendation, a digital section is defined as the whole of the means of digital transmission of a digital signal of specified rate between two consecutive reference points. A digital link comprises one or more digital sections and may include either a multiplexer or concentrator, but not switching.

3 Characteristics of digital exchange interfaces for subscriber access

3.1 *General*

As an objective, the characteristics of digital interfaces on the subscriber side of the exchange should be aligned with the characteristics of ISDN user/network access structures (Recommendation I.411).

However in many countries, digital access arrangements not structured according to ISDN principles are used, e.g., to ensure compatibility with existing networks and services and it is expected that these arrangements will continue to be used for several years. Only certain characteristics of these arrangements are the subject of CCITT Recommendations.

3.2 *Interface V_1*

3.2.1 *General*

Interface V_1 may be used at the V_1 reference point to connect to an ISDN basic access digital section for the provision of a single basic

access. The characteristics of the basic access digital section are defined in Recommendation G.960 and the characteristics and parameters of a digital transmission system which may form part of the digital section for the ISDN basic rate access are given in Recommendation G.961.

3.2.2 *Functional characteristics*

The functional description is illustrated in Figure 2/Q.512 and the following functional requirements are defined:

1) *(2B + D) channels*

To provide the bidirectional transmission capability for two B channels and one 16 kbit/s D channel as described in Recommendation I.412.

2) *Bit timing*

To provide bit (signal element) timing to enable the digital section to recover information from the aggregate bit stream.

3) *Frame timing*

To provide frame timing to enable digital section and ET to recover the time division multiplexed channels.

4) *CV*

The CV_1 channel provides, for each direction of transmission, the capability to transfer management functions required for the digital section as specified in Recommendations G.960 and I.603. The CV_1 channel may carry one or more functional links. These functions include activation from network side, activation request from a digital section, deactivation from ET side, operation and maintenance signals.

5) *Power feed*

This function provides for remote power feeding for the digital section and possibly terminal equipment. This function is optional.

3.2.3 *Electrical characteristics*

The electrical characteristics of interface V_1 are not subject to CCITT Recommendations.

3.2.4 *Channel types, channel allocation and signalling*

The channel types associated with interface V_1 include two B channels and one D channel as defined at the user network interface in Recommendation I.412. In addition, the CV_1 channel is required to support the operational and maintenance functions.

The channel allocation is not subject to CCITT Recommendations.

The D channel signalling procedures are defined in the Q.920 and Q.930-Series Recommendations.

Figure 2/Q.512, p.

3.3 *Interface V_2*

3.3.1 *General*

Interface V_2 is a generic digital interface used to connect remote or local digital network equipment via a first or second order digital section. This network equipment may support any combination of analogue, digital and ISDN subscriber access. The characteristics of this interface may not be structured according to the ISDN principles.

3.3.2 *Functional characteristics*

The functional characteristics depend on the specific application of the V_2 interface. These are not generally subject to CCITT Recommendations.

3.3.3 *Electrical characteristics*

The electrical characteristics of interface V_2 are described in Recommendation G.703.

The basic frame structure at interface V_2 should be identical to that of the first or second order rate multiplexes described in Recommendations G.704 and G.705.

3.3.4 *Channel types, channel allocation and signalling*

The channel types, channel allocation and signalling depends on the specific application of the V_2 interface. These are not generally subject to CCITT Recommendations.

3.4 *Interface V_3*

3.4.1 *General*

Interface V_3 is a digital interface used to connect digital subscriber equipment (e.g., PABX) via a generic digital subscriber section. The characteristics of this interface may not be structured according to the ISDN principles. In this case, only the electrical characteristics defined in § 3.4.2 are recommended. However, in the case of ISDN where interface V_3 is used to connect a primary rate access digital section for the provision of a single primary rate access, all of the following characteristics apply.

3.4.2 *Functional characteristics*

The use of the Cyclic Redundancy Check (CRC) procedures described in Recommendations G.704 and G.706 is recommended. The information on the status of the CRC processing shall be passed across the V_3 interface. The maintenance procedures are defined in Recommendation I.604.

3.4.3 *Electrical characteristics*

The electrical characteristics of interface V_3 are described in Recommendation G.703.

The frame structure at interface V_3 should be identical to that described in Recommendations G.704 and G.705.

3.4.4 *Channel types, channel allocation and signalling*

The channel types and allocation associated with interface V_3 are 30 B + 1 D at 2048 kbit/s or 23 B + 1 D at 1544 kbit/s as described in Recommendation I.431.

The channel allocation should also consider that:

a) when the signalling for the B channels in one primary rate structure is carried by the D channel in another primary rate structure, the channel timeslot normally used for signalling may be used to provide an additional B channel;

b) at interface V_3 the designated number of B channels is always present within the multiplexed channel structure, but one or more of the B channels may not be used in any given application.

The D channel signalling procedures are defined in the Q.920 and Q.930-Series Recommendations.

3.5 *Interface V_4*

3.5.1 *General*

Interface V_4 is a digital interface used to connect a digital access link which includes a static multiplexer supporting several basic access digital sections. The local digital multiplexer application is considered to be a subset of the remote digital multiplexer application.

3.5.2 *Functional characteristics*

The functional description is illustrated in Figure 3/Q.512 and the following functional requirements are defined:

— $m \times (2\text{ B} + \text{D} + \text{CV}_1)$: to provide the bidirectional transmission capability for the B, and D, CV_1 channels from each basic rate access section.

— Timing: to provide the necessary timing information for bit transmission, frame synchronization and subscriber line synchronization.

— Operations and maintenance: to provide the transmission capability to carry the operation and maintenance signals of the digital link and the basic access muldex as defined in I.605.

Figure 3/Q.512, p.

