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SERIES V: DATA COMMUNICATION OVER THE TELEPHONE NETWORK

Interworking with other networks

Procedures for establishing communication between two multiprotocol audiovisual terminals using digital channels at a multiple of 64 or 56 kbit/s

ITU-T Recommendation V.140

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ITU-T Recommendation V.140

Procedures for establishing communication between two multiprotocol audiovisual terminals using digital channels at a multiple of 64 or 56 kbit/s

Summary

This Recommendation describes a standardized method for automatic mode negotiation, detection of bit alignment, and confirmation of subchannel connectivity for multimedia terminals on digital networks. This new protocol provides backward compatibility with existing standards and creates an extensible mechanism to negotiate future protocols.

The two primary benefits from implementing this Recommendation are:

1) improved reliability in completing calls and successfully establishing multimedia communications, since peculiar network characteristics (such as "restricted" networks) that interfere with call establishment and protocol negotiations are automatically handled by V.140 procedures; and

2) for terminals that support multiple communication modes, an automatic means of selecting modes.

Principal features of this Recommendation include the ability to find bit alignment, detect remote network type, and perform in-band testing of channel characteristics; a flexible and extensible capability exchange and mode selection facility is also built-in.

V.140 procedures apply to every channel of a multi-channel call and begin following establishment of the end-to-end digital connection, and before any multimedia or other communication protocols are initiated. The procedures are divided into three phases:

- Phase 1 – Send/search for V.140 signature (note that V.8/V.8 *bis*, voice, and H.221 FAS, or any subset of these may be simultaneously transmitted). If such signature is detected, proceed to:
- Phase 2 – Characterize the digital connection (64 vs 56 kbit/s, detect octet/septet alignment), and diagnose any odd characteristics of the network, (i.e., it could be restricted, that is, it transfers only 7 of 8 bits to the far-end). Once this is complete,
- Phase 3 – Exchange mode capabilities (similar to V.8 *bis*) and select desired operation mode. Modes can include voice communications, multimedia communications, and channel aggregation protocols, but capabilities are kept simple, given that the purpose of this Recommendation is only to select a particular protocol, not to determine all of the parameters related to that protocol (which can typically be determined using the protocol itself).

The Phase 1 procedures have been designed to allow simultaneously signalling of other protocols, such as H.320, to minimize the amount of time lost in beginning communications if a terminal that implements V.140 finds itself communicating with a terminal that does not.

Following Phase 3, a terminal can immediately begin procedures associated with the selected operation mode.

This revised version incorporates corrections to errors noted between the original approval in February 1998 until November 2004. In particular, the bit order illustrated in Figure 11 has been corrected to match the body text, and in Annex A incomplete ASN.1 syntax has been restored and references to multilink operation according to Annex F/H.324 have been added.

Source

ITU-T Recommendation V.140 was approved on 8 January 2005 by ITU-T Study Group 16 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation V.140

Procedures for establishing communication between two multiprotocol audiovisual terminals using digital channels at a multiple of 64 or 56 kbit/s

1 Introduction and scope

This Recommendation defines automatic mode negotiation and selection for multiprotocol audiovisual terminals connected to digital networks such as the ISDN. The procedures in this Recommendation are intended to avoid interference with those of pre-existing Recommendations.

The procedures in this Recommendation automatically determine network connectivity and bit alignment between terminals. Also, they enable prompt and accurate negotiation of a common mode of operation when one or both terminals support multiple protocols for audiovisual communication. For example, a terminal might support H.320, H.324 over voiceband modem, and H.323 over ISDN; in this case, the procedures in this Recommendation would be used to negotiate a common protocol, e.g., H.323. Once a mode is selected, further negotiations as recommended for that mode may use information derived from V.140 negotiations, if applicable.

V.140 procedures can also be used to provide an optional initial voice telephony mode before proceeding to multimedia telephony, and to switch from one multimedia telephony mode to another, or back into voice telephony mode.

The means by which digital channels are established between terminals are outside the scope of this Recommendation (see ITU-T Rec. H.200/AV.420). Information regarding the nature of the endpoint terminals available from D-channel signalling may be useful in further accelerating V.140 negotiations; use of such information is for further study.

The procedures of this Recommendation concern only the flow of signals along the fixed digital paths used for the transport of audiovisual content during the call, at integer multiples of 64 kbit/s (or 56 kbit/s in certain networks).

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.

– ITU-T Recommendation H.221 (2004), *Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices*.

– ITU-T Recommendation H.242 (2004), *System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s*.

– ITU-T Recommendation H.320 (2004), *Narrow-band visual telephone systems and terminal equipment*.

– ITU-T Recommendation H.324 (2002), *Terminal for low bit-rate multimedia communication*.

- ITU-T Recommendation V.8 (2000), *Procedures for starting sessions of data transmission over the public switched telephone network*.
- ITU-T Recommendation V.8 *bis* (2000), *Procedures for the identification and selection of common modes of operation between data circuit-terminating equipments (DCEs) and between data terminal equipments (DTEs) over the general switched telephone network and on leased point-to-point telephone-type circuits*.
- ITU-T Recommendation X.680 (2002) | ISO/IEC 8824-1:2002, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.
- ITU-T Recommendation X.691 (2002) | ISO/IEC 8825-2:2002, *Information technology – ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)*.
- ISO/IEC 3309:1993, *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures – Frame structure*.
- ISO/IEC 13871:1995, *Information technology – Telecommunications and information exchange between systems – Private telecommunications networks – Digital channel aggregation*.

3 Definitions

This Recommendation defines the following terms:

3.1 56C interface: A 56 kbit/s network interface which transfers all bits to the far-end.

3.2 64C interface: A 64 kbit/s network interface which transfers all bits to the network.

3.3 64R interface: A 64 kbit/s network interface which transfers 7 of each 8 bits to the far-end, for a net throughput of 56 kbit/s.

3.4 acquire: To detect a signal a sufficient number of times to meet the specified acquisition criteria.

3.5 aligned channel: A channel for which network byte timing is available to the terminal. Ordinarily, an aligned channel is needed to transport unframed G.711 voice telephony. Network interfaces which do not pass network byte timing, such as V.35 interfaces, cause the terminal to operate as if connected to a non-aligned channel.

3.6 byte: A septet for networks with either a 56C or 64R interface. Also, an octet for networks with a 64C interface.

3.7 detect: To receive a given signal a single time.

3.8 octet: A group of 8 bits. For Phases 1 and 2, if on an aligned channel, each new octet begins at the time specified by network timing.

3.9 protocol data unit (PDU): An HDLC frame carrying a Phase 3 message.

3.10 public switched data service network (PSDSN): A 56 kbit/s public switched data service network, for example the "Switched-56" network in the United States as specified by TIA/EIA-596. Such a network may be sensitive to emulation of escape codes by data entering the network via a 64C interface.

3.11 restricted channel: A channel carried on a network whose B-channels are effectively restricted to 56 kbit/s, or whose channels at H_0 or higher are restricted by ones-density considerations. This can be because the terminal is on a 56C interface or a 64R interface or because of the nature of the network.

3.12 round-trip: Given two terminals, A and B, connected via an ISDN, a round-trip is the transmission via the ISDN of a message from terminal A to terminal B and then from terminal B to terminal A; it is generally assumed that the time required to process and otherwise manipulate the message is negligible compared to the time required for transmission and propagation.

3.13 reflected signature pattern (RSP): A bit pattern transmitted during Phase 2 that is computed from the bit pattern in a particular subchannel as received from a remote terminal. RSP is transmitted in the same subchannel in which it is received to signal the alignment of subchannels received at the terminal.

3.14 septet: A group of 7 bits. If on an aligned channel, each new septet begins at the time specified by network timing.

3.15 signature pattern (SP): A bit pattern transmitted within an individual subchannel to signal the presence of V.140 support and to permit determination of subchannel alignment and continuity.

3.16 subchannel: The bits in a particular bit position of a sequence of bytes. Bits within a byte are numbered 1, 2, 3, 4, … in order of decreasing significance. The number of the subchannel is the same as the number of the bit position. For example, the sequence of bits in bit position 4 in successive bytes form the bitstream corresponding to subchannel 4.

3.17 terminal: Any of several types of endpoint devices connected to a digital network, including digital terminal equipment and Multipoint Control Units (MCUs).

4 Abbreviations

This Recommendation uses the following abbreviations:

BC	Bearer Capability
CPF	Compatible Protocol Field
FCS	Frame Check Sequence
GSTN	General Switched Telephone Network
HLC	High-Level Capability
ISDN	Integrated Services Digital Network
PCM	Pulse Code Modulation (per ITU-T Rec. G.711)
PDU	Protocol Data Unit
PSDSN	Public Switched Data Service Network
RSP	Reflected Signature Pattern
SP	Signature Pattern
UDI	Unrestricted Digital Information

5 Conventions

The word "shall" is used in this Recommendation to specify a mandatory requirement.

The word "should" is used in this Recommendation to specify a suggested, but not required, course of action.

The word "may" is used in this Recommendation to specify an optional course of action, without expressing a preference.

References in this Recommendation to specific ASN.1 message structures are presented in **this typeface**.

6 Overview

The procedures involve three phases:

- Phase 1 – Send/search for V.140 signature (note that V.8/V.8 *bis*, voice, and H.221 FAS, or any subset of these may be simultaneously transmitted). If signature is detected, proceed to:
- Phase 2 – Characterize digital connection (64 vs 56 kbit/s, detect octet/septet alignment).
- Phase 3 – Exchange mode capabilities (similar to V.8 *bis*) and select desired operation mode.

Once Phase 3 is complete, the selected mode (H.320, H.324, voice, etc.) is entered and normal call startup proceeds.

Each phase should take little more than one round-trip time to complete, so the complete V.140 procedure should finish in little over 3½ round-trip times. Under typical circumstances (an intracontinental call via a 64 kbit/s clear interface), less than 1 second will be added to call startup.

If no "signature" is detected, this indicates that the far-end does not support V.140. The terminal then falls back to any other non-V.140 protocol supported, such as H.320 (if H.221 FAS is detected) or V.8/V.8 *bis* GSTN modes (if V.8/V.8 *bis* is detected), or voice telephony.

These procedures are designed so that terminals can transition from one phase of V.140 to the next at different times without ill effects: the timing of such transitions does not need to be precisely synchronized between terminals.

6.1 Phase 1 – V.140 signature transmission and acquisition

Phase 1 begins with the establishment of the end-to-end digital connection.

