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H.324

Annex F
(09/98)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Systems and
terminal equipment for audiovisual services

Terminal for low bit-rate multimedia communication

Annex F: Multilink operation

ITU-T Recommendation H.324 – Annex F

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION H.324

TERMINAL FOR LOW BIT-RATE MULTIMEDIA COMMUNICATION

ANNEX F

Multilink operation

Source

Annex F to ITU-T Recommendation H.324 was prepared by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 25th of September 1998.

FOREWORD

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The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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.

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As of the date of approval of this Recommendation, the ITU had 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.

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Recommendation H.324

TERMINAL FOR LOW BIT-RATE MULTIMEDIA COMMUNICATION

ANNEX F

Multilink operation

(Geneva, 1998)

F.1 Scope

This Annex defines the operation of H.324 over multiple independent physical connections, aggregated together according to H.226 to provide a higher total bit rate. These connections may be GSTN circuits, or ISDN circuits as defined in Annex D/H.324. The use of both GSTN and ISDN connections in the same call is supported.

F.2 References

- [1] ITU-T Recommendation V.140 (1998), *Procedures for establishing communication between two multiprotocol audiovisual terminals using digital channels at a multiple of 64 or 56 kbit/s*.
- [2] ITU-T Recommendation H.226 (1998), *Channel aggregation protocol for multilink operation on circuit-switched networks*.

F.3 Functional requirements

For use on GSTN connections, terminals compliant with this Annex shall comply with Recommendation H.324 and support V.8 *bis* operation.

For use on ISDN connections, terminals compliant with this Annex shall comply with Annex D/H.324.

F.4 Overview

In summary, the establishment of a H.324 multilink call involves the following steps:

- 1) Initial channel physical connection is established.
- 2) V.8 *bis* or V.140 is executed, selecting *H.324-Multilink* as the mode for the call.
- 3) H.324 operation begins on the initial channel, using H.226.
- 4) H.245 is used to exchange information about available additional channels, including a 32-bit **callAssociationNumber** which will be used to identify the call.
- 5) An additional channel physical connection is established.
- 6) V.8 *bis* or V.140 is executed on the new channel, selecting *Multilink-Additional-Connection* as the mode; the initiator supplies the previously received **callAssociationNumber** to identify that the new channel is associated with the existing call.
- 7) The new channel is added to the H.226 Channel Set as part of the H.324 multilink call.

Figure F.2 illustrates these steps. Steps 5), 6) and 7) may proceed in parallel for any number of additional channels.

F.5 Procedures

F.5.1 Establishing multilink H.324 operation

F.5.1.1 Establishment of initial physical connection

The initial physical connection shall be established according to the procedures of H.324 (for GSTN circuits) or Annex D/H.324 (for ISDN circuits), call setup phases A and B.

F.5.1.2 Execution of V.8 *bis* or V.140 procedure on initial connection

Multilink operation shall be initiated via the capabilities exchange and mode selection procedures of V.8 *bis* (according to Phase C of the H.324 call setup procedure) in the case of a GSTN initial physical connection, or V.140 (according to Annex D/H.324) in the case of an ISDN initial physical connection.

Using the procedures of V.8 *bis* or V.140, as appropriate, if the *H.324-Multilink* capability is present at both terminals of a connection, the terminal performing the mode selection may choose *H.324-Multilink* as the selected mode of communication.

If *H.324-Multilink* is chosen as the selected mode, the procedures defined in this Annex for H.324 multilink operation shall be used for all subsequent communications until the end of the communication session or until the procedures of V.8 *bis* or V.140, as appropriate, are re-established to negotiate into a different mode.

NOTE – Since V.8 *bis* is an integral part of establishing multilink operation for H.324, V.8 *bis* is required for this mode over GSTN, unlike basic H.324 which allows the use of V.8 instead.