The use of the Cyclic Redundancy Check (CRC) procedures described in Recommendations G.704 and G.706 are recommended. The information on the status of the CRC processing shall be passed across the V_4 interface.

3.5.3 *Electrical characteristics*

The electrical characteristics of interface V_4 are described in Recommendation G.703.

The basic frame structure at interface V_4 should be identical to that of the first order multiplexes described in Recommendations G.704 and G.705.

3.5.4 *Channel types, channel allocation and signalling*

3.5.4.1 *General*

The V_4 interface is composed of a number of individual ISDN basic rate access digital sections, as described in § 3.2.

The channel allocation at interface V_4 is defined within a first order structure using a static multiplexing principle as follows:

3.5.4.2 *Static multiplexed at 2048 kbit/s*

3.5.4.2.1 *Channel allocation*

In this case 12 basic access channels are multiplexed in a static manner using fixed allocation of the channels. Figure 4/Q.512 illustrates the channel allocation for 2048 kbit/s, where 24 channel timeslots are used by B1 and B2 channels and 6 channel timeslots are used by the D and CV_1 channels of the 12 basic accesses.

The CV_1 and D channels of two basic accesses are multiplexed into one channel timeslot. Five contiguous channel timeslots are occupied by two basic accesses each consisting of B1 + B2 + D + CV_1 channels.

Channel timeslot 0 is used for frame alignment including the application of CRC4 according to Recommendation G.704. Additionally, the alarm handling facilities of channel timeslot 0 are used for maintenance of the primary link as described in Recommendation I.605.

According to the channel allocation shown in Figure 4/Q.512, the CV_1 channels are located in timeslots 5, 10, 15, 21, 26 and 31. These represent 8 bits, namely two bits for each of the D and CV_1 channels of two basic accesses.

Figure 4/Q.512 [T2.512], p.

3.5.4.2.2 *CV*

To facilitate separate treatment of bundles of two basic accesses, represented by five 64 kbit/s channels, multi-frame alignment should be performed individually for each bundle. The relevant overhead information should be contained in the CV_1 channels. CV_1 channel structure is for further study.

The D channel signalling procedures are defined in the Q.920 and Q.930-Series Recommendations.

3.5.4.3 *Static multiplexed 1544 kbit/s*

For further study.

4 Characteristics of analogue exchange interface for subscriber access

4.1 *Interface Z*

Interface Z is a generic analogue interface defined at the exchange side of an analogue subscriber line used to connect subscriber equipment (e.g., single telephone set or PABX).

It is recognized that the characteristics of analogue interfaces (generally designated Z interface) vary considerably from country to country and therefore it is not intended that those interfaces be the subject of CCITT Recommendations beyond those aspects covered in Recommendations Q.551/552.

5 Combined digital and analogue interface for subscriber access

In the evolution towards an ISDN, user network accesses may exist which have a combination of both analogue and digital interfaces.

This type of interface is not presently considered to be a matter for CCITT Recommendations.

Recommendation Q.513

EXCHANGE INTERFACES FOR OPERATIONS,

ADMINISTRATION AND MAINTENANCE

1 General

This Recommendation applies to digital local, combined, transit and international exchanges for telephony in Integrated Digital Networks (IDN) and mixed (analogue/digital) networks, and also to local, combined, transit and international exchanges in an Integrated Services Digital Network (ISDN).

The field of application of this Recommendation is more fully defined in Recommendation Q.500.

This Recommendation is not intended to define any systems or equipment in or connected to, a digital exchange via these interfaces. Therefore only the interfaces characteristics are described.

In the text of this Recommendation, references are made to operation, administration and maintenance (OAM) equipment which comprises either or both of the following:

a) operations systems (OS) which support personnel responsible for exchange OAM. Note that the word exchange includes both signalling and switching equipment;

b) human-machine terminals which provide access to exchanges or operations systems.

2 General characteristics of the interfaces to OAM equipment

2.1 Interfaces are provided for the transfer of information between exchanges and locations where OAM functions are performed. Items a) and b) below illustrate examples of information that may cross the interface and which may need to be catered for. (The choice of information that crosses the interface is a matter for each Administration/RPOA.)

a) The information transferred from the exchange to OAM equipment may include customer usage and charging data, exchange system status indication, system resource utilization data, system performance measurements, alarms and messages alerting operating personnel to the current state of the exchange and other data.

b) The information transferred to the exchange from the OAM equipment may include commands for system initializations and configuration control, data to effect changes in system operation, commands to initiate, terminate, or otherwise modify the services provided to customers, requests for status information and other commands.

2.2 An exchange may have access to one or more OAM equipment.

2.3 Access may be provided using separate data links, multiplexed data links, or one or more data networks to each OAM equipment.

2.4 The exchange shall not become unavailable due to the failure or malfunction of OAM equipment, or the failure of links between the exchange and OAM equipment.

2.5 The choice between single and multiple physical links at the exchange, and the configuration of the OAM equipment is a national matter, not subject to CCITT Recommendations.

3 Functional characteristics of the interface to OAM equipment

3.1 The exchange should not depend for its basic operation on the correct functioning of the OAM equipment.

3.2 The interface should provide basic initialization, error detection and automatic recovery procedures for the data link.

3.3 The interface should support data transport mechanisms that may be employed by the exchange and the OAM equipment to assure the reliable transfer of particular information (e.g., charging data).

3.4 The interface should support the setting of priorities by the exchange or OAM equipment for the use of the transmission medium (data links).

3.5 The interface should support priority transfer of urgent messages.

4 Exchange OAM interfaces

Exchange OAM interfaces are shown in Figure 1/Q.513.

There are two general classes of OAM interfaces:

a) human-machine interfaces;

b) interfaces to OAM OSs and workstations.

