Videophone-ready Modem Handbook

Revision 1.1

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NOTICES

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Revision History		
Revision	Date	Comments
1.0	10-June-1998	Initial Release
1.1	15-July-1998	Refinement; delete #DO command

Requirements for Videophone-ready Modems

1. Introduction

This specification defines the minimum set of features for retail and OEM “video-ready” modems such that they will be capable of supporting the Intel Video Phone. It defines requirements for data (videotelephony) mode (e.g., V.80 support), and for data mode startup and voice-to-data transitions. Modems that conform to this specification will be able to support low-latency, bandwidth-efficient videotelephony operation, and smooth voice-telephony-to-videophone transitions.

1.1 H.324

H.324 is the ITU standard, or “Recommendation”, for point-to-point videotelephony on “POTS” (e.g., Plain Old Telephone Service) connections. H.324 products are available in various configurations, such as set-top boxes that use a TV as a video display device, and a variety of OEM pre-installed and retail PC add-on products. In essence, H.324 devices digitize and compress the audio and video signals, multiplex them together along with a possible data channel, and use a modem to transport the resultant data stream across the POTS connection.

Figure 1 shows the protocol stack present in every H.324 videotelephone terminal. At the bottom layer of the stack is a V.34 modem signal converter or “data pump”, the device which converts the digital bitstream from the upper layers into analog signals that can be transported through the PSTN. This data pump may be integrated with the upper protocol layers within the same enclosure, as in the case of a stand-alone H.324 “videotelephone box”. Alternately, the upper layers may be implemented on a PC, with the data pump residing within a separate modem card, or external modem box. It is this second configuration, a PC combined with a “video-ready” modem, that is discussed in this specification.

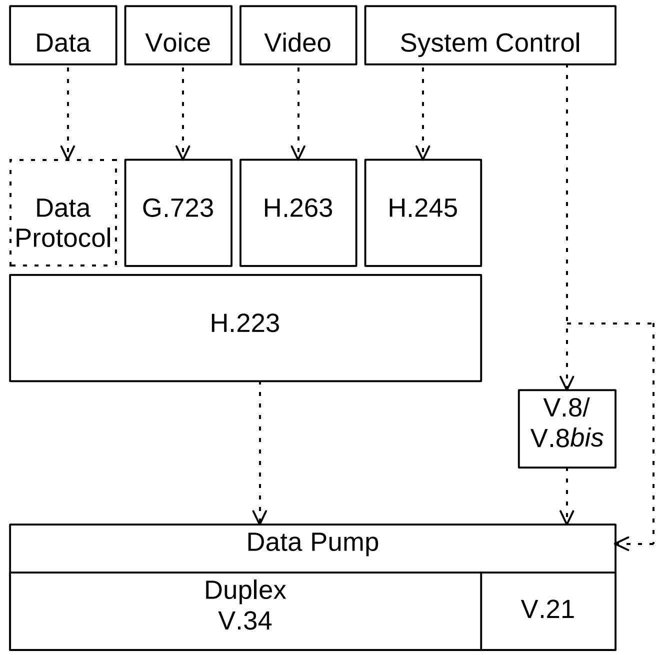


Figure 1, H.324 Videotelephone System

It should be noted that, in a conventional fax/data modem, while operating in data configuration (i.e., FCLASS=0), a duplex data protocol is always present in the modem, located directly above the data pump. This protocol is either the V.42 or Annex A/V.42 error control protocols, or the simpler V.14 async-to-sync protocol. Since these protocols cannot be turned off in the modem, a conventional data modem cannot be used with a PC to implement an H.324 device. Video-ready modems incorporate V.80 procedures that allow these modem protocols to be bypassed. Refer to "5. Appendix I Modem Architecture and V.80 Requirements" for more detail.

1.2 H.323

ITU-T Recommendation H.323 specifies procedures for videotelephony between computers on a network, such as a Local Area Network (LAN) or a Wide Area Network (WAN). The most common WAN application for H.323 is Internet videotelephony. The Intel Internet Video Phone is an example of an H.323 product.

In an H.323 Internet videotelephony stack, the lowest protocol layer residing in the PC is the Point-to-Point Protocol (PPP) Internet Protocol. As commonly implemented with a conventional fax/data modem, this PPP layer is framed with asynchronous (start-stop framed) characters, so that they be can transported using the V.42 protocol in the modem.

Alternately, in a modem equipped with V.80, PPP can be used with synchronous HDLC framing (as is used with ISDN adapters). This method avoids the latency and jitter introduced by the V.42 protocol, but it does require synchronous PPP access to be supported by the Internet Service Provider's (ISP's) modem pools.

1.3 Summary of Modem Requirements

In order to fully support H.324 videotelephone applications, a “video-ready” modem must include the features shown in the following table. These requirements are fully described in the following sections of this specification.

Function	Supported Feature	Relevant Section(s)
Data Mode	V.80 Synchronous Access Mode – Framed sub-Mode	0
Call Origination	Generation of V.8 CI signal at startup when calling	0
Video Mode Initiation during a Call	Generation of V.8 CI signal when initiating video mode	0
Responding to Video Mode Initiation during a Call	Detection of V.8 CI signal during an existing call in non-voice mode (all modems) and voice mode (if voice modem)	0
V.8 Call Function Value	Acceptance of V.8 Call Function octet values 0x21 or 0xC1 when answering/responding	0
“V.8 prime” fallback from V.8 *bis*	Support of CI detection while supporting V.8 *bis*[1]	0
Feature Identification	Support +GMM information text	0

Table 1 Required Modem Features

2. Data Mode

For either the stand-alone videotelephone or the PC-based videotelephone, in order to ensure interoperability and H.324 compliance, the data stream transmitted across the PSTN to the remote H.324 terminal must be formatted identically, and consist of MUX-PDU packets as defined in Recommendation H.223. This is analogous to the situation with Group 3 facsimile devices, which must produce a properly-formatted T.30 bitstream on the wire, whether the facsimile terminal is a stand-alone fax machine, or a fax modem-PC combination. This is required so that intelligible messages can be sent from one class of device to the other.

In the PC / video-ready modem configuration for H.324 terminals, H.223 is supported in the modem using the Synchronous Access Mode (S.A.M.) procedures defined in § 8 of ITU-T Recommendation V.80, *In-Band DCE Control and Synchronous Data Modes for Asynchronous DTE*. A description of modem architectures and a rationale for the need for V.80 in video-ready modems can be found in Appendix 1 of this paper.

[1] Note: V.8 *bis* + ‘V.prime’ is the preferred implementation, but V.8 *bis* support is not mandatory.

2.1 V.80 AT Configuration Commands

This section describes the AT command setting needed to properly configure V.80 in the modem to support the Intel Video Phone.

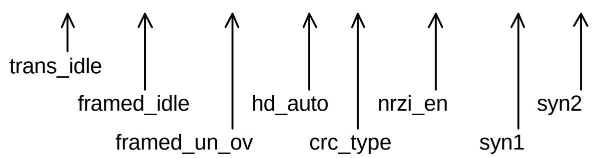
2.1.1 +ESA - Synchronous Access Mode Configuration

The DTE (in this case a PC) may use the **AT+ESA** command to query the DCE (i.e., the modem) as to whether or not it supports V.80 Synchronous Access mode functionality, A DCE which does not will return an **ERROR** result code to the **AT+ESA=?** query.

<u>Required Subparameter Values</u>

AT+ESA=? should return, at minimum,

+ESA: (0),(0),(0-1),,(0),(0),(126),



Simple transparent sub-Mode (<trans_idle>=0, no hunt mode), is required for V.80 compliance. Framed sub-Mode is not required for V.80 compliance, but is required to support the H.324 stack in an efficient manner and is required by many DTE-based stacks. Only flag-idle (<framed_idle>=0) need be supported. In the event of a transmit underrun, the default action should be supported (<framed_under>=0, send an abort), as well as the procedure described in §8.8.2.1/V.80, which allows for recovery from a TX underrun in the middle of an interruptible H.223 MUX-PDU.

The <hd_auto> subparameter need not be supported, as half-duplex V.34 is not used for H.324 operation.

For H.324, support for <crc_type>=0 is all that is needed, although support for other values may be desirable for other uses of V.80 (e.g., DTE-based V.42). Note, however, that for H.324 operation, it is assumed that the CRC will always be computed by the DTE and inserted in the bitstream. There is no facility in V.80 to dynamically enable/disable or modify CRC calculation on a frame-by-frame basis (this would be impossible in some DCE hardware configurations), so there is no way to, say, enable a 16-bit CRC in one frame, and an 8-bit in the next.

For <nrzi_en>, only zero needs to be supported. Finally, the <syn1> value of 126_{10} ($7E_{16}$) should be supported, so that the transmitter will send flags when idle in transparent sub-Mode. This ensures that the DCE transmitter sends flags once data mode is entered immediately at the end of modem training, as specified by H.324. The <syn2> subparameter does not need to be supported if the only supported value of <trans_idle> is zero.

2.1.2 +ES - Synchronous Modes Enable

In addition to the **AT+ESA** configuration command, a method is needed to direct the DCE to enter Synchronous Access Mode upon entering Data State. V.80 defines new subparameter values for the existing V.250 (formerly V.25 *ter*) **AT+ES** command in order to accomplish this function. Thus, the **`AT+ES=6,,8`** command configures a V.250-compliant modem into Synchronous Access Mode for Originate and Answer. Some modems may use proprietary AT commands to select the error-controlled operation mode, and these may simply extend the proprietary command by defining additional parameter values for S.A.M. The disadvantage of this, of course, is that the PC software must be configured differently for each model of modem (true for all non-V.250 command set modems), and if the old, basic AT command syntax is used, the "**`=?`**" query is not available. Use of non-V.250 commands for this purpose is therefore discouraged.

2.1.3 +ITF - Transmit Flow Control Thresholds

This command is not necessary for V.80 compliance, but its implementation allows the H.324 stack to minimize the amount of latency and jitter caused by the transmit buffer in the DCE.

