INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

T.38

Amendment 2
(04/2004)

SERIES T: TERMINALS FOR TELEMATIC SERVICES

Support for optional RTP encapsulation, clarification of version negation procedures and modification of "no-signal"

Amendment 2

CAUTION !

PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.
The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.
The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.
In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

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

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.
As of the date of approval of this Recommendation, ITU [had/had not] received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

T.38 Amendment 2:
Support for optional RTP encapsulation, clarification of version negation procedures and modification of "no-signal".

Summary

Amendment 2 to Recommendation T.38 provides for the following updates:

- Support of optional RTP encapsulation when using UDP transport. The optional RTP encapsulation is used when both gateways indicate this capability during call setup.
- Description of the use of redundancy and FEC in the context of UDP/RTP.
- Annex B and Annex D are updated to include negotiation of a RTP-based T.38 capability.
- Annex G is added to specify the signaling of RTP encapsulation of T.38 as a generic H.245 capability.
- Clarification of the version negotiation procedures introduced in T.38 Amendment 1.
- Modification of "no-signal" to allow it to be sent between modem changes (currently practice in implementations).

1. Introduction

This Amendment to Recommendation T.38 allows optional support of RTP encapsulation when using UDP. This may be accomplished by amending Sections 2, 4, 7, 7.1.3, 9 and Annexes B, D and E of T.38 Amendment 1 and by the addition of Sections 9.1 and 9.2 and Annex G.

This Amendment to Recommendation T.38 provides clarification of version negotiation by amending Section 5 of T.38 Amendment 1.

This Amendment to Recommendation T.38 modifies the "no-signal" through changes to Section 7.3.1 of T.38 Amendment 1.

2 Amendments to Recommendation T.38

2.1 Amendments to Section 2 Normative references

Add the following references to Section 2:

– RFC 3550, *RTP: A Transport Protocol for Real-Time Applications.*

– RFC 2198, *RTP Payload for Redundant Audio Data.*

– RFC 2733, *An RTP Payload Format for Generic Forward Error Correction.*

2.2 Amendments to Section 4 Abbreviations

Amend to Section 4 by adding the following abbreviations:

This Recommendation uses the following abbreviations:

RTP	Real Time Protocol
RTCP	Real Time Control Protocol
FEC	Forward Error Correction

2.3 Amendments to Section 5 Introduction

…

The T.38 version number is a mandatory attribute (Table B1/T.38) that shall be exchanged between the emitting and receiving gateways. An endpoint shall signal the version that it supports in the T38Version attribute in its offer. The recipient of the offer shall accept that version or modify the version attribute to be an equal or lower version when transmitting an answer to the initial offer. The recipient of an offer shall not respond with an answer containing a higher version than that which was offered.

Early implementations of T.38 equipment may not provide a T.38 version number. In receipt of SDP without the version attribute, the endpoint shall assume that the version is 0. Version 0 devices are recommended to explicitly advertise their version.

2.4 Amendments to Section 7.1.3

7.1.3 IFP Packet Layers for TCP/IP and UDP/IP

The IFP packets described in 7.2 are combined with the appropriate headers for TCP/IP and UDP/IP as shown in Figures 4, 5 and 6. In Figure 4, the UDPTL header represents the additional header information required for error control over UDP. The TPKT header defined in RFC1006 shall precede the IFP Packet in TCP implementations as shown in Figure 4. Implementations using TPKT shall set the version to 1 or higher. Version 0 implementations shall not use TPKT.

For the UDP transport, IFP data may be encapsulated in UDPTL, as shown in Figure 5, or alternatively encapsulated in RTP, as shown in Figure 6.

In Figure 5, the UDPTL header represents the additional header information required for error control over UDP. When UDPTL encapsulation is used, the payload structure is as defined in Annex A for **UDPTLPacket**.

RTP encapsulation of T.38 facsimile signals may only be used if both gateways negotiate this capability during call setup. This negotiation is described in Annex B, Annex D, Annex E, or H.323 Annex D. With RTP encapsulation, the optional redundancy and FEC mechanisms described in RFC 2198 and RFC 2733 may be used.

Figure 6 represents the packet structure when optional RTP encapsulation is used. Within an RTP packet, an IFP packet may be optionally combined with a redundant IFP packet (RFC 2198) or with a FEC packet (RFC 2733 and RFC 2198). Another valid RFC 2733 option, not shown in Figure 6, allows FEC packets to be sent as a separate RTP stream rather than being combined with IFP packets into RTP packets. The RTP payload corresponds to a single IFP packet when RFC 2198 is not used to combine it with a redundant IFP packet or with a FEC packet.

