T.38: Problems related to SIP/SDP Negotiation

While the T.38 protocol, approved by the ITU-T in 1998, was designed to allow fax machines and computer-based fax to carry forward in a transitioning communications infrastructure of both IP- and TDM-based telephony, in 2010 there are still enough problems and confusion among vendors, enterprises, and service providers to significantly slow the use of IP as a real-time fax transport. The cross-vendor issues surrounding IP-based fax in general and the use of T.38 make it difficult for users to determine if T.38 can or will work reliably and thus offer an alternative to traditional TDM-based fax transport. To address these problems and offer solutions, the SIP Forum has chartered the FoIP Task Group (TG).

The charter of the SIP Forum FoIP task group is to investigate ongoing issues with the deployment of fax services, specifically ITU-T T.38, in SIP networks. SIP networks cannot adequately replace analog and digital PSTN in enterprises unless essential services such as fax are accommodated.

This document details a number of SDP offer/answer interoperability issues found while implementing and connecting T.38 compliant endpoints together, primarily over the SIP signaling mechanism. However, many of the issues presented here are not specific to SIP or SDP, but are in fact problems that would occur over any T.38-capable signaling mechanism.

Definitions and References

1. ITU Recommendation T.38 (T38-2007)
   In this document, references to the ITU T.38 Recommendation are specific to the April, 2007 published version.

2. ITU Recommendation T.38 Draft (T38-2009)
   In this document, references to the ITU T.38 Recommendation Draft are specific to the November, 2009 published version.

3. IETF SDP Revised Offer/Answer Capability Negotiation (SDPCapNeg)
   The MMUSIC working group of the IETF has published a series of Internet-Drafts (the current version as of this writing is draft-ietf-mmusic-sdp-capability-negotiation-13.txt) that provide 'potential' and 'latent' capability, and configuration, expression and negotiation over SDP. The T38-2009 draft includes normative references to SDPCapNeg and provides examples of its usage. The task group will support the MMUSIC working group as it moves this draft towards publication as a Proposed Standard RFC.
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4. IETF SDP Media Capability Negotiation (MediaCapNeg)
   The MMUSIC working group of the IETF has published a series of Internet-Drafts (the
current version as of this writing is draft-ietf-mmusic-sdp-media-capabilities-09.txt) that
provide additional media stream capability, and configuration, expression and negotiation
over SDP, using the framework defined in SDPCapNeg. The T38-2009 draft includes
normative references to MediaCapNeg and provides examples of its usage. The task group
will support the MMUSIC working group as it moves this draft towards publication as a
Proposed Standard RFC.

5. Internet Facsimile Transfer (IFT)
   As defined in T38-2007 and T38-2009, the method of transferring facsimile data over the
Internet.

6. Internet Facsimile Protocol (IFP)
   As defined in T38-2007 and T38-2009, the protocol used to implement IFT by carrying
ITU T.30 facsimile protocol signaling and data over an Internet Protocol connection.

7. Party A or Calling Party
   The endpoint that initiated the call in question.

8. Party B or Called Party
   The endpoint that received the call in question.

9. Emitting Gateway
   As defined in T38-2007 and T38-2009, the IFP endpoint which initiates IFT service for a
calling facsimile endpoint. In typical networks, this will be a media gateway or similar device.

10. Receiving Gateway
    As defined in T38-2007 and T38-2009, the IFP endpoint which accepts an IFT service
connection request from an Emitting Gateway and provides IFT service to an answering
facsimile endpoint. In typical networks, this will be a media gateway or similar device.

11. Internet-Aware FAX (IAF)
    A facsimile endpoint that can communicate using the T.38 IFT directly, without the need
of a media gateway. IAFs were first defined in T.38 Amendment 3.

Problems and Recommendations

While the following is not an all-inclusive list, it presents the highest-priority issues as
determined by the Task Group.

