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Paul E. Jones, Ed.
Cisco
Gonzalo Salgueiro, Ed.
Cisco
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Abstract

This memo is published for informational purposes to document the issues identified by the SIP Forum with respect to the transmission of facsimile signaling messages and fax page data over Internet Protocol (IP) networks. Further, it is the intent of this memo to alert the IETF to the formation of a Fax Over IP Task Group within the SIP Forum chartered to investigate and address identified issues as they relate to the deployment of fax services in Session Initiation Protocol (SIP) networks.

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[1.](#) Introduction

While the T.38 protocol [[3](#)], 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 Time Division Multiplexing (TDM)-based telephony, in 2009 there

are enough problems and confusion among vendors, enterprises, and service providers to slow the use of IP as a real-time fax transport significantly.

The 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 Fax over IP (FoIP) Task Group (TG).

The proposed 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 [4] networks. SIP networks cannot adequately replace analog the Public Switched Telephone Network (PSTN) in enterprises unless essential services such as fax are accommodated.

This document details the problems the Task Group has chosen to address. Subsequent documents will make recommendations to the industry to solve the problems. For those problems that cannot be solved, the TG's role will be to describe the problems and recommend best practices to be followed to alleviate them. Many of these real-time IP-fax problems are occurring with increasing frequency due to the maturation of IP telephony within the enterprise and carrier networks.

Today, capex by both enterprises and carriers is largely confined to IP infrastructure, creating demand for SIP trunking and reducing the need for gateways. The absence of gateways and substitution of SIP trunking, then, boosts demand for effective support of fax in access-provider and backbone IP networks. This move to interconnect the enterprise and wide area networks creates new interoperability requirements.

Previously, when IP stopped at the enterprise edge, T.38 interoperability was relatively simple, as it was only required between the Analog Terminal Adapter (ATA) or fax server and the enterprise PSTN gateway. But with direct SIP connections, T.38 interoperability is required between the enterprise and access provider, and between the access and long-haul providers. And all of the links in this chain must provide effective T.38 support. It's the addition of all these "moving parts" that present today's

challenges.

Despite the existence of the necessary standards, 11 years in the case of T.38, the overall experience of the industry in dealing with IP fax is low, exacerbating the problems. This committee's goal is to publish the guidelines (recommended practices) that will reduce the implementation problems that are hindering IP-based fax deployments today.

If, in the judgment of the SIP Forum FoIP Task Group, existing IETF and or ITU standards need to be modified, the Task Group will develop a recommendation to the appropriate Standards Development

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Organization (SDO) on what has been discovered and recommend appropriate action by the SDO to remedy the issue.

[2. Problem Summary](#)

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

[2.1. Network Interconnection and Peering](#)

Effective wide-area transport of IP fax requires that T.38 be supported in all IP networks traversed by a fax session, and that the inter-network signaling be correctly implemented. Yet the information needed by equipment vendors, integrators, and end users is difficult to obtain due to the difficulty of obtaining SIP trunking and peering information from service providers.

It is a goal of the TG to assist interconnection and peering through its recommendations, but carriers and equipment vendors can immediately improve the situation by publishing on the Web all the information needed for T.38 inter-network interoperability.

[2.2. Product Validation](#)

A major issue facing effective IP fax is that many media gateway vendors have simply not had the tools nor focus and desire to test their T.38 implementations thoroughly. Many are satisfied with their implementations based on data that can be misleading since transaction logs, an often-used metric for T.38 effectiveness, do

not necessarily expose errors in the facsimile document.

Several test-equipment vendors offer IP-fax test capability, but enterprise and service provider exposure to fax technology is so light that effective testing is still not understood. This Task Group will publish a set of recommended tests for T.38-capable gateways and fax-servers.

Users should be aware that all media gateways are not created equal when it comes to load and T.38. Few vendors have the ability to perform full load tests for their T.38-capable products. The problem is that fax often requires more compute resources than does Voice over IP (VoIP). For example, while a gateway may be able to process a full DS-3 of voice calls, that same gateway may only be able to handle a few DS-1s of fax before hitting critical CPU utilization levels.