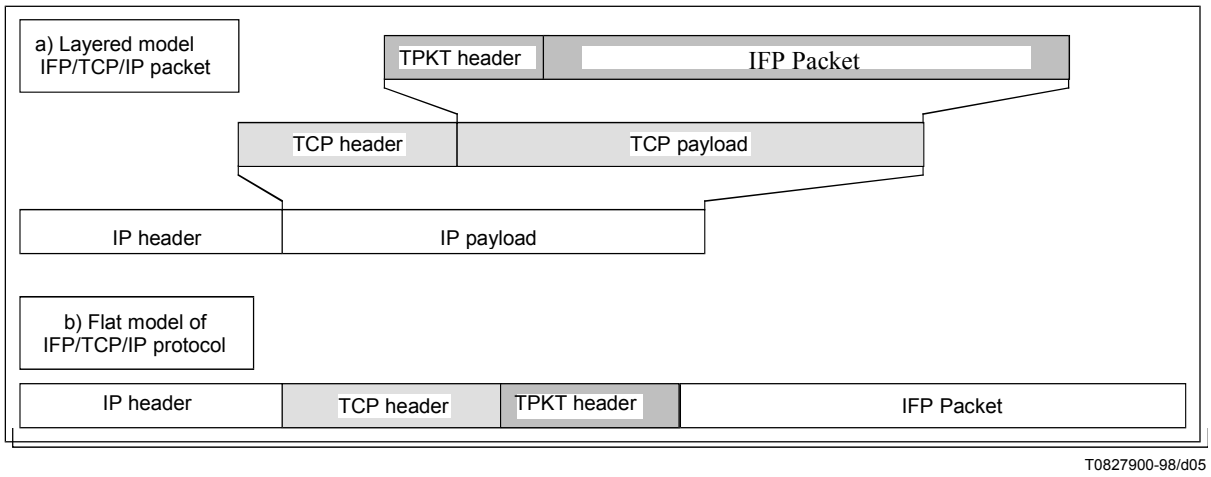

Figure 4/T.38 – High-level TCP/TPKT/IP Packet Structure

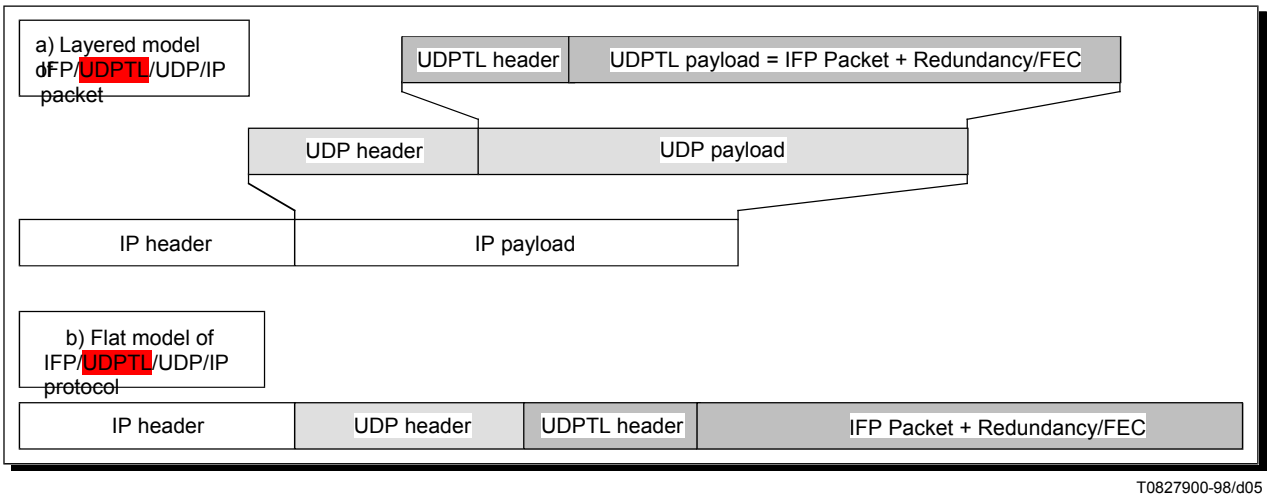

Figure 5/T.38 – High-level UDPTL/UDP/IP packet structure

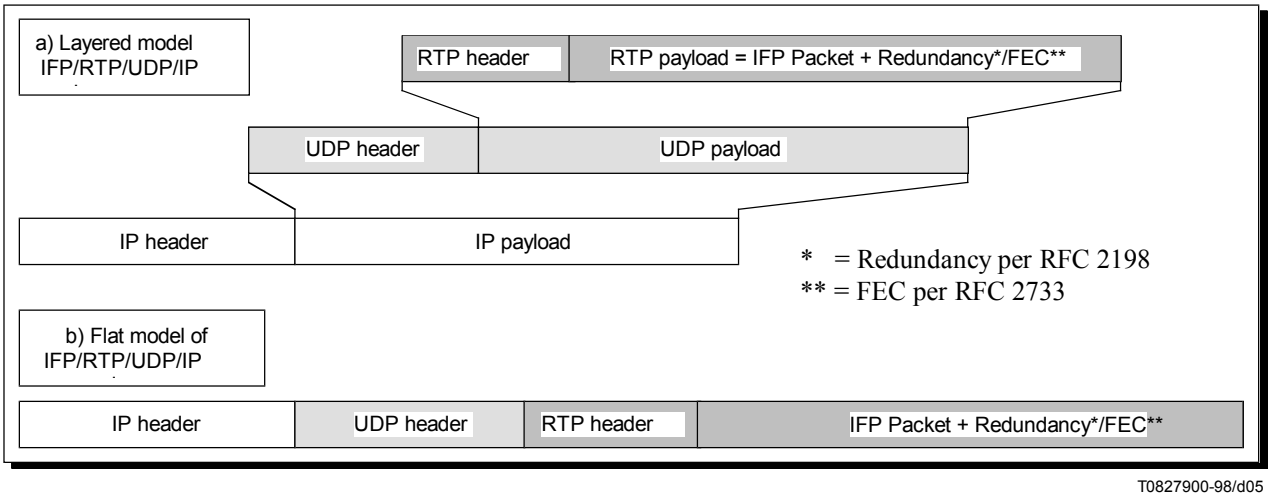

Figure 6/T.38 – High-level RTP/UDP/IP packet structure

2.7 Amendment to Section 7.3.1

…
"No signal" indicator may be sent whenever there is no signal in TDM input. For example, it may be used when modem is changed, from V.21 modem to V.17 one or from V.17 modem to V.21 one.

2.8 Rename Section 9 as below and create subsection in Section 9 (moving all subheadings down in outline by one level)

9 IFT over UDP transport

9.1 IFT over UDP transport using UDPTL protocol: IFT/UDPTL/UDP

2.9 Rename Figure 6

Rename Figure 6 in Section 9.3 and references made to it to Figure 7.

2.10 Rename Figure 7

Rename Figure 7 in Section 9.4.1 and references made to it to Figure 8.

2.11 New Section 9.2

9.2 IFT over UDP transport using RTP protocol: IFT/RTP/UDP

For UDP transport, the RTP protocol (RFC 1889) may be used as an alternative to UDPTL. The RTP protocol is used when both gateways negotiate this capability during call setup. This negotiation is described in Annex B and Annex D.

Additional capabilities available to RTP streams may optionally be used as long as these are negotiated by both gateways. These include redundancy (RFC 2198) and FEC (RFC 2733).

There are a few differences which must be considered when using RTP instead of UDPTL. These differences result from differences in the payload format and operational procedures for RTP and UDPTL. Along with the similarities between these formats, these differences are highlighted in Table 9.

Table 9/T.38 – Similarities and Differences between RTP and UDPTL

Feature	UDPTL mechanism	RTP mechanism
Payload Format	**UDPTLPacket** specified in Annex A	Without redundancy and FEC, RTP payload is a single IFP packet. When FEC packets constitute a separate stream (RFC 2733), the RTP payload is a single IFP packet. With RFC 2198-based redundancy, the RTP payload structure is as specified in RFC 2198. With FEC that uses RFC 2198 encapsulation, the RTP payload structure is as specified in RFC 2733 and RFC 2198.