The interfaces for local and remote human-machine functions should conform to the MML Z.300-Series of Recommendations.

It is planned to provide Recommendations which specify interfaces between exchanges and operations systems and between exchanges and workstations. Such specifications will be based on the concept of the Telecommunications Management Network (TMN). The principles and architecture of the TMN are defined in Recommendation M.30.

4.1 *TMN interfaces*

4.1.1 *Q*

Interface Q_3 connects exchanges to OSs via the Data Communication Network (DCN).

Figure 1/Q.513, p.

The interface shall be capable of supporting the following two broad categories of information to be communicated:

a) transactions: low data volumes to be transported, e.g., exchange alarm messages;

b) bulk data transfers: large data volumes to be transported, e.g., billing data.

The characterization of these information types is for further study.

The protocols used across the Q_3 interface will be based on the OSI model and will use OSI protocols specified by CCITT where possible. To allow for alternative DCNs, alternative lower layer protocol sets may be used, depending on the specific situation. Several protocol sets for layers 1, 2 and 3 have been used for similar data communications networks. Examples include:

a) X.25

b) Signalling System No. 7 MTPB/FSCCP

c) Q.921/Q.931.

Their use in TMN applications is for further study.

It is recommended that each set of TMN application functions with similar protocol needs be supported with unique protocol selections for layers 4 through 7 as defined by the OSI Reference Model (Recommendation X.200). The nulling of service options of individual layers above layer 3 and even entire layers above layer 3 may be necessary where justifiable.

4.1.2 *Q*

Interface Q_2 may be used to connect exchanges to Mediation Devices (MDs) or to Network Elements (NEs) which contain a mediation function.

The need for the Q_2 interface on an exchange is for further study.

4.1.3 *Q*

Interface Q_1 may be used to connect exchanges to NEs which support only the Network Element Function and no mediation function.

The need for the Q_1 interface on an exchange is for further study.

4.1.4 *F interface*

Interface F connects exchanges to workstations. The definition of functions and protocols is for further study.

4.1.5 *G interface*

Interface G is the human-machine interface for OAM functions, providing output displays and text (e.g., CRT, printer, light panel) and input capabilities (e.g., keyboard).

This interface is specified in the Z.300-Series of Recommendations which may be enhanced in the future.

4.2 *Other OAM interfaces*

These interfaces are intended to represent existing OAM interfaces during the period of transition to TMN. They are not subject to CCITT Recommendations.

4.2.1 *Q*

Interface Q_0 connects exchanges to OSs, MDs and NEs using protocols and functions other than those defined in TMN Recommendations.

4.2.2 *F*

Interface F_0 connects exchanges to workstations, using function and protocols not specified in TMN Recommendations.

4.2.3 *G*

Interface G_0 is a human-machine interface not subject to CCITT Recommendations.

4.3 *ISDN access interfaces*

The exchange requirements for interworking between the exchange ISDN access sub-system including the V interfaces and the exchange TMN sub-system are for futher study.

4.4 *Signalling System No. 7 network interface*

The exchange requirements for interworking between the exchange Signalling System No. 7 sub-systems and the exchange TMN sub-system are for further study.

EXCHANGE FUNCTIONS

1 General

This Recommendation applies to digital local, combined, transit and international exchanges for telephony in Integrated Digital Networks (IDN) and mixed (analogue/digital) networks and also to local, combined, transit and international exchanges in an Integrated Services Digital Network (ISDN).

The field of application of this Recommendation is more fully defined in Recommendation Q.500.

Some text may only apply to a certain type (types) of exchange, e.g. digital transit, local or combined. Where this occurs, the application is defined in the text. Not all the recommended functions will necessarily be provided in every exchange.

2 Exchange functions — Introduction and framework

2.1 *General*

The purpose of this Recommendation is to specifically address those functions required to support basic and supplementary services in performing this test, this Recommendation takes account of the principles set down in Recommendation I.310 and draws a clear distinction between services and the exchange capabilities required to support them.

It should be noted that the list of functions identified in this Recommendation is not necessarily extensive.

2.2 *Exchange model*

The functions described in this and associated Recommendations can be considered within the framework of an exchange functional model. Such a model is shown in Figure 1/Q.521. This divides the exchange into three functional areas as follows:

a) control functions — Those functions required to control services and connections, e.g. signalling, routing and connectionB/Fresources handling functions;

b) connection functions — Those functions directly related to the connection path through an exchange, i.e. switching and transmission mechanism (including ET);

c) operation and maintenance functions — Those functions of an operational, management and maintenance nature which are not employed for call establishment and supervisory purposes, e.g. test functions.

The exchange functional model shown in Figure 1/Q.521 is appropriate to exchanges operating in an IDN and also those operating in an IDN which is evolving towards an ISDN. In terms of this Recommendation, most of the functions fall within the control functions area.

Figure 1/Q.521, p.

Connection functions are primarily covered in Recommendation Q.522. These address the basic switch characteristics of different connection types. OAM functions are primarily covered in Recommendation Q.542.

3 Utilization of exchange functions for services

3.1 *General*

Exchange functions are used and reused in various stages of call processing. Some may be combined with others to create features used in providing supplementary services. The specific functions used in a given context will be determined by the requested service.

Within the framework of the model shown in Figure 1/Q.521 the utilization of functions arising from a service request, can be considered in the following way:

a) on receipt of a service request (via the Signalling Functions) the Service Processing Functions are used to identify the appropriate connection type(s);

b) the appropriate type of connection is established by use of the Connection/Resources Handling Functions;

c) Supplementary Services which involve additional functions and information flows beyond those required for bearer services, are provided under the control of logic residing in the Service Processing Function. This logic is designed to provide specific services. Corresponding service/feature capabilities must also reside in the Signalling and Connection/Resources Handling Functions.