A repeating 80-bit pattern containing the V.140 signature is transmitted. The purpose of the signature is to indicate to the far-end that this terminal implements V.140, and is capable of proceeding to the later phases.

The signature has special characteristics. It is transmitted in the low-order bits of each byte to minimize the disruption of G.711 audio and permit simultaneous 48 kbit/s G.711 audio operation.

These characteristics make it possible for the V.140 terminal to signal its signature while also sending GSTN modem tones and H.320 signals for compatibility with existing GSTN and H.320 ISDN terminals (see 6.5), as well as carrying normal speech telephony without startup delay.

If the V.140 signature is detected in received data, this indicates that the far-end also supports V.140. The terminal then mutes received audio and enters Phase 2.

If, after a time-out, the V.140 signature has not been found, the terminal may proceed to any other non-V.140 protocol it supports. If it was also searching for other protocols while looking for the V.140 signature, it may have already detected the far-end's ability to use these modes, and so has not lost any time starting these protocols.

Otherwise, the terminal can continue the call as a voice telephone call, or can initiate another non-V.140 protocol.

6.2 Phase 2 – Channel characterization

There are a variety of national digital network types and interfaces in use. These include 64 and 56 kbit/s networks, and networks and interfaces which do or do not provide octet (or septet) timing. Even between two terminals with 64 kbit/s ISDN connections with network octet timing, it is possible on some national networks to have an intervening 56 kbit/s link. The nature of the end-to-end digital link, including rate and bit alignment, must be confirmed before the link can be used for multimedia communication.

Upon entering Phase 2, each terminal probes the channel to determine the relative octet (if 64 kbit/s) or septet (if 56 kbit/s) alignment between the terminals. This is accomplished using Signature Patterns (SP) that are transmitted independently in each of the eight bit positions on the line.

The bit position in which each SP appears at the receiver tells the receiver about relative alignment between transmitter and receiver. After the SP is detected, each receiver reflects its received SP back to the transmitter. Each terminal can then determine bit alignment and any network restriction for each direction of transmission.

Once this procedure is complete, the terminals proceed to Phase 3.

6.3 Phase 3 – Capability exchange and mode selection

In Phase 3, the two terminals exchange mode capabilities and select a mode.

Using the entire 64 (or 56) kbit/s bandwidth, each terminal sends an HDLC-framed message containing a simple list of its capabilities (detailed capability exchange is left to the procedures of the selected mode). One terminal, normally the calling terminal, then selects a single mode from the list.

The terminal which would ordinarily choose the mode can instead send a **youChoose** message to the far-end, requiring that the other end decide. This can be useful for situations where the calling terminal does not know the intended purpose of the call.

Once Phase 3 is complete, the terminals go directly to the selected mode.

6.4 Using V.140 to switch among multimedia operation modes

These procedures may be used to switch from one multimedia telephony mode to another, or back into voice telephony mode, by re-starting the Phase 3 procedures after termination of a previous mode.

Also, Phase 1 V.140 procedures may be used in a "late-start" mode, after a period of G.711 voice telephony.

6.5 Interoperability with terminals that do not support V.140

In order to support interoperability with existing terminals that do not support V.140, the Phase 1 V.140 signature has been designed to accommodate simultaneous signalling of other compatible protocols. The procedures given below specify how to use the facilities in V.140 to promote interoperability with particular protocols.

A terminal that is attached to an aligned channel and supports G.711 audio:

- shall transmit G.711 audio truncated to 6 bits during Phase 1 (see 8.2.1).

A terminal that supports V.140 and H.320:

- should transmit signals for H.320 operation as defined in ITU-T Rec. H.221 during Phase 1 of V.140 (see 8.2.1 and 8.2.2);
- should not respond to any signals defined by H.320 (i.e., should not complete Sequence A) until it fails to detect the V.140 Phase 1 signature from the far-end terminal.

A terminal that supports GSTN modem operation (e.g., as defined in ITU-T Rec. V.34):

- should transmit signals for GSTN modem operation as defined by V.8 or V.8 *bis* during Phase 1 of V.140 (see 8.2.2);
- should not respond to any signals defined by V.8 or V.8 *bis* until it fails to detect the V.140 Phase 1 signature from the far-end terminal.

A terminal that supports ISO/IEC 13871:

- should search for received signals as defined by ISO/IEC 13871 during Phase 1 of V.140 in order to determine if the far-end terminal supports ISO/IEC 13871 but does not support V.140;
- should not respond to any such signals until it fails to detect the V.140 Phase 1 signature from the far-end terminal.

6.6 Interworking with PSDSNs

Experience indicates that when a call is made from a 64 kbit/s ISDN to some Public Switched Data Service Networks (PSDSN), the low-order bit of each ISDN octet is transported without modification from the ISDN to the PSDSN. This bit is often used by PSDSN devices, such as Channel Service Units (CSUs), for in-band signalling of supervisory messages from the network to the CSU. Under some circumstances, bit values of zero in this position activate features of the CSU leading to loopback of the data stream, call termination, or entry of the CSU into a test mode. In the United States, the code values used for supervisory functions are standardized in TIA/EIA-596.

The procedures given in this Recommendation have been designed to avoid emulation of PSDSN supervisory messages. In certain cases, particular octet values are either mandated or forbidden for this reason.

7 Network types

This Recommendation addresses terminals connected to the following types of digital network interfaces:

- 64 kbit/s clear interfaces (64C) and restricted interfaces (64R) – variants of the same interface;
- 56 kbit/s clear interfaces (56C);
- H_0 interfaces (H_0);
- H_{11} interfaces (H_{11});
- H_{12} interfaces (H_{12}).

A terminal cannot determine if a 64 kbit/s interface is 64C or 64R without using these procedures, since the clear or restricted characteristic is a result of a particular network route and may change from one call to the next. In effect, 64R and 64C are variants of the same interface.

The terminal can be connected to only one of the five network types listed at any particular time. The terminal will know which of the five digital network interfaces it is using.

In every case, the terminal implementing these procedures shall have direct access to and control of the network interface. For example, it is acceptable to use a digital terminal adapter as an interface to the network, but not a channel aggregation device based upon the protocol defined by ISO/IEC 13871 that does not also implement the procedures of this Recommendation.

NOTE – The terminal may use these procedures to negotiate the subsequent use of ISO/IEC 13871 and other channel aggregation protocols, but the procedures of this Recommendation must be executed first of all.

Each network type may or may not have byte-timing alignment from the network.

The procedures of this Recommendation shall be used on each digital channel of every call, including digital voice-only calls, as said channel becomes available for use.

64C interfaces transfer all bits to the far-end, at a rate of 64 kbit/s.

64R interfaces locally interface at 64 kbit/s, but transfer 7 of each 8 bits to the far-end, for a net throughput of 56 kbit/s. One bit in each 8 is not transferred by the network. 64R interfaces are not specifically addressed in the procedures of Phase 1 because a terminal may not be aware whether it is connected to a 64C or 64R interface; however, the procedures of Phase 2 shall be used by terminals to identify which bit of the 8 is not being transferred to the far-end. Once terminals know which bit position in each octet is not being transferred, terminals shall ensure that valid data is never placed in said bit position, i.e., that bit shall be skipped.

Terminals on 64R interfaces shall follow the procedures for 64C terminals, except that if a terminal has a priori information that it is on a 64R interface, and if it has network byte timing alignment, it shall fill subchannel 8 with binary ONEs at all times, and otherwise follow the procedures for 56C interfaces.

56C interfaces transfer all bits to the far-end, at a rate of 56 kbit/s.

An H_0, H_{11} or H_{12} channel may be regarded as consisting of a number of 64 kbit/s Time-Slots (TS), as defined and numbered in ITU-T Rec. H.221. The lowest-numbered of these TS shall be used by terminals to transmit the various signals described in this Recommendation; however, any terminal attempting to receive such signals shall search for them in any and all TS. The results of the procedures described in this Recommendation apply to all TS.

The procedures to be followed for connections that consist of multiple 64 kbit/s B-channels interworking with an H_0, H_{11} or H_{12} channel or multiple H_0 channels interworking with an H_{11} or H_{12} channel are for further study.

8 Signals

8.1 Data stream model

All signals for Phases 1 and 2 are defined using a byte-oriented model of the data stream (as is used in ITU-T Rec. H.221). In the case of 64C interfaces, the data stream is modelled as a series of octets, whereas in the case of 56C interfaces, the data stream is modelled as a series of septets.

Figure 1 illustrates subchannels within the byte-oriented data stream carrying example 8-bit values "1, 2, 3, 4, 5". 56C interfaces send only subchannels 1 through 7; this is illustrated through shading of subchannel 8 in Figure 1 and subsequent figures. All references in this Recommendation to transmission of information in subchannel 8 apply only to 64C interfaces.

For each byte, subchannel 1 holds the most significant bit of G.711 audio samples in ISDN telephony, and is the first bit transmitted by the network. Subchannel 8 holds the least significant bit of G.711 audio samples, and is the last bit transmitted by the network.

For signals carried within a single subchannel, bits are sent starting with the most significant bit of the signal; signals are shown in vertical columns (each column representing a subchannel) with the most significant bit at the top of the column.

Byte number	**(MSB) Subchannel 1**	**Subchannel 2**	**Subchannel 3**	**Subchannel 4**	**Subchannel 5**	**Subchannel 6**	**Subchannel 7**	**(LSB) Subchannel 8**
n	0	0	0	0	0	0	0	1
n + 1	0	0	0	0	0	0	1	0
n + 2	0	0	0	0	0	0	1	1
n + 3	0	0	0	0	0	1	0	0
etc.	0	0	0	0	0	1	0	1

Figure 1/V.140 – Illustration of data stream model

8.2 Phase 1 – V.140 signature block and compatible protocol field

An 80-byte Phase 1 signal is repeatedly transmitted during Phase 1. There are two forms of the Phase 1 signal: one that shall be transmitted by terminals attached to aligned channels and another that shall be transmitted by terminals attached to non-aligned channels. The differences between the two forms of the Phase 1 signal are irrelevant to terminals that receive said signal.

8.2.1 Terminals attached to aligned channels

Terminals attached to aligned channels have some flexibility in determining certain characteristics of the signal to be transmitted during Phase 1. Within the Phase 1 signal, subchannels 1-6 shall carry PCM audio according to G.711, truncated to 6 bits, unless the terminal does not support G.711 audio. Any valid audio signal may be transmitted, including speech or GSTN modem signalling such as V.8 or V.8 *bis*.

If the terminal does not support G.711 audio, subchannels 1-6 shall carry all binary ONEs.