Negotiation necessary to use RTP or UDPTL protocol	In order to be used, the UDPTL-based T.38 capability must be proposed by one gateway and selected/accepted by the other gateway. The capability declaration and negotiation procedures are per Annexes B, D, and E, or H.323 Annex D.	In order to be used, the RTP-based T.38 capability must be proposed by one gateway and selected/accepted by the other gateway. The capability declaration and negotiation procedures are per Annexes B, D, and E, or H.323 Annex D.
Payload Sequencing	UDPTL sequence number	RTP sequence number
Redundancy	Uses mechanism defined in Section 9	RFC 2198
FEC	Uses mechanism defined in Annex C	RFC 2733, with or without RFC 2198 encapsulation

Each RTP packet starts with a fixed RTP header. The following describes the payload specific fields of the RTP fixed header when the RTP packet encapsulates fax:

Payload Type (PT): The payload type for fax is a dynamic payload type identified by the name “t38”. If redundancy is used per RFC-2198, the payload type must indicate the payload format RED (as per RFC-2198).

Marker (M) bit: The marker bit is not used for fax and MUST be set to zero. The Marker bit should be ignored by the receiver of the packet.

2.12 Edits to Annex B

B.3.1.2 Media channels

Recommendation H.323 Annex D requires that T.38 facsimile packets are sent on a separate TCP/UDP port from H.225.0 call signaling. All required ports are established during the initial **fastStart** exchange. A minimal T.38 Annex B implementation requires a TCP port for call signaling and either a UDP port for UDPTL, or two UDP ports for RTP (one for RTP and one for RTCP), or a TCP port for T.38 facsimile information.

B.3.3 Capabilities negotiation

There are several options that need to be negotiated to determine which options the gateways support and use. See Table B.1.