In addition to services provided by use of logic/data residing in the exchange, some services may be provided under the control of logic located at separate specialized nodes (Service Control Points). Also, data required or process certain service requests may be kept in a remote data base accessed by use of the Signalling Function.

4 General functions required for operation of an exchange in the IDN, ISDN or mixed analogue/digital environment

4.1 *Timing and synchronization*

4.1.1 Exchange timing — Ability to distribute timing within the exchange so that it will maintain synchronism on 64 kbit/s channel timeslots in a connection through the exchange.

4.1.2 Synchronization — Ability to operate in the IDN or ISDN in synchronism with other digital entities and provide timing signals to other network entities as required.

4.1.3 Interval timing — Ability to measure time between events as required in call processing and/or in signalling.

4.1.4 Time-of-day clock — Ability to determine time of day.

Note — The level of accuracy is for further study.

4.2. *Signalling*

4.2.1 *User-access signalling functions*

4.2.1.1 Ability to receive and interpret decadic or Dual Tone Multi-Frequency (DTMF) signalling from user terminals.

4.2.1.2 Ability to support user-access signalling layers 1 and 2 in accordance with Recommendations I.430, Q.921 (I.441).

4.2.1.3 Ability to communicate with user terminals using layer 3 signalling in accordance with Recommendation Q.931 (I.451).

4.2.2 *Network signalling functions*

4.2.2.1 Ability to use and support CCITT signalling systems included in Recommendation Q.7, particularly CCITT Signalling System No. 7.

4.2.2.2 Ability to communicate with other network entities using the CCITT Signalling System No. 7, Q.700-Series of Recommendations User Parts.

Recommendation Q.522

DIGITAL EXCHANGE CONNECTIONS,

SIGNALLING AND ANCILLARY FUNCTIONS

1 General

This Recommendation applies to digital local, combined, transit and international exchanges for telephony in Integrated Digital Networks (IDN) and also to local, combined, transit, and international exchanges in an Integrated Services Digital Network (ISDN). The field of application of this Recommendation is more fully defined in Recommendation Q.500.

2 Connections through an exchange

2.1 *General*

The characteristics of the connections detailed in this section refer to an established connection when it is made available to the users.

An exchange must be able to provide originating, terminating and internal exchange connections between input and output interfaces for telephony and other services as required. It may also provide transit connections:

— A connection (if any) between an incoming and an outgoing circuit at interfaces to other exchangesB/Fnetworks is called a transit connection.

— A connection between channel(s) of a calling subscriber line at an interface for subscriber access and an outgoing circuit at an interface to other exchange/networks is called an originating connection.

— A connection between an incoming circuit at an interface to other exchange/networks and channel(s) of a called subscriber line at an interface for subscriber access is called a terminating connection.

— A connection between channels of two subscriber lines at interfaces for subscriber access is called an internal connection.

An exchange must be able to provide bidirectional connections between input and output interfaces for telephony and other services as required.

Also unidirectional connections may be required.

2.2 *Basic exchange connections*

2.2.1 *General*

The requirements in this section primarily apply to digital local or combined exchanges. Applicability to digital transit or international exchanges requires further study.

Four types of exchange connection have been identified to show the basic forms of connection and their associated information flows that a digital local or combined exchange may be required to handle in an ISDN. They have been based on originatingB/Fterminating connections established via interfaces for subscriber access as described in Recommendation Q.512 to/from locations external to the exchange. Calls may be set up in either direction, i.e., subscriber to network or network to subscriber.

These diagrams are functional and not intended to represent any particular implementation. They illustrate the options which may be available for handling a given information type or service within a digital local or combined exchange. Although this approach leads to some duplication between the individual diagrams when considered from the connection point of view, the approach is a logical basis for the further consideration of the more detailed issues arising from the impact of the ISDN on a digital local or combined exchange.

It is not intended to imply that every digital local or combined exchange should necessarily have the capability to handle all these types of connection.

Other types of connection and variants of these basic exchange connections may be feasible in an ISDN and are the subject of further study.

The signalling and control aspects of these connections are covered in §§ 3 and 5 of this Recommendation.

2.2.2 *Explanatory information on the exchange connection diagrams*

The functions associated with the groupings shown on the types I-IV exchanges connection diagrams are covered in § 3.

Key

information other than separate signalling ——————— separate signalling(s)

Information flows

— p_1: packet data information different from customer-originated packetized data;

— s_1, s_2, s_4, s_5: signalling information different from the signalling associated with customer terminals;

— packet switching interworking functions may be provided at other exchanges in an ISDN or at the point of access to a separate packet switched network.

2.2.3 *Type 1 exchange connection* (Figure 1/Q.522)

This connection is sued to transport telephony and associated voice services.

This connection is characterized by (see Table 2/I.340, A | , A | , A | and A |):

— *Information transfer attributes*

mode: circuit

rate: 64 kbit/s

capability: speech — 3.1 kHz audio

establishment: switched — semi-permanent

symmetry: bidirectional — symmetric

configuration: point-to-point uniform

structure: 8 kHz integrity

— *Access attributes* (Table 1/Q.522)

H.T. [T1.522]
TABLE 1/Q.522

Access attributes	User access	Network access
Access channel and rate		
Information	B/64	{
Digital circuit with access to analogue/digital switched network		
}		
Signalling	D/16-64	Digital circuit (s 1)
Access protocol | ua)		
Layer 1	For further study	Q.702, others
Layer 2	I.441	Q.703, others
Layer 3	I.451	Q.704, Q.714, Q.764, others

a) Only for switched services.

Table 1/Q.522 [T1.522], p.