The transmit buffer used with V.42 in modems contributes a second or more of end-to-end latency. A method to reduce this latency is required in modems supporting the Intel Video Phone.

<u>Required Subparameter Values</u>

`AT+ITF=?` should return, at minimum,

`+ITF: (`list of supported <off> values**`),(`**list of supported <on> values**`),(0)`**

This indicates that the DCE allows the DTE to set the low- and high-level flow control thresholds for optimum operation.

Note that the value of the <on> subparameter is indicative of the DTE's anticipated worst-case transmit interrupt latency; i.e., it serves to indicate to the DCE how much data the DCE may have to transmit "on its own", without assistance from the DTE. This latency may be due to operating system and other considerations. Thus, in order to minimize the occurrence of transmit underruns, if the DCE is transmitting idle (interframe) flags when the first octet of a new MUX-PDU is received from the DTE, the DCE should store the octets in its transmit buffer until either <on> octets are received or until the entire MUX-PDU is received from the DTE.

Optionally, the DCE may support non-zero values of the third subparameter, <report_period>. Non-zero values enable periodic in-band messages from the DCE to DCE that inform the DTE of the number of octets currently in the DCE's transmit buffer. Some DTE-based H.324 stacks may desire this information, in order to maintain "finer-grained" control over the number of octets in the transmit buffer, rather than letting it bounce between the flow-on and flow-off thresholds. Not all V.80 modems implement this facility, however. It is not used by the Intel Video Phone.

2.2 In-Band Commands

Table 9/V.80 lists the command codes used by S.A.M. for the purposes of character transparency, transparent sub-Mode / framed sub-Mode transitions and formatting, underrun/overrun reporting and management, and data pump control and status reporting.

In the character transparency section, at least the <t1>-<t4> codes need to be supported by the DCE for the receive direction (i.e., data sent from DCE to DTE). In the transmit direction (i.e. data received by DCE from DTE), the complete <t1>-<t20> code set needs to be supported.

The <bnum> codepoint does not need to be supported if non-zero values of the <report_period> subparameter in the **+ITF** command are not supported (i.e., the <bnum> codepoint is never used if <report_period> is always zero).

Also, the half duplex carrier control commands (e.g., <pri>, <ctl>, <rtnh>, <rtnc>, <rateh>, <eoth> obviously do not need to be supported for duplex operation; indeed, these codepoints overlay the duplex carrier control codes, as the two modulation modes are mutually exclusive. The duplex carrier control codes are useful to the DTE-based stack so that it may vary its operational parameters based on the current connect rate. Additionally, the DTE may request retrains/rate renegotiations as a result of the observed receive data error rate.

While it is not explicitly mentioned in V.80, it is recommended that V.80 modem implementations, upon the conclusion of modem training and the commencement of Data State, send an <EM><rate><tx><rx> message to the DTE to give it an explicit indication of the transmit and receive bit rates at startup. The DTE thus gets an indication of the speed in both directions (which may vary in V.34), without the need to attempt to parse the information text or result codes that precede Data State. It should be noted that initial modem training is equivalent to a retrain, so the <EM><rate><tx><rx> message may be viewed as simply reporting the outcome of this "initial retrain".

In addition, V.80 modem implementers are advised to ensure that an <EM><esc> acknowledging code is sent in response to an <EM><esc> command, prior to sending the OK result code, so that the DTE receives positive indication that Data State has been terminated, as defined in §8.8.3/V.80.

V.80 modem implementers are also advised to ensure that an <EM><eot> in-band indication is sent to the DTE, followed by a **NO CARRIER** result code in Command State, whenever carrier is lost. This carrier loss may be due to an <EM><eot> command, a failed retrain, or another reason. See §8.8.4.3/V.80. The modem shall remain off-hook at carrier termination, until commanded to go on-hook with the **ATH** command. Also note that, in response to an <EM><eot> command, the modem should initiate V.34 cleardown procedures so that the remote terminal receives positive indication that the remote carrier is about to be lost.

All other codes in Table 9/V.80 should also be implemented in order to support H.223 operation.

Note: Typically, H.324 applications are somewhat less tolerant of bit errors than typical LAPM implementations. Modem vendors are cautioned to not be overly aggressive in their selection of data rates while in V.80 mode.

2.3 V.34 Seamless Rate Change

Annex A/V.34 defines procedures for implementing seamless rate changes (SRC) on V.34 modems, i.e., it allows the transmit and/or receive bit rates on the telephone line to be changed without interruption of the data stream.

SRC has obvious advantages for videotelephony, as the modem is able to adjust its line speed to changing line conditions without interrupting or "glitching" the audio or video. In contrast, bit rate changes via retrains stop data transmission for several seconds, and even V.34 rate renegotiations generate a several-hundred-millisecond glitch in the data.

Another advantage of using SRC is that it often allows the initial startup and training of the modems to complete in a shorter period of time. Two V.34 modems may be able to train and connect in a shorter period of time than normal, albeit at suboptimal line rates, if their echo cancellers and equalizers are only partially converged during training. With SRC, the modems can accomplish this "quick train", refine their tap settings using the actual data, and then seamlessly change to a higher line speed.

It is therefore strongly recommended that modems use SRC rather than rate renegotiations whenever possible. The same V.80 in-band command codepoints may be used for both (the host PC does not need to distinguish between an SRC and a rate renegotiation). It is acknowledged that, even with SRC, full V.34 retrains may still be needed in response to some line disturbances.

3. Modem Startup

An H.324 videotelephone session commences with establishment of the V.34 data channel. This may take place either at call establishment (i.e., the call starts in videotelephony mode), or during the course of a call previously initiated in telephony mode (i.e., standard analog voice). Videotelephone operation commences at call establishment when the Video Phone application is used to instruct the modem to dial the connection, and a corresponding Video Phone application answers the call. A telephony (voice mode) call may be established on a PC connected to a "voice modem" (i.e., a modem which implements the V.253 AT+V standard or equivalent). Alternately, it may be established with the use of an extension phone, either wired to the PHONE jack of the modem or wired to another wall jack.

H.324-compliant terminals may initiate V.34 modem training using the procedures in ITU-T Recommendation V.8, *Procedures for Starting Sessions of Data Transmission over the General Switched Telephone Network*, or those in ITU-T Recommendation V.8 *bis*, *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*. The use of V.8 *bis* is strongly recommended, as it allows identification and selection between the various modes of operation of the caller and answerer in a "user-friendly" manner. In other words, if one of the endpoints is a simple voice-only user, an attempt at a V.8 *bis* transaction by the other endpoint will not unduly annoy the voice user.

Appendix 2 describes the operation of V.8 *bis* in detail. Appendix 3 describes the operation of V.8.

3.1 Originating a Call in Videotelephony Mode

Since the H.324 videotelephone Recommendation was approved prior to V.8 *bis* being approved, there exist many H.324 devices that do not implement it. Provisions must be made in newer H.324 devices so that they interwork with these older non-V.8 *bis* terminals. Thus, the following points must be adhered to:

- When originating a call in V.80 mode[2], the modem *must* transmit the V.8 CI signal, unless explicitly commanded not to do so (say, by AT commands defined in ITU-T Recommendation V.251). In other words, unless the value of the <v8o> subparameter in the **`+A8E`** command is set 0, 2, 4, or 5, CI shall be transmitted. The call function value to use in V.80 mode shall be that specified by the **`+A8E`** <v8cf> subparameter (the DTE will normally specify this to be 0x21). Typically, the DTE shall issue **`AT+A8E=6,5,21;+ES=6,,8`** and then **`ATD`**<number>.

  Note that when in V.80 mode, transmission of CI is of higher importance than call progress tone detection (Busy, Ringing Tone, etc.). Even though the V.21 low channel used for CI is above the call progress frequency band, some modem implementation may be unable to implement both functions simultaneously. If this is the case, transmission of CI shall have priority while in V.80 mode. In other words, while in V.80 mode, the **`ATX3`** setting is equivalent to **`ATX1`**, and **`ATX4`** is equivalent to **`ATX2`**.

  Note: At some future point in time, when the percentage of modems in the installed base that do not implement V.8 bis *is insignificant, then the transmission of the CI signal will not be necessary. Using only V.8* bis *procedures in this case allows clean interworking with H.324 or non-H.324 (voice) answerers. At this time, however, transmission of CI is necessary in order to interwork with the installed base of H.324 terminals.*

- When originating a call in V.80 mode, the modem should look for V.8 *bis* signals CR_e, MR_e, or ES_i while it is transmitting the CI sequences (see § 10.2.1/V.8 *bis*). If detected, the modem shall terminate the transmission of CI. DTE-controlled V.8 *bis*, using the appropriate V.251 commands, is the recommended method for supporting V.8 *bis* in the modem. In this instance, the modem shall issue the appropriate **`+A8R`** indication to the DTE and await further instruction. If the modem implements DCE-controlled V.8 *bis*, it shall participate in an appropriate V.8 *bis* transaction and select H.324 videotelephony operation (the modem can use the fact that the DTE configured it for V.80 mode, with a Call Function octet value of 0x21, as indication that the DTE wishes videotelephone operation). Modems implementing DCE-controlled V.8 *bis* shall indicate this to the DTE by supporting the <v8b>=1 subparameter in the **`+A8E`** command.

[2] This is not a requirement that V.251 AT commands function differently when the modem is in V.80 mode from the manner in which they operate when the modem is in other modes. This is only meant to signify that the operation of the modem outside of V.80 mode is outside the scope of this document.

- When originating a call, the modem should always be capable of detecting answer tone (V.8 ANSam). When answer tone is detected in V.80 mode, transmission of CI shall stop, and operation shall proceed as defined in Recommendation V.8. When answer tone is detected in Voice Mode, the modem shall notify the DTE (for example, with a **`+A8A`** indication if <v8a>=2..5), and shall be prepared to proceed with modem handshaking immediately upon receiving the commands from the DTE to switch to V.80 mode and start V.34 training.