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1. Triggering of T.38 switchover

Problems

T38-2007 does not indicate which party (Party A or Party B) is responsible for detecting that a FAX transmission is being attempted and initiating the switch from audio mode to T.38 mode. In practice, this results in some common scenarios:

- A Receiving Gateway may initiate T.38 after detecting CED/ANS tones generated by the Party B endpoint.
- A Receiving Gateway may initiate T.38 after detecting the V.21 HDLC flags (preamble) generated by the party B endpoint.
- A Receiving Gateway may initiate T.38 after detecting CNG tone generated by the Party A Endpoint.
- An Emitting Gateway may initiate T.38 after detecting CNG tone generated by the Party A endpoint.

In some cases, gateways may attempt to detect tones generated by the far endpoint, which may be unreliable if the audio connection between the endpoints is using a highly compressed voice codec.

While it is generally accepted that the Receiving Gateway should initiate the switch to T.38, and it should only do this after detecting the V.21 HDLC flags generated by the endpoint it services (to ensure that the answering device is in fact a facsimile endpoint, and not a data modem or other device that might also generate CED/ANS tones), in practice this is not the case, and actual devices may act in any of the fashions listed above. This can easily result in ‘glare’, where both gateways attempt to switch to T.38 (nearly) simultaneously, or a complete lack of T.38 switchover if the detection method in use is not adequately able to detect the far endpoint’s generated tones. In a ‘glare’ situation, if the gateways do not properly implement backoff procedures as defined in RFC 3261, the call will likely fail.

Recommendations

T38-2009 adds an explicit statement in D.2.2.4.2 (titled 'SIP-controlled state transitioning between voice and facsimile') stating:

Upon detection of facsimile by the receiving gateway, a SIP INVITE request is sent to the emitting gateway (with the same Call-ID as the existing voice connection) for a T.38 facsimile connection.

The task group supports the addition of this statement in T38-2009 as it will resolve this problem for compliant gateways. However, this recommendation only applies to gateways that do not support V.34 FAX, or that are able to determine that the calling FAX endpoint is not offering V.34 FAX. If V.34 FAX is offered by the calling FAX endpoint, the procedures documented in T38-2009 for negotiating V.34 FAX over T.38 should be followed (allowing for fallback to V.17 or other modulations if required), which require the emitting gateway to
send the initial T.38 INVITE so that it can determine whether the receiving gateway supports V.34 FAX as well.

Note that 'detection of facsimile by the receiving gateway' should generally only be achieved by detection of the V.21 flag bits (preamble) generated by the the answering FAX endpoint before it sends NSF/CSI/DIS. The receiving gateway should be able to confirm the presence of the preamble within the first 200 milliseconds of the preamble sequence, and issue the T.38 re-INVITE accordingly.

2. T.38 requested on initial INVITE

Problems

IAF devices and some gateways may send an initial INVITE containing a T.38 media stream offer. In most cases, this media stream will be marked as 'inactive', and will be accompanied by an active audio stream offer. In other cases, no audio stream offer will be present at all (primarily IAF devices). If no audio stream is present, a receiving endpoint may reject the INVITE because it cannot determine whether T.38 will be supported by the session's eventual destination until after some call routing processes have completed.

Recommendations

All endpoints that initiate sessions should include an audio session in their initial offer, even if the audio session must be marked as 'recvonly' because the endpoint will not (or can not) send audio. As per T38-2009, if the endpoint wishes to offer a T.38 media stream in the initial offer, it should do so by including either a 'potential' or 'latent' T.38 configuration (as defined in T38-2009 using the SDPCapNeg and MediaCapNeg procedures). This will allow the receiving endpoint to switch the T.38 media stream to active when it determines that T.38 will be used to handle the session's media stream.

If an initial INVITE is received that contains only a T.38 offer (presumably from an endpoint that is not compliant with the recommendations in T38-2009), the receiver of that INVITE is free to respond with a '488 Not Acceptable Here' if it cannot establish a T.38 session without first establishing an audio session.

3. T.38 session parameters changed during T.30 session

Problems

Some endpoints will send re-INVITE messages containing modified T.38 session parameters in their SDP offer after the endpoints have previously agreed on T.38 session parameters and the T.38 session has begun. If the receiver of this offer accepts it, the implication is that the active T.38 session's parameters will be modified to conform to the new offer, which is unlikely to be possible since the session is already active. If the receiver of the offer rejects it, the sender of the offer is likely to drop the call.
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Recommendations

The task group recommends that endpoints should not send offers containing modified T.38 session parameters after their initial T.38 session offer has been accepted. If an endpoint receives such an offer, it should accept the offer without attempting to modify the parameters of the active T.38 session.