Subchannel 7 shall carry a "signature block" consisting of 80 bits. Bits 1 through 16 shall contain a "Compatible Protocol Field" (CPF), which carries either all binary ONEs or a compatible protocol. The CPF is followed by the 8 bit "Signature Pattern" (SP) field defined for that subchannel, i.e., SP-G (see 8.2.3), which is followed by a fill pattern of 8 bits set to binary ONE. SP is repeated four times in the subchannel, as is the fill pattern. The 16-bit CPF, combined with four repetitions each of the SP and the fill pattern complete the 80 bit signature block. V.140 signature blocks shall be transmitted in subchannel 7 only.

Subchannel 8 shall also carry a block of 80 bits. Like subchannel 7, bits 1 through 16 shall contain a CPF. However, the remaining bits shall carry all binary ONEs.

NOTE – The CPF is primarily intended to carry H.221 FAS and BAS signalling. However, the provision of a CPF in both subchannels 7 and 8 does not imply that H.221 FAS and BAS (or some other compatible protocol) should be sent in both subchannels simultaneously. The CPF merely provides a reserved portion of the Phase 1 signal for the use of other protocols. Use of CPF by a compatible protocol should comply with the Recommendation for that protocol. Any portion of any CPF which is not used to transmit a compatible protocol should carry all binary ONEs.

In order to avoid emulation of PSDSN supervisory messages, terminals that transmit octets and are attached to aligned channels shall check each of the first 16 octets of the 80-octet Phase 1 signal to determine if that octet has one of the values listed in the column of Table 1 labelled "Forbidden" Value. If so, that octet shall not be transmitted; instead, it shall be replaced by the corresponding value in the column of Table 1 labelled "Safe" Replacement. All remaining octets of the 80-octet Phase 1 signal have the low-order bit set to binary ONE by definition and therefore cannot take on any of the "Forbidden" values.

Table 1/V.140 – Translation of byte values for "safe" transmission of audio

"Forbidden" value	"Safe" replacement
2A	28
2E	30
AA	A8
AC	A8
AE	B0

Subchannel 8 also carries a repeated 80-bit pattern which shall be aligned with the 80-bit pattern in subchannel 7. Bits 1 through 16 carry a CPF, like subchannel 7, but the remaining bits carry all binary ONEs.

The V.140 signature block is always 80 bits in length, regardless of the subchannel in which it is signalled.

While transmitting the Phase 1 signal, terminals on aligned channels should concurrently transmit compatible protocols, such as H.221 framing, G.711 audio, and modem modulations within G.711 audio. Subchannels 7 and 8 are used because they occupy the least significant bit positions of G.711 audio, and so will be minimally disruptive of audio signals.

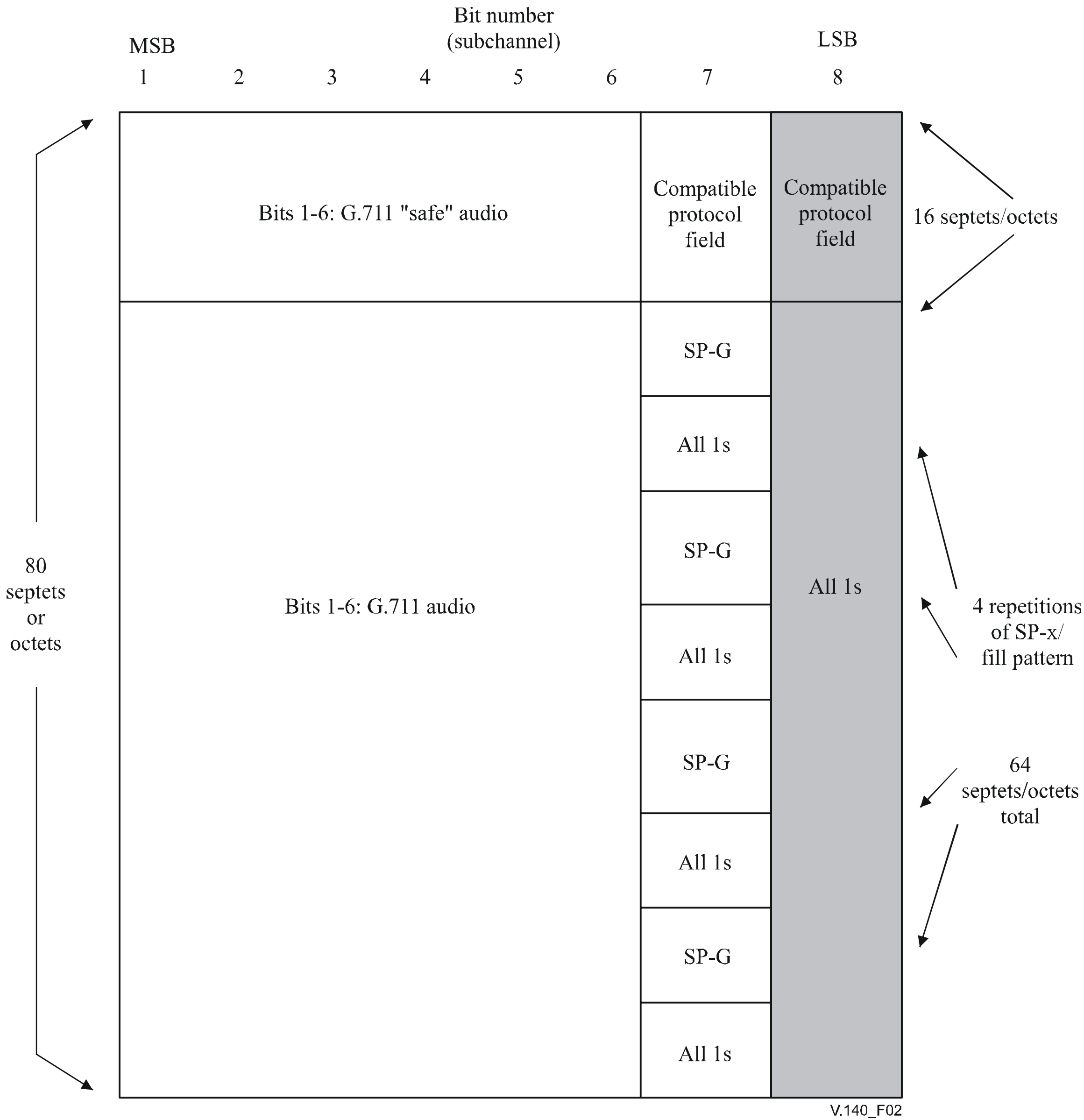

Figure 2/V.140 – Phase 1 signal for terminals attached to aligned channels (shaded bit position not present on 56C interfaces)

8.2.2 Terminals attached to non-aligned channels

Terminals attached to non-aligned channels transmit a somewhat different Phase 1 signal from the one just described; these terminals shall not transmit G.711 audio at all.

If the terminal transmits octets, the first 16 it transmits shall be chosen from those in Table 2. This selection of values accommodates all possible choices for the CPF, which is carried in bits 1 through 16 of subchannels 7 and 8. If the terminals transmits septets, bits 1 through 16 in subchannels 1 through 6 shall be set to binary ONE.

Table 2/V.140 – Safe values for transmission during the first 16 bytes of the Phase 1 signal

F8
FD
FE
FF

After the first 16 octets, the following pattern of 16 octets is repeated 4 times (hexadecimal codes are given):

DD FF EE DD EE DD FF 00 FF FF FF FF FF FF FF FF

This pattern contains the SP fields assigned to subchannels 7 and 8 (SP-G and SP-H) embedded within it (see 8.2.3). Terminals sending septets should simply drop the least significant bit of each hexadecimal code.

The V.140 signature block is always 80 bits in length, regardless of the subchannel in which it is signalled.

While transmitting the Phase 1 signal, terminals should concurrently transmit compatible protocols such as H.221 framing by transmitting the codes in Table 2 during the first 16 bytes of the Phase 1 signal to set appropriate values in the CPF.

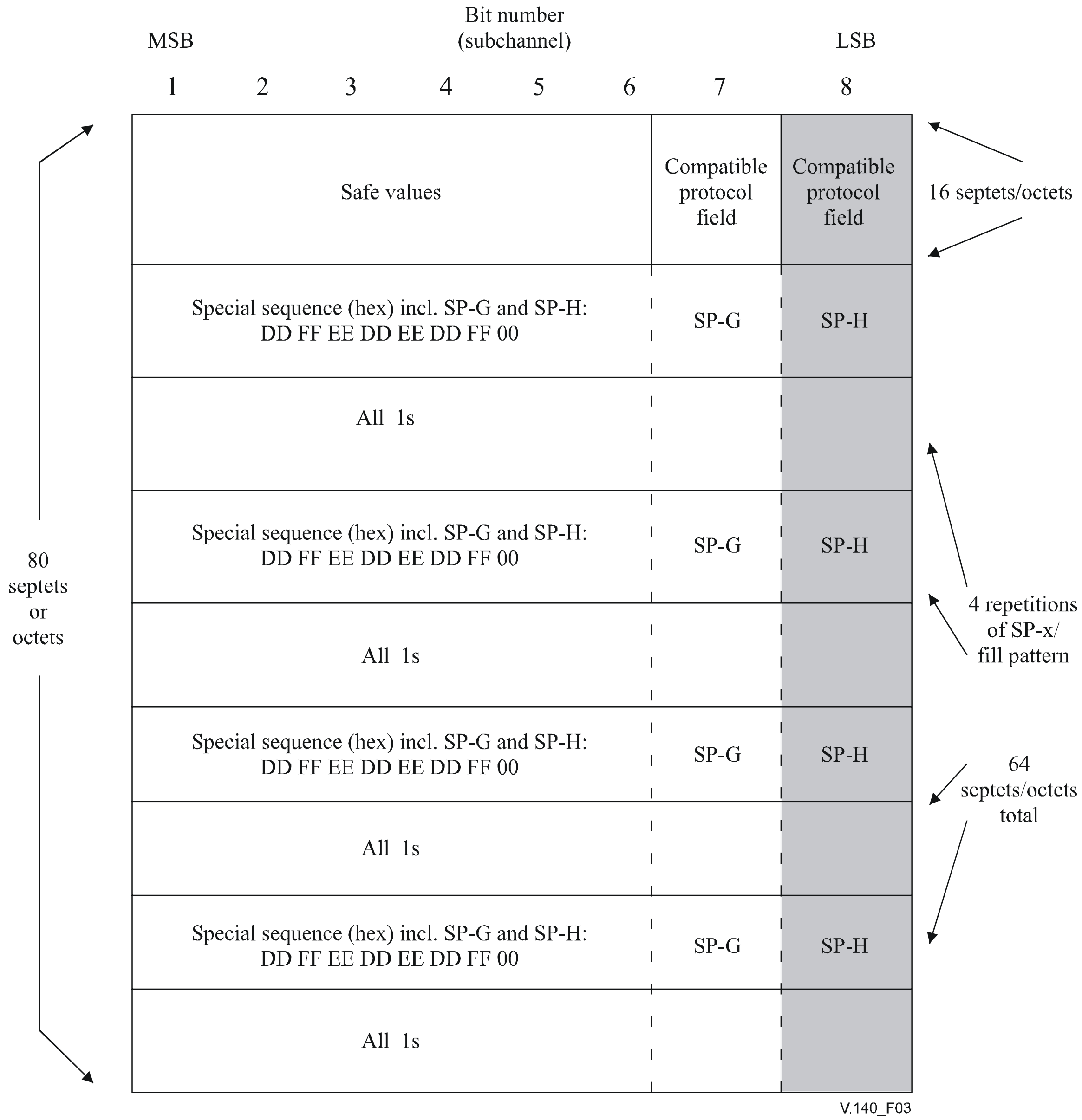

Figure 3/V.140 – Phase 1 signal for terminals attached to non-aligned channels (shaded bit position not present on 56C interfaces)

8.2.3 Signature Pattern (SP) field

The "SP" field is 8 bits in length and contains a unique pattern which depends upon the subchannel in which it is being transmitted.