— *Other attributes*

For further study.

Figure 1/Q.522, p.

2.2.4 *Type II exchange connection* | Figure 2/Q.522)

This connection is used to transport circuit switched services such as data, telephony, multiple subrate information streams multiplexed into 64 kbit/s by the user, transparent access to a PSPDN (see § 5.2.2).

This connection is characterized by:

— *Information transfer attributes* (see Table 2/I.340, A | and A |)

mode: circuit

rate: 64 kbit/s

capability: unrestricted digital information

establishment: switched — semi-permanent

symmetry: bidirectional — symmetric

configuration: point-to-point uniform

structure: 8 kHz integrity

— *Access attributes* (Table 2/Q.522)

H.T. [T2.522]
TABLE 2/Q.522

Access attributes	User access	Network access
Access channel and rate Information Digital circuit with access to analogue/digital switched network } Signalling Access protocol See type I (For signalling only) | ua) } See type I (For signalling access to digital switched network) | ua) }	 B/64 D/16-64 { {	 { Digital circuit (s 1)

a) Further study is required for information transfer protocol or access to PSPDN.

Table 2/Q.522 [T2.522], p.

— *Other attributes*

For further study.

Figure 2/Q.522, p.

2.2.5 *Type III exchange connection* (Figure 3/Q.522)

This is a connection used to transport packetized data information between an information channel on a digital subscriber access and a 64 kbit/s digital circuit which has an access to:

a) a remote ISDN Packet Handling Functional Grouping;

b) a remote ISDN Packet Switching Interworking Functional Grouping;

c) a public packet network (see § 5.2.3).

This connection is characterized by:

— *Information transfer attributes* | see Table 3/Q.522)

(see Table 2/I.340, A | 0 and A | 1)

H.T. [T3.522]
TABLE 3/Q.522

Access attributes	Option a)	Options b) and c)
Mode	Circuit	Packet
Rate	64 kbit/s (further study)	64 kbit/s (further study)
Capability	{	
Unrestricted digital information		
}	{	
Unrestricted digital information		
}		
Establishment	{	
Switched — semi-permanent		
}	{	
Switched — semi-permanent		
}		
Symmetry	Bidirectional symmetric	Bidirectional symmetric
Configuration	Point-to-point	Point-to-point
Structure	8 kHz	Service data unit integrity

Tableau 3/Q.522 [T3.522], p.

— *Access attributes* | Table 4/Q.522)

H.T. [T4.522]
TABLE 4/Q.522

Access attributes	User access	Network access
Access channel and rate		
Information		
Options a), b), c)	B/Further study	{
64 kbit/s digital circuit | ua)		
}		
Signalling a), b), c)	D/16-64	{
64 kbit/s digital circuit | ua)		
}		
Access protocol		
Options a), b)	For further study	For further study
Option c)	For further study	X.75 | (hy | .25

a) Information and signalling may be carried by the same circuit (in-band signalling).

Table 4/Q.522 [T4.522], p.

— *Other attributes*

For further study.

Figure 3a/Q.522, p.

Figure 3b/Q.522, p.

Figure 3c/Q.522, p.

2.2.6 *Type IV exchange connection* | Figure 4/Q.522)

This connection is used to transport message type data, for example packetized data messages or teleaction information messages (see § 5.2.4).

It consists of a message/packet type connection via a D channel on a digital subscriber access to an access port to either:

a) a remote ISDN Interworking Functional Grouping; or

b) a public packet network.

This connection is characterized by:

— *Information transfer attributes*

(see Table 2/I.340).

See type III, options b) and c).

— *Access attributes* | Table 5/Q.522).

H.T. [T5.522]
TABLE 5/Q.522

Access attributes	User access	Network access
Access channel and rate Information and signalling Options a) and b) D/For further study | ua) } 64 kbit/s digital circuit b) }	{ {	
Access protocol		
Option a)	For further study	For further study
Option a)	For further study	X.75 | (hy | .25

a) Signalling in-band or out-band.

b) Signalling in-band or out-band for option a), or in-band for option b).

Table 5/Q.522 [T5.522], p.

Blanc

— *Other attributes*

For further study.

Figure 4/Q.522, p.

2.3 *Functions associated with attributes shown in § 2.2*

The following information is to clarify which functions may be associated with the attributes shown on the types I-IV exchange connection diagrams described in § 2.2.

2.3.1 *Layer 1 functions* (see Note in § 2.3.4)

This functional grouping includes:

— digital line/exchange termination interface functions.

2.3.2 *Layer 2 functions* (see Note in § 2.3.4)

This functional grouping includes:

— layer 2 D-channel protocol handling (LAP D)

2.3.3 *64 kbit/s circuit switching functions*

This functional grouping includes:

— 64 kbit/s switching stage(s).

2.3.4 *Signalling handling and exchange control functions*

This functional grouping may include:

— layer 3 D-channel protocol for signalling (see Note);

— functions related to circuit switched connection control;

— signalling functions for common channel signalling;

— signalling interfaces with ‘‘packet handling function’’;

— functions related to packet switched connections;

— signalling interface with ‘‘packet switching interworking function’’.

Note — The term ‘‘layer’’ refers to Open Systems Interconnection as applied to CCITT signalling systems as defined by Recommendations X.200 and I.112.

2.3.5 *Packet switching interworking functions*

This functional grouping may include:

— signalling interface with ‘‘packet handling function’’ and ‘‘signalling handling and exchange control function’’ allowing call packets to be routed to/from the appropriate subscriber terminals;

— routing functions;

— functions such as compatibility checking;

— protocol conversion;

— numbering interworking;

— control function (see Note in § 2.3.6).