F.5.1.3 Initiation of H.226 and H.324 operation

If *H.324-Multilink* is the selected mode of communication, once the procedures of V.8 *bis* or V.140 have been completed, all subsequent communication shall apply the procedures of H.226 to all data transmitted over the connection. Specifically, the H.324 bitstream that would otherwise be transmitted in ordinary H.324 (or Annex D/H.324) operation is instead used as the input to the H.226 Input Queue as defined by the Transmitter Model in H.226. Similarly, received information shall pass through the H.226 receiver and the data stream produced by the Output Queue defined in the H.226 Receiver Model shall be used as input to the ordinary H.324 (or Annex D/H.324) receiver. The model of H.324 multilink operation is shown in Figure F.1. Prior to associating any additional physical connections, H.226 shall initially operate using a Channel Set size of one.

H.324 call setup shall complete according to Phases D and E of the H.324 call setup procedure, using the procedures of H.226 to transport the H.223 bitstream.

It is possible that, upon establishment of the initial connection, the terminals may not yet know if any additional connections will later be established. If no additional connections are established, H.324 multilink operation shall continue to be used, as defined for a Channel Set size of one, throughout the H.324 communication session.

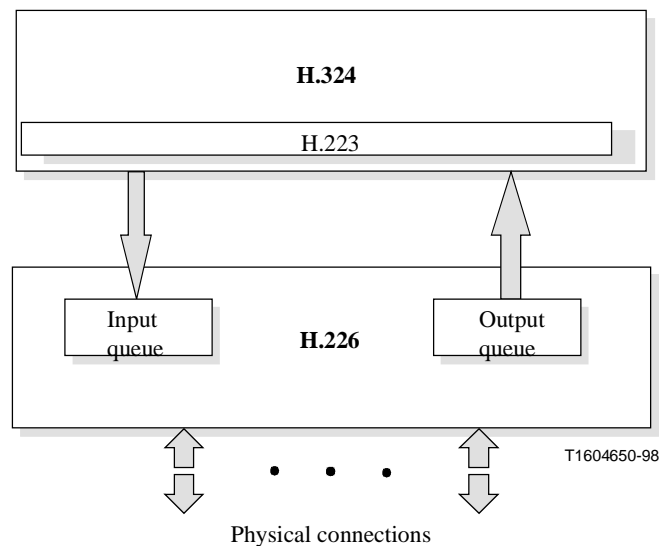


Figure F.1/H.324 – Model of H.324 multilink operation

F.5.2 Adding physical connections

The procedures for adding associated physical connections require one of the two terminals to be designated as the initiator and the other as the responder. If the initial physical connection is over GSTN, the terminal considered the *calling station* as defined in Recommendation V.8 *bis* shall be considered the initiator, and the *answering station* as defined in Recommendation V.8 *bis* shall be considered the responder. If the initial physical connection is over ISDN, the initiator and responder shall correspond to the *initiator* and *responder* as determined in Phase 3 of Recommendation V.140.

The procedures for establishing and associating additional connections may be used on multiple connections at the same time.

F.5.2.1 Exchanging call information

At any time after H.324 multilink operation is established, the initiator may begin the procedures to establish additional connections.

To request the information needed to establish and associate additional connections, the initiator shall send the H.245 **MultilinkRequest.callInformation** message to the responder. In this message, the initiator shall indicate the maximum number of additional connections that it is capable of establishing in the **maxNumberOfAdditionalConnections** parameter.

On receipt of a **MultilinkRequest.callInformation** message, the responder shall send the H.245 **MultilinkResponse.callInformation** message to the initiator. In this message, the responder shall include the **diallingInformation** parameter, with contents as described below, as well as a **callAssociationNumber**. The **callAssociationNumber** shall contain a 32-bit random number (uniformly distributed). Any subsequent **callInformation** exchanges within the same H.324 session shall re-use the identical **callAssociationNumber**.

The **DiallingInformation** parameter should be used to provide explicit dialling information to allow the initiator to establish the additional connections. If this information is not available, it shall indicate the maximum number of additional connections available with no indication of how to dial those connections.