SP is transmitted within individual subchannels to signal the presence of V.140 support and to permit determination of subchannel alignment and end-to-end connectivity.

The 8 SP values are uniquely distinguishable from each other so that if subchannel alignment is lost in the network, the receiver can determine the transmitter's subchannel alignment by finding particular SP values in received subchannels.

The SP values are given in Table 3, and their transmission in the data stream is illustrated in Figure 4.

Table 3/V.140 – Signature pattern values

Subchannel number	Signature pattern name	Signature pattern value
1	SP-A	10101100
2	SP-B	01011010
3	SP-C	10110110
4	SP-D	01101100
5	SP-E	11011010
6	SP-F	10110100
7	SP-G	01101010
8	SP-H	11010110

Byte number	Subchannel 1	Subchannel 2	Subchannel 3	Subchannel 4	Subchannel 5	Subchannel 6	Subchannel 7	Subchannel 8
1	1	0	1	0	1	1	0	1
2	0	1	0	1	1	0	1	1
3	1	0	1	1	0	1	1	0
4	0	1	1	0	1	1	0	1
5	1	1	0	1	1	0	1	0
6	1	0	1	1	0	1	0	1
7	0	1	1	0	1	0	1	1
8	0	0	0	0	0	0	0	0

Figure 4/V.140 – Transmission of SP values in data stream

Only SP-G and SP-H are used in Phase 1. All eight SP values are used in Phase 2.

8.3 Phase 2 – Alignment probing

During Phase 2, terminals alternately transmit two fields, Field A and Field B. No other signals shall be transmitted during this phase; audio and any compatible protocol shall be turned off. Each field is 8 bytes in length, and each field is composed only of contiguous bytes. The terminal shall commence transmission of the Phase 2 signal immediately after it completes its final transmission of the Phase 1 signal (see Figure 5).

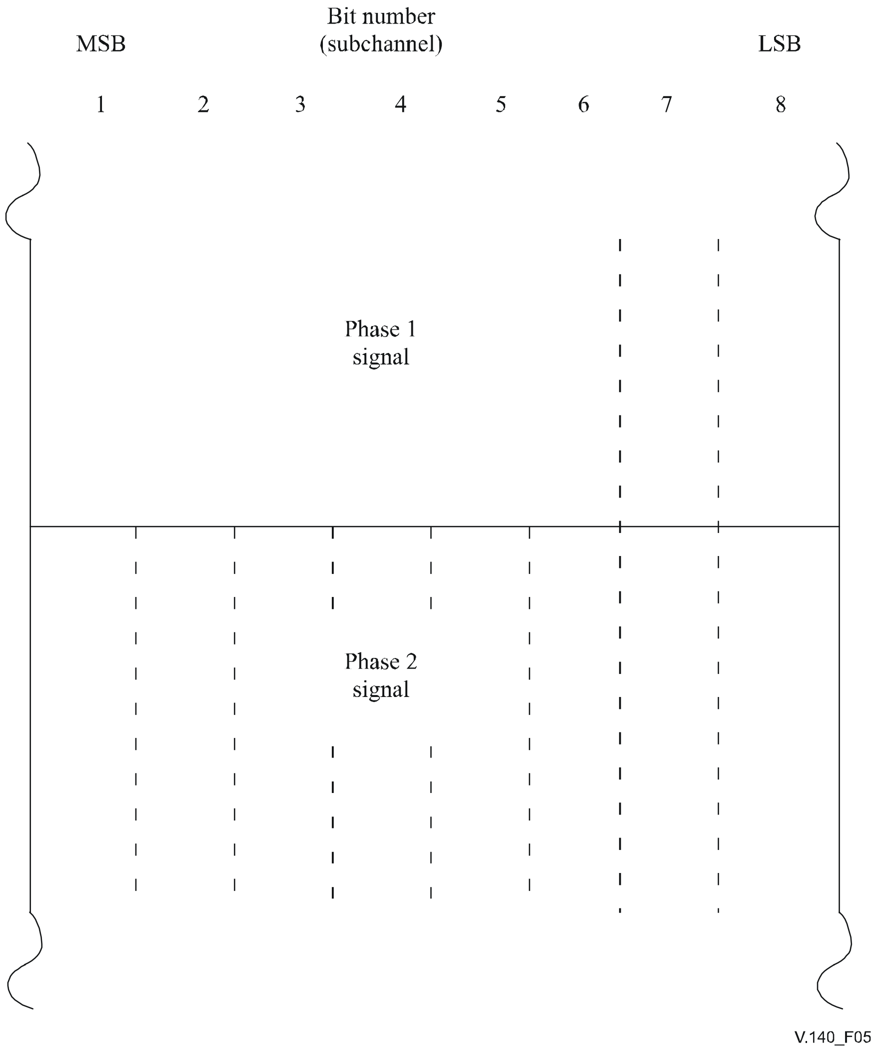

Figure 5/V.140 – Transition from Phase 1 to Phase 2

Variation of the contents of Fields A and B during the subphases 2a, 2b, and 2c allow these fields to be used both as probing signals for a particular subphase and as acknowledgment of the far-end's most recent signal.

Terminals on 56C interfaces shall transmit only subchannels 1 through 7 of Field A and Field B as presented in this clause.

Phase 2 consists of three subphases: 2a, 2b, and 2c.

8.3.1 Phase 2a – Initial values

In Phase 2a, Field A contains SP, as defined above, in all subchannels.

NOTE – The values of SP are defined such that the last bit of the SP for every subchannel is set to binary ZERO. This feature can be used confirm where each SP begins in a subchannel.

Field B contains all binary ONEs in all subchannels.

Figure 6 illustrates the Phase 2a signal, with Field A above the heavy line, and Field B below it.

Byte number	(MSB) 1	2	3	4	5	6	7	(LSB) 8
1	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
2	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
3	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
4	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
5	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
6	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
7	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
8	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1

Figure 6/V.140 – Phase 2a signal

8.3.2 Phase 2b – After SP acquisition

A transmitter switches to Phase 2b after it has acquired SP from the received Field A; the procedure for doing so is described in 9.3.1.2.

In Phase 2b, Field A contains SP, as defined above, in all subchannels (unchanged from Phase 2a).

Field B contains "Reflected Signature Pattern" (RSP) as defined by the procedures for computing RSP in 9.3.2.1.

The actual value of RSP in Field B depends on the relative alignment of byte timing between the two terminals and the treatment of subchannels in the network between them.

The Phase 2b signal is illustrated in Figure 7.

Byte number	(MSB) 1	2	3	4	5	6	7	(LSB) 8
1	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
2	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
3	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
4	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
5	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
6	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
7	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
8	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
9	*RSP as calculated from received SP*							
10	*RSP as calculated from received SP*							
11	*RSP as calculated from received SP*							
12	*RSP as calculated from received SP*							
13	*RSP as calculated from received SP*							
14	*RSP as calculated from received SP*							
15	*RSP as calculated from received SP*							
16	*RSP as calculated from received SP*							

Figure 7/V.140 – Phase 2b signal

8.3.3 Phase 2c – After RSP acquisition

A transmitter switches to Phase 2c after it has acquired RSP from the received Field B.

In Phase 2c, Field A contains all binary ONEs (as a signal that RSP has been acquired).

Field B contains "Reflected Signature Pattern" (RSP) as defined by the procedures for computing RSP in 9.3.2.1 (unchanged from Phase 2b).

The Phase 2c signal is illustrated in Figure 8.

Byte number	**(MSB) 1**	**2**	**3**	**4**	**5**	**6**	**7**	**(LSB) 8**
1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	*RSP as calculated from received SP*							
10	*RSP as calculated from received SP*							
11	*RSP as calculated from received SP*							
12	*RSP as calculated from received SP*							
13	*RSP as calculated from received SP*							
14	*RSP as calculated from received SP*							
15	*RSP as calculated from received SP*							
16	*RSP as calculated from received SP*							

Figure 8/V.140 – Phase 2c signal

8.4 Phase 3 signals

Phase 3 signals are used to establish authority for mode selection, to exchange capabilities, to select a common operation mode from among the expressed capabilities, and to provide indications for abnormal termination of V.140.

Phase 3 signals consist of HDLC-framed PDUs defined using ASN.1 syntax according to ITU-T Rec. X.680 and coded according to the packed encoding rules of ITU-T Rec. X.691. These PDUs are sent using the entire bit rate available on the channel. The actual PDUs are defined in Annex A. This clause describes the HDLC framing and semantics for each PDU.

Phase 3 signals use a bit-oriented model of the channel. All bits of Phase 3 messages shall be transmitted bit-sequentially without regard to the interface type, and without regard to network byte timing alignment, with the following exception: if any bit positions within each byte of the channel are not being transferred to the far-end by the network (as determined by the Phase 2 procedures), the terminal shall insert a binary ONE at those bit positions so that they are skipped. The receiver of Phase 3 signals should perform the converse of the operations performed by the transmitter (see 9.3.4).

During Phase 3, the following PDUs may be transmitted:

- **roleAndCapability**;
- **youChoose**;
- **modeSelect**;
- **modeSelectAcknowledge**;
- **terminate**;
- **nonStandard**.

