



Brooktrout Technology and Real-Time Fax Over IP

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white paper

Introduction

It is estimated that there are 112 million fax machines in use in the world today with more than 6 million new units sold each year. Despite the rise of email and the Internet, fax continues to be an important means for business communications. One of the main reasons that fax has seen continued growth is its simplicity. Fax machines are easy to use and hence a simple way to receive documents quickly, safely and securely.

Recently, however, as businesses migrate their voice traffic to an IP environment, there also exists a natural inclination to migrate their fax traffic to IP. This whitepaper will review the growing need for real-time fax over IP solutions, the issues associated with implementations of real-time fax over IP, and discusses Brooktrout's strategy for bringing a robust, reliable solution based on the T.38 protocol to market in 2004.

Faxing has traditionally been done in real-time over the Public Switched Telephone Network (PSTN), via the T.30 fax protocol and several modem standards, as defined by the International Telecommunications Union (ITU). The reasons for the popularity of real-time circuit-switched fax include the real-time receipt of a fax, immediate notification that the fax has been successfully sent, and that the receiver gets information on the sender's telephone number and the time the fax was received. These features have become essential parts of the fax experience and have set expectations that will continue to apply for advances in fax communication, including fax over IP.

Why Businesses Need Fax Over IP

One of the most fundamental reasons businesses look to implement real-time fax over IP is the consolidation of voice and data traffic onto a single in-house IP network. As IP environments increase, businesses will have less access to PSTN phone jacks for their fax machines and fax servers. In the most extreme example, a customer installing an all-IP PBX will require a fax over IP solution to integrate their communications infrastructure.

And while a pure IP environment is a fundamental driver for fax over IP, there are a number of issues that need to be considered before implementing a fax over IP solution. For example, the routers used in an existing network need to be checked to ensure they support the T.38 protocol essential to a Fax over IP solution. Many businesses assume they can use their existing network routers to route T.38 fax traffic, but it may not be the case. T.38 support from router vendors is a relatively recent addition, so installed routers may need an upgrade before they can be used.

Also, many businesses expect to realize savings from reduced long distance charges if faxes are sent over the Internet. This may only be true in special circumstances, such as intra-company faxing on a company's internal IP network, where a fax sent over IP not need to also cross a traditional PSTN network. So while there are significant benefits from using a single communications network, savings from reduced long distance charges should be evaluated carefully.

How Real-Time Fax Over IP Works

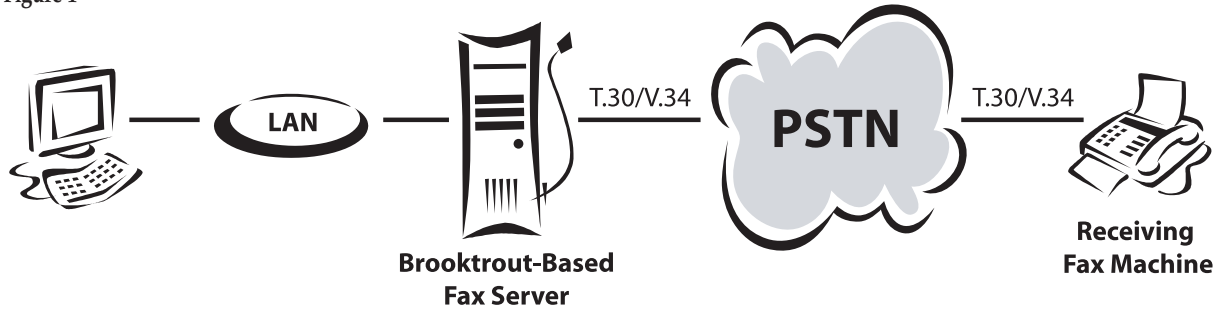
There are two methods for sending faxes over an IP network:

- T.37, which is a "store and forward" approach but not real-time
- T.38, where faxes are sent and received in real-time, the same way as on a PSTN-based fax call

Because of its familiar behavior, most businesses are interested in real-time fax over IP, so the focus of this white paper is on T.38. Let's look at a traditional PSTN based T.30-only fax transmission. Sending a fax this way requires three fax components:

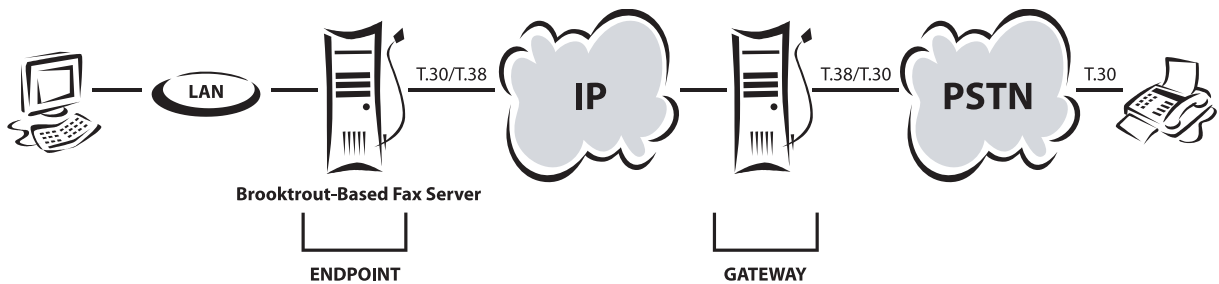
- A **T.30 protocol engine**. While T.30 is a mature technology, an effective T.30 implementation is complex due in large part to the challenge of connecting with the installed base of 120 million fax machines whose own compliance to the standard varies considerably.
- An **image conversion engine**. The sending device must adapt (scale and/or transcode) the image to the capabilities of the receiver. The receiver must check the received file for errors and try to correct ones that occur.
- A **modem** to carry the protocol and image data across the PSTN network.

Figure 1



The functionality of these elements continues to play in IP environments. With T.38, there are two types of devices used to implement, an *endpoint* and a *T.38 gateway*. Here's how they fit in a likely IP fax scenario:

Figure 2



The endpoint uses the T.30 protocol to negotiate the connection and performs the image conversion. The gateway simply passes the fax between a PSTN and IP connection. In endpoint facsimile devices, such as a network fax server, the T.38 protocol provides the equivalent to the modem in traditional faxing. In a gateway, the T.38 protocol is used to translate T.30 protocol and image data from the modems in the gateway to and from the IP endpoint connection.