F.5.2.1.1 Differential automatic dialling information

If the responder chooses to provide dialling information for the additional connections, it may do so using the **differential** choice of the **DiallingInformation** parameter. In this case, the responder shall provide a list of **DiallingInformationNumber** parameters, one for each potential additional connection. The length of this list indicates implicitly the maximum number of additional connections available. For each potential additional connection, **DiallingInformationNumber** includes up to three subparameters that indicate the dialling information for this connection differentially relative to the corresponding information for the already established initial connection.

The **networkAddress** parameter shall include the least significant (rightmost) portion of the telephone number for this connection, up to and including the most significant digit that is different from the number for the initially established connection, and shall include no digits that are more significant than this. If the number for the additional connection is identical to that of the initial connection, the **networkAddress** parameter shall consist of a zero-length string (since there are no differing digits in the telephone number).

NOTE – The differential digit method is used instead of the full E.164 digit string because the first few digits of the number to be dialed can vary based on the geographic location of the two terminals; for example whether or not they are located in the same city.

If there is a subaddress used for dialling, and the subaddress of a given connection is different from that of the initial connection, the responder shall include the subaddress, in full, in the optional **subAddress** parameter.

The responder shall indicate the network types supported for the connection (GSTN, ISDN, or both) using the **networkType** parameter.

F.5.2.1.2 Automatic dialling information not available

If the responder chooses not to provide any dialling information (or if the dialling information is provided using an out-of-band mechanism), it shall indicate this using the **infoNotAvailable** setting of the **DiallingInformation** parameter. In this case, the responder shall indicate the maximum number of additional connections that are available.

NOTE – It is suggested that whenever possible, the responder should indicate the explicit dialling information to allow the initiator to automatically establish additional connections. This avoids the need for the user at the calling terminal to provide these numbers explicitly.

F.5.2.2 Establishing additional physical connections

The initiator of the initial physical connection may at any time establish additional physical connections to be used for multilink operation. It shall not establish additional connections that exceed the maximum number of additional connections indicated by the responder during the exchange of call information.

If the initiator chooses to establish additional connections, it shall do so using the following procedure.

In the case that the responder provided dialling information in a **DiallingInformation.differential** parameter, the initiator shall form the network address (telephone number) to be dialed by taking the network address used to dial the initially established connection, and replacing the least significant N digits with the contents of the **networkAddress** parameter. If this parameter has zero length, the network address used to dial the initial connection shall be used in full without modification.

For example, if the initial connection was established by dialling "0019786234349", and the **networkAddress** parameter contains "51", the number to be dialed for the additional connection is "0019786234351".

If the **subAddress** parameter is present, the contents of this parameter shall fully replace any subaddress used to establish the initial connection. Use of the **networkType** parameter by the initiator is a local matter, beyond the scope of this Recommendation.

In the case that the responder did not provide any dialling information (indicated by **infoNotAvailable**), the initiator may either choose not to add additional connections, or may attempt to determine the network address of the additional connections through other means (e.g., requesting from the local user or through an out-of-band communication mechanism). Any such means is beyond the scope of this Recommendation.

F.5.2.2.1 Responder request to add additional connections

At any time the responder may request that the initiator add physical connections. This shall be done using the **MultilinkRequest.addConnection** message in H.245. The responder shall indicate the connections desired to be added using the **DiallingInformation** structure as described above. On receiving this message, the initiator shall respond with an **MultilinkResponse.addConnection** message indicating that it either intends to add the connections as requested, or that it does not intend to do so, along with the appropriate reason code.

NOTE – It is possible that the responder could be the terminal that establishes additional physical connections instead of the initiator. The procedures and exchange of information needed to facilitate this are for further study.

F.5.2.3 Associating additional physical connections

Upon establishment of a GSTN circuit, the procedures of V.8 *bis* shall be executed, leading to establishment of a V-series modem data connection.