Table B.1/T.38 – Gateway option capability support indications

Option	Description
Data rate management method	Method 1, local generation of TCF is required for use with TCP. Method 2, transfer of TCF is required for use with UDP (UDPTL or RTP). Method 2 is not recommended for use with TCP.
Data transport protocol	The emitting gateway may indicate a preference for either UDP/UDPTL, or UDP/RTP), or TCP for transport of T.38 IFP-Packets. The receiving device selects the transport protocol.
Fill bit removal	Indicates the capability to remove and insert fill bits in Phase C, non-ECM data to reduce bandwidth in the packet network. Optional. See Note.
MMR transcoding	Indicates the ability to convert to/from MMR from/to the line format for increasing the compression of the data and reducing the bandwidth in the packet network. Optional. See Note.
JBIG transcoding	Indicates the ability to convert to/from JBIG to reduce bandwidth. Optional. See Note.
Maximum buffer size	For UDP (UDPTL or RTP) modes, this option indicates the maximum number of octets that can be stored on the remote device before an overflow condition occurs. It is the responsibility of the transmitting application to limit the transfer rate to prevent an overflow. The negotiated data rate should be used to determine the rate at which data is being removed from the buffer.
Maximum datagram size	This option indicates the maximum size of a UDPTL packet or the maximum size of the payload within an RTP packet that can be accepted by the remote device.
Version	This is the version number of ITU-T Rec. T.38. New versions shall be compatible with previous versions.
NOTE – Bandwidth reduction shall only be done on suitable Phase C data, i.e. MH, MR and – in the case of transcoding to JBIG – MMR. MMR and JBIG require reliable data transport such as that provided by TCP. When transcoding is selected, it shall be applied to every suitable page in a call.	

These capabilities are negotiated using the OLC elements as defined in the T38faxProfile of H.245 V7 (or higher).

Two unidirectional, reliable or unreliable, logical channels (sender to receiver channel and receiver to sender channel) as shown in Figure B.1 or, optionally, one bidirectional reliable channel as shown in Figure B.2 shall be opened for the transfer of T.38 packets. T.38 packets can be transferred using either TCP or UDP (UDPTL or RTP). In general, the usage of TCP is more effective when the bandwidth for facsimile communication is limited, or for IAF to IAF transfers since TCP provides flow control. On the other hand, the usage of UDP (UDPTL or RTP) may be more effective when the bandwidth for facsimile communication is sufficient.

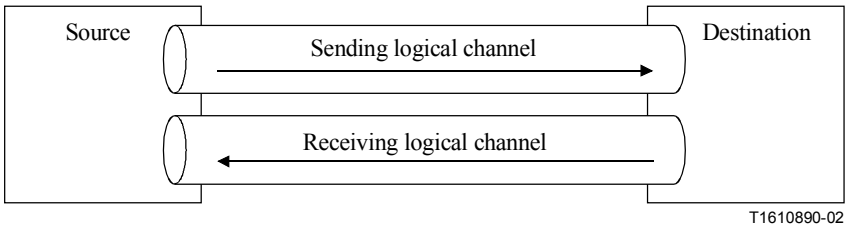

Figure B.1/T.38 – A pair of unidirectional channels

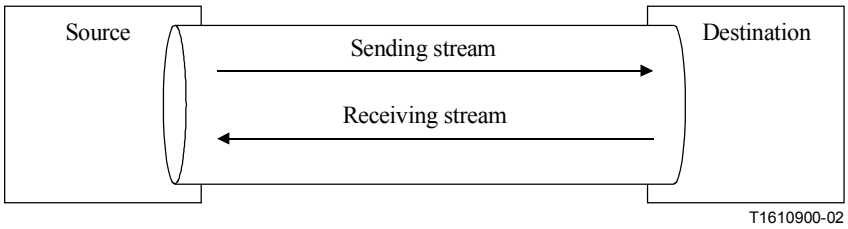

Figure B.2/T.38 – A single of bidirectional channels

The sender terminal specifies a TCP/UDP port in the **OpenLogicalChannel** in the **fastStart** element of *Setup when transmitting T.38 via TCP or UDPTL.* The receiver terminal shall provide its TCP (or UDP) port in the **OpenLogicalChannel** of the **fastStart** element as specified by the procedures in 8.1.7/H.323: "Fast connect".

The receiver should open the TCP/UDP port based on the preference of the sender. If the sender terminal has a preference for UDP (UDPTL or RTP) or TCP, then it shall provide its preference in the **OpenLogicalChannel** with the appropriate port in the **fastStart** sequence. The receiving terminal can select the transport, TCP or UDP (UDPTL or RTP), by specifying one of the two in **OpenLogicalChannel** structures in the **fastStart** element of *Connect*.

When transmitting T.38 over RTP, the **OpenLogicalChannel** contains the generic audio capability defined in Annex G and shall be included in the **fastStart** element in the Setup message as specified in 8.1.7/H.323: "Fast Connect". The parameter names in the generic audio capability are named the same as those used in the H.245 ASN.1.