2.3.6 *Packets handling function*

This functional grouping may include:

— layer 3 D-channel protocol for packet calls;

— packet level multiplexing for outgoing calls;

— packet level demultiplexing for incoming calls;

— signalling interface with the ‘‘signalling handling function’’ and subscriber terminals via layer 1 and 2 functional block;

— control functions for packet switched connections (see Note);

— some or all the functions associated with packet switching (e.g., internal packet calls).

Note — Clarification of control function would need further study.

In the case where the packet switching interworking function is not present in the local exchange, the local exchange contains the minimum functions necessary to enable it to communicate with the packet switching interworking function. The protocols to carry out this minimum function require further study.

2.4 *Bit rate of a connection through an exchange*

2.4.1 *Basic bit rate for circuit switched connections*

The exchange should be able to make circuit switched connections between channel timeslots with the basic bit rate of 64 kbit/s. The channel timeslots to be connected are contained in primary or higher order frame structures appearing at the digital interfaces of the exchange or derived from analogue channels appearing at the analogue interfaces, or from individual digital interfaces for subscriber access.

Switching at rates other than 64 kbit/s is for further study.

2.4.2 *Basic bit rate for message/packet switched connections Type IV*

The bit rate of a messageB/Fpacket connection Type IV will depend on a number of factors including the bit rate of the subscriber terminal equipment, the bit rate of the D channel and the bit rate capacity of the connection to the appropriate network.

2.5 *Services offered at bit rates less than 64 kbit/s*

Services requiring less than 64 kbit/s for a connection should be switched as 64 kbit/s connections.

2.6 *Services offered at bit rates greater than 64 kbit/s*

2.6.1 *General*

Services requiring more than 64 kbit/s for a connection are through-connected as a multiple of 64 kbit/s connections. They are called multi-slot connections

The exchange may be required to establish the following types of multi-slot connections (see Recommendation I.340):

— 2×64 kbit/s connections;

— 6×64 kbitB/Fs connections to provide a H_0channel;

— 24×64 kbitB/Fs connections to provide a $H_{1\backslash d1}$channel;

— 30×64 kbitB/Fs connections to provide a $H_{1\backslash d2}$channel.

It should be noted that an $n \times 64$ kbit/s connection can seriously affect the blocking probability of an exchange and the network, particularly if all n timeslots are routed in a defined order in the same multiplex. The ability to handle multi-slot traffic will be influenced by the traffic loading of the exchange at any instant and the number of circuits available on the required route.

2.6.2 *2 × 64 kbit/s connections*

This connection type is characterized by the following attributes (see Recommendation I.340).

The attributes are for further study.

A 2×64 kbitB/Fs connection is established in response to signalling information received on the subscriber line or on an inter-exchange link.

The exchange should maintain restricted differential time delay between the two timeslots involved in the connection. The precise definition of ’’restricted differential time delay’’ is still to be formulated, but the intention is to ensure that the time delay between the individual slots forming a 2×64 kbit/s connection is not excessive, for example as could occur if the two channels were routed out of the exchange on diverse physical routings.

The exchange aspects of meeting this requirement require further study, but will include the need for the exchange to be capable of recognizing the signalling information on incoming inter-exchange circuits/subscriber accesses which indicates that there is an association between two incoming 64 kbit/s channels and to ensure that the two channels are handled by the exchange in a uniform manner.

2.6.3 *Switching of 6 × 64 kbit/s connections (H_0channel)*

The 64 kbit/s timeslots which form an H_0channel are transmitted over the same primary multiplex system within the same frame. This is valid for both the subscriber line and the inter-exchange links.

The requirement for 6×64 kbit/s connections can be satisfied by establishing 6 separate 64 kbit/s semi-permanent connections, each of which would be set up to preserve the sequence with the other slots forming the 6×64 kbit/s connection.

2.6.4 *Switching of 24 or 30 × 64 kbit/s connection (H_1channels)*

This is for further study.

2.7 *Mode of establishment*

2.7.1 *Circuit switched connections, Type I, Type II and Type III option a)*

Circuit switched connections are set up at any time on demand in response to signalling information received from subscribers, other exchanges or other networks.

2.7.2 *Packet switched connections, Type III options b) and c)*

For further study.

2.7.3 *MessageB/Fpacket switched connections, Type IV*

These connections are set up on demand subject to any D channel priority/flow control restrictions that may be applicable.

2.7.4 *Semi-permanent connections*

The exchange should have the capability of establishing semi-permanent connections which pass through the exchange switching network.

Other features of semi-permanent connections, e.g. grade of service, the need for an out-slot signalling channel associated with the connection, etc. are for further study.

2.8 *Bit sequence independence*

See Recommendation Q.554.

2.9 *Bit integrity*

See Recommendation Q.554.

2.10 *Octet sequence integrity*

See Recommendation Q.9.

2.11 *8 kHz (structure) integrity*

See Recommendation I.140.

2.12 *Bit patterns generated by the exchange in idle channel timeslots*

At interfaces A and B, the following patterns are recommended for the idle condition, where the left-most digit is the polarity digit.

01111111 for 1544 kbit/s systems

01010100 for 2048 and 8448 kbit/s systems.

At other interfaces the bit pattern generated in idle channel timeslots is for further study.

The patterns should not be used as an indication of the idle or barred conditions of a channel since this information should be derived from the control or signalling functions.

Note — These patterns are slightly different from the quiet code produced by external test equipment and used as an auxiliary signal for noise and crosstalk measurements on digital exchanges (see Recommendations Q.551, § 1.2.3.1, Q.552, §§ 2, 2.2.3, 3.1.4 and Q.553, §§ 2.1.1.2, 3.1.4).

2.13 *Error performance*

See Recommendation Q.554.