4. Minimum/maximum redundancy IFPs in UDPTL frames

Problems

T38-2007 documents an error correction scheme (referred to as 'error protection') that involves sending redundant copies of previously-transmitted IFP messages in subsequent UDPTL frames. This affords the receiver the opportunity to recover frames lost in transit. Indication of the support of this mode is made by setting the T38FaxUdpEC parameter to 't38UDPRedundancy'. However, T38-2007 makes no recommendation about the number of redundancy messages that should be included in a UDPTL packet, nor does it have any language to take into account the redundancy messages when computing the maximum IFP size that can be transmitted to the receiving endpoint (based on its reported T38FaxMaxBuffer and/or T38FaxMaxDatagram parameters).

Recommendations

In order to more clearly communicate an endpoint's desires for error correction and datagram size management, the task group feels it would be useful to add minimum and maximum thresholds for error protection frames to be included in UDPTL datagrams. A possible implementation would be to add a new T38FaxUdpECDepth parameter definition as follows (in ABNF):

```
Error Correction
  Att-field = T38FaxUdpECDepth
  Att-value = minred [ maxred ]
  minred = 1*(DIGIT)
  maxred = 1*(DIGIT)
```

This would be an optional declarative (non-negotiated) parameter, and if specified, 'minred' indicates that the offerer would prefer to receive at least that many redundancy frames or FEC frames per UDPTL datagram (except for cases at the beginning of the session where there have not been enough frames sent to fulfill the request). Most implementations should have a default value of '1' (one) for 'minred', but allow a configurable override to set it to '0' (zero) if desired.

If 'maxred' is specified, it would indicate that the offerer would prefer not to receive more than that many redundancy frames or FEC frames in any UDPTL datagram.

Note that these are only preferences indicated by the offerer, and that the receiver of the offer is under no obligation to abide by them. Specifically, some gateways will emit larger numbers of redundancy frames or FEC frames for V.21 messages (signaling) than they do for image frames (data), since the image data is frequently already protected using ECM at the T.30 level. If the offerer indicates that they can accept at least one redundancy or FEC...
frame, that indicates explicitly that they have the ability to accept an image frame for that purpose, and since V.21 frames are significantly shorter than image frames, sending a larger number of redundant V.21 frames should not risk overrunning the offerer’s datagram buffers.

In addition, a concern has been raised that it is currently not possible for a T.38 endpoint to indicate to the other endpoint the maximum span over which it is able to compare and verify incoming FEC frames. Some endpoints may have very limited ability to store previously received frames (especially image frames), and if an FEC frame is received that spans more frames than that endpoint has stored, the only action the endpoint can take is to ignore it, which results in ineffective error protection. In order to address this, it would be beneficial for an endpoint to be able to expressly indicate the maximum frame span it is willing and able to preserve for comparison and verification of incoming FEC frames. A possible implementation would be to add the T38FaxFECMaxSpan parameter definition as follows (in ABNF):

```
Error Correction
   Att-field = T38FaxFECMaxSpan
   Att-value = 1*(DIGIT)
```

This would be an optional declarative (non-negotiated) parameter, and much like T38FaxUdpECDepth above, this is only a suggestion from the offerer, and the receiver of the offer is under no obligation to abide by it. However, if the receiver of the offer sends FEC frames that cover a larger span than indicated via this parameter, the offerer is likely to ignore them, which would result in no effective error protection for the session.

5. Suppression of audio during T.38 switchover

**Problems**

When a Receiving Gateway detects that the endpoint it is servicing is attempting to initiate a facsimile connection, and the gateway intends to switch to T.38 to service that connection, it might not suppress the audio stream from the endpoint towards the Emitting Gateway. If the Receiving Gateway does not do so, the endpoints will attempt to negotiate a T.30 facsimile connection over the audio stream while the T.38 session is being established in the signaling path. While the T.38 session negotiation process, under normal circumstances, should occur rapidly enough to prevent the endpoints from exchanging DIS and DCS, if this does not occur in a timely fashion when the T.38 session begins the facsimile connection will have progressed too far to be recovered and it will fail.