All T.38 Annex B implementations shall include a T38fax OLC with **t38FaxUdpOptions** and **transferredTCF** set in the **fastStart** structure,.. Note that all H.323 Annex D devices supporting T38, also are required to include these structures. In addition, T.38 Annex B devices shall include an OLC with **t38FaxTcpOptions** and **localTCF** set and with **tcp** selected as the **t38FaxProtocol** choice. Optionally, T.38 Annex B devices may include an OLC with the T38RTP generic audio capability specified with the **transferredTCF** included in the **fastStart** structure. As described in 8.1.7/H.323, the order in which OLCs are included in the **fastStart** element indicates preference on the part of the sender. The receiver only includes the OLCs that it wishes to use in the **fastStart** element of the *Connect*.

NOTE – In the first version of Annex B, it was not possible to use a single bidirectional reliable channel. In order to retain backward compatibility, the endpoint may specify support for bidirectional reliable channels by including the **t38FaxTcpOptions** SEQUENCE and setting the **t38TCPBidirectionalMode** field to TRUE. If the other endpoint does not include the **t38FaxTcpOptions** SEQUENCE, the endpoint shall assume that a single bidirectional reliable channel for T.38 is not supported and shall use either two unidirectional reliable or unreliable channels.

B.3.4 Examples of call set-up OLCs

The examples in this clause illustrate the OLC elements that are sent in various cases. The rules of 8.1.7/H.323 are followed using OLC definitions in ITU-T Rec. H.245. Refer to ITU-T Rec. H.245 for the relevant ASN.1.

B.3.4.1 TCP, UDP (UDPTL), or RTP support

The default case requires support for both TCP and UDP (UDPTL). In this case, the sender shall send OLCs for **T38/TCP&localTCF** and **T38/UDPTL&transferredTCF**. Optionally, the sender may send OLCs for **T38RTP&transferredTCF**. If the receiver wishes to use UDP, an OLC for **T38/UDPTL&transferredTCF** is returned. If the receiver wishes to use RTP, an OLC for **T38RTP&transferredTCF** is returned. Otherwise, the OLC for **T38/TCP&localTCF** is returned.

B.3.4.2 UDP (UDPTL) with data rate management method 1 support

For the case where the sender wishes to use data rate management method 1 and UDP (UDPTL) for data transport, it shall send OLCs for **T38/UDPTL&transferredTCF**, **T38/UDPTL&localTCF**, **T38/TCP&localTCF**. If the receiver agrees to use **UDPTL&localTCF**, an OLC for **T38/UDPTL&localTCF** is returned.

B.3.4.3 RTP with data rate management method 1 support

For the case where the sender wishes to use data rate management method 1 and RTP for data transport, it shall send OLCs for **T38RTP&transferredTCF** and **T38RTP&localTCF**. If the receiver agrees to use **RTP&localTCF**, an OLC for **T38RTP&localTCF** is returned.

2.13 Rename Annex C

The Optional Forward Error Correction Scheme for UDPTL

2.14 Edits to Annex D

D.2.3 Capabilities negotiation

There are several capabilities that need to be negotiated to determine which options the gateways support and use. These are described in Table B.1/T.38.

The IETF RFC 2327 Session Description Protocol (SDP) provides mechanisms for describing sessions for SIP. There are several T.38 specific parameters that may be negotiated when establishing a T.38 media stream. For historic reasons, this is done differently for the UDPTL/TCP transport and the RTP transport.

D.2.3.1 UDPTL and TCP Negotiation

New attributes (section 6 of SDP) are required to support ITU-T T.38 when using the UDPTL and TCP transports. Note that the attributes defined below are specific to the use of T.38 with either the UDPTL or

TCP transport and do not apply to the use of T.38 with RTP (see D.2.3.2). Specifically, the following options are registered with IANA as valid att-field and att-value values per the procedure noted in Appendix B of SDP (IETF RFC 2327). Note that options without values are "atson" – their presence indicates that they are valid for the session. These capabilities are negotiated using the following ABNF elements defined for use with ITU-T T.38:

```
Version
      Att-field=T38FaxVersion
      Att-value = 1*(DIGIT)
      ;Version 0, the default, refers to T.38 (1998)
Maximum Bit Rate
      Att-field=T38MaxBitRate
      Att-value = 1*(DIGIT)
Fill Bit Removal
      Att-field=T38FaxFillBitRemoval
MMR Transcoding
      Att-field=T38FaxTranscodingMMR
JBIG Transcoding
      Att-field=T38FaxTranscodingJBIG
Data Rate Management Method
      Att-field=T38FaxRateManagement
      Att-value = localTCF | transferredTCF

UDPTL Options
Maximum Buffer Size
      Att-field=T38FaxMaxBuffer
       Att-value = 1*(DIGIT)
      ;optional
Maximum Datagram Size
      Att-field=T38FaxMaxDatagram
      Att-value = 1*(DIGIT)
      ;optional
Error Correction
      Att-field=T38FaxUdpEC
      Att-value = t38UDPFEC | t38UDPRedundancy
```