3.2 Answering a Call in Videotelephony Mode

- The modem shall support the <cfrange> subparameter, in order to allow Call Function octet values of either 0x21 or 0xC1 to be accepted when answering a call. This ensures maximum compatibility with the installed base. For example, when the value of the **`+A8E`** command <v8a> subparameter is equal to 5, with <v8cf>=21, the modem shall support a <cfrange> subparameter value of "6". When the call is answered the modem shall proceed with V.8 procedures by transmitting ANSam, whether or not CI is detected.

- If the answering modem is a voice modem, the DTE will often configure it to answer the line in Voice Mode. This is due to the fact that it is often unknown whether the incoming call is a simple voice call, or a videotelephone call. Upon answering a call in this instance, the terminal should transmit the V.8 *bis* CR_e signal in order to attempt to determine the call function intended by the originator. For a simple voice caller, the brief CR_e signal will not be unduly annoying.

  For a modem implementing DTE-controlled V.8 *bis*, the DTE shall command the modem to transmit this signal. For a modem implementing DCE-controlled V.8 *bis*, the modem should transmit the signal shortly after going off hook. For example, if a responding CR_d signal is received from the caller, then V.8 *bis* transaction #12 may be performed in order to inform the caller of the answering terminal's H.324 capabilities, and to allow the caller to specify videotelephone operation (the modem can use the fact that the DTE configured it for a Call Function octet value of 0x21, as indication that that it should include videotelephony along with voice in its list of capabilities).

  If the CI signal is detected in Voice Mode, the modem shall notify the DTE with a **`+A8I`** indication, and shall be prepared to proceed with modem handshaking immediately upon receiving commands from the DTE to switch to V.80 mode and start V.34 training.

See Section 0, "3.4 Startup Control: V.251 AT Commands", for a description of the commands needed to implement these requirements.

3.3 Voice-to-Data Transitions

H.324-compliant terminals may initiate V.34 modem training during an existing telephony call using the procedures in Recommendation V.8 *bis*. Unfortunately, the

V.8 *bis* Recommendation was not approved until after H.324 was approved. Therefore, several H.324 system providers implemented an extension of the V.8 procedures, colloquially termed “Voice Call First” or “V.8 prime”, to provide an interim method of transitioning from telephony to H.324 during an existing voice call. Thus, provisions must be made to interwork with both V.8 *bis* and “V.8 prime” systems.

Often during an existing voice call, a person may be using a telephone on another extension on the same line, or a telephone connected to the PHONE jack on the rear panel of the modem. On many modems, the PHONE jack is simply wired in parallel with the LINE jack and is merely provided as a convenience; a telephone so connected is thus equivalent to an extension phone.

In other cases during an existing voice call, the modem has control over the telephone being used, and can disconnect the phone device from the line. Such is the case for modems which incorporate a cutout or “talk/data” relay on the PHONE jack. This is also the case for voice modems. It is recommended that modems include a cutout relay, as well as current sense circuitry so that they may determine when the PHONE-jack-connected phone (often called the Local Phone) is off hook.

For either V.8 *bis* or “V.8 prime”, the voice-to-data transition is initiated by one endpoint sending an appropriate signal to the other endpoint. The initiator may have been either the originator or answerer of the original call. During the voice phase of the call, the modems at both endpoints must monitor the line for the presence of these initiating signals, so that it may respond at the appropriate time.

3.3.1 Initiating Modem

- For an existing call, the DTE will issue the **`ATX1S6=0D;`** command, which should cause the modem to issue an immediate **`OK`** result code.[3]
- The Video Phone application will then prompt the user to hang up the telephone. Once the user has confirmed the hang-up, the DTE will instruct the modem to transmit the initiating signal. For modems without V.8 *bis*, the subparameters in the +**`A8E`** command are typically preconfigured for “V.8 prime” operation (i.e., with <v8o> equal to 6 and <v8cf> equal to 21), so DTE just issues an **`ATD`** command.
- For modems implementing DTE-controlled V.8 *bis*, the DTE will instruct the modem to transmit an initiating CR_d signal. If no response is received to the CR_d signal within 2-3 seconds, the DTE will switch to “V.8 prime” operation (the DTE may attempt one or two more V.8 *bis* transactions before falling back to “V.8 prime”). If a response is received to the CR_d, either a CL or a CLR message, the DTE will implement V.8 *bis* transaction #2 or #3, respectively. If the remote endpoint issues a NAK(2) message in response to the transaction, then additional

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[3] Note: Some modems will enforce a 2-second delay even with S6=0. Also, some non-North American countries prohibit the use of two simultaneous extensions on a single connection. Modems configured for operation in these countries may return `NO DIALTONE` if the existing call involves a parallel extension. Some countries also prohibit “blind dialing” and thus require dialtone detection. Given that no digits are actually dialed in this instance, however, it may still be permissible to perform this action.

transactions will be repeated every few seconds until either an ACK message is received from the remote endpoint, or until the local DTE times out.

For modems implementing DCE-controlled V.8 *bis*, the DTE will just issue the **ATD** command, and the modem shall perform the above transactions of its own accord.

Note: Some responding H.324 devices, having previously responded with a NAK(2) message during transaction #2, may shortly thereafter initiate a transaction #1 to go to video mode. Therefore, the first initiating modem should be prepared to detect the MR_d signal from the other endpoint.

3.3.2 Responding Modem

- When so instructed by the DTE, the responding modem must monitor the line during the voice call, looking for initiating signals from the remote endpoint. The DTE shall use the **ATX1S6=0D;** command to put the modem off-hook to look for these signals. The DTE will typically configure the modem with **+A8E=,5,21,1,"6";+ES=,,8**. Note that this instructs the modem to accept Call Function octet values of either 0x21 or 0xC1. Note that the DTE *must* issue the **+A8E** command prior to issuing **ATD**, as **+A8E** is an action command when issued off hook, and it would cause the modem to commence transmission of CI in this case.

  If the CI signal is detected from the remote endpoint, the modem shall indicate this to the DTE with the **+A8I** indication. The DTE will then confirm with the user that the telephone has been hung up. The DTE will then issue the **ATA** command to proceed with modem training.

  If the modem implements DTE-controlled V.8 *bis* and a CR_d signal is detected, the modem shall report this with a **+A8R: 5** indication. The DTE will typically then perform #2 transactions, ending with NAK(2) messages, until the user confirms that the telephone is hung up and a transition to videotelephony is desired.

  If the modem implements DCE-controlled V.8 *bis* with **+A8E=,,,1** it should respond to received CR_d signals with transaction #2, issuing a **RING** result code to the DTE for each transaction. The DTE will then confirm with the user that the telephone has been hung up. The DTE will then issue the **ATA** command to proceed with modem training. When V.8 procedures are performed at the conclusion of the V.8 *bis* transactions, the modem shall report the received CM and CJ signals with the **+A8M** and **+A8J** indications, respectively, provided such reporting has been enabled by the DTE, and then followed by the **CONNECT** result code.

  Note: Even after detecting a CR_d signal, the modem should be prepared to detect a subsequent CI signal. If one or both modems are unable to *mute telephone audio, the initiating modem may fail to detect the CL response message and conclude that the responding modem does not support V.8* bis*.*

3.4 Startup Control: V.251 AT Commands

3.4.1 V.8 and "V.8 prime"

At a minimum, the indications defined in V.251 (formerly Annex A/V.25 *ter*) for reporting of received V.8 signals should be supported. For those implementations where DTE control of the V.8 session is not feasible, the following subparameter values for the **AT+A8E** configuration command can be used:

<v8o> = 6 enable DCE-controlled V.8 origination negotiation, enable V.251 indications only

<v8a> = 5 enable DCE-controlled V.8 answer negotiation, enable V.251 indications only

For DCE-controlled V.8 origination (i.e., <v8o> equals 1 or 6), a word on the setting of the Call Function octet value is in order. In V.251, the setting is "based implicitly on manufacturer-determined procedures and on previous commands". For example, in FCLASS=0 operation, the octet value is $C1_{16}$, the Transmit and Receive Data value, and the value of the <v8cf> subparameter would be ignored; indeed, the CI signal is often not transmitted in this configuration. However, if V.80 Synchronous Access mode operation is simultaneously enabled with **AT+ES=6**, then the protocol and thus the call function will be determined by the DTE. In this case, if the DTE sets the <v8cf> subparameter, the DCE should configure the V.8 Call Function octet value to that set by the DTE and transmit the CI signal.

3.4.2 V.8 *bis*

V.251 defines a couple of AT commands/indications (i.e., **AT+A8T** and **+A8R**) that allow most of the V.8 *bis* procedures to be implemented in the DTE, with the modem only required to do simple tone generation and detection.

3.4.3 Sample Sessions

See the following sample sessions for examples of V.8 *bis* and "V.8 prime" startups, with voice and non-voice modems. Sessions 1, 2, 3, and 4 include some optional capabilities, while sessions 5, 6, and 7 only include modem capabilities which are mandatory in this specification.