**Recommendations**

The task group recommends that when a Receiving Gateway decides to initiate the transition to T.38 for a session, it should suppress audio in both directions for the answering FAX endpoint, until the T.38 transition either succeeds or fails. During this period, the receiving gateway should generate silence towards the Emitting Gateway, and also generate silence towards the answering FAX endpoint, dropping any actual audio that might be received from either device destined for the other device. The suppression must be
initiated before the V.21 flags (preamble) that initiated the T.38 transition ends, or there is a risk that the NSF/CSI/DIS sent by the answering FAX endpoint might leak through to the calling FAX endpoint. If this occurs, the T.30 session could enter a non-recoverable state, and when the T.38 transition is completed, the FAX transaction will fail. As recommended in item 1, the transition should be triggered by the Receiving Gateway no later than 200 milliseconds after the first V.21 flag was detected, so the audio suppression should occur no later than 800 milliseconds after that (less if the Receiving Gateway’s V.21 detector is not aware of exactly when the first flag began). If the Receiving Gateway follows these guidelines, it will be able to assure that no portion of the NSF/CSI/DIS will be transmitted to the Emitting Gateway. If the Receiving Gateway cannot follow these guidelines, it can still choose to suppress the audio bidirectionally, at the risk of causing some calling FAX endpoints to terminate the call or otherwise fail to negotiate properly due to the presence of a partial NSF/CSI/DIS in the audio stream.

6. T.38 Session Parameter: T38FaxVersion

Problems

This parameter appears clear and simple at first sight, but recent discussions show that some people try to read more into this parameter than they should. Some people interpret the version as more of a functionality level indicator, so 3 implies the T.38 device supports V.34. T38-2007 does not appear to support this interpretation, though it offers no clear way for a T.38 device to assess if a remote T.38 device supports V.34 (though T38MaxBitRate may imply it).

Testing if T38FaxVersion is zero vs non-zero is a critically important distinction terminals need to make, otherwise they can’t interpret the ASN.1 they receive. Implementations must support all versions up to the one they advertise as T38FaxVersion. If one side says it supports up to version X, and the other side says it supports up to version Y, when Y > X, the communication will happen both ways in version X mode. That is, the highest version they have in common will be used.

A missing T38FaxVersion field implies version 0, and this appears to achieve natural compatibility with the very oldest implementations.

Even today, version 0 is still by far the most common in use. Most T.38 entities support nothing else.

Recommendations

T38-2009 includes this statement in clause 5:

This Recommendation provides a version number that explicitly defines which syntax and version dependent form of the ASN.1 that is supported. This version number is not meant to imply that a T.38 device will support a given feature or function. Only that it is capable of syntactically parsing the ASN.1 defined in a particular version of ITU-T T.38.

T38-2009 includes these statements in D.2.1.3.1 (titled ‘SDP parameter definitions’):
T38ModemType: Indicates modem capability supported by the endpoint. Valid options are

“t38G3FaxOnly” (0) and
“t38G3AndV34G3” (1).

Note: if not provided the implied value of this parameter is 0.

T38-2009 includes these statements in D.2.3.5 (also titled 'SDP parameter definitions'):

T38ModemType is negotiated. If the parameter is not present in the SIP/SDP negotiation, The Group 3 facsimile only (t38G3FaxOnly) is assumed.

The statements in Annex D were added via a previous contribution from this task group, and the task group agrees that the combination of these three statements suffice to address the problem stated in this section.

7. T.38 Session Parameter: T38MaxBitRate

Problems

This parameter indicates the maximum fax image bit rate supported by the endpoint. This is an odd way to express things, as the endpoints vary by which modem standards they support, rather than which bit rates. However, in practice the following implications seem to work out OK for all known implementations of T.38:

T38MaxBitRate:9600 implies V.29 and V.27ter support.
T38MaxBitRate:14400 implies V.17, V.29 and V.27ter support.
T38MaxBitRate:33600 implies V.34, V.17, V.29 and V.27ter support.