Moreover, the problem can become even more complex since load balancers and routing rules have not been designed or tested for T.38 loads. Often a user learns of the need to load-balance the

T.38 fax traffic differently due to CPU loading issues, but they then find that their load balancer is unable to perform this task reliably.

The Task Group will investigate whether practicable T.38 load-test facilities are available and recommend them to the industry, if available.

[2.3. Interoperability](#)

In a market where vendors are struggling to get T.38 to work, adding the necessary testing to ensure interoperability among the myriad of T.38-capable ATAs and media gateways adds to the challenge. Fax has always been a complex specialized technology. T.30's complexity makes it common to encounter a non-conforming fax terminal. Getting fax machines to send/receive directly and reliably between each other was complicated to start with; now the industry is adding many more "moving parts" in the form of IP-PSTN gateways. And as an emerging technology, there are many unproven gateways, media servers, and IP networks. The validation challenge to vendors and users is daunting. This includes compatibility for a wide range of fax machines due to modem implementations, issues to do with local

loop, T.38 and T.30 implementations.

The Task Group will explore the possibility of a public test facility or a test suite that will validate equipments and networks against the problems defined here.

[2.4.](#) T.38 Performance

T.38 implementations vary as to features, interoperability, and performance. Features are usually quite obvious: Does the implementation support T.38 Version 3 (V3)? Error Correction Mode (ECM)? Does it support User Datagram Protocol Transport Layer (UDPTL), Real-time Transport Protocol (RTP) and Transmission Control Protocol (TCP)? Determining interoperability is more difficult, but can be readily done with T.38-specific test tools and time-in-market of the T.38 implementation. By far the most difficult characteristic to determine is performance.

The FoIP Task Group's objective is to improve the effectiveness of T.38 in supporting real-time fax transport in IP networks using SIP signaling. The Task Group has identified several recurring problems that need to be addressed and that can be divided into several categories:

1. SIP interoperability:

Can the TG promote standardization of T.38-related Session Description protocol (SDP) negotiations?

2. Gateway media-handling strategy:

How does the gateway handle media-specific (voice/fax/data) negotiations, such as V.34 to V.17 step-down? Can the TG help standardize T.38 V3 and V.8 call flows?

3. T.38 interoperability:

No specific T.38 interoperability problems have been identified, but the need for better interoperability testing has been noted.

4. T.38 relay performance:

Many of the problems the TG has identified, such as multi-TDM-hop networks, satellite hops, and packet loss, are related to performance of T.38 relay implementations.

The TG has noted that few equipment vendors and even fewer enterprises and service providers understand the differences between interoperability and performance, and, if they did, doubt they could adequately test performance with the tools available today. The TG has indentified three metrics of T.38 relay performance:

1. The Task Group identified a need to provide guidance on delay tolerance of the relay. Some handle a fraction of a second; some up to five seconds. Packet-delay tolerance is the relay's ability to keep the two T.30 end-point terminals engaged in the transaction in spite of packet delays. T.38 does not give any guidance on how to improve delay tolerance, but, as we know, it is improved through so-called spoofing techniques implemented by skilled T.38 relay developers. Better relays can handle up to five seconds of round-trip delay in the IP path.

2. The Task Group identified multi-TDM-hop delays exacerbated by high gateway latencies. Part of the delay is the result of requirements of the T.38 recommendation. The requirement to suppress High-level Data Link Control (HDLC) framing and Cyclic Redundancy Check (CRC) octets forces a delay of three HDLC payload octets (80ms) into the relay. To this you add IP transmit data buffering of, say, 40ms and Pulse Code Modulation (PCM) buffering. The PCM jitter buffer should be deep enough to accommodate the expected network delay, 160ms being a typical minimum. Performance can be affected by things such as whether the jitter buffer is dynamic, for example by emitting packets immediately if there are no errors.