D.2.3.2 RTP Negotiation

The MIME type registration for "audio/T38" defines several optional parameters that may be used with T.38 over RTP. Those parameters are supplied in a semi-colon separated list of "parameter" or "parameter=value" pairs using the "a=fmtp" parameter defined in SDP; the "parameter" form is used for boolean values, where presence equals "true" and absence "false". The parameter definitions are repeated here:

```
Version
      Name=T38FaxVersion
      Value= 1*(DIGIT)
```

```
      ;Version 0, the default, refers to T.38 (1998)
Maximum Bit Rate
      Name=T38MaxBitRate
      Value= 1*(DIGIT)
Fill Bit Removal
      Name=T38FaxFillBitRemoval
      ;Boolean
MMR Transcoding
      Name=T38FaxTranscodingMMR
      ;Boolean
JBIG Transcoding
      Name=T38FaxTranscodingJBIG
      ;Boolean
Data Rate Management Method
      Name=T38FaxRateManagement
      Value = "localTCF" | "transferredTCF"
Maximum Buffer Size
      Name=T38FaxMaxBuffer
       Value = 1*(DIGIT)
      ;optional
Maximum Datagram Size
      Name=T38FaxMaxDatagram
      Value = 1*(DIGIT)
          ;optional
```

Note: There is no Error Correction defined for T.38 over RTP Redundancy and FEC can be declared for RTP payloads according to the SDP usage defined in RFC 2198 and RFC 2733.

D.2.3.1 Declaration of T.38 in SDP

The image/t38 MIME content type in SDP indicates ITU-T T.38.
This choice is consistent with image/tiff used in ITU-T T.37 and image/g3fax used for ITU-T X.420.

D.2.3.2 Use of either TCP or UDP

Two logical channels (sender to receiver channel and receiver to sender channel) shall be opened for the transfer of T.38 packets. T.38 packets can be transferred using either TCP or UDP. In general, the usage of TCP is more effective when the bandwidth for facsimile communication is limited, or for IAF to IAF transfers since TCP provides flow control. On the other hand, the usage of UDP may be more effective when the bandwidth for facsimile communication is sufficient.
Note that during the SIP call setup, the calling party suggests the transport (TCP or UDP) by listing its preferred first in the SDP of a SIP INVITE. The receiver should open the TCP/UDP port based on the preference of the sender, but the receiver decides.
In support of T.38 choice of UDP or TCP transport, SDP extensions:

- indicate UDPTL (facsimile user datagram protocol transport layer) as a valid transport value (third field).
- indicate TCP (transmission control protocol) as a valid transport value (third field).
- indicate RTP/AVP (Real Time Protocol/Audio-Video Profile) as a valid transport value (third field).

- indicate RTP/SAVP (Real Time Protocol/Secure Audio-Video Profile) as a valid transport value (third field).
- indicate other RTP profiles (e.g. AVPF and SAVPF) as a valid transport value (third field).
- include t38 as a valid format type value (fourth field). This value is used when the transport value is UDPTL or TCP.
- include an RTP payload type as a valid format type value (fourth field). This value is used when the transport value is RTP/AVP or RTP/SAVP. This payload type is mapped via an 'rtpmap' attribute to the MIME type "audio/t38".

When the transport layer is RTP, standard RTP mechanisms for packet redundancy (RFC 2198) and FEC protection (RFC 2733) may be used. The declaration of these mechanisms in SDP is described in RFC 2198 and RFC 2733.

NOTE – As t38 is not an RTP-defined value, it has to be a MIME sub-type of the media type. As a result, this is awaiting the publication of an IETF RFC to define the registration of audio/t38 with IANA as a valid MIME content-type per the procedure noted in Appendix B of SDP (IETF RFC 2327).

D.2.4.1 Facsimile only invite

The default case requires support for both TCP and UDP. A UDPTL or RTP encapsulation method may be used in conjunction with UDP transport. In this case, two 'm=' lines are listed with the preferred one first in the INVITE. The rejected media connection will be indicated with a port number set to zero in the response.