Session 1: Voice-Modem-to-Voice-Modem Speaker Phone Call and Transition to H.324 Operation with V.8 *bis*

Initiating Terminal		Responding Terminal		Notes
DTE	DCE	DTE	DCE	
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification
AT+FCLASS=8;+VNH=2;+VLS=7 [OR 13]	OK	AT+FCLASS=8;+VNH=2;+VLS=7 [OR 13]	OK	Set up speakerphone
AT+A8E=6,5,21,2,"6"	OK	AT+A8E=6,5,21,2,"6"	OK	Configure for V.8 *bis* control by DTEs
ATD<string>				Dial desired number
			RING	Incoming call
		ATA	OK	Answer call
	OK			Ringbacks stop; connected to other party; voice call established
AT+A8T=0,,,0	OK	AT+A8T=0,,,0	OK	Enable reception of initiating signals
AT+A8T=5,,,1,1	OK			Send CR_d
			+A8R: 5	Indicate received CR_d
		AT+A8T=0,1281808004C3,,0,1	OK	Send CL, indicate H.324
	+A8R: 0,1281808004C3			Indicate received CL
AT+A8T=0,1189808004C3	OK			Send MS with H.324 selected
			+A8R: 0,1189808084C0	Receive MS
		AT+A8T=0,19	OK	Send NAK(2)
	+A8R: 0,19			Receive NAK(2)
AT+A8T=0,,,0	OK			Enable reception of initiating signals
AT+A8T=5,,,1,1	OK			After several seconds, send CR_d again
			+A8R: 5	Indicate received CR_d
		AT+A8T=0,1281808004C3,,0,1	OK	Send CL, indicate H.324

	+A8R: 0,1281808004C3			Indicate received CL
AT+A8T=0,1189808004C3	OK			Send MS with H.324 selected
			+A8R: 0,1189808084C0	Receive MS
		AT+A8T=0,14;+FCLASS=0;+ES=,,8;A		This time, send ACK and start modem training
	+A8R: 0,14			Receive ACK
AT+FLCASS=0;+ES=6;D				Start modem training
	+A8A: 1		+A8M: 2145	
	+A8M: 2145 +A8J: 1		+A8J: 1	
	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Session 2: Non-voice Modems; H.324 (Videotelephony) Operation at Call Establishment with DTE-controlled V.8 *bis*

Calling Terminal		Answering Terminal		Notes
DTE	DCE	DTE	DCE	
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification
AT+A8E=?	(1,6),(1,5),(1),(0,2),(2,6) OK	AT+A8E=?	(1,6),(1,5),(1),(0,2),(2,6) OK	Check options supported – DTE-controlled V.8 *bis*
AT+A8E=6,5,21,2,”6”	OK	AT+A8E=6,5,21,2,”6”	OK	Configure for V.8 *bis* control by DTEs
AT+ES=6;+A8T=0,,,0; S6=0D<string>	OK			Put in V.80 mode, enable reception of initiating V.8 *bis* signals, dial, and start sending CI
			RING	Inform DTE of incoming call
		ATA	OK	Take DCE off hook
		AT+A8T=3,,,1,1	OK	Send CR_e before CI is detected
	+A8R: 3			Stop CI transmission; indicate received CR_e
AT+A8T=9,,,1,1	OK			Send CR_d
			+A8R: 9	Indicate received CR_d
		AT+A8T=0,1281808004C3,,0,1	OK	Send CL, indicate H.324
	+A8R: 0,1281808004C3			Indicate received CL
AT+A8T=0,1189808004C3	OK			Send MS with H.324 selected
			+A8R: 0,1189808084C0	Receive MS
		AT+A8T=0,14;+ES=,,8;A		Send ACK and start modem training
	+A8R: 0,14			Receive ACK
ATD				Start modem training
	+A8A: 1 +A8M: 2145 +A8J: 1		+A8M: 2145 +A8J: 1	

	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Session 3: Non-voice Modems; Transition to H.324 Operation with DCE-controlled V.8 *bis*

Initiating Terminal		Responding Terminal		Notes
DTE	DCE	DTE	DCE	
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification
AT+A8E=?	(1,6),(1,5),(1),(0,1),(2,6) OK	AT+A8E=?	(1,6),(1,5),(1),(0,1),(2,6) OK	Check options supported – only DCE-controlled V.8 *bis*
AT+A8E=6,5,21,1,”6”	OK	AT+A8E=6,5,21,1,”6”	OK	Configure for V.8 *bis* control by DCEs
				[Confirm existing call with user]
ATX1+ES=6;S6=0D;	OK	ATX1+ES=6;S6=0D;	OK	Put in V.80 mode and monitor line for signals
				[Confirm with initiating user that phone is hung up]
ATD				Send CR_d
			RING	Respond with NAK(2)
			RING	Respond with NAK(2)
		ATA		Start modem training when user confirms
	+A8A: 1		+A8M: 2145	
	+A8M: 2145 +A8J: 1		+A8J: 1	
	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Session 4: Non-voice Modems; Transition to H.324 Operation with fallback to “V.8 prime”

Initiating Terminal		Responding Terminal		Notes
DTE	**DCE**	**DTE**	**DCE**	
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification
AT+A8E=6,5,21,2,”6”	OK	AT+A8E=6,5,21,2,”6”	OK	Configure for V.8 *bis* control by DTEs
				[Confirm existing call with user]
ATX1S6=0D;	OK	ATX1S6=0D;	OK	Monitor line for signals
AT+A8T=0,,,0	OK	AT+A8T=0,,,0	OK	Enable reception of V.8 *bis* initiating signals
				Confirm with initiating user that phone is hung up
AT+A8T=5,,,1,1	OK			Send CR_d
			+A8R: 5	Indicate received CR_d
		AT+A8T=0,1281808004C3,,0, 1	OK	Send CL, indicate H.324
				CL gets corrupted/lost and is never received
AT+A8T=0,,,0	OK			Enable reception of initiating signals
AT+ES=6;D				Switch to “V.8 prime”, send CI
			+A8I: 21	Receive CI; ask user to hang up phone and confirm
			+A8I: 21	Receive another CI
		AT+ES=,,8;A		Start modem training when user confirms
	+A8A: 1		+A8M: 2145	
	+A8M: 2145 +A8J: 1		+A8J: 1	
	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Session 5: (Mandatory) Non-voice Modems; Transition to H.324 Operation with “V.8 prime”

Initiating Terminal		Responding Terminal		Notes
DTE	DCE	DTE	DCE	
AT+A8E=?	(1,6),(1,5),(2),(0),(2,6) OK	AT+A8E=?	(1,6),(1,5),(2),(0),(2,6) OK	Check options supported – no V.8 *bis*
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification – this means at least “V.8 prime” is supported.
AT+ITF=?	+ITF: (128),(64),(0) OK	AT+ITF=?	+ITF: (128),(64),(0) OK	Check buffer setting: only one value is supported, but it is OK
AT+A8E=6,5,21,,”6”	OK	AT+A8E=6,5,21,,”6”	OK	Configure for DCE-controlled V.8 w. notification to DTE
ATX1S6=0D;	OK	ATX1S6=0D;	OK	Monitor line for signals
				[Confirm with initiating user that phone is hung up]
AT+ES=6;+ESA=0,0,0,,0,0,126;D				Put in V.80 mode; send CI
			+A8I: 21	Receive CI; ask user to hang up phone and confirm
			+A8I: 21	Receive another CI
		AT+ES=,,8;+ESA=0,0,0,,0,0,126;A		Put in V.80 mode and start modem training when user confirms
	+A8A: 1		+A8M: 2145	
	+A8M: 2145 +A8J: 1		+A8J: 1	
	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Session 6 (Mandatory): Non-voice Modems; H.324 (Videotelephony) Operation at Call Establishment with "V.8 prime"

Initiating Terminal		Responding Terminal		Notes
DTE	DCE	DTE	DCE	
AT+A8E=?	(1,6),(1,5),(2),(0),(2,6) OK	AT+A8E=?	(1,6),(1,5),(2),(0),(2,6) OK	Check options supported – no V.8 *bis*
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification – this means at least "V.8 prime" is supported.
AT+ITF=?	+ITF: (128),(64),(0) OK	AT+ITF=?	+ITF: (128),(64),(0) OK	Check buffer setting: only one value is supported, but it is OK
AT+A8E=6,5,21,,"6"	OK	AT+A8E=6,5,21,,"6"	OK	Configure for DCE-controlled V.8 w. notification to DTE
AT+ES=6,,8;+ESA=0,0,0,,0,0,126	OK	AT+ES=6,,8;+ESA=0,0,0,,0,0,126	OK	Put in V.80 mode
ATD<string>				Dial, and start sending CI
			RING	Inform DTE of incoming call
		ATA		Take DCE off hook
			+A8I: 21	Receive CI
	+A8A: 1		+A8M: 2145	
	+A8M: 2145 +A8J: 1		+A8J: 1	
	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Session 7 (Mandatory): Voice-Modem-to-Voice-Modem Speaker Phone Call and Transition to H.324 Operation with “V.8 prime”

Initiating Terminal		Responding Terminal		Notes
DTE	DCE	DTE	DCE	
AT+GMM	H.324 video-ready rev. 1.0 OK	AT+GMM	H.324 video-ready rev. 1.0 OK	Verify compliance with this specification
AT+A8E=?	(1,6),(1,5),(2),(0),(2,6) OK	AT+A8E=?	(1,6),(1,5),(2),(0),(2,6) OK	Check options supported – no V.8 *bis*
AT+ITF=?	+ITF: (128),(64),(0) OK	AT+ITF=?	+ITF: (128),(64),(0) OK	Check buffer setting: only one value is supported, but it is OK
AT+FCLASS=8;+VNH=2;+VLS=7 [*See Note 1*]	OK	AT+FCLASS=8;+VNH=2;+VLS=7 [*See Note 1*]	OK	Set up speakerphone
ATD<string>				Dial desired number
			RING	Incoming call
		ATA	OK	Answer call
	OK			Ringbacks stop; connected to other party; voice call established
AT+A8E=6,5,21,,”6”;+FLCASS=0 [*See Note 2*]	OK			Configure for DCE-controlled V.8 w. notification to DTE, & switch to data mode
AT+ES=6;+ESA=0,0,0,,0,0,126 ;D				Configure for V.80 & start sending CI
			+A8I: 21	Receive CI
		AT+A8E=6,5,21,,”6”;+FCLASS=0 [*See Note 2*]	OK	Configure for DCE-controlled V.8 w. notification to DTE, & switch to data mode
		AT+ES=,,8;+ESA=0,0,0,,0,0,126; A		Configure for V.80 & start modem training
	+A8A: 1		+A8M: 2145	
	+A8M: 2145 +A8J: 1		+A8J: 1	
	+MCR: V34 +MRR: 28800 +ER: NONE CONNECT		+MCR: V34 +MRR: 28800 +ER: NONE CONNECT	Exchange data

Notes:

1.) Example commands shown here are for a V.253 standard-compliant voice modem. The Intel Videophone uses the TAPI functions to make a VoiceCall, and UnmuteSpeaker, to perform this step. Thus, whatever commands are in the TAPI registry for these functions will be used.