The **nonStandard** PDU may be used to extend this set as needed. Although the meaning of non-standard messages is defined by individual organizations, equipment built by any manufacturer may signal any non-standard message, as long as the meaning of the message is known.

Non-standard capabilities and modes may be issued using the **NonStandardParameter** structure.

8.4.1 roleAndCapability PDU

The **roleAndCapability** PDU transmitted by a terminal shall contain a declaration of the role taken by that terminal in establishing the network connection; a random value used for role arbitration when both terminals have taken the same role in establishing the network connection (e.g., for leased line connections); and a list of the capabilities for multimedia and other communication protocols available on that terminal.

The **role** field of the **roleAndCapability** PDU takes one of three values: **answer**, **originate**, or **unknown**. The terminal shall assign the value of **originate** to the **role** field of any **roleAndCapability** PDU it transmits if the call was initiated at that terminal and the value of **answer** if the call was initiated at the other terminal. If the terminal lacks sufficient information to determine which end actually initiated the call, it shall assign the value of **unknown** to the **role** field. The value transmitted by the terminal in the **role** field shall be fixed for the duration of a network connection. The **arbitrationField** contains a 32-bit random number chosen using a random number generator with a uniform probability distribution. If a call consists of more than one digital channel, then the same **role** field and **arbitrationField** (random number) shall be selected and used in the Phase 3 procedures for all channels of that call.

The **capabilitySet** field of the **roleAndCapability** PDU contains a sequence of one or more **Capability** structures, each expressing the terminal's ability to work in a particular multimedia or other communication protocol. The transmitter shall include the complete list of modes in which it is currently able to operate. The list of possible modes is defined in Annex A, and may be extended in the future. Capabilities shall be listed in order of preference, from most-preferred to least-preferred.

NOTE – The terminal transmitting a **modeSelect** PDU is not required to take account of the order of preference of capabilities received from the far-end terminal, although it should do so.

Some individual capabilities include additional sub-capability information. These indicate that the terminal is capable of using the stated sub-modes within the capability indicated. The far-end terminal may use this information to influence its choice of modes.

8.4.2 modeSelect PDU

The **modeSelect** PDU shall contain a single mode which has been selected from the far-end's **capabilitySet** as the mode of operation to follow completion of V.140 negotiation. The **modeSelect** PDU is structured differently than the **Capability** structure of the **roleAndCapability** PDU, since some individual modes include additional information. This information shall be used by the far-end terminal to set up the appropriate sub-mode as requested.

8.4.3 youChoose PDU

The **youChoose** PDU may be transmitted in place of the **modeSelect** PDU by a terminal which would otherwise choose the selected mode. It indicates that that terminal has deferred selection to the other terminal.

8.4.4 modeSelectAcknowledge PDU

The **modeSelectAcknowledge** PDU indicates reception and acceptance of a **modeSelect** PDU.

8.4.5 terminate PDU

The **terminate** PDU indicates abnormal termination of V.140 negotiations. The **terminate** PDU includes a cause field and optional fields with values as required for a particular cause field.

8.5 Phase 3 HDLC framing

Messages shall use the frame structure shown in Figure 9.

NOTE – HDLC framing used in V.140 is similar to that in ITU-T Rec. V.8 *bis*.

8	7	6	5	4	3	2	1	
Flag								Octet 1
Flag								2
0	1	1	1	0	0	1	1	
0	1	1	0	0	0	1	0	
0	1	1	0	0	0	0	1	
0	1	1	0	0	1	0	0	
Information field								
FCS (first octet)								N – 2
FCS (second octet)								N – 1
Flag								N

Figure 9/V.140 – Phase 3 message structure

8.5.1 Format convention

The basic format convention used for messages is illustrated in Figure 10. Bits are grouped into octets. The bits of each octet are shown horizontally and are numbered from 1 to 8. Octets are displayed vertically and are numbered from 1 to N.

The octets are transmitted in ascending numerical order. Within an octet, bit 1 is the first bit to be transmitted.

For the two-octet Frame Check Sequence (FCS) field, bit 1 of the first octet is the MSB and bit 8 of the second octet is the LSB (Figure 11).

8	7	6	5	4	3	2	1	
								Octet 1
								2
								...
								N

Figure 10/V.140 – Format convention

8	7	6	5	4	3	2	1	
2^8							2^{15}	1st octet of field
2^0							2^7	2nd octet of field

Figure 11/V.140 – FCS mapping convention

8.5.2 Flag sequence

Messages shall start and end with the standard HDLC flag octet (01111110) as defined in ISO/IEC 3309. Two flags shall be sent to begin each message (the use of two increases error resilience). One flag shall follow the FCS of each message. As a result, there shall be three flags between consecutive messages.

8.5.3 Distinguishing sequence

Following the sequence of two flag octets at the beginning of the message and preceding the information field, there shall be a four-octet sequence with the hexadecimal values 73 62 61 64. This sequence serves to distinguish this PDU format from others that use a similar HDLC framing structure.

8.5.4 Information field

The contents of the information field shall consist of an integral number of octets containing a single PDU structured in accordance with Annex A. PDUs shall be encoded from the ASN.1 by applying the packed encoding rules specified in ITU-T Rec. X.691 using the basic aligned variant. The bit string that results from the ASN.1 encoding shall be placed in the octet string in the information field in the order such that for each octet, the leading bit is placed in bit 1 and the trailing bit is placed in bit 8.

8.5.5 Frame check sequence field

The FCS field is 16 bits (2 octets) in length. As defined in ISO/IEC 3309, it shall be the one's complement of the sum (modulo 2) of:

a) the remainder of $x^k (x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the last bit of the final opening flag and the first bit of the FCS, excluding bits (binary ZEROs) inserted for transparency; and

b) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the last bit of the final opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all binary ONEs and is then modified by division by the generator polynomial (as described above) on the information field. The one's complement of the resulting remainder is transmitted as the 16-bit FCS.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder of the division is preset to all binary ONEs. The final remainder, after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the FCS, will be 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

8.5.6 Transparency

The transmitting terminal shall examine the contents of the information and FCS fields (everything between the opening and closing flags) and insert a binary ZERO after every sequence of five contiguous binary ONEs to ensure that the flag octet is not simulated within the frame. The receiving terminal shall examine the contents of the frame between the opening and closing flags and discard any binary ZERO which directly follows five contiguous binary ONEs.

9 Procedures

The general sequence of signal exchanges required for completion of the procedures in this Recommendation is shown in Figure 12.

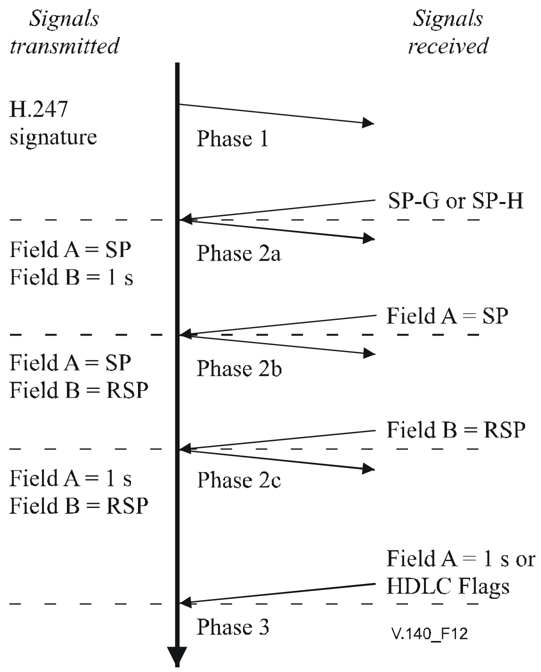

Figure 12/V.140 – "Ladder" diagram of the sequence of signals and phases of V.140

All signals shall be transmitted repeatedly until acknowledged. Whenever one signal is changed to another, for example when moving from one phase or sub-phase to the next, the change shall only take place at an allowed boundary as defined for the signal prior to the change. The allowed boundaries are as follows:

- Phase 1: the completion of the 80 byte Phase 1 signal.
- Phase 2: the completion of Field B.
- Phase 3: the completion of an HDLC frame.

9.1 Channel establishment

The end-to-end digital connection shall be established according to the procedures appropriate for the network in use, according to national standards.

9.1.1 Interactions with ISDN D-channel signalling

Terminals originating calls on the ISDN shall signal the ISDN Bearer Capabilities (BC) and High Level Capabilities (HLC) according to either the row marked "Attempt 1" or the row marked "Attempt 2" in Table 5. If the call is rejected by the network and the indicated Cause, as defined in ITU-T Rec. Q.850, is one of those listed in Table 4, the originating terminal shall automatically re-try the call attempt using different values of BC and HLC according to Table 5. Since this procedure incorporates a call re-try mechanism, terminals shall not use the bearer capability selection option.

NOTE – The bearer capability selection option allows a calling terminal to encode two bearer capabilities in a setup message, such that the alternative bearer capability is automatically invoked in case the preferred bearer capability is unavailable or if interworking (e.g., to the PSTN) is encountered (see ITU-T Rec. Q.931).

Originating terminals shall continue call attempts according to Table 5 until the BC value is no longer compatible with any desired mode of operation, or until reaching the end of the table.

Terminals initiating a call on the ISDN should eliminate protocols from the Phase 3 capability set that are not appropriate given the BC and HLC signalled for the call. Similarly, answering terminals should disable all locally supported protocols inappropriate for the received values of BC and HLC, and should remove those protocols from the Phase 3 capability set.

Table 4/V.140 – List of causes that may indicate an incompatible BC (see ITU-T Rec. Q.931)

Cause No. (from ITU-T Rec. Q.850)	Cause name (from ITU-T Rec. Q.850)
18	No user responding
57	Bearer capability not authorized
58	Bearer capability not presently available
63	Service or option not available, unspecified
65	Bearer service not implemented
88	Incompatible destination

Table 5/V.140 – BC and HLC values for ISDN calls

	BC (Information transfer capability)	HLC value
Attempt 1	Unrestricted digital information with tones/announcements	None, or per national standards
Attempt 2	Unrestricted Digital Information (UDI)	None, or per national standards
Attempt 3	UDI, rate adapted to 56 kbit/s	None, or per national standards
Attempt 4	3.1 kHz audio	None, or per national standards
Attempt 5	Speech	None, or per national standards

9.2 Phase 1 – Signature transmission and acquisition

If the procedures of V.140 are in use, an optional period of G.711 voice telephony may begin when the called party answers. In this mode, users have the opportunity to speak with one another before proceeding to multimedia telephony. During this period, the terminal shall continuously search for a Phase 1 signature from the far-end terminal.