For a two-party facsimile-only call between T.38 gateways, when UDPTL encapsulation is used in conjunction with the UDP transport protocol:

```
C->S: INVITE sip:+1-212-555-1234@bell-tel.com SIP/2.0
      Via: SIP/2.0/UDP kton.bell-tel.com
      From: A. Bell <sip:+1-519-555-1234@bell-tel.com>
      To: T. Watson <sip:+1-212-555-1234@bell-tel.com>
      Call-ID: 3298420296@kton.bell-tel.com
      Cseq: 1 INVITE
      Subject: Mr. Watson, here is a fax
      Content-Type: application/sdp
      Content-Length: …
      v=0
      o=faxgw1 2890844526 2890842807 IN IP4 128.59.19.68
      e=+1-212-555-1234@bell-tel.com
      t=2873397496 0
      c=IN IP4 128.59.19.68
      m=image 49170 udptl t38
      a=T38FaxRateManagement :transferredTCF
      a=T38FaxUdpEC :t38UDPFEC
      m=image 49172 tcp t38
      a=T38FaxRateManagement :localTCF

S->C: SIP/2.0 200 OK
      Via: SIP/2.0/UDP kton.bell-tel.com
      From: A. Bell <sip:+1-519-555-1234@bell-tel.com>
      To: T. Watson <sip:+1-212-555-1234@bell-tel.com>
      Call-ID: 3298420296@kton.bell-tel.com
      Cseq: 1 INVITE
      Contact: sip:atson@boston.bell-tel.com
      Content-Type: application/sdp
       Content-Length: …
      v=0
```

```
        o=faxwatson 4858949 4858949 IN IP4 192.1.2.3
       c=IN IP4 boston.bell-tel.com
       m=image 5002 udptl t38
       a=T38FaxRateManagement :transferredTCF
       a=T38FaxUdpEC :t38UDPFEC
       m=image 0 tcp t38
```

For a two-party facsimile-only call between T.38 gateways, when RTP encapsulation is used in conjunction with the UDP transport protocol:

```
C->S: INVITE sip:+1-212-555-1234@bell-tel.com SIP/2.0
       Via: SIP/2.0/UDP kton.bell-tel.com
       From: A. Bell <sip:+1-519-555-1234@bell-tel.com>
       To: T. Watson <sip:+1-212-555-1234@bell-tel.com>
       Call-ID: 3298420296@kton.bell-tel.com
       Cseq: 1 INVITE
       Subject: Mr. Watson, here is a fax
       Content-Type: application/sdp
       Content-Length: …
       v=0
       o=faxgw1 2890844526 2890842807 IN IP4 128.59.19.68
       e=+1-212-555-1234@bell-tel.com
       t=2873397496 0
       c=IN IP4 128.59.19.68
       m=audio 49170 RTP/AVP 100 101
       a=rtpmap:100 t38/8000
       a=fmtp:100 T38FaxRateManagement=transferredTCF
       a=rtpmap:101 parityfec/8000
       a=fmtp:101 49173 IN IP4 128.59.19.68
       m=image 49172 tcp t38
       a=T38FaxRateManagement :localTCF

S->C: SIP/2.0 200 OK
       Via: SIP/2.0/UDP kton.bell-tel.com
       From: A. Bell <sip:+1-519-555-1234@bell-tel.com>
       To: T. Watson <sip:+1-212-555-1234@bell-tel.com>
       Call-ID: 3298420296@kton.bell-tel.com
       Cseq: 1 INVITE
       Contact: sip:atson@boston.bell-tel.com
       Content-Type: application/sdp
       Content-Length: …
       v=0
       o=faxwatson 4858949 4858949 IN IP4 192.1.2.3
       c=IN IP4 boston.bell-tel.com
       m=audio 5002 RTP/AVP 100 101
       a=rtpmap:100 t38/8000
       a=fmtp:100 T38FaxRateManagement=transferredTCF
       a=rtpmap:101 parityfec/8000
       a=fmtp:101 5004 IN IP4 192.1.2.3
       m=image 0 tcp t38
```

This example shows forward error correction (FEC) as defined for RTP media streams in RFC 2733. In this case, a separate UDP port is allocated to the FEC stream. For the case when RFC 2198 encapsulation is used in conjunction with FEC, the SDP descriptors in this example will need to be modified per RFC 2733.

For secure RTP, the third field (transport protocol) on the 'm=' lines would have been RTP/SAVP rather than RTP/AVP.

For a two-party voice and fax call between gateways, when RTP encapsulation is used in conjunction with the UDP transport protocol:

```
C->S: INVITE sip:+1-212-555-1234@bell-tel.com SIP/2.0
      Via: SIP/2.0/UDP kton.bell-tel.com
      From: A. Bell <sip:+1-519-555-1234@bell-tel.com>
      To: T. Watson <sip:+1-212-555-1234@bell-tel.com>
      Call-ID: 3298420296@kton.bell-tel.com
      Cseq: 1 INVITE
      Subject: Mr. Watson, here is a fax
      Content-Type: application/sdp
      Content-Length: …
      v=0
      o=faxgw1 2890844526 2890842807 IN IP4 128.59.19.68
      e=+1-212-555-1234@bell-tel.com
      t=2873397496 0
      c=IN IP4 128.59.19.68
      m=audio 49170 RTP/AVP 121 0 100
      a=rtpmap:100 t38/8000
      a=fmtp:100 T38FaxRateManagement=transferredTCF
      a=rtpmap:121 red/8000
      a=fmtp:121 100/100
      m=image 49172 tcp t38
      a=T38FaxRateManagement:localTCF

S->C: SIP/2.0 200 OK
      Via: SIP/2.0/UDP kton.bell-tel.com
      From: A. Bell <sip:+1-519-555-1234@bell-tel.com>
      To: T. Watson <sip:+1-212-555-1234@bell-tel.com>
      Call-ID: 3298420296@kton.bell-tel.com
      Cseq: 1 INVITE
      Contact: sip:atson@boston.bell-tel.com
      Content-Type: application/sdp
      Content-Length: …
      v=0
      o=faxwatson 4858949 4858949 IN IP4 192.1.2.3
      c=IN IP4 boston.bell-tel.com
      m=audio 5002 RTP/AVP 121 0 100
      a=rtpmap:100 t38/8000
      a=fmtp:100 T38FaxRateManagement=transferredTCF
      a=rtpmap:121 red/8000
      a=fmtp:121 100/100
      m=image 0 tcp t38
```