2.14 *In-call rearrangement*

In-call rearrangement is the rearrangement by the exchange of the established connections across the switchblock in a more efficient manner.

When it is provided, it is essential that the requirements for error performance, Quality of Service, etc. be met (see Recommendation Q.543).

2.15 *Transmission performance characteristics*

See Recommendations Q.551 to Q.554.

3 Signalling and D-channel handling

3.1 *General*

The exchange should be capable of interworking with other exchanges using signalling systems indicated in Recommendation Q.7, and for local or combined exchanges with user equipment on digital access lines (e.g., terminals and PABXs) using the signalling procedures in Recommendations I.430, I.431, and Q.920 (I.440), Q.930 (I.450)-Series of Recommendations.

For a local or combined exchange interworking with user terminals or analogue subscriber access lines should be accomplished using nationally recommended signalling procedures.

64 kbit/s signalling channels entering the exchange via a multiplex structure may be connected through the exchange as semi-permanent channels.

3.2 *Signalling associated with exchange connections Types I-IV*

This section applies to local or combined exchanges only.

3.2.1 *General*

Details of the exchange connections Types I-IV are given in § 5.

For internal and originating connections, the call set up signalling information will be received from the subscriber.

For terminating and transit connections, the call set up signalling information will be received from the appropriate network or separate signalling network.

Note — Receipt of call set up signalling information may be affected by the involvement of supplementary services.

3.2.2 *Basic connections including Type I exchange connection*

The exchange should carry out the functions defined in the following signalling systems.

3.2.2.1 *On the subscribers side* :

a) analogue line signalling systems as defined nationally; and

b) the defined digital subscriber access signalling system(s) if digital subscriber accesses are provided (see Recommendations I.430 and Q.920, Q.930-Series of Recommendations).

3.2.2.2 *On the network side*

One or more of the signalling systems are defined in Recommendation Q.7.

3.2.3 *Type II exchange connection*

The exchange should carry out the functions defined in the following signalling systems.

3.2.3.1 *On the subscriber side*

The defined digital subscriber access signalling system(s) (see Recommendations I.430 and Q.920, Q.930-Series of Recommendations).

3.2.3.2 *On the network side*

One or more of the signalling systems defined in Recommendation Q.7.

Note — Further study is required for information transfer protocol or access to PSPDN.

3.2.4 *Type III exchange connection*

3.2.4.1 *On the subscriber side*

For further study.

3.2.4.2 *On the network side*

The signalling associated with the messages/packets may be:

a) contained in the individual message/packets; or

b) transported separately, in accordance with one or more of the signalling systems defined in Recommendation Q.7.

A local exchange which supports such services must contain a function that is capable of either interpreting them and routing them appropriately, or of sending them directly to an appropriate interworking function.

3.2.5 *Type IV exchange connection*

On the subscriber side:

The signalling associated with the messagesB/Fpackets may be:

a) contained in the individual message/packet, or

b) transported separately as s-information (see Recommendations I.430 and Q.920, and Q.930-Series of Recommendations).

On the trunk side:

The signalling associated with the messages/packets may be:

a) contained in the individual message/packet (p_1); or

b) transported separately ($s_1$information), in accordance with one or more of the signalling systems defined in Recommendation Q.7.

A local exchange which supports such services must contain a function that is capable of either interpreting them and routing appropriately, or of sending them directly to an appropriate interworking function.

3.3 *Digital subscriber access — D channel and protocol handling layers 1, 2 and 3*

The following text refers to handling the D-channel protocol on the exchange side of the interfaces U and V_1.

The functions associated with handling the D-channel protocol are defined in the parts of Recommendations I.430, Q.920 and Q.930-Series of Recommendations relating to call establishment for subscribers connected to the U or V_1 interfaces. Exchange functions for D-channel signalling procedures for users connected via a primary rate multiple access are also given in I.431, Q.920 and Q.930-Series of Recommendations.

3.4 *User-to-user signalling*

The exchange may receive signals from the user (e.g., from a PABX) for transport across the network. It must be capable of receiving this information, verifying its acceptability, and if the service is permitted to the requesting user, send it via the inter-exchange signalling or other network to the distant exchange. Similarly the exchange may receive information from the signalling network for transmission to the subscriber. This capability may not be provided on all types of connection.

Where user-to-user signalling involves network inter-exchange facilities, it may be necessary for the originating local exchange to process this signalling information before sending it to the network, to ensure that it is compatible with signalling, charging and flow control requirements of the originating exchange and network.

4 Ancillary functions

4.1 *Connection of ancillary equipment*

Ancillary equipment may be connected in the following way:

i) Serially. This may require more than one connection through the exchange. Examples of serially connected equipment include:

— echo control devices,

— encoding law converters,

— manual board access equipment (for operator controlled traffic).

ii) As terminal connected equipment usually requiring one connection through the exchange. Examples of such equipment include:

— recorded announcements,

— manual board terminations,

— speech codecs,

— data terminal facilities,

— test equipment (such as a test call sender),

— tone generators,

— signalling receivers.

The interface between the exchange and the items of equipment listed above may be left to the national designers. However, the use of internationally standardized interfaces is preferred.

Note — In some cases it may be necessary to establish more than one connection to one timeslot at the same time.

4.2 *Digitally generated tones and frequencies*

When tones and frequencies are digitally generated the following minimum requirements apply on a provisional basis.

4.2.1 *Service tones*

Digitally generated tones should meet the recommended limits specified in Recommendation Q.35 when decoded.

4.2.2 *Signalling frequencies*

Digitally generated signalling frequencies should be such that they can be detected after decoding by any analogue receivers designed to CCITT Recommendations.