There appears to be some confusion that this parameter has some bandwidth management purpose. T38-2007 doesn't support that. It simply says it is the maximum FAX bit rate. The actual bandwidth in the IP channel may vary greatly, depending on chunk sizes and the level of redundancy/FEC used.

Recommendations

The task group recommends that endpoints should not infer from the T38MaxBitRate parameter any limit or expectation of the bandwidth required for the T.38 session, but rather only the maximum bit rate for image data expressed in the primary IFP messages included in each UDPTL frame.

8. T.38 Session Parameter: T38FaxFillBitRemoval

Problems

This parameter indicates that it is acceptable for the Emitting Gateway to remove all fill bits from a non-ECM image, because the receiving side will reinsert the appropriate minimum amount. This seems clear, though it is seldom supported.
Removing 100% of the fill bits requires deep inspection of the image, but removing >95% is actually a very lightweight processing task, and can save some worthwhile bandwidth for non-ECM calls. The receiving side needs to adjust the fill bits, for flow control and timing synchronization, so reimposing a minimum on a bit stream stripped of fill bits at the same time is a minor additional task.

Recommendations

There seem to be no real issues with this parameter, but wider support would be nice. Due to the requirement for non-ECM facsimile sessions for this function to be performed, the task group recommends that it should only be offered if the endpoint is also offering to accept error correction (via T38FaxUdpEC) or the T.38 stream is being transferred over a guaranteed-delivery transport mechanism (such as TCP). If there is no error protection on the T.38 stream itself, and ECM is not used at the T.30 layer, then the FAX transmission is subject to image corruption whether fill bit removal is employed or not; it is conceivable that fill bit removal may actually reduce the likelihood of corruption occurring (because less image data is being transferred), but use of fill bit removal does not itself make the transmission more likely to be corrupted. The emitting and receiving gateways can declare their support for fill bit removal for all T.38 sessions, but only activate the bit removal functionality when they have determined that the T.30 session is not using ECM. The desire for fill bit removal should not be used to indicate to the FAX endpoints that they should not use ECM when they otherwise would choose to do, unless the T.38 transport in use will provide adequate protection of the image transmission.

In addition, T38-2009 has added an Annex H that attempts to centralize T.38 stream parameter definitions, providing guidance on their interpretations and default values for each 'profile' (transport protocol mode and signaling protocol), but this Annex is not yet complete so the task group cannot determine whether it will address this problem adequately.

9. T.38 Session Parameter: T38FaxTranscodingMMR

Problems

This parameter indicates the ability to transcode MH/MMR from/to a facsimile endpoint to MMR data between the T.38 gateways. It is unclear whether this is supposed to work only for non-ECM transmission, or for non-ECM and ECM. Since most ECM transmission uses T.6 or JBIG encoding, it may not be a big issue, but it isn't properly specified. It is easy to implement this for non-ECM faxing, but it would be impracticable for ECM. This kind of transcoding does have the potential to cut the bandwidth requirement between the T.38 gateways significantly. However, nearly all fax machines are able to do MMR compression these days, so machines that don't use it do so by configuration choice. It is questionable, therefore, whether the T.38 gateways should override such user choices.

Recommendations

Use of this parameter for non-ECM faxing seems clear, and unproblematic. However, the task group recommends clarification in T38-2009 about the ECM issue. Since MMR is not an error-limiting coding, this function should only be offered if the endpoint is also
offering to accept error correction (via T38FaxUdpEC) or the T.38 stream is being transferred over a guaranteed-delivery transport mechanism (such as TCP). T38-2007 contains a similar recommendation in Table B.1 (the H.323 call establishment procedures appendix), but this recommendation should be repeated in Annexes D and E (for SIP and H.248.1, respectively).

In addition, T38-2009 has added an Annex H that attempts to centralize T.38 stream parameter definitions, providing guidance on their interpretations and default values for each ‘profile’ (transport protocol mode and signaling protocol), but this Annex is not yet complete so the task group cannot determine whether it will address this problem adequately.

10. T.38 Session Parameter: T38FaxTranscodingJBIG

Problems

It seems impossible to use the T38FaxTranscodingJBIG option, as T38-2007 specifies it so vaguely. It is supposed to indicate the ability to send JBIG data between T.38 gateways, when the facsimile endpoints connected to those gateways are using some other (presumably poorer) bi-level compression. However, T38-2007 says nothing about how this is supposed to work. JBIG can only be used with guaranteed-delivery transport (such as TCP).