If the terminal is conditioned to go directly into digital communication mode, this optional period shall be bypassed, and the terminal shall proceed directly to Phase 1 immediately upon end-to-end network connection of the digital channel. If the terminal is conditioned for initial G.711 voice telephony mode, the terminal shall proceed to Phase 1 when either of the following conditions is met:

- the user manually causes the terminal to initiate transmission of the Phase 1 signature; or
- the terminal detects a Phase 1 signature from the far-end terminal.

9.2.1 Transmitter procedure

In Phase 1, terminals shall repeatedly transmit the appropriate Phase 1 signal. The Phase 1 signal to be transmitted by a terminal attached to an aligned channel is described in 8.2.1. A somewhat different Phase 1 signal is to be transmitted by a terminal attached to a non-aligned channel, and is described in 8.2.2.

In either case, the CPF field shall carry a compatible protocol or bits set to binary ONE. Such compatible protocol signals may be sent in order that far-end terminals of these types which do not support these procedures may initiate their negotiation.

9.2.2 Receiver procedure

The receiver shall search all received subchannels in the received Phase 1 signal, i.e., subchannels 1 to 8, for SP-G and SP-H. Presence of either of these signals indicates that the far-end supports V.140.

The terminal may carry out any procedures (i.e., related to another protocol) during Phase 1 of V.140 that do not interfere with any phase of V.140. For example, while searching for SP, the receiver may search for signals conforming to any other protocols supported locally. However, the terminal shall proceed with another protocol only:

1) if and when it is established that the far-end does not support V.140, as defined in 9.2.2.1; or
2) after selection of that protocol by the Phase 3 procedure.

In addition, if the receiver is on an aligned channel, bits 1-6 of each byte may be decoded as audio according to ITU-T Rec. G.711 and delivered to the user while executing this procedure, so that voice telephony is established immediately upon connection of the circuit, if the far-end terminal supports voice telephony.

If the receiver decodes G.711 audio, it shall automatically determine the proper G.711 law of the incoming audio, for example by using the procedures of Appendix I/G.725. Note that the G.711 law is allowed to be different in each direction.

Terminals attached to non-aligned channels need not search for G.711 audio or modem tones (as defined in V.8 and V.8 *bis*, since such terminals cannot decode or otherwise use audio signals without a framing pattern (e.g., provided by ITU-T Rec. H.221).

9.2.2.1 Signature pattern (SP) acquisition criteria and time-out

To acquire an SP (either SP-G or SP-H), the terminal shall attempt to detect, within any single subchannel, all four occurrences of that SP properly positioned within 3 contiguously received 80-bit Phase 1 signals. If the attempt is successful, the terminal shall enter Phase 2a.

Since SP is included in the Phase 2a signal, the signature can still be acquired from a far-end terminal which has already entered Phase 2a.

If SP acquisition does not occur within 2 to 8 seconds of connection of the digital channel, the receiver shall interpret this as an indication that the far-end terminal does not support V.140, and shall terminate V.140 procedures. The local terminal may then optionally disconnect the channel, or may optionally proceed with any other protocol supported by the terminal, such as voice telephony, H.320, HDLC-based protocols, or GSTN modem signalling such as V.8 or V.8 *bis*.

NOTE 1 – There is a small probability ($\sim 2^{-128}$) that a completely random signal could emulate the signature within the Phase 1 signal. This probability may be slightly higher if the signal is not completely random, i.e., if it is made up of G.711 audio or V.8/V.8 *bis* modem signals.

NOTE 2 – Terminals that allow periods approaching the upper limit of the above range (i.e., 8 seconds) to elapse before terminating V.140 procedures can encounter interoperability problems when interworking with terminals that do not implement V.140 procedures because other protocols such as H.320 and ISO/IEC 13871 may time out.

9.3 Phase 2 – Determination of network characteristics and bit alignment

Upon entry to Phase 2, the terminal shall disconnect the output of the audio decoder from any sound output devices and cease transmitting audio and all other protocols.

Phase 2 signals shall begin with Field A immediately following the final Phase 1 signal. Field A and Field B shall be transmitted alternately throughout Phase 2.

Terminals on 56C interfaces shall transmit only bits 1 through 7 of Field A and Field B.

9.3.1 Phase 2a – Transmitting and acquiring SP in each subchannel

9.3.1.1 Transmitter procedure

The transmitter shall repeatedly transmit the Phase 2a signal.

This signal serves to acknowledge the acquisition of the far-end's Phase 1 signal and to transmit a unique SP in each subchannel, with SP-A in subchannel 1, SP-B in subchannel 2, SP-C in subchannel 3, SP-D in subchannel 4, SP-E in subchannel 5, SP-F in subchannel 6, and continuing to transmit SP-G and SP-H in subchannels 7 and 8, respectively, in case the far-end has not yet proceeded to Phase 2a.

9.3.1.2 Receiver procedure

In Phase 2a, the receiver shall search all received subchannels for any of the eight values of SP and the "all binary ONEs" pattern. Since the subchannel alignment between the transmitter and receiver may be different, transmitted SP patterns may appear in different subchannel positions at the receiver.

Moreover, if the receiver detects the "all binary ONEs" pattern in one subchannel and correct values of SP in at least four other subchannels, it is possible that one of the bytes in the 8-byte sequence that comprises the transmitted SP patterns has been corrupted by network equipment: every bit in that byte will be a binary ONE (see Figure 13 for an example). The terminal shall determine if this is the case by checking, as follows, the subchannels that contain neither SP nor all binary ONEs:

- if these subchannels contain a pattern similar to SP except for a single replacement of binary ZERO with binary ONE; and
- if the replacement occurs in the same bit position for all such subchannels,

then the terminal shall consider all eight values of SP to have been detected correctly if and only if all subsequently received SPs are corrupted in the same fashion.

Byte number	Subchannel 1	Subchannel 2	Subchannel 3	Subchannel 4	Subchannel 5	Subchannel 6	Subchannel 7	Subchannel 8
x	1	0	1	0	1	1	1	1
x + 1	0	1	0	1	1	0	1	1
x + 2	1	0	1	1	0	1	1	0
x + 3	0	1	1	0	1	1	1	1
x + 4	1	1	0	1	1	0	1	0
x + 5	1	0	1	1	0	1	1	1
x + 6	1	1	1	1	1	1	1	1
x + 7	0	0	0	0	0	0	1	0

Figure 13/V.140 – Example of corruption of SP values by network equipment: Subchannel 7 is all ONEs and byte (x + 6) is corrupted, also all ONEs

For each subchannel, SP shall be considered to have been acquired when it is detected in four consecutive Field A positions.

For each subchannel, the all-binary-ONEs pattern shall be considered to have been acquired when it is detected in four consecutive Field A positions.

If SP is not acquired in at least 7 subchannels within two seconds of entry into Phase 2a, the V.140 procedures shall terminate.

The receiver shall stop searching for additional SP or all-binary-ONEs patterns in subchannels when any one of the following conditions is satisfied:

- SPs have been acquired in all subchannels; or
- after 20 Field A positions beyond the point at which the seventh SP pattern was acquired, given that the eight SP has been replaced by a pattern of all binary ONEs.

Subchannels on which SP was not acquired shall be considered to be unusable in the direction toward the local terminal. The terminal shall then determine the subchannel numbering of the transmitting terminal and determine which subchannel, if any, is not transmitted or not passed through the network by examining Field A. It shall then proceed to Phase 2b.

NOTE 1 – The difference between the number of a subchannel and the number of the SP (SP-A = 1, SP-B = 2, etc.) acquired in that subchannel indicates the number of bit positions that the bytes transmitted by the far-end terminal are rotated, i.e., if SP-E is received in subchannel 1, the transmitted signal is rotated 4 bit positions to the left.

NOTE 2 – If a terminal acquires a pattern of all binary ONEs in any subchannel, that subchannel is not being transmitted by or passed through the network from the far-end terminal.

9.3.2 Phase 2b – Reflected SP and alignment recovery

9.3.2.1 Transmitter procedure

The transmitter shall repeatedly transmit the Phase 2b signal.

This signal serves to acknowledge the acquisition of SP and to transmit a "Reflected Signature Pattern" (RSP) in each subchannel in Field B, while continuing to transmit SP in all subchannels in Field A, in case the far-end has not yet proceeded to Phase 2b.

The value of the RSP for each subchannel is computed from the received Field A on the same subchannel.

RSP shall be computed for each subchannel as follows:

1) If SP was acquired on the received subchannel *n* (where *n* takes the values 1 to 8), subchannel *n* of transmitted Field B shall contain the one's complement of the first 7 bits of the SP (the correct SP as defined in Table 3 shall be sent even if a corrupted version was received) followed by a binary ZERO.
2) Otherwise, the first 7 bits of that subchannel of transmitted Field B shall be set to binary ONE, and the eighth bit of that subchannel shall be set to binary ZERO.

NOTE – The RSP is one's complemented so that the receiver can unambiguously distinguish Field A from Field B, even in case of loss of synchronization.

9.3.2.2 Receiver procedure

In Phase 2b, the receiver shall search all received subchannels in Field B for any of the eight possible values of RSP and the "all binary ONEs" pattern. Since the subchannel alignment between the transmitter and receiver may be different, transmitted RSP patterns may appear in different subchannel positions at the receiver.

Moreover, if the receiver detects the "all binary ONEs" pattern in one subchannel and correct values of RSP in at least four other subchannels, it is possible that one of the bytes in the 8-byte sequence that comprises the transmitted RSP patterns has been corrupted by network equipment – every bit in that byte will be a binary ONE (see 9.3.1.2 for an example of this phenomenon at work in Phase 2a). The terminal shall determine if this is the case by checking, as follows, the subchannels that contain neither RSP nor all binary ONEs:

- if these subchannels contain a pattern similar to RSP except for a single replacement of binary ZERO with binary ONE; and
- if the replacement occurs in the same bit position for all such subchannels,

then the terminal shall consider all eight values of RSP to have been detected correctly if, and only if, all subsequently received RSPs are corrupted in the same fashion.

RSP shall be considered to have been acquired when it is detected in 4 consecutive Field B positions. If RSP is not acquired in at least 6 subchannels within 2 seconds of entry into Phase 2b, the V.140 procedures shall terminate.