2.) The +FCLASS=0 example here is shown for a V.253 standard-compliant voice modem. The Intel Videophone uses commands contained in the TAPI registry entry VoiceToDataAnswer to perform this function (with the exception that the last command in the entry, the “A” command, is not sent to the modem).

4. Feature Identification

In order to make use of the video-ready features of the modem, the H.324 videotelephone application must be able to verify in an efficient manner that all of the requirements listed in Table 1 are implemented. Support for some of the listed features (e.g., generation of CI at call establishment when <v8o>=6) cannot be verified by the DTE by querying the modem with AT commands, unless a special mechanism is defined to allow for such verification. Therefore, this specification defines such a mechanism, using the V.250 **`+GMM`** command.

The **`+GMM`** command, *Request Model Identification*, is defined in § 6.1.5 of ITU-T Recommendation V.250. This command, “causes the DCE to transmit one or more lines of information text, determined by the manufacturer, which is intended to permit the user of the DCE to identify the specific model of device”, and is thus manufacturer-specific. Modems that comply with this specification shall include the following line of information text in response to this command:

`H.324 video-ready rev. 1.0`<CR><LF>

Other manufacturer-specific lines of information text may be returned as well. Note that a line containing the **`OK`** result code must be sent to the DTE following the transmission of the line(s) of information text. The result code indicates to the DTE that the modem can now accept another AT command.

5. Appendix I Modem Architecture and V.80 Requirements

In telecommunications parlance, a generalized term for a modem is a DCE (i.e., Data Circuit-terminating Equipment), and the device connected to the DCE, the PC in this case, is commonly referred to as a DTE (Data Terminal Equipment). These terms are used throughout this section, as well as throughout the documents that are referenced herein.

At the bottom level of the H.324 stack within the DTE is a layer that performs the adaptation and multiplexing functions defined in Recommendation H.223. The H.223 MUX-PDU packets use the same framing and data transparency procedures as synchronous HDLC frames (minus the FCS), as defined in § 4.5.1 of ISO/IEC 3309, *Information technology — Telecommunications and information exchanges between systems — High-level data link control (HDLC) procedures — Frame structure*. Thus, while the upper layers of the H.324 protocol stack may treat the data has possessing integral octet-oriented (character) boundaries, at the physical link layer, the zero insertion flag transparency procedures create MUX-PDU packets that are non-integral number of octets in length. This bit-oriented synchronous data stream must be transported between the H.223 layer in the DTE and the data pump in the modem. Depending on the type of serial ports on the DTE-DCE interface, different issues must be faced.

5.1 Synchronous Interface

If the serial port on the DTE is a USART that supports both bit-synchronous and asynchronous operation, such as the 85C30 SCC, and the DCE serial data port supports a synchronous connection, then the transport of the H.223-formatted bitstream is straightforward. What is needed is merely a serial cable or other physical connection that includes clock signals for both transmit and receive data (V.24 circuit 115, *Receiver signal element timing*, and circuit 114, *Transmitter signal element timing*).

With a synchronous interface, care must be taken in the use and programming of the USART hardware in the DTE. It is tempting to use the HDLC/SDLC support facilities in the USART to implement flag generation and detection, and zero insertion and deletion for flag transparency, as required by H.223. It must be remembered, however, that the last two octets before the closing flags in an H.223 MUX-PDU are not FCS octets, but instead are frame data that are passed up to higher layers in the stack. Thus, for transmit data, the USART must not automatically append CRC octets to the end of the frame data. Also, on receive, the last two octets must be passed up to the upper layers unscathed. In some USART devices, however, the last octet value is modified in the process of CRC checking. In summary, for some USART devices, their SDLC mode cannot be used, and flag generation/detection and zero insertion/deletion must be performed in software.

Most “external” box modems with DB-25 serial connectors support a bit-synchronous connection. The modem should be configured to switch to synchronous mode at the end of training. Depending on the modem, this may be accomplished with the **`AT+ES=5,,7`** V.250 command, or with proprietary commands such as **`AT&Q1`**. When so configured, upon entering Data State, the modem data pump is connected directly to the DB-25 serial connector, with no additional protocol running in the modem, i.e., the synchronous bitstream from the DTE is converted to analog form and output directly to the PSTN line.

In addition, the modem should be configured to supply the transmit clock to the DTE (i.e., V.250 **`AT+ICLOK=0`**, proprietary **`AT&X0`**, or equivalent), as the V.34 transmit speed is likely to vary from call to call and even during the duration of a single call.

Unfortunately, the serial ports on most DTE do not support synchronous serial communication. For example, the ubiquitous 16550-based COM port found in PCs only operates in start-stop, character oriented, asynchronous mode. External COM port connectors do not include the transmit and receive bit clock signals. In addition, "internal" add-in modem cards either include COM port hardware or emulate it in software, and do not support operation in synchronous mode.

5.2 Asynchronous interface - V.80

5.2.1 Background

In most instances, the DTE-DCE interface only supports character-oriented start-stop asynchronous framing. In this form of serial data transmission, separate circuits for bit clock timing are not used. The data stream is assumed to consist of an integral number of characters, commonly eight bits in length. It is also required that the transmitter and receiver on the asynchronous connection operate at a previously agreed-upon common bit rate.

In-between character transmissions, the serial line is held by the transmitter at the "Mark" (logical 1) level. Each character is then preceded by a "start bit" at the "Space" (logical 0) level, one bit time in length. This is then followed by the eight bits of the character data (parity bits are intentionally being ignored in this discussion), after which the line returns to the Mark level for at least one bit time. This is referred to as the "stop bit", although the Mark condition can continue for any arbitrary length of time greater than or equal to one bit time.

A receiver on the asynchronous connection uses the Mark-to-Space transition at the beginning of the start bit to establish the correct start-of-bit timing for the remainder of the character, sampling the serial line once per bit time in the middle of the bit cell at the previously agreed-upon rate. The stop bit at the end of the character allows the receiver to prepare for the next Mark-to-Space transmission at the beginning of the next start bit (yes, actual UART receivers are typically more complex than this, but this is the basic idea).

As asynchronous characters were at one time generated by electromechanical devices, the allowed bit timing tolerance is quite loose. Receivers must correctly operate with a bit rate tolerance of +1% to -2.5% in "basic" range, or +2.3% to -2.5% in "extended" range.

As stated previously, most DTE are only capable of generating serial data in asynchronous character format as just described. Even when the DTE-DCE interface is implemented entirely in software in a COM port emulation, it is assumed that the data format being delivered to the modem is in this format.

However, the V.34 data pump used in H.324 systems transports serial data only in bit synchronous form. The data pump supplies bit clocks at the transmit and receive bit rates, at a tolerance of ±0.01% of the nominal rate. Character (octet) framing information is not transported. This is also true of any common modem that operates with a bit rate of 600 bit/s or greater.

Therefore, V.34 modems implement some type of protocol to convert between the start-stop framed characters used by the DTE, and the synchronous bitstream required by the data pump. The two protocols available in almost all modems for this purpose are V.14 and V.42, used for data applications. Additional protocols may also be available for support of facsimile and/or Telephone Answering Device (TAD) applications (see Figure 2).

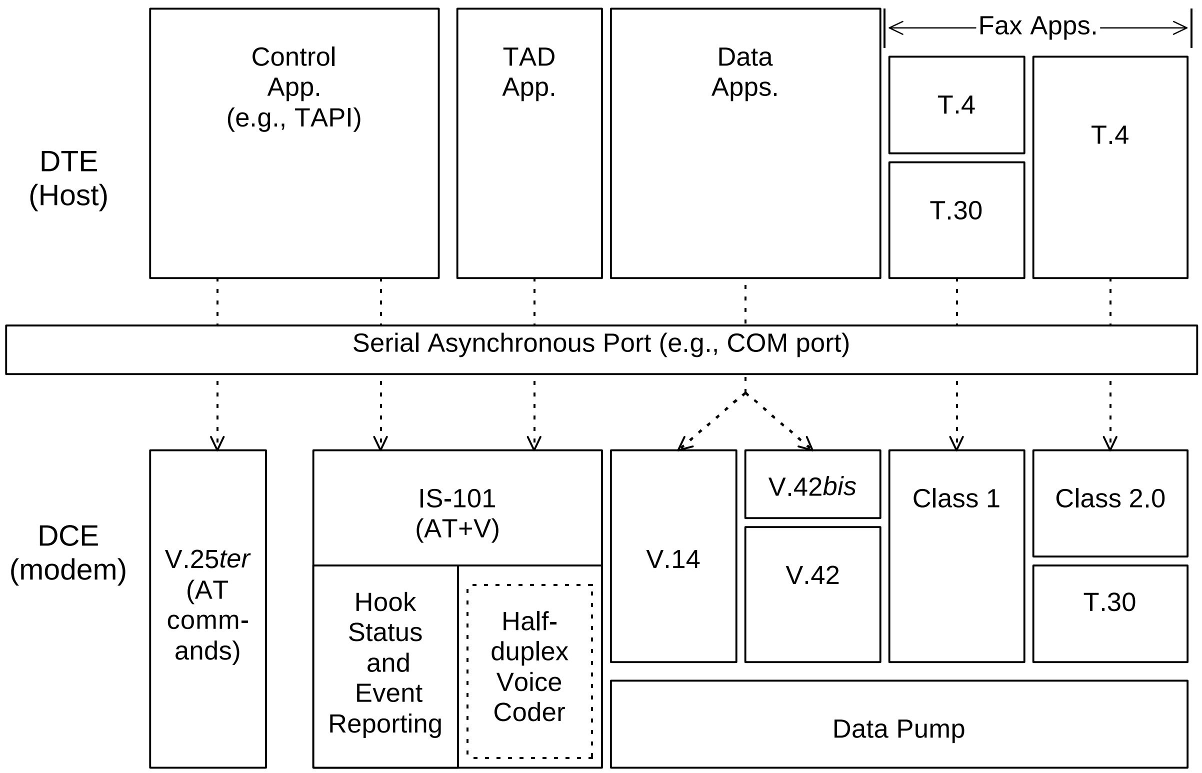


Figure 2, Typical "Voice Modem" and Associated DTE Applications

Recommendation V.14, *Transmission of Start-Stop Characters Over Synchronous Bearer Channels*, is the simplest of the two data protocols. For transmit data, incoming characters, beginning with the start bit, are merely synchronized to the data pump transmit clock, and sent to the remote end. If the asynchronous bit timing appears to be operating at an “overspeed” condition, i.e., at a bit rate higher than the nominal rate of the data pump, a stop bit will occasionally be deleted to avoid characters from “piling up” in the modem. For receive data, a missing stop bit between consecutive characters is regenerated by the modem, which may shorten the duration of one or more stop bits and/or output characters in the upper range of the asynchronous timing tolerance, in order to “make room” for the additional bits. Things get complicated when it is required to distinguish between a null (value 00_{16}) character with missing stop bit, and a Break signal (a long Space sequence); see §7.3/V.14.