Recommendations

Use of this parameter for non-ECM faxing seems clear, and unproblematic. However, the task group recommends clarification in T38-2009 about the ECM issue. Since JBIG is not an error-tolerant coding, this function should only be offered if the endpoint is also offering to accept error correction (via T38FaxUdpEC) or the T.38 stream is being transferred over a guaranteed-delivery transport mechanism (such as TCP). T38-2007 contains a similar recommendation in Table B.1 (the H.323 call establishment procedures appendix), but this recommendation should be repeated in Annexes D and E (for SIP and H.248.1, respectively).

In addition, T38-2009 has added an Annex H that attempts to centralize T.38 stream parameter definitions, providing guidance on their interpretations and default values for each ‘profile’ (transport protocol mode and signaling protocol), but this Annex is not yet complete so the task group cannot determine whether it will address this problem adequately.

11. T.38 Session Parameter: T38FaxMaxBuffer

Problems

This parameter tells each end how much buffer space the other end has. The values for the two directions are completely independent. However, the exact meaning of "buffer space" is not clarified in T38-2007. Is it received UDPTL/RTP/TPKT packets? Is it IFP messages? Is it the data extracted from IFP messages? Also, the exact playout status of the far end is never known, as it needs to time various things for itself. T38-2007 gives no guidance about the timing of the start of data relative to the carrier start indicators, which makes this buffer issue quite serious. It is never possible to determine exactly how much
might be in the far end's buffer. Therefore, this parameter seems to be of little practical value. Most T.38 implementations advertise only a small buffer, so it is important not to flood them with data, which could overrun such a small buffer. In practice, most implementations just seem to avoid sending anything until its time appears to be due, and hope for the best.

Recommendations
The task group has no particular recommendation for this parameter; it continues to be of limited (or no) utility.

12. T.38 Session Parameter: T38FaxMaxDatagram

Problems
This parameter seems to be interpreted in different ways by different implementations of T.38. It is tied in with the greatest weakness of the T.38 recommendation right now - the lack of adequate chunking and timing guidance. The lack of this gives the designer of the receiving side only a vague idea of what to expect from the sending side, seriously dumbing down what the receiving side can do. It also mightily confuses the designer of the sending side as to what is appropriate to send for maximum compatibility.

T38-2007 table B.1 says:

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.

T38-2007 D.2.1.3.1 says:

The maximum size of the payload within an RTP packet that can be accepted by the remote device.

T38-2007 D.2.3.5 says:

This parameter signals the largest acceptable datagram for the offering endpoint and the answering endpoint (i.e. the maximum size of the RTP payload). The answering endpoint may accept a larger or smaller datagram than the offering endpoint. Each endpoint should be considerate of the maximum datagram size of the opposite endpoint.

What exactly is the RTP payload? Before adding redundancy, or after? What about UDPTL? A transmitted RTP packet can obviously be larger than T38FaxMaxDatagram, as the framing words must be added to the payload. What happens in the case of UDPTL, where the framing and redundancy coalesce? The meaning of T38FaxMaxDatagram appears to depend on the transport type, which is a rather odd design.

In practice it seems some systems treat T38FaxMaxDatagram as the maximum IFP length, and some treat it as the maximum UDPTL length. We infer this, because some systems use a number too small for it to be anything but the maximum IFP length. Either that, or they are not prepared to accept any redundancy/FEC data. The number is also much smaller than the same endpoint is prepared to accept for an RTP packet of audio, which seems to imply its buffers can accept much bigger UDP packets.
The only other real guidance about chunking seems to be in T38-2007 7.5. This says the following, in recent versions of T.38, as a supposed clarification of earlier wording:

*Limitation of V.21 frame packet size*

To reduce the gateway processing delay, the use of smaller V.21 frame data packets is more beneficial for interconnected gateways to flexibly perform jitter buffer adjustment according to the network situation and compatibility of the facsimile terminal.

The maximum V.21 packet size shall be 7 bytes, except for IAF devices. Larger V.21 frames shall be sent in multiple packets.