Upon establishment of an ISDN circuit, the procedures of V.140 shall be executed.

F.5.2.3.1 V.8 bis or V.140 capability exchange

When an additional physical connection is established, the capability list in V.8 *bis* or V.140 shall include the *Multilink-Additional-Connection* capability.

If a terminal is only capable of establishing this connection such that it is associated with an already established session, it shall only indicate the *Multilink-Additional-Connection* capability and no others (it shall not indicate *H.324* or *H.324-Multilink* capability).

If a terminal is capable of allowing this connection to either be associated with an already established connection, or to be an independent connection, then other capabilities in addition to *Multilink-Additional-Connection* may be listed as well. The additional capabilities indicate *only* the capabilities for independent connections, therefore, the *H.324* or *H.324-Multilink* capability may or may not be included depending on whether the terminal can support a separate H.324 or H.324-Multilink session in addition to the existing H.324-Multilink session.

NOTE – The *Multilink-Additional-Connection* capability indicates the ability for the connection to be associated with an existing H.226 session. The *H.324* or *H.324-Multilink* capabilities indicate the ability for the connection to become a new H.324 or H.324-Multilink session.

F.5.2.3.2 V.8 bis or V.140 mode selection

To associate a connection with an existing H.324-Multilink session, the terminal that issues the V.8 *bis* or V.140 mode selection command shall indicate *Multilink-Additional-Connection* as the selected mode, and shall set the call association parameter to the value of the **callAssociationNumber** previously specified in the **MultilinkResponse.callInformation** message.

On reception of a *Multilink-Additional-Connection* mode selection command, the receiving terminal shall determine which existing H.324-Multilink session to associate the new connection with by

comparing the call association number in the mode selection command with the **callAssociationNumber** corresponding to any existing sessions. If the terminal has no existing sessions with the corresponding **callAssociationNumber**, it shall reject the connection.

NOTE – Since V.8 *bis* is an integral part of establishing multilink operation for H.324, V.8 *bis* is required for this mode over GSTN, unlike basic H.324 which allows the use of V.8 instead.

F.5.3 Removing physical connections

F.5.3.1 Removing last remaining connection

Phases F and G of the H.324 call setup procedures shall be followed to remove the last remaining physical connection at the end of a H.324 session. Note that the last remaining connection need not be the same as the initially established connection.

F.5.3.2 Removing additional connections

At any time, a terminal may remove additional physical connections. Note that the initially established connection may be removed just like any other connection. Removal of the last remaining connection (which may or may not be the same as the initially established connection) is described above.

If a connection is removed intentionally, the terminal initiating the removal shall remove this channel from the H.226 channel set prior to removal of the physical connection (allowing sufficient time for local data buffers for that channel to empty). Also prior to removal of the physical connection, it shall send the **MultilinkRequest.removeConnection** message in H.245 to the remote site. In this message it shall indicate which channel is to be removed. It shall wait until it either receives the **MultilinkResponse.removeConnection** message from the remote site indicating that the corresponding channel has stopped being used, or a locally specified time-out, and then it should remove the physical connection.

On receipt of a **MultilinkRequest.removeConnection** message, a terminal shall remove the indicated channel from its transmitted H.226 channel set (assuming that the indicated channel is bidirectional, and is in use by this terminal). In any case, it shall send the **MultilinkResponse.removeConnection** message in response to the remote site, indicating that this channel is no longer (or was never) in use.

Identification of the channel to be removed is done with respect to the channel numbering received via H.226 from the terminal to which the **MultilinkRequest.removeConnection** is being sent. The **connectionIdentifier** parameter in each message shall identify a channel by indicating a combination of **channelTag** and **sequenceNumber** corresponding to a recently received H.226 Header on the channel to be removed. If a Channel Tag was not specified at all in the Header, a value of zero shall be used for the **channelTag** parameter. In the **MultilinkResponse.removeConnection**, the **connectionIdentifier** shall be identical to the value in the corresponding **MultilinkRequest.removeConnection** message.