Some modem transmitters merely buffer incoming data and use flow control to avoid data overrun, and thus do not need to delete stop bits. However, the receivers in such modems must still implement a full V.14 converter, as the remote modem transmitter may be doing stop bit deletion.

Note that in V.14 operation, all start bits, and almost all stop bits, are transmitted on the serial channel to the remote terminal. Thus, two of the ten bits used to transmit a character, or 20% of the available data bandwidth, is used for the sole purpose of communicating character boundary information across the serial channel.

Recommendation V.42, *Error-Correcting Procedures for DCEs Using Asynchronous-to-Synchronous Conversion*, is more commonly used. Here, for transmit data, the modem strips the start and stop bits off the incoming characters, assembles the 8 bit characters into blocks of (typically) 128-256 character blocks, and sends them to the remote end in the information field of synchronous HDLC frames. A protocol referred to as LAPM (i.e., Link Access Procedures for Modems) is used to correct for transmission errors and ensure reliable data delivery.

Since character framing information is transmitted via the HDLC flags at the beginning and end of frames and via zero insertion, which together make up a small percentage of the aggregate bitstream, utilization of the available data bandwidth is quite efficient. However, the retransmission procedures used for correction of bit errors mean the propagation delay for data from one DTE to the remote DTE may be highly variable. Thus, this is not optimum for the case where the DTE-to-DTE data may include real-time media streams such as voice, for which a small constant propagation delay is usually more important than data reliability.

5.2.2 H.223 support with V.80

It should be clear from the previous section that neither the V.14 nor V.42 protocols commonly implemented in modems are capable of generating an H.223-compliant bitstream on the PSTN line. The asynchronous UARTs in DTEs append a “0” start bit and a “1” stop bit to each group of 8 bits that they output, which are not contained in H.223 MUX-PDUs. If V.14 is used in the modem, an indeterminate number of these stop bits will be deleted or added, and if V.42 is used, an additional complex protocol layer is added by the modem. In either case, the resulting bitstream will not interoperate with H.324-compliant devices that deliver properly-formatted H.223 data to the PSTN line.

What is needed to deal with this situation is an additional protocol layer in the DTE, underneath the H.223 layer, that converts or encapsulates the synchronous bitstream into asynchronous characters that can be output by the DTE’s UART. A corresponding protocol layer is then needed in the modem, which replaces V.14 or V.42, and which losslessly converts these asynchronous characters back to the original synchronous data and delivers it directly to the data pump.

In such a system, it is advantageous to allow the modem to handle some of the low-level bit formatting. Specifically:

- On transmit, generation of flags, and insertion of zeros for flag transparency.
- On receive, detection of flags, and removal of flag-transparency zeros.

This allows the DTE to encode MUX-PDU boundaries with command code sequences, so it can ignore the issue of data sequences that may appear to be flags. Also, by having the modem implement zero insertion and deletion, the octet boundaries seen by the DTE remain aligned with the start/stop bit boundaries imposed by the DTE's UART, so that bit shifting and rotation do not need to be implemented in the DTE.

Such a modem protocol should also have the following characteristics:

- Bi-directional flow control.
- On receive, indications of buffer overrun.
- On transmit, indications of buffer overrun.

In addition, control and status monitoring of the data pump simultaneous with data transmission is highly useful. The following are facilities are recommended:

- Indication of rate renegotiation initiated by remote end.
- Indication of retrain initiated by remote end.
- Means to initiate a retrain.
- Means to initiate a rate renegotiation.
- Means to constrain the bit rate in subsequent retrains and/or rate negotiations.

The Synchronous Access Mode procedures defined in §8/V.80 provide mechanisms for modems to support DTE-based H.324 stacks across asynchronous DTE-DCE links.

Recommendation V.80, *In-band DCE Control and Synchronous Data Modes for Asynchronous DTE*, defines procedures for several different aspects of the DTE-DCE interface. This Recommendation defines a series of in-band commands, each beginning with an escape character of value 19_{16} (ASCII EM), followed by a command code octet, and depending on the specific command code, zero or more additional characters. In §7/V.80, in-band commands are defined that allow the status of V.24 handshake circuits such as CTS, DTR, etc., to be communicated across the Transmit and Receive data circuits. This facility is useful for those cases where the physical handshake circuits do not exist. For example, the standards for data transmission services over digital cellular modem links reference this section of V.80 (or its U.S. predecessor, TIA-617). Since these messages indicate handshake lead changes, they may occur in both V.250 Command State or Data State (i.e., in either AT command state, or during data transfer state), and thus may occur when the DTE-DCE character framing is either 7-bit or 8-bit. Typically, the character framing is determined automatically by the modem from the framing used for the last AT command sent by the DTE. All the command code values defined in §7/V.80 are 7-bit values (i.e., in the range $0\text{-}127_{10}$) so that they may be sent regardless of character framing.

These in-band status messages are enabled with the **`AT+IBC`** command, which also indicates whether the high order bit in the command codes are ignored (which restricts the codes to 7-bit values that can be used during either 7- or 8-bit character framing), or whether the high order bit is significant (which, during 8-bit character framing operation, allows additional command code value to be defined, which will not conflict with those defined in §7/V.80).

In §7/V.80, codes are also defined to permit AT commands and result codes to be exchanged between the DTE and modem during Data State without needing to transition to OnLine Data State. This facility is also used by digital cellular standards to report and control transmit power, battery charge level, etc., and is also enabled with the **AT+IBC** command.

The procedures needed to support H.223 operation as defined in §8/V.80, “8-Bit Commands: Synchronous Data Modes”. Several different synchronous data modes are defined in this section of the Recommendation. The mode of interest for H.223 support is Synchronous Access Mode (S.A.M.), defined in §8.8/V.80. S.A.M. uses 8-bit command codes to define procedures that allow the DTE to instruct the modem to generate any desired bitstream or protocol on the PSTN line, including H.223. These 8-bit codes are enabled by configuring the modem to implement S.A.M. operation while in Data State. This configuration is accomplished with the **AT+ES=6,,8** command. S.A.M. operation is enabled independently of the **AT+IBC** command and the 7-bit codes in §7/V.80, other than the fact that the **AT+IBC** command cannot be set to enable the 7-bit command codes and ignore the high order bit (this would cause the command codes used by S.A.M. to be confused with the 7-bit codes defined in §7/V.80).

Additionally, §8/V.80 defines AT commands to enable and configure synchronous data mode operation, and to control the setting of the transmit buffer flow control thresholds. This last point is important, as H.324 involves the transport of real-time, interactive media streams such as conversational speech and video, and long latencies due to excessive data buffering in the DCE should be avoided.

Figure 3 shows a typical DTE-based H.324 system, using a V.80 modem.