This example shows redundant encoding for RTP fax as defined in RFC-2198. For g.711 encoding of voice, redundancy is not used.

2.15 Edits to Annex E

E.2.3 Capabilities negotiation

There are several options that need to be negotiated to determine which options the gateways support and use. These are described in Table B.1/T.38.38 and are defined as SDP extensions in T.38 Annex D Section 2.3. They are also defined as binary types in the IP Fax package of Rec. H.248.2.

A T.38 Annex E implementation may use the SDP extensions to describe the fax media terminations in text mode of the protocol. An H.248.1 implementation shall use the IP Fax package as the preferred method to describe the fax media termination. These media descriptors indicate the capabilities of, or requested of a media gateway (e.g., TCP, UDPTL or RTP transport).

In addition, as well as being able to identify that a call is using T.38 transport for facsimile, Rec. H.248.1 may also indicate other transports.

2.16 New Annex G

Annex G: H.245 Capability Definition for T.38 over RTP

This section defines a generic H.245 capability that allows for the transport of T.38 over RTP. It is intended that this capability would be signaled as an **audioCapability** within H.245-based systems.

Note that H.245 already defines a T.38 capability for transport of IFP packets over UDP and TCP, which is a **dataApplicationCapability**. The capability definition in this section is not intended to replace that definition, but rather to provide a means of transporting T.38 IFP packets over RTP only.

Capability name:	T38RTP
Capability class:	Audio Capability
Capability identifier type	Standard.
Capability identifier value	itu-t (0) recommendation (0) t (20) 38 h245-audio-capability(0)
maxBitRate	This parameter is optional.
collapsing	This field shall not be included and shall be ignored if received.
nonCollapsing	This field shall be present and consist of the parameters defined below.
nonCollapsingRaw	This field shall not be included and shall be ignored if received.
transport	This field shall not be included.

Parameters for this capability are defined in the following tables:

Parameter name:	BooleanOptions
Parameter description:	This is a nonCollapsing capability. Contains various Boolean options that must be conveyed.
Parameter identifier value:	0
Parameter status:	Mandatory.
Parameter type:	BooleanArray LSb is bit 0. Bit value 1 = TRUE. Bit 0 – fillBitRemoval Bit 1 – transcodingJBIG Bit 2 – transcodingMMR All other bits are reserved and shall be ignored.
Supersedes:	-

Parameter name:	Version
Parameter description:	This is a nonCollapsing capability. This identifies the version of the T.38 protocol.
Parameter identifier value:	1
Parameter status:	Optional. If absent, version 0 is assumed.
Parameter type:	unsignedMin
Supersedes:	-

Parameter name:	T38FaxRateManagement
Parameter description:	This is a nonCollapsing capability. This specifies the fax rate management modes.
Parameter identifier value:	2

Parameter status:	Required. Only one sub-parameter of T38FaxRateManagement may be included in this parameter
Parameter type:	genericParameter
Supersedes:	-

Parameter name:	T38FaxRateManagement-localTCF
Parameter description:	This is a nonCollapsing capability that is an element of T38FaxRateManagement.
Parameter identifier value:	0
Parameter status:	Optional.
Parameter type:	Logical
Supersedes:	-

Parameter name:	T38FaxRateManagement-transferredTCF
Parameter description:	This is a nonCollapsing capability that is an element of T38FaxRateManagement.
Parameter identifier value:	1
Parameter status:	Optional.
Parameter type:	Logical
Supersedes:	-

Parameter name:	t38FaxMaxBuffer
Parameter description:	This is a nonCollapsing capability. This specifies the maximum buffer size.
Parameter identifier value:	3
Parameter status:	Optional.
Parameter type:	unsigned32Max
Supersedes:	-

Parameter name:	t38FaxMaxDatagram
Parameter description:	This is a nonCollapsing capability. This specifies the maximum datagram size.
Parameter identifier value:	4
Parameter status:	Optional.
Parameter type:	unsigned32Max
Supersedes:	-