NOTE – Since the value of the Channel Tag is meaningful only with respect to a particular Header Set, the Sequence Number must be used in combination with the Channel Tag to uniquely specify the channel to be removed. The receiver of a **MultilinkRequest.removeConnection** must have the ability to determine from these two values, which channel the requester intends to be removed. To do this, it must have the ability to remember the correspondence between physical connections and Channel Tags for Header Sets that have already been sent. Maintaining the same value of Channel Tag for a given physical channel is a straightforward means of determining this correspondence without explicitly saving these values for all Header Sets.

If a connection is removed accidentally, each terminal should, as soon as possible, begin transmission of a new H.226 data set which no longer includes this connection in the channel set.

F.5.4 Negotiating the Maximum Header Interval

For use with this Annex, the value of the H.226 Maximum Header Interval shall not be greater than 2 seconds, unless negotiated to another value as described below.

A terminal may send the **MultilinkRequest.maximumHeaderInterval** message in H.245. In this message, it may either indicate that it wishes to know the actual interval being used by the remote transmitter without altering it, or it may request a particular value to be used instead.

A terminal receiving a **MultilinkRequest.maximumHeaderInterval** message shall respond by sending a **MultilinkResponse.maximumHeaderInterval** message. If the corresponding request indicated a request for information about the current minimum rate, the terminal shall provide the value that its transmitter is currently using as the Maximum Header Interval in the response. If the corresponding request specified a particular minimum rate to use, the terminal should attempt to comply with this request by modifying the Maximum Header Interval used by its transmitter. Whether or not it makes a change to the Maximum Header Interval, the response shall indicate the new value that is in use (which may be different from the requested value).

NOTE – A receiver may use its knowledge of the Maximum Header Interval used by the remote transmitter to help ensure that data over a physical channel are continuing to be received successfully. By knowing the maximum interval between headers, long periods of time with no headers may indicate a malfunctioning channel. The ability to request a Maximum Header Interval also allows a terminal to bound the error propagation of data that it is receiving.

F.5.5 Using the optional data CRC

In H.226, a transmitter may include an optional CRC on the data. This CRC may be used by a receiver to determine the quality of a given channel. A terminal may indicate its desire that the remote terminal send this CRC in all subsequent data sets by sending the H.245 **MultilinkIndication.crcDesired** message. The receiving terminal may optionally comply, there is no explicit acknowledgment or response required.

F.5.6 Using the excessive error indication

A terminal may indicate to the remote terminal that excessive errors are being received on a particular connection. The means for the terminal to determine the error rate or the criterion for determining what is excessive is defined locally at that terminal. It could, for example, result from receiving an excessive number of H.226 headers that contain errors, from the failure to receive H.226 headers at the minimum specified rate, or from an excessive rate of errors detected using the optional data CRC. In any case, the indication should be given with the expectation that the remote terminal will take some corrective action. This indication is made by sending the **MultilinkIndication.excessiveError** message in H.245 indicating which connection is causing problems. The connection is indicated using the **connectionIdentifier** parameter in the same manner as defined above for the **MultilinkRequest.removeConnection** message.

On receipt of this message, a terminal may choose to take corrective action. The particular corrective action that it should take is not specified. Examples include removing the connection from use or lowering the rate of the connection in hopes of reducing the error rate.

F.6 Maximum Transmit Skew

In using H.226 for H.324 multilink operation as defined in this Annex, the value of the Maximum Transmit Skew shall equal 50 milliseconds.

F.7 Sequence diagram for establishment of multilink operation

Figure F.2 shows the sequence of events in establishing multilink operation. In the figure, solid lines represent exchanges over the initial connection, dotted lines represent exchanges over additional connection(s), and heavy solid lines represent exchanges over all connections.

