I.324 defines the reference point between two interconnected ISDNs to be the N_x reference point. This Recommendation (I.520) identifies other Recommendations which should be applied to the N_x reference point and clarifies the functions and requirements for interworking at the N_x reference point.

3. REQUIRED INFORMATION AND INFORMATION HANDLING

Figure 1 illustrates the general configuration for interworking between two ISDNs. The information given in Tables 1, 2 and 3, when required, has to be carried by Signalling System No. 7 (SS No. 7) ISUP and X.75, and is handled at the IWF in one of the following ways:

Tables 1, 2 and 3 also show the classification of information into the above four categories for circuit mode bearer services, circuit mode supplementary services and packet mode bearer services respectively.

Additional information required specifically for OA&M functions is for further study.

4. Description of ISDN-ISDN interworking configurations

4.1 ISDN-ISDN interface where circuit mode bearer services are provided by both ISDNs

FIGURE 2

4.1.1 Bearer services

Individual bearer service categories are defined in the I.230-Series of Recommendations.

Layer 1 interworking specifications are recommended in I.511. Layers 2 and 3 in the U-plane are passed transparently.

4.1.2 Supplementary services

4.1.2.1 Other than User-to-user signalling

For supplementary services other than user-to-user signalling, call control information is transferred via Signalling System No. 7 across the N_x reference point. The interface for user information transfer is not different from that of basic bearer services.

4.1.2.2 User-to-user signalling services

There are two methods of transferring user-to-user signalling. One is transfer of user-to-user signalling within Q.931 call control messages which have been mapped into Signalling System No. 7 messages and then are conveyed via the Signalling System No. 7 network. The other is transfer of user-to-user signalling within stand alone USER INFO messages (which have been mapped into Signalling System No. 7 messages and then are conveyed via the Signalling System No. 7 network), or optionally may be transferred via packet handlers (PHs) in some ISDNs. In the case where user-to-user signalling is transferred between packet handlers (PHs) in both ISDNs, the X.75 protocol may be applied to the internetwork interface to transfer user-to-user signalling. In the case where user-to-user signalling is transferred via Signalling System No. 7 networks in both ISDNs or at least in one ISDN, the Signalling System No. 7 protocol should be applied to the internetwork interface for user-to-user signalling.

4.1.3 Signalling System No. 7 for the control of circuit mode services at the Nx reference point

For the control of circuit mode services in the long term, Signalling System No. 7 with ISUP will be used at the N_x reference point.

4.2 ISDN-ISDN Interface where both ISDNs provide X.31 case B based packet mode bearer services

The X.75 protocol is used to transfer X.31 based packet mode services at the N_x reference point. Layers 1, 2, and 3 for this interface are specified in X.75.

4.3 ISDN-ISDN Interface where a circuit mode bearer service is provided by one ISDN to access either a PSPDN or a PH and an X.31 case B packet mode bearer service provided by another ISDN

With this type of interworking, two different configurations are considered, I and II. In configuration I, interworking between the two ISDNs utilizes X.75 interexchange signalling.

FIGURE 4

Configuration 1
ISDN(cs) Interworking with ISDN(ps)

Note - The IWF is logically part of the ISDN $_{(cs)}$. For further detail, see Recommendation X.320.

In configuration II, a circuit switched access to the PH in the ISDN $_{(ps)}$ is provided, and the interworking between the two ISDNs utilizes a Signalling System No. 7 protocol.

Note - For accessing the PH, the IWF must include access unit (AU) functionality as defined in Recommendation X.31 for the PSPDN.

This interworking arrangement applies for data transmission services. General arrangements are covered in section 6.3 of X.320. There are two possibilities:

i) X.31 case A interworking with X.31 case B. Case A refers to the situation where a transparent circuit switched access to PSPDN is provided by ISDN. Case B refers to the situation where a packet mode bearer service is provided by an ISDN PH.

ii) ISDN circuit switched access to ISDN PH (this case may exist if the originating ISDN does not have PH functionality).

Several aspects of interworking for data transmission services as well as its application to other transmission services are for further study.

4.4 ISDN-ISDN interworking via a transit network

ISDN-ISDN interworking via a non-ISDN transit network (Figure 5) may be a useful configuration in the short term for extending specific ISDN services on an end-to-end basis. Special transmission, switching and signalling capabilities may have to be deployed in the transit network to ensure that the specific ISDN service is available end-to-end.

The detailed interworking functions and interfaces for this configuration are for further study.

FIGURE 5

Interworking of two ISDNs via a transit network

4.5 ISDN-ISDN Interface for additional packet mode bearer services

For packet mode services that are currently under study, out-band call control signalling is used. The same out-band call control is used for circuit mode services. Two alternatives can be considered for this out-band call control: one is enhancement of Signalling System No. 7 and the other is enhancement of the D-Channel protocol. The choice between the two alternatives is for further study.

4.6 ISDN-ISDN Interface where an X.31 case B based packet mode bearer service is provided on one ISDN and an additional packet mode bearer service is requested on another ISDN

Two alternatives can be considered. One is based on in-band signalling (X.75), and the other is based on out-band signalling (Signalling System No. 7 or D-Channel protocol). The choice between the two alternatives is for further study.

4.7 ISDN-ISDN Interface for circuit mode to additional packet mode

This section is for further study.

Note 1 - For charging use.

Note 2 - For discrimination of priority call/ordinary call.

Note 3 - These indicators are used to identify (1) international incoming call, (2) available end-to-end signalling system, (3) charged call/noncharged call.

Note 4 - When a satellite circuit is employed for an interworking call at the interworking point, this information is processed at the IWF. If a satellite circuit is not employed for a call, this information is transferred through the IWF transparently.

Note 5 - This information is used only when access charging is necessary.