3. A relay's ability to handle the situation that occurs when packet loss exceeds the redundancy or Forward Error Correction (FEC) settings is also a dimension of performance, not interoperability. How does the relay handle the modem signal when lost packets cannot be recovered? The high-speed modem of the receiving fax terminal will see the error, possibly producing a bad line or lines, depending on the mode. But how does the relay handle the control frames that cannot be recovered in time? What

does the relay do when the V.21-preamble signal is missing? What about a missing V.21 octet? T.38 doesn't say, but the answers will determine whether the session succeeds or fails. This has to do with relay performance, not interoperability.

The FoIP Task Group will recommend tests for T.38 performance.

[2.5.](#) G.711-V.34 Data-V.34 Fax Negotiations

The negotiation and fall-back procedures implemented in network gateways are inconsistent at best, and fail at worst. They may also be disturbed by malfunctioning echo cancellers (see problem 12). The Task Group will recommend best practices to follow and support them with call-flow/use-case examples that enable proper fax, modem and textphone functionality.

The Task Group will operate with the understanding that no recommendation has the unintended consequence of interfering with other media and protocols, e.g. modem and textphone protocols.

[2.6.](#) SDP Negotiations

In general, implementers are inconsistent in their handling of T.38 SDP negotiations. When should a Re-invite to T.38 be accepted? When can and should T.38 capability be declared? Should fax-only T.38 endpoints be able to invite directly to T.38?

These questions will be answered by the Task Group and supported by use cases and call flows. Task Group will recommend the necessary syntax for T.38 to aid in consistent implementations.

[2.7.](#) Tandem Networks

With increased deployment, users are seeing three, four, and five TDM-network segments in a fax call. Once the cumulative delays exceed the T.4 (3 sec. +-15%) timer in the endpoint T.30 terminals, the chance of collision between repeated signals from the calling and called terminals increases significantly. The Task Group will investigate and define the problem and include recommended best practices in its results.

[2.8.](#) Unified-Messaging "single number" faxing is problematic

A standard procedure for one-number voice-fax systems is required. One common problem is a deadlock issue: the Unified Messaging (UM) system answers in voice mode and listens for Calling (CNG) tone to transition to fax. However, a calling fax device may be listening for the Calling Terminal Identification (CED) tone to proceed. If the calling terminal assumes the called entity is a fax terminal, then it can emit CNG tones immediately on answer and enter into fax negotiation. If, however, the answering endpoint does not know if it's a fax or voice call, it must enable a call classifier. However, if the calling device is waiting for the CED or V.21 fax tones to enter fax sending mode the call will not proceed. There are solutions to this problem, however the calling and called party must know which solution is being used and behave accordingly for the call to succeed.

The Task Group will develop best practices for such UM systems.

[2.9](#). Improvements to T.38 Recommendation

Although the TG has identified no specific problems with T.38, if some are made during the operational phase of the TG's work, they will be collected here. It has been suggested that one improvement would be to recommend default settings.

[2.10](#). Position of the TG Regarding T.38, V.152, and G.711 pass-through

A Working Group (WG) will be formed to draft a recommendation to the industry regarding the use of T.38, V.152, and G.711 pass-through in various types of networks. The WG will consider if it should recommend the use of a particular version of T.38.

[2.11](#). Redundancy/FEC/ECM for Further Study

A Working Group will be formed to draft recommendations regarding the use of redundancy, FEC, and ECM in different network scenarios.

[2.12](#). LECs in access and tandem gateways

The effective use of Line Echo Cancellers (LECs) in access and tandem-network gateways is reported to be inconsistent and problematic. The TG will study the question and offer recommendations as to the settings of LECs in order to avoid problems when handling fax calls.

[3. Security Considerations](#)

There are security risks associated with the transmission of facsimile signaling and page data over IP networks, though no security risks are introduced in this memo.