4.3 *Echo control devices*

The exchange should be able to be equipped with echo control devices (echo suppressors/echo cancellers conforming to Recommendations G.164 and G.165 respectively). When required the exchange should be able to control such devices to meet the requirements of Recommendation Q.115. The means of control by the exchange is for further study.

(*Note* — It is recognized that there is a need for an internationally agreed method of disabling and enabling echo control devices for the purposes of making end-to-end circuit transmission maintenance measurements, e.g. as recommended in Recommendation V.25.)

5 Control functions associated with call handling

5.1 *Basic control functions*

The requirements for the basic control functions are implicit in the requirements recommended for the other functions of the exchange. However recommendation of a number of new requirements for the control functions associated with the handling of digital subscriber lines and the use of a digital local exchange within an ISDN, may be necessary.

The exchange should provide the capability to avoid fraudulent use of the connection. Such capabilities may be based on the use of digital pads or an asymmetrical through-connect procedure.

An originating local exchange should be capable of supporting either symmetric or asymmetric through-connect procedures. The choice of procedure may be determined on the basis of service.

Terminating and transit exchange need only support symmetric through-connect procedure.

This subject is for further study.

5.2 *Exchange connections Types I-IV, general control aspects*

5.2.1 *Type I*

These connections will be set up between the accesses associated with network addresses specified in response to the signalling information received. Voice-associated facilities, e.g. tones, should be provided where appropriate and telephony supplementary services may be invoked if provided.

5.2.2 *Type II*

Such connections will be set up between the accesses associated with network addresses specified in response to the signalling messages received. Compatibility checking may be provided before the connection is completely established (see § 2.3.1). Voice associated facilities (e.g. tones, pads) will be disabled in order to provide a transparent digital path, (the means of doing this is for further study). Data supplementary services may be invoked if provided.

5.2.3 *Type III*

Such connections will be set up between the accesses associated with network addresses specified in response to the signalling messages received. Compatibility checking may be provided before the connection is completely established (see § 2.3.1). Voice associated facilities (e.g. tones, pads) will be disabled in order to provide a transparent digital path (the means of doing this is for further study). Data supplementary services may be invoked if provided.

For option a) in the switched access case, originating calls will be set up over the B channel towards the 64 kbit/s digital circuit using the ISDN signalling procedures prior to starting X.25 layer 2 and layer 3 functions. The corresponding service requested in the Q.931 SET-UP message is ISDN packet mode bearer service. For calls originated by the network, the same consideration applies (see Recommendations X.31 and I.462).

The distant packet handling must be selected by the called address in the D-channel protocol when the terminal sets up the circuit switched connection.

Packet data communications, when using a switched B channel, will be established by separating the establishment phase of the B channel (carried out by the exchange) and the control phase of the virtual circuit using the X.25 link layer and packet layer protocol (carried out in the distant packet handling function).

For options b) and c) the same considerations as above apply except that the control phase of the virtual circuit is performed within the exchange.

5.2.4 *Type IV*

These connections will be of the messageB/Fpacket type (e.g., virtual circuit). The ‘‘p-information handling function’’ and ‘‘packet switching interworking function’’ shown in Figure 4/Q.521 will implement procedures for control of the logical links on the D channel (e.g., flow control, error control) (see also § 3.2.5). Voice associated facilities (e.g., tones, pads) will be disabled in order to provide a transparent digital path.

The D channel provides a semi-permanent physical connection which enables the user terminal to access a packet handling function by establishing a link layer connection (with a specific SAPI) to that function which can then be used to support packet communications according to X.25 layer 3 procedures. The X.25 packet layer will use the acknowledged information service provided by LAP D (see Recommendation Q.920). X.25 layer 3 procedures are transferred transparently over the D Channel link.

A single or multiple LAP D link must support the multiplexing of logical channels at layer 3.

5.3 *Control functions associated with calls over a digital subscriber access via Interfaces U and* V_1

5.3.1 *Control of circuit switched calls Types I, II and III*

In response to s-information carried on the D channel and network signalling messages, the exchange must have the following capabilities.

a) *Setting up a call*

The exchange must receive address information (overlap sending or en bloc), establish the desired path (digital only or mixed) and send further (e.g., Signalling System No. 7) signalling, if necessary (e.g., address, calling line identity, service indicator) into the network.

The call set up procedure may include steps to verify compatibility based on the record in the exchange of the services permitted for the subscriber. The degree of compatibility checking provided by the exchange requires further study.

b) *During a call*

In addition to the basic functions of maintaining a call record, supervising the call, charging for the call, etc., the exchange must be able to handle in-call serviceB/Ffacility requests. These include for example transfer of a call to another terminal or conferencing.

If it is required that a terminal be moved from one location to another on the same access during a call, the exchange must be able to hold the call while the transfer is made and to re-establish communication on request by the user (including carrying out any compatibility checks). The exchange may limit the time allowed for moving a terminal. In addition, the user must send a signal to the exchange indicating that terminal movement is about to take place. Signalling procedures for terminal movement are given in Recommendation Q.931.

c) *Clearing a call*

The exchange will need to initiate call clearing on receipt of a clear request signal from the terminal or network.

d) *Without a call path*

The exchange may be required to handle signalling information without establishment of a call path (subscriber-network transactions).

5.3.2 *Control of message/packet calls over the D channel, Type IV*

Any messages carrying p-information on the D channel must be handled by the exchange in accordance with the applicable Recommendation for services (e.g., Recommendation X.25) requested by the user. It is not necessary that every digital local or combined exchange in an ISDN should be able to

to carry out all the possible functions associated with handling this information. It is possible for example that the exchange may route such traffic to another node which has the appropriate handling facilities.

6 **Control functions associated with maintenance and automatic supervision**

See Recommendation Q.542.

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