Note 6 - All ISDNs do not necessarily provide identical services (or connection types). When a change of services occurs at the IWF, the network should send the indication for change of services and may solicit acceptance of change of services to a calling user in certain cases (see section 5.3.1 of this Recommmendation).

Note 7 - There may be cases where the terminal compatibility information is processed (see section 5.4 of this Recommendation).

Note 8 - The information in this category is transferred through the IWF transparently.

Table 4 shows the permitted relationship between circuit mode bearer services and various forms of speech processing functionality. These speech processing functions include DSI, LRE and DCM. Depending upon the particular relationship to the circuit mode bearer services, these processing functions are specified as essential, optional, prohibited or functionally disabled.

For a speech, 3.1 kHz audio, or 64 Kbit/s unrestricted call within an ISDN, appropriate network control is required to ensure that the relationship shown within Table 4/I.520 is realized. An example of this control might be

routing (to exclude or include a function) or out-band signalling (to disable a function). Further, it is to be noted that a disabling tone (see V.25 and I.530) may be used to functionally remove echo control devices on a 3.1 kHz audio bearer service connection.

1) the Signalling System No. 7 ISUP bearer capability information element, and

2) the use of disabling tone (see V.25 and I.530) by terminals, in the case of 3.1 kHz audio bearer service.

The control of speech processing functions (DCM, A/Mu conversion, echo control, etc.) by exchanges is:

1) not needed when a disabling tone (see V.25 and I.530) is used, in conjunction with the 3.1 kHz audio bearer service by a terminal(s), and

2) to be implemented using out-band call processes (currently under study) when needed.

The procedures in the case of alternate speech/64 kbit/s unrestricted bearer service, are for further study.

Note 1 - Although echo control may not be required in ISDN-ISDN interworking for digital telephones (for further study), its inclusion for possible internetworking reasons for the speech bearer service is essential (see also I.530)

Note 2 - The necessity for network or terminal provided echo control in 4-wire end-to-end speech connections is for further study.

Note 3 - For 3.1 kHz audio bearer service, echo control is included in the connection at the time of call setup. It is disabled for the transmission of voice-band data by use of the disabling tone (see V.25 and I.530).

Note 4 - The network may include signal processing techniques provided they are appropriately modified or functionally removed prior to information transfer.

Note 5 - The IWF converting A/Mu laws should also make the necessary bit translation in the bearer capability information element to indicate the law used.

Note 6 - The 64 kbit/s transparent capability will be invoked, subject to the available transmission capacity, by the adjoining exchange over a dedicated out-band signalling system.

Note 7 - The provision of this bearer service using DCM is subject to the ability of the out-band signalling system and the DCM equipment to execute in-call modifications initiated by the adjoining exchange.

Note 8 - The exchange may set up a 64 kbit/s unrestricted bearer path with echo control devices and A/Mu law converters (if necessary) enabled for speech. In any case, the set up of parallel paths for speech and 64 kbit/s unrestricted must be avoided.

Note 9 - Echo control needs to be disabled when continuity check is performed.

5.2 Generation of in-band tones and announcements for speech and 3.1 kHz audio bearer services

(Note - This function is also necessary for a call within one ISDN, which does not involve network interworking nor internal ISDN interworking.)

5.2.1 Unsuccessful call delivery

The point of call failure (i.e., the point at which the connection cannot proceed further) should generate the appropriate out-band clearing message toward the calling exchange. In response to this message, the calling exchange should send the appropriate out-band message to the calling user. However, for speech and 3.1 kHz audio bearer services, the network must be capable of generating the appropriate in-band tones or announcements. In this case, the clearing message should not be sent prior to the completion of the announcements.

5.2.2 Successful call delivery

For speech and 3.1 kHz audio bearer services, the terminating exchange should generate in-band ring back tone towards the calling user upon successful delivery of the call.

5.3 Call negotiation between ISDNs

There are two aspects of call negotiation between ISDNs: service agreement and connection agreement.

5.3.1 Service agreement between ISDNs

Service agreement between ISDNs is defined as established compatibility between the two networks on a requested service. The service agreement does not necessarily occur on a call-by-call basis, but in a pre-determined way which has been agreed by bilateral negotiation between the two ISDNs. If the service agreement is established, connection agreement then begins between the two ISDNs.

If the service agreement is not established, procedures are for further study, including the following four alternatives. Additionally, the impact of these alternatives on user-to-network protocols or inter-network protocols is for further study.

5.3.2 Connection agreement between ISDNs

Connection agreement between ISDNs is defined as negotiation on the connection element between the two networks. Connection agreement is required when the connection elements employed in each ISDN are different, even if service agreement exists. (For example, see the appendix of this Recommendation.) The use of call progress indicators for this purpose is for further study.

A/Mu conversion) or agreed between two ISDNS.

5.4 Compatibility checking between end users of different ISDNs

1) Low Layer Compatibility (LLC)

LLC information would normally be used for user-to-user call negotiation and would be passed transparently through the networks. The IWF may, where required, examine and act on LLC information (see I.515, section 2.2.1.3) in the cases where the LLC checking lists (see Q.931) employed by the relevant ISDNs are different.

2) High Layer Compatibility (HLC)

The HLC is to be conveyed transparently and the networks need not operate on it. The examination and action on HLC information by the IWF is for further study, in the case where the HLC checking lists employed by the relevant ISDNs are different.

3) User defined Compatibility Checking

User defined compatibility checking is the user responsibility. The network does not participate in this compatibility checking.

7. References

See Recommendation I.500

1.3 Considerations for terminal designed to operate with restricted 64 kbit/s transfer capability (Figure I-2/I.520)

Existing terminals at rates less than 64 kbit/s will require rate adaption to operate with restricted 64 kbit/s transfer capability (see Recommendation I.464).