Relating to the IP portion of the communication, the Task Group will explore and recommend security options such as Datagram Transport Layer Security (DTLS) or Secure Real-Time Transport Protocol (SRTP). It is not the Task Group's intention to discuss security issues between the gateway and the terminal.

[4. IANA Considerations](#)

There are no Internet Assigned Numbers Authority (IANA) considerations.

[5. Preliminary Recommendations: The Low-Hanging Fruit](#)

The following are preliminary implementation recommendations for IP fax.

[5.1. V.34 to V.17 Fallback](#)

Carrier deployments of gateways with T.38 V3, which supports V.34, have, thus far, had very limited application. But with the arrival of T.38 V3, carriers must ensure that they correctly handle fallback from V.34. Some carriers do not step down V.34 connections to T.38 with V.17 when fax is detected, but rather attempt to transport the V.34 session with G.711 pass-through. Fax reliability requires that if a V.34 fax session is detected (V.8 with Answer tone, amplitude modulated [ANSam] tone), the non-V3 gateway must Re-INVITE to T.38 and negotiate V.17.

[5.2. Support for ECM in gateways is strongly recommended.](#)

MMR (Modified Modified Read) compression, which significantly reduces bandwidth requirements, requires ECM. So does color fax and V.34. Automated processing of faxes is a requirement in many enterprises that process large volumes of faxes. The value of ECM becomes immediately obvious when deploying automated Intelligent Character Recognition (ICR)/ Optical Character Recognition (OCR) and barcode processing. Chat carriers that deploy gateways that do not support ECM lower the value of their service. But despite this, many IP-backbone providers have based their second-generation infrastructure on gateways that do not currently support ECM. These

carriers must update to any software release for these gateways that supports ECM.

Moreover, ECM also supports quality monitoring. The ECM error count does an excellent job of highlighting line-quality issues. Enterprises should be knowledgeable of these details so they can easily monitor their networks for the quality of service they are receiving.

[6](#). Normative References

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Authors' Addresses

Ximing Michael Chen
LSI Corp.
1110 American Parkway NE
Room 12E-220A
Allentown, PA 18109
USA

Tel: +1 610 712 3596
Email: Michael.Chen@LSI.COM

Mike Coffee
Commetrex Corporation
1225 Northmeadow Pkwy, Ste 120
Roswell, GA 30076

Phone: +1 770 407 6021
Email: mcoffee@commetrex.com

Kevin P. Fleming
Digium, Inc.
445 Jan Davis Drive NW
Huntsville, AL 35806
USA

Phone: +1 256 428 6012
Email: kpffleming@digium.com

Gunnar Hellstrom
Omnitor AB
Renathvagen 2
SE-121 37 Johanneshov
Sweden

Phone: +46 708 204 288
Email: gunnar.hellstrom@omnitor.se

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Paul Jones
Cisco Systems, Inc.
7025 Kit Creek Rd.
Research Triangle Park, NC 27709
USA

Phone: +1 919 476 2048
Email: paulej@packetizer.com

John Lunsford
QualityLogic, Inc.
5401 Tech Circle
Moorpark, CA 93021

Email: jlunsford@qualitylogic.com

Antonios Papageorgiou
Siemens Enterprise Communications
Metaxa 15, 14564
Kato Kifisia, Athens
Greece

Phone: +30 210 8189659

Email: antonios.papageorgiou@siemens-enterprise.com

Gonzalo Salgueiro
Cisco Systems, Inc.
7025 Kit Creek Rd.
Research Triangle Park, NC 27709
USA

Phone: +1 919 392 3266
Email: gsalguei@cisco.com

Ed Schulz
LSI Corporation
1110 American Parkway NE
Room 12C-265
Allentown, PA 18109
USA

Phone: +1 610 712 2068
Email: ed.schulz@lsi.com

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Neil Weldon
Dialogic Corporation
4034 Kingswood Ave.,
Citywest, Saggart, Co. Dublin
Ireland

Phone: +353 1 630 9000
Email: neil.weldon@dialogic.com