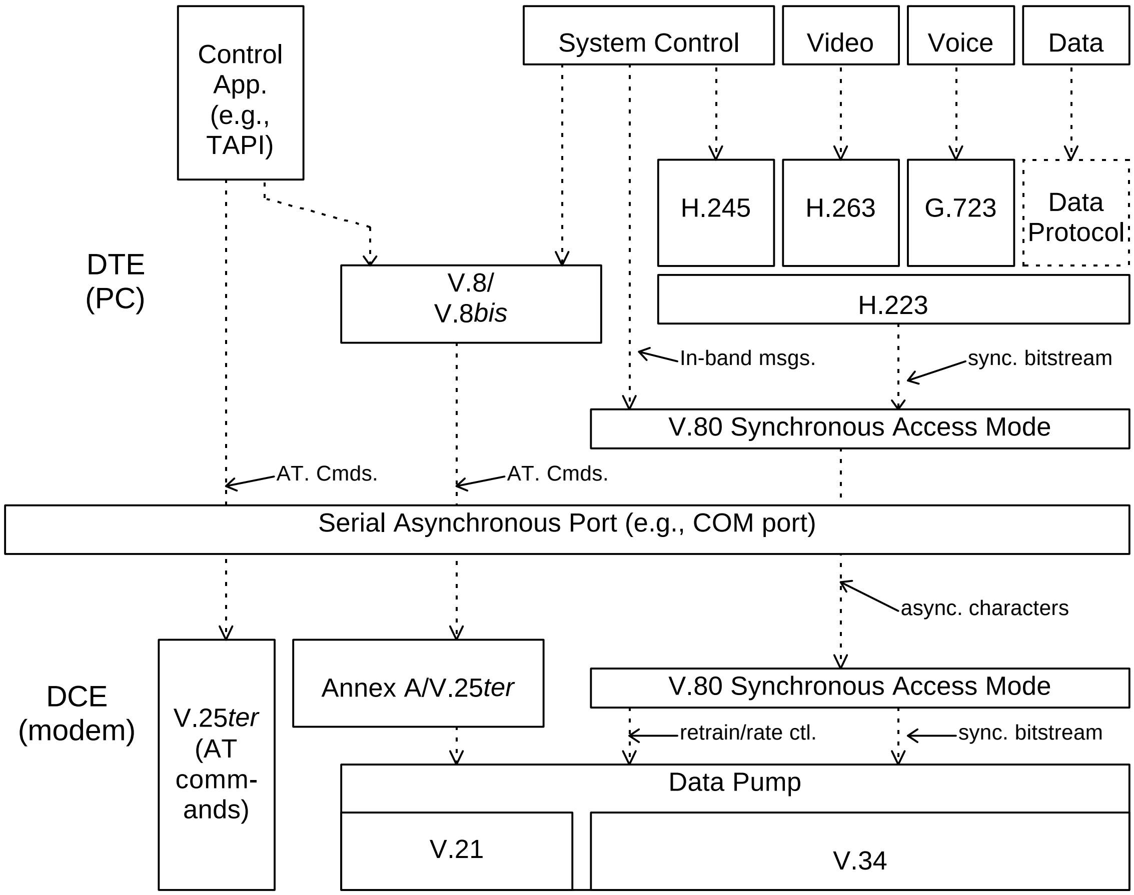


Figure 3, DTE + V.80 Modem-Based H.324 system

6. Appendix II: V.8 *bis*

Recommendation V.8 *bis*, *Procedures for the Identification of and Selection of Common Modes of Operation Between Data Circuit terminating Equipment (DCE) and between Data Terminal Equipment (DTE) over the General Switched Telephone Network and on Leased Point-to-Point Telephone-type Circuits*, is a rich specification that defines signals, messages, and procedures for exchange over the GSTN, when the modes of operation of DCEs and DTEs communicating over the connection need to be automatically established and selected, but before signals are exchanged which are specific to a particular mode of operation.

Refer to Appendix I/V.8 *bis*, "Recommendation V.8 *bis* Features", for a comparison of V.8 and V.8 *bis* features and a description of interworking considerations.

Support of V.8 *bis* operation for H.324 terminals is strongly recommended. If V.8 *bis* operation is supported, it is recommended that this be accomplished by implementing the **AT+A8T** and **+A8R** command and indication in V.251 (formerly Annex A/V.25 *ter*). These commands allow a very efficient implementation of V.8 *bis* in the modem, as the modem need only supply signal and message generation and detection facilities, with transaction management taking place in the DTE.

Taken from the text of V.8 *bis,* the principal characteristics of the Recommendation are:

a) "use over the GSTN or on leased telephone-type circuits,
b) "use at call establishment on the GSTN upon automatic answering,
c) "use after GSTN call establishment when the circuit is in telephony mode,
d) "provisions to exchange capabilities information for identifying common modes of operation between DCEs and between DTEs,
e) "provisions for a DCE to request the remote DCE to initiate a common mode of operation:
    - "mode determination by the calling station upon automatic answering at GSTN call establishment,
    - "mode determination by the answering station upon automatic answering at GSTN call establishment, and
    - "mode determination after circuit establishment by either station.
f) "provisions to prevent inadvertent disconnection of calls or annoying disturbance to users who may not have V.8*bis* capability or be aware of V.8*bis* procedures."

Figure 4 shows the capability hierarchy currently defined in the Recommendation. Means are defined in the standard to allow this to be extended for manufacturer-specific Non-Standard (N.S.) capabilities. In fact, at least one of the proprietary PCM modem techniques currently on the market (commonly referred to as "56K modems") uses the V.8 *bis* N.S. facilities for startup.

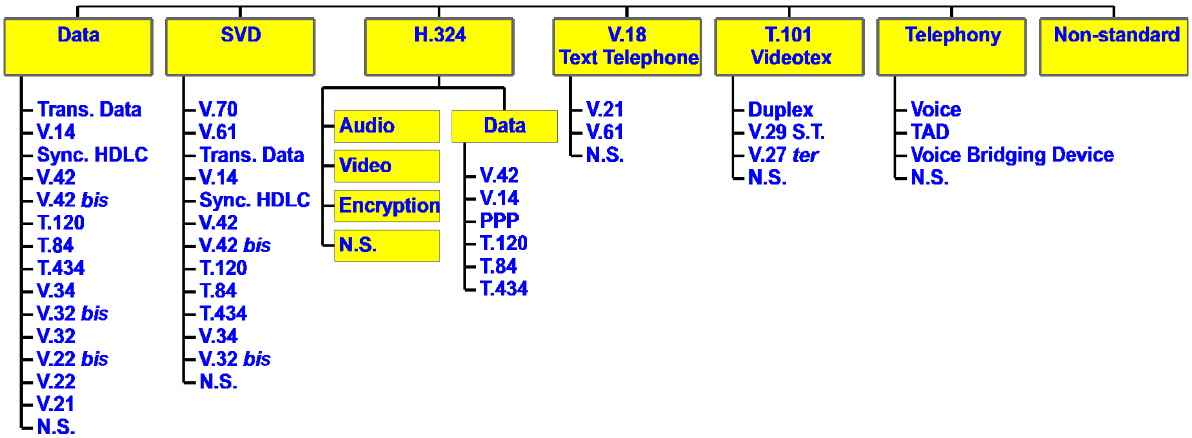


Figure 4, V.8 *bis* "Capability Tree"

Table 8/V.8*bis* defines allowed transactions, numbered #1 to #13. As an example, to transition from voice to H.324 operation during a call, where it has already been established that the remote end is H.324 and V.8 *bis* capable, Transaction #4 is may be used; this transaction is the shortest duration available. It is shown in the following figure, taken from the Recommendation:

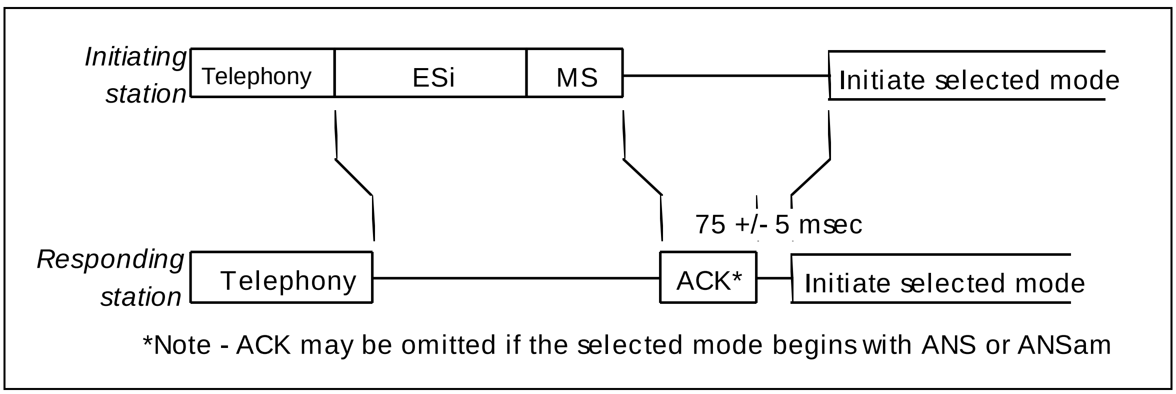


Figure 5, Transaction #4/V.8 *bis* during established connection

In other words, the initiating station sends an ES_i signal followed by an MS message selecting H.324 operation. The Responding station receives this, sends back an optional ACK message if requested to by the MS, and starts the V.34 training by sending answer tone ANSam.

ES_i is a 400 msec. dual tone followed by a 100 msec. single tone, and is a signal designed to be detected in the presence of speech. MS is an HDLC-framed message that specifies H.324 operation, sent with V.21 modulation. For this application, the coding for MS would be as follows:

Octet Coding for H.324 MS Message

Octet Encoding	8	7	6	5	4	3	2	1
V.8*bis* Revision # + MS identification	0	0	0	1	0	0	0	1
ID Field {NPar(1)}: don't tx ACK, send short V.8	1	0	0	0	0	0	1	0
ID Field {SPar(1)}: No network types set	1	0	0	0	0	0	0	0
Info Field {NPar(1)}: no parameters	1	0	0	0	0	0	0	0
Info Field {SPar(1)}: H.324	0	0	0	0	0	1	0	0
H.324 {NPar(2)}: audio & video; no {SPar(2)}'s	1	1	0	0	0	0	1	1

These six octets are preceded by at least two flags, and followed by two FCS octets and at least one flag, to form the complete message. The total number of octets in the message is thus 2 [flags] + 6 [ID & Info fields] + 2 [FCS] +1 [flag] = 11 octets, or 88 bits. At 300 bit/s, this will take 293 msec. to transmit.

This coding selects H.324 as the operational mode with audio and video.

In the ID Field {NPar(1)}, the responder is told not to bother with sending an ACK message; the responder will begin by sending ANSam answer tone. In addition, a shortened V.8 sequence is requested, in order to hasten the transition to data mode. The full transaction is as follows:

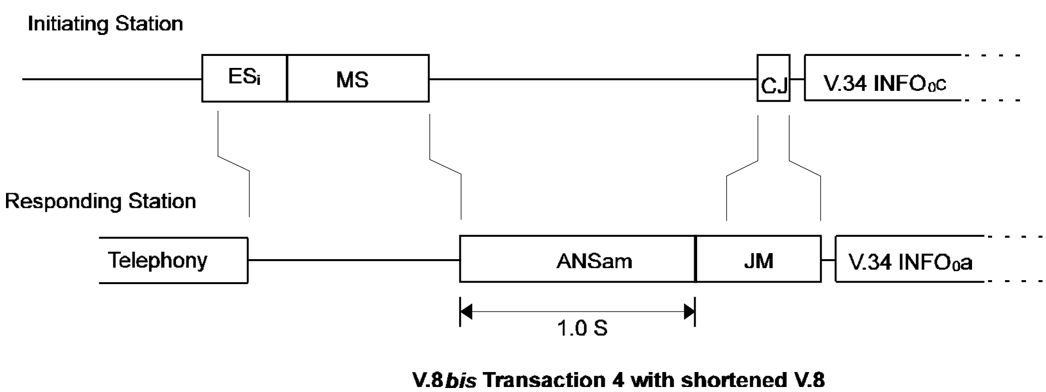


Figure 6, V.8 bis transaction w. Shortened V.8

A "safer" use of V.8 *bis*, which does not require *a priori* knowledge that the remote end is V.8 *bis* or H.324 capable, is Transaction #2:

Figure 7, "Safe" Transaction #2

Here, the initiator first sends out a CR (Capabilities Request) signal. A non-V.8 *bis* user merely hears a minimally-annoying ½ second "blip", while a V.8 *bis* equipped responder sends CL (Capabilities List) message, enumerating its capabilities. The initiating terminal, now having confirmation that H.324 operation is available in the remote terminal, sends an MS message to commence modem training.