NOTE – Even if network misalignment and restriction is different in each direction of transmission, the receiver of the Phase 2b signal will detect, at most, two Field B subchannels without RSP. One of these will have been anticipated based on the result of Phase 2a, and the other will indicate which subchannel is restricted in the network direction toward the far-end.

The receiver shall stop searching for additional RSP patterns in subchannels when any one of the following conditions is satisfied:

- RSPs have been acquired in all subchannels; or
- after 20 Field B positions beyond the point at which the sixth RSP pattern was acquired, given that the remaining RSPs have been replaced either by a pattern of all binary ONEs or by a pattern of 7 binary ONEs followed by a binary ZERO.

The terminal shall then determine subchannel alignment and presence as received at the far-end terminal by examining Field B. It shall then proceed to Phase 2c.

9.3.3 Determination of network characteristics and bit-alignment from received SP/RSP

The primary goal of the procedures of Phase 2a and 2b is to determine whether a 64 kbit/s interface is restricted (i.e., 64R rather than 64C), because terminals that ascertain that their interface is 64R must then compensate for those subchannels that do not carry data. See 9.3.4 for details.

If all of the received subchannels in Phase 2a contain valid SP, the interface is 64C or 56C, and no special procedures are required.

NOTE 1 – In some cases, when the "all-binary-ONEs pattern" is referred to below, a pattern of 7 binary ONEs and one binary ZERO may be assumed to be synonymous with the all-binary-ONEs pattern. If a terminal acquires a pattern of 7 binary ONEs, and one binary ZERO in any subchannel in Field B, a subchannel is not being transmitted by or passed through the network from the local terminal. This pattern was received at the far-end terminal as all binary ONEs and but was sent back as specified in 9.3.2.1 (7 binary ONEs and one binary ZERO).

However, if any of the received subchannels in Phase 2a contain the all-binary-ONEs pattern rather than the expected SP, the interface is 64R. The received subchannel that contains the all-binary-ONEs pattern does not carry any useful data and shall be ignored (see 9.3.4).

Moreover, if during Phase 2b there are one or two subchannels that contain the all-binary-ONEs pattern rather than the expected RSP, a subchannel is not being transmitted by the near-end terminal. To determine which subchannel is not being transmitted, the terminal shall identify the RSP(s) missing from the Phase 2b signal. Each missing RSP can be associated with a subchannel by assuming that RSPs are transmitted in subchannels in the order RSP-A through RSP-H, i.e., if subchannel x contains RSP-A, subchannel (x + 1) mod 8 will contain RSP-B, subchannel (x + 2) mod 8 will contain RSP-C, and so forth up to RSP-H. Once this association is done, one or more of these RSP(s) will be missing (i.e., replaced by the all-binary-ONEs pattern) and is, therefore, not being received from the far-end terminal. Hence, one of the corresponding SPs is not being transmitted to the far-end by the network (although the near-end terminal is attempting to transmit it).

NOTE 2 – If the result of Phase 2a indicates that only 7 subchannels are active, and Phase 2b results in 7 RSP patterns and one pattern of all binary ONEs, this also indicates that a subchannel is not being transmitted by or passed through the network from the local terminal; it can be assumed that two directions of restriction overlap, since networks are always restricted in both directions.

In order to determine which RSP and hence which SP is not being transmitted, the terminal shall identify the subchannel that DOES NOT contain all binary ONEs in Phase 2a but DOES contain all binary ONEs in Phase 2b. The RSP corresponding to this subchannel is missing, and the SP corresponding to this RSP was not transmitted by the network. See Figure 14 for an example.

NOTE 3 – In the example shown in Figure 14, the results of Phases 2a and 2b for a particular terminal are shown. In this case, the terminal received all-binary-ONEs in subchannel 4 during Phase 2a, rather than SP-H, which was expected. Also, during Phase 2b, the terminal received all-binary-ONEs in subchannels 4 and 7; it was expecting RSP-B and RSP-E, respectively, in those subchannels. Since the all-binary-ONEs pattern was received in subchannel 4 during both Phase 2a or Phase 2b, it can be inferred that this subchannel 4 does not contain valid received data. However, subchannel 7 DID contain valid data during Phase 2a, but NOT during Phase 2b. Therefore, RSP-E was never received because it was never sent by the far-end; the far-end did not send it because it did not receive SP-E, and therefore subchannel 5 is not being transmitted to the far-end by the network and should not be used.

	Subchannel 1	**Subchannel 2**	**Subchannel 3**	**Subchannel 4**	**Subchannel 5**	**Subchannel 6**	**Subchannel 7**	**Subchannel 8**
SP sent	*SP-A*	*SP-B*	*SP-C*	*SP-D*	*SP-E*	*SP-F*	*SP-G*	*SP-H*
SP received (Phase 2a)	*SP-E*	*SP-F*	*SP-G*	*All ONEs*	*SP-A*	*SP-B*	*SP-C*	*SP-D*
RSP received (Phase 2b)	*RSP-G*	*RSP-H*	*RSP-A*	*All ONEs*	*RSP-C*	*RSP-D*	*All ONEs*	*RSP-F*
RSP NOT received				*RSP-B*			*RSP-E*	
Channel not transmitted from far-end				***No data received here***				
SP not transmitted from near-end							***SP-E not received, but data is received***	

(No data is received on subchannel 4 during Phases 2a and 2b,
therefore, it is not being transferred from the far-end.
Data IS received on subchannel 7, but RSP-E should have been.)

Figure 14/V.140 – Example of determination of network characteristics from Phase 2a and Phase 2b

Relative misalignment of subchannels between terminals can also be determined using the information accumulated during Phases 2a and 2b, if necessary (most protocols do not require any compensation for such misalignment, but a few do, e.g., unframed G.711 audio).

9.3.4 Phase 2c – Concluding Phase 2 and proceeding to Phase 3

At the conclusion of Phase 2, each terminal has knowledge of the relative alignment of subchannels between the terminals, as well as knowledge, if any, of the subchannels which are not transmitted to and from the remote terminal. Each terminal shall use such knowledge as follows:

- When transmitting bytes during Phase 2c, the terminal shall leave out bits as necessary to avoid sending data in a subchannel that is not being transmitted or passed through the network to the far-end terminal. The terminal shall follow this procedure, when appropriate, for other protocols (typically, protocols that include a framing signal), EXCEPT:

- during Phase 3, when the terminal shall insert fill bits as necessary to avoid sending data in a subchannel that is not being transmitted (or passed through the network) to the far-end terminal. Also, the terminal shall follow this procedure when appropriate for other protocols (typically, protocols based upon HDLC).
- When receiving bytes, the terminal shall skip bits to eliminate data received in a subchannel that is not being received (or passed through the network) from the far-end terminal.
- If the terminal is to support protocols that require proper alignment (e.g., unframed G.711 audio) of subchannels between transmitter and receiver, the transmitter shall compensate as necessary for any relative misalignment of the subchannels between it and the far-end terminal so that the far-end terminal will receive data properly aligned on octet boundaries.

The terminal shall follow the above procedures for the duration of the network connection, i.e., during Phases 2c and 3 and in any protocols or procedures used subsequently.

9.3.4.1 Transmitter procedure

The transmitter shall repeatedly transmit the Phase 2c signal.

This signal serves to acknowledge the acquisition of RSP, while continuing to transmit RSP in all subchannels, in case the far-end has not yet proceeded to Phase 2c.

9.3.4.2 Receiver procedure

In Phase 2c, the receiver shall search for:

- Field A of the Phase 2c signal; and
- two or more contiguous HDLC flags (01111110) coded according to the Phase 3 signalling.

This signal shall be considered to have been acquired when either four consecutive Phase 2c Field A signals are detected or when two sets of two contiguous HDLC flags are detected. If this signal is not acquired within two seconds of entry into Phase 2c, the V.140 procedures shall terminate, and the terminal shall disconnect the channel or proceed as otherwise pre-conditioned.

NOTE – The HDLC flags will be detected if the far-end terminal enters Phase 3 before the near-end terminal does.

Upon acquiring this signal, the terminal shall proceed to Phase 3.

9.4 Phase 3 – Role arbitration, capability exchange, and mode selection

In Phase 3, the two terminals exchange capabilities, select a protocol mode, and initiate operation in the selected mode.

Throughout Phase 3, the most recently transmitted message PDUs shall be repeated continuously, one message in each HDLC frame, until a different message PDU is transmitted or V.140 procedures terminate.

9.4.1 roleAndCapability transmission

Upon entering Phase 3, the terminal shall transmit the **roleAndCapability** PDU.

Upon receiving a **roleAndCapability** PDU, the terminal shall assign a numerical value to the **role** parameter in said PDU according to Table 6 and also to the **role** parameter value that it transmitted. If these numerical values differ, the terminal shall be the "Initiator" if it has the higher number or the "Responder" if it has the lower number.

Table 6/V.140 – Initiator/Responder determination table

Role	Value
originate	3
unknown	2
answer	1

If the two values from Table 6 are equal, each terminal's **arbitrationField** value shall be substituted for its **role** value. The terminal with the higher value shall be considered the Initiator, and the other terminal shall be considered the Responder.

If the two values from Table 6 are equal, and the **arbitrationField** values are equal, the terminal shall transmit the **terminate** PDU with the **cause** value set to **roleCollision**.

9.4.2 Initiator procedure

The Initiator shall transmit either:

1) the **modeSelect** PDU to choose the selected mode; or
2) the **youChoose** PDU to defer selection to the other terminal; or
3) the **terminate** PDU with the **cause** field set to **noSuitableModes**. This should occur only if the far-end's capability set did not include any protocol modes useful to the calling user.

When transmitting the **modeSelect** PDU, the Initiator should take account of the order of preferences of capabilities indicated in the **roleAndCapability** PDU it had previously received from the Responder.

If the Initiator sent **modeSelect**, it shall wait for receipt of the **modeSelectAcknowledge** PDU, and upon receiving it, shall terminate V.140 procedures and begin the selected protocol mode.

If the Initiator sent **youChoose**, it shall wait for receipt of the **modeSelect** PDU, and upon receiving it, shall transmit the **modeSelectAcknowledge** PDU 20 times, then terminate V.140 procedures and begin the selected protocol mode.

The Initiator shall not transmit the **youChoose** PDU unless it has identified one or more useful common modes; i.e., the **roleAndCapability** PDU it had previously received from the Responder must contains useful modes that are the same as those signalled by the Initiator using the **roleAndCapability** PDU.

9.4.3 Responder procedure

The Responder shall wait for receipt of either a **modeSelect** PDU, a **youChoose** PDU, or a **terminate** PDU.