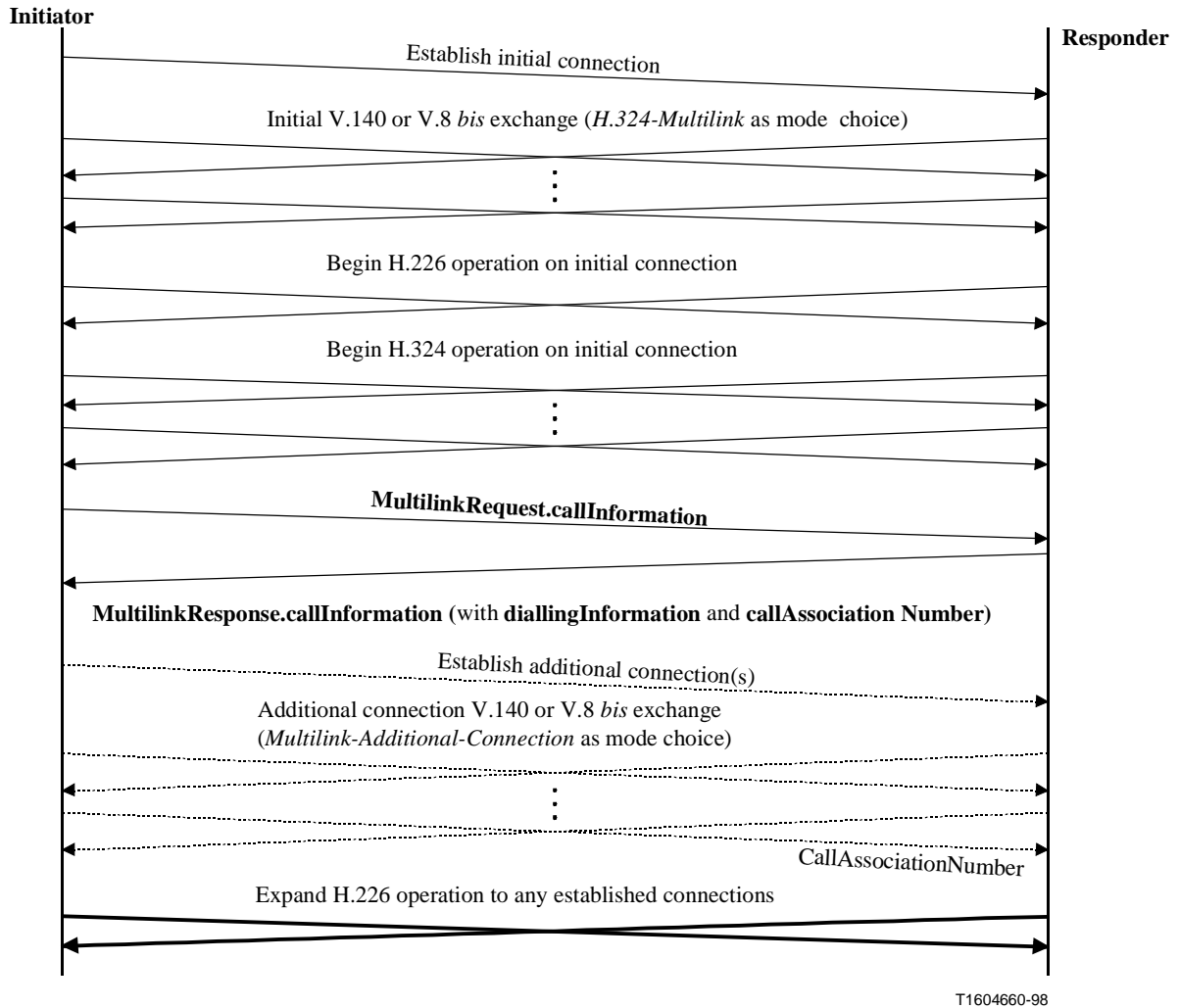


Figure F.2/H.324 – Sequence diagram for establishing multilink operation

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