What does "The maximum V.21 packet size" mean? Presumably packet here refers to an IFP, but is it the total IFP packet that should be <=7 bytes or its V.21 payload? The description seems to imply the total packet length, yet its the payload length we are trying to constrain. T38-2007 7.5 seems to confuse more than clarify.

In practice a lot of ATAs are not happy if the V.21 data IFPs contain more than 1 byte of V.21 data. Most gateways send one byte per frame, and this is reasonably harmless. The annoying (though fully workable) case is sending T.38 from a terminating T.38 entity. Here 100% of the HDLC frame's content is known at the instant frame transmission starts, and the frames are always fairly small. Still, we end up sending a messy and inefficient stream of packets, with one byte of the HDLC frame in each, to maximize compatibility.

**Recommendations**

The task group recommends that in concert with the recommendations for T38FaxUdpEC (supplying minimum/maximum redundancy message thresholds) a new parameter should be clearly defined to be the maximum IFP primary message size the endpoint is prepared to receive. The size would not include any redundancy/FEC data, UDPTL/RTP/TPKT framing, or any other overhead. In combination with a redefined T38FaxMaxBuffer, this would allow a sending endpoint to have a clear understanding of the receiving endpoint's ability to accept packets and deconstruct them to extract the IFP messages they contain (although this would not supply the sender any information as to how many of these IFP messages the receiver may be able to buffer and later play out). A possible implementation would be to add the T38FaxMaxIFP parameter definition as follows (in ABNF):

*Maximum Primary IFP Size*

Att-field = T38FaxMaxIFP
Att-value = 1*(DIGIT)

This would be an optional declarative (non-negotiated) parameter, and is only a suggestion from the offerer; the receiver of the offer is under no obligation to abide by it. If the receiver of the offer chooses to send IFPs larger than the value provided in the offer, they will likely be truncated by the offerer, resulting in retraining and/or retransmissions, which will negatively affect the FAX transaction time.

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The task group also recommends that T38-2009 compliant endpoints assume that a T38FaxMaxDatagram parameter included in a T38-2009 compliant SDP offer (indicated by the presence of the T38FaxMaxIFP parameter) be trusted to be the offering endpoint’s actual maximum datagram size as defined in T38-2009. Offers received without a T38FaxMaxIFP parameter may be from T38-2009 compliant endpoints or endpoints compliant with an earlier T.38 version, or they may be from a non-compliant endpoint as documented above. Such offers should be treated as endpoints currently treat them, as no assumption can be made about the validity of the T38FaxMaxDatagram value included in the offer.

13. Media Stream Configuration after T.38 switchover from audio

Problems
When a call begins as audio and then switches to T.38, the media stream configuration in place after the switchover can vary greatly depending on the endpoint implementations. There are examples in the field of:

1. The call begins with only an audio stream, and after switchover there is only a T.38 stream.
2. The call begins with an audio stream (active) and a T.38 stream (inactive); after switchover, the audio stream is inactive and the T.38 stream is active.
3. The call begins with only an audio stream, but after switchover there are both audio and T.38 streams, with both marked as active. In this case, it is highly unlikely that the endpoint sending such an offer is actually prepared to receive audio and T.38 simultaneously.
4. The call begins with only an audio stream, but after switchover that stream is converted to T.38 and a new audio stream is added to the SDP. While the endpoint may in fact be expecting this to be treated as retaining the existing audio stream (active or inactive), the SDP RFCs define behavior based on the position that the stream appears in the offer or answer, and “moving” the audio stream from the first position to the second position in fact makes it a new (different) stream from the one that was in place prior to the switchover. Receivers of such an offer will likely treat the offer in the way that the offerer intended (retain the existing audio stream, possibly changing its active state, and adding a T.38 stream), but this is only because implementers have learned to do so to increase interoperability, not because the standards mandate, or even suggest, such behavior.

Recommendations
T38-2009 has made extensive use of SDPCapNeg and MediaCapNeg to better define behavior of endpoints when switching between audio and facsimile modes, and includes many session examples and call flow diagrams.

The task group supports these changes and believes they will adequately address the problem stated in this section.