If the Responder receives **modeSelect**, it shall transmit the **modeSelectAcknowledge** PDU 20 times, then terminate V.140 procedures and begin the selected protocol mode.

If the Responder receives **youChoose**, it shall transmit the **modeSelect** PDU, then wait for receipt of the **modeSelectAcknowledge** PDU, and upon receiving it, shall terminate V.140 procedures and begin the selected protocol mode. When transmitting the **modeSelect** PDU, the Responder should take account of the order of preferences of capabilities indicated in the **roleAndCapability** PDU it had previously received from the Initiator.

The Responder shall never transmit **youChoose**.

9.4.4 General Phase 3 procedures

The procedures in this clause apply to all of Phase 3, for both Initiator and Responder, in addition to the procedures above.

Any terminal which has sent the **modeSelect** PDU shall wait for the **modeSelectAcknowledge** PDU to arrive. While waiting, such a terminal shall also search for signals appropriate to the protocol mode selected. Any such terminal shall repeatedly send the **modeSelect** PDU until either:

- signals appropriate to the selected protocol mode are detected; or
- the **modeSelectAcknowledge** PDU is received with a correct FCS field.

If either of these two events occurs, the terminal shall immediately cease transmitting Phase 3 PDUs and shall begin transmission of signals and execution of procedures appropriate to the selected protocol mode for negotiation, exchange of capabilities, etc. as defined for that protocol.

Unrecognized **nonStandard** messages and capabilities shall be ignored.

9.4.4.1 Time-out and abnormal termination

If the terminal waits longer than two seconds for a responding PDU, the terminal shall transmit the **terminate** PDU with the **cause** field set to **timerExpiration**.

Any terminal receiving a PDU, other than those specified as appropriate in these procedures, shall transmit the **terminate** PDU with the **cause** field set to **protocolViolation**.

Any terminal receiving a **modeSelect** PDU containing a mode which was not listed in its transmitted **capabilitySet** shall transmit the **terminate** PDU with the **cause** field set to **modeNotAvailable**.

Any terminal transmitting the **terminate** PDU for any reason shall transmit it 20 times, then terminate V.140 procedures. The terminal may optionally disconnect the channel at that point.

If the terminal receives the **terminate** PDU with a correct FCS field, it shall immediately terminate V.140 procedures. The terminal may optionally disconnect the channel at that point.

9.5 Entering selected mode

Terminals shall enter the selected protocol mode by stopping all transmission of data related to V.140 and starting procedures appropriate to the selected mode. Terminals shall not transmit useful data bits in subchannels which were identified in Phase 2 as not being passed by the network, and shall skip or otherwise ignore bits in similar received subchannels (see 9.3.4).

Terminals entering G.711 audio, or any mode making use of G.711 audio (such as GSTN modem modulations over G.711 audio) as the selected mode shall continuously examine subchannels 7 and 8 for resumption of Phase 1 signalling by the far-end.

10 Resuming V.140 from a selected mode

The procedures of V.140 can be used to select another operation mode after termination of a previously selected mode.

Terminals shall return to V.140 from selected modes by one of the following procedures:

- Terminals returning to V.140 from G.711 audio shall follow the procedures of V.140 starting with Phase 1.
- Terminals returning to V.140 from any other mode shall terminate transmissions by any protocols other than V.140 and provide a clear channel for V.140 procedures. The terminal shall then follow the procedures of Phase 3.

In either case, the terminal initiating return to V.140 shall be considered the Originator for the Phase 3 **roleAndCapability** message, and the responding terminal shall be considered the Answerer.

This feature may be used to provide an optional initial phase at the beginning of a multimedia call in which users have the opportunity to speak in voice telephony mode before proceeding to multimedia telephony. This feature may also be used to switch from one multimedia telephony mode to another, or back into voice telephony mode.

Annex A

ASN.1 definition of Phase 3 PDU values

This annex specifies the syntax of PDUs using the notation defined in ASN.1 according to ITU-T Rec. X.680 | ISO/IEC 8824-1.

```
HDISPATCH DEFINITIONS AUTOMATIC TAGS ::=
BEGIN

-- Export all symbols

-- =================================================================================
-- Top level PDUs
-- =================================================================================

HDispatchPDU ::= CHOICE {
  nonStandard            NonStandardMessage,
  roleAndCapability      RoleAndCapabilityMessage,
  modeSelect             Mode,
  youChoose              NULL,
  modeSelectAcknowledge  NULL,
  terminate              TerminateMessage,
  ...
}

RoleAndCapabilityMessage ::= SEQUENCE {
  role
    CHOICE {originate  NULL,
            unknown    NULL,
            answer     NULL,
            ...},
  arbitrationField  INTEGER(0..4294967295), -- 32 bit random #
  capabilitySet     SEQUENCE SIZE (1..65535) OF Capability,
  ...
}

Capability ::= CHOICE {
  nonStandard  NonStandardParameter,
  isdn
    CHOICE {isdnCapability                 IsdnCapability,
            multilinkAdditionalConnection  NULL,
              -- Express this cap alone to force--
              -- association of this channel with
              -- an existing call
            is13871
              SEQUENCE -- "BONDING" protocol-- {withIsdnCapability
                                                  IsdnCapability,
                                                ...},
            h244
              SEQUENCE -- channel aggregation protocol-- {withIsdnCapability
                                                            IsdnCapability,
                                                          ...},
            ...},
  ...
}

IsdnCapability ::= CHOICE {
  g711aLaw       SEQUENCE {...},
  g711uLaw       SEQUENCE {...},
  h320           SEQUENCE {...},
```

```
  h324AnnexD     SEQUENCE {...},
  h324Multilink  SEQUENCE {...},
  group4Fax      SEQUENCE {...},
  t120           SEQUENCE {...},
  t140           SEQUENCE {...}, -- text chatting protocol
  v110           SEQUENCE {...},
  v120           SEQUENCE {...},
  rfc1661        SEQUENCE {withH323  BOOLEAN,
                           ...},
  ...
}

Mode ::= CHOICE {
  nonStandard                     NonStandardParameter,
  plainIsdnMode                   IsdnMode,
  h244                            IsdnMode,
  is13871                         IsdnMode, -- BONDING protocol
  multilinkAdditionalConnection
    SEQUENCE {callAssociationNumber  INTEGER(0..4294967295),
              ...},
  ...
}

IsdnMode ::= CHOICE {
  nonStandard    NonStandardParameter,
  g711aLaw       SEQUENCE {...},
  g711uLaw       SEQUENCE {...},
  h320           SEQUENCE {...},
  h324AnnexD     SEQUENCE {...},
  h324Multilink  SEQUENCE {...},
  group4Fax      SEQUENCE {...},
  t120           SEQUENCE {...},
  rfc1661        SEQUENCE {...},
  ...
}

TerminateMessage ::= SEQUENCE {
  cause
    CHOICE {nonStandard          NonStandardParameter,
            timerExpiration      NULL,
            roleCollision        NULL,
            noSuitableModes      NULL,
            invalidModeSelected  NULL,
            protocolViolation    NULL,
            modeNotAvailable     NULL,
            ...},
  ...
}

-- ================================================================================
-- Non standard Message definitions
-- ================================================================================

NonStandardMessage ::= SEQUENCE {nonStandardData  NonStandardParameter,
                                 ...
}

NonStandardParameter ::= SEQUENCE {
  nonStandardIdentifier  NonStandardIdentifier,
  data                   OCTET STRING
}
```

```
NonStandardIdentifier ::= CHOICE {
  object           OBJECT IDENTIFIER,
  h221NonStandard
    SEQUENCE {t35CountryCode    INTEGER(0..255), -- country, per T.35--
              t35Extension      INTEGER(0..255), -- assigned nationally--
              manufacturerCode  INTEGER(0..65535)}
} -- assigned nationally

END
```

The use of ITU-T Recs G.722 and G.725 within these procedures is for further study.

The following refers to fields and structures used within the **roleAndCapability** PDU:

- **g711aLaw**, **g711uLaw**, **h320**, **h324AnnexD**, **h324Multilink, group4Fax**, **t120**, **t140**, **v110**, or **v120** assigned to an **IsdnCapability** field shall indicate that the terminal can support operation according to ITU-T Recs G.711 (A-law encoding), G.711 (μ-law encoding), H.320, Annex D/H.324, T.6, T.120. T.140, V.110, or V.120, respectively.
- **rfc1661** assigned to the **IsdnCapability** structure shall indicate that the terminal can support operation according to RFC 1661 (also known as Internet Standard 51), as adopted by the Internet Engineering Task Force (IETF). If the **withH323** sub-field is set true, the terminal can support operation according to ITU-T Rec. H.323 overlying the protocol defined in RFC 1661.
- **is13871** assigned to the **isdn** structure which is within the **Capability** structure shall indicate that the terminal can support channel aggregation according to the procedures of ISO/IEC 13871 (also known as BONDING), and the accompanying **withIsdnCapability** field shall indicate a communications protocol which can be run in conjunction with ISO/IEC 13871.
- **h244** assigned to the **isdn** structure within the **Capability** structure shall indicate that the terminal can support channel aggregation using the procedures of ITU-T Rec. H.244, and the accompanying **withIsdnCapability** field shall indicate a protocol which can be run in conjunction with said procedures.

The following refers to fields and structures used within the **modeSelect** PDU:

- **g711aLaw**, **g711uLaw**, **h320**, **h324AnnexD**, **h324Multilink, group4Fax**, **t120**, **t140**, **v110**, or **v120** assigned to the **plainIsdnMode** field (an **IsdnMode** structure) shall indicate that the terminal has selected operation according to ITU-T Recs G.711 (a-law encoding), G.711 (μ-law encoding), H.320, Annex D/H.324, Annex F/H.324, T.6, T.120. T.140, V.110, or V.120, respectively.
- **rfc1661** assigned to the **plainIsdnMode** field (an **IsdnMode** structure) shall indicate that the terminal has selected operation according to RFC 1661 (Internet Standard 51), the Point-to-Point protocol, as adopted by the Internet Engineering Task Force (IETF).
- **is13871** (an **IsdnMode** structure) assigned to the **Mode** structure shall indicate that the terminal has chosen to use the ISO/IEC 13871 channel aggregation protocol, and the value selected for the **is13871** field shall indicate which communications protocol shall be used in conjunction with ISO/IEC 13871.
- **h244** (an **IsdnMode** structure) assigned to the **Mode** structure shall indicate that the terminal has chosen to use the H.244 channel aggregation protocol, and the value selected for the **h244** field shall indicate which communications protocol shall be used in conjunction with ITU-T Rec. H.244.

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