Another example of the use of V.8 *bis*, this time at call establishment, is the following example, where an auto-answer terminal uses Transaction #10:

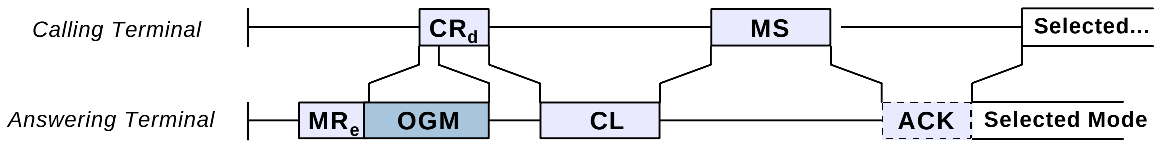


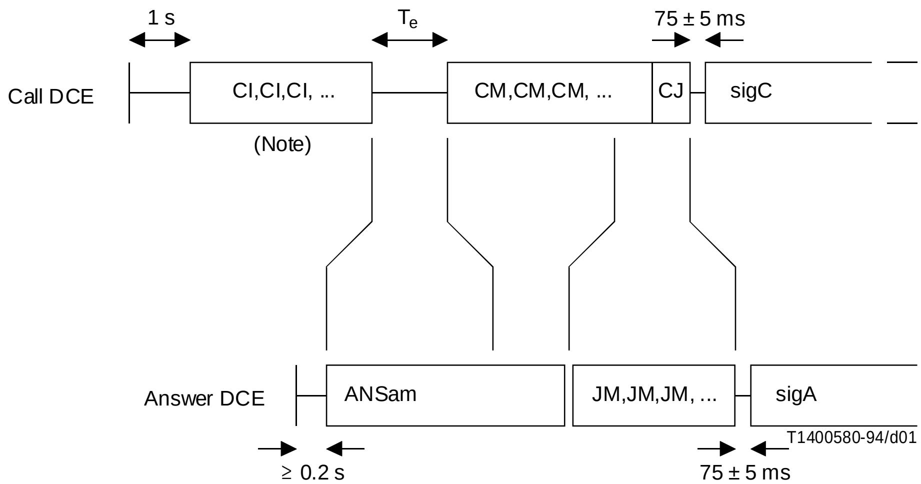
Figure 8, Transaction #10, Auto-answer Terminal

Here, the answering terminal goes off hook in response to a ring, pauses briefly to listen for calling tones such as CI, and hearing none, transmits a Mode Request (MR) signal. It then outputs an OutGoing Message (OGM) greeting, in the event the caller is a voice user. The calling terminal transmits a CR (Capability Request) signal in response to the MR, which the answering terminal detects and, now knowing that the other device is V.8 *bis* capable, terminates OGM transmission and instead sends a CL (Capabilities List) message, enumerating its capabilities. The caller then chooses one of these modes (H.324, presumably), and indicates that choice with an MS (Mode Select) message. The answering terminal then begins modem training and initializes the H.324 stack, and notifies the local user that an incoming H.324 call is being answered.

V.251 defines a couple of AT commands/indications that allow most of the V.8 *bis* procedures to be implemented in the DTE, with the modem only required to do simple tone generation and detection. Specifically, the **AT+A8T** command is used to generate V.8 *bis* signals and/or messages, and the **+A8R** indication is used to report detected signals and/or messages to the DTE.

7. Appendix III: V.8

Recommendation V.8, *Procedures for Starting and Ending Sessions of Data Transmission over the General Switched Telephone Network*, is implemented in every V.34 modem. V.21 300 bit/s FSK modulation is used to exchange preliminary information in a series of short messages with the designations CI, CM, JM, and CJ. The following figure, taken from the Recommendation, shows a typical V.8 session.



NOTE – Use of CI as a call signal is optional. Compatibility with existing answer terminals will sometimes mandate the use of CNG or CT.

FIGURE 1/V.8

Use of the CI call signal and exchange of CM/JM menu signals

Figure 9, V.8 Transaction

Typical V.34 modems used for standard data applications usually do not send CI. In these applications, the answering modem type is sometimes unknown, and the CI signal can sometimes confuse some implementations of older, non-V.34 modems such that they fail to connect.

The V.8 CM and JM sequences are capable of signaling four categories of information: Network Type, Call Type, Modulation, and Protocol. The CI sequence is capable of signaling the Call Type category. The CJ sequence is merely used to indicate the conclusion of the V.8 session and communicates no other information.

The network category can be used by one end to inform the other that operation is taking place on a cellular link, so that the other end may adjust its operation accordingly (e.g., more robust error control protocol parameters). The call type category is used by the caller to identify the type of function to be performed during the call. ITU-T defined call type values are Data, Send facsimile, Receive facsimile, Videotex, and the newly-defined H.324 value. The modulation category is used to negotiate the modem modulation scheme to be used during the call. Finally, the protocol category, if present, is used by the caller to inform the answerer of the protocol to be used once modulation training has completed. The only defined value is LAPM, and this is used to indicate that the V.42 detection phase will be bypassed.

Note that for the call type and protocol categories, the calling end, as the "paying customer", gets to determine which category value is used during the call. The caller, in the CM sequence, indicates the call type and protocol to be performed during the call (call type is also sent in CI if it is transmitted). The only options available to the answerer are to either accept these choices by sending a JM with the identical category values, or reject them (although the answerer can send out a JM with call type and protocol category values it *does* like, to suggest to the caller that it might have better success with *those* values in a subsequent V.8 session). In other words, the caller does *not* send a "menu" of call type and protocol "choices" to the answerer, from which the answerer chooses one.

The modulation category is a bit different. In this case, the category coding is defined so that the caller can send a list of all modulations the caller is capable of doing; this is sent in CM. The answerer then sends back a JM with all the modulations it is capable of, that were also received in the CM. Modem training takes place at the "highest" modulation (i.e., most advanced) in the JM.

As specified in the original published version of ITU-T Recommendation H.324, videotelephones use a call type value of Data, and do not use the protocol category. H.324-compliant devices may thus be confused with data-only modems that do not transmit the protocol category (even data modems intending to perform LAPM procedures are not required to transmit the protocol category).

To avoid this confusion, H.324 is being revised with several additions, among them the specification of a unique H.324 call type value. This unique value produces a call function octet of 21_{16}. This has the advantage of unambiguously identifying the calling terminal as an H.324 device.

Also included in this revision to H.324 is a recommendation that, if V.8 *bis* operation is not available in the calling terminal, that the V.8 CI signal be sent at call establishment. Transmitting CI aids answering multimode terminals (i.e., those that perform other modes as well as H.324, especially those that perform telephony) in quickly determining the call function desired by the originator, even though the full call function selection facilities provided by V.8 *bis* are not available.

It is recommended that H.324 implementations adopt the new call function octet of 21_{16} and the transmission of CI as quickly as possible, in order to realize the utmost benefits from the changes.

7.1 "V.8 prime"

The use of V.8 procedures for transitioning from voice to video operation is colloquially referred to as "V.8 Voice Call First" (VCF) or "V.8 prime". The principal reason for devising this scheme has been the belated availability of modems that support V.8 *bis.* This method of transitioning from telephony to H.324 operation is intended as a temporary solution until V.8 *bis* devices are widely available, and is not officially sanctioned in an ITU-T Recommendation. It has, however, been widely deployed.

The key concept of the "V.8 prime" scheme is the use of the V.8 CI signal during telephony to indicate the desire to transition from telephony to H.324 operation.

7.1.1 Origination

Upon command by the DTE, the modem must mute the local telephony audio and initiate a V.8 session with the proper category values. The modem must report the success or failure of this session and of the modem training. Preferably, the modem should indicate detection of ANSam answer tone (sent by the responding modem), and should indicate the received JM octet values.

For support of a DTE-based H.324 stack, the commands and indications in V.251 are used to manage the V.8 session. At a minimum, a subset of V.251 should be supported, such that indications of received ANSam and JM signals are given to the DTE, although the V.8 session itself may be controlled by either the DTE or the modem. Refer to Section 0, “3.4 Startup Control: V.251 AT Commands”, for more details.

7.1.2 Answerer/Responder

During an analog telephony call, the modem must be configured to monitor the connection for an incoming CI sequence from the remote terminal. Upon detection of such a signal, the modem must mute the local telephony audio, transmit ANSam, and complete a V.8 session with the proper category values. The modem must report the initial CI detection, as well as the success or failure of the V.8 session and of the modem training. Preferably, the modem should indicate the received CI and CM octet values. In the most likely scenario, the modem will be configured in Voice Class (FCLASS=8) while the call is in analog telephony mode; the modem must be capable of detecting CI in this Class, and delivering the appropriate indication to the DTE.

For support of a DTE-based H.324 stack, the commands and indications in V.251 are used to manage the V.8 session. At a minimum, a subset of V.251 should be supported, such that indications of received CI and CM sequences are given to the DTE, although the V.8 session itself may be controlled by either the DTE or the modem. Refer to Section 0, “3.4 Startup Control: V.251 AT Commands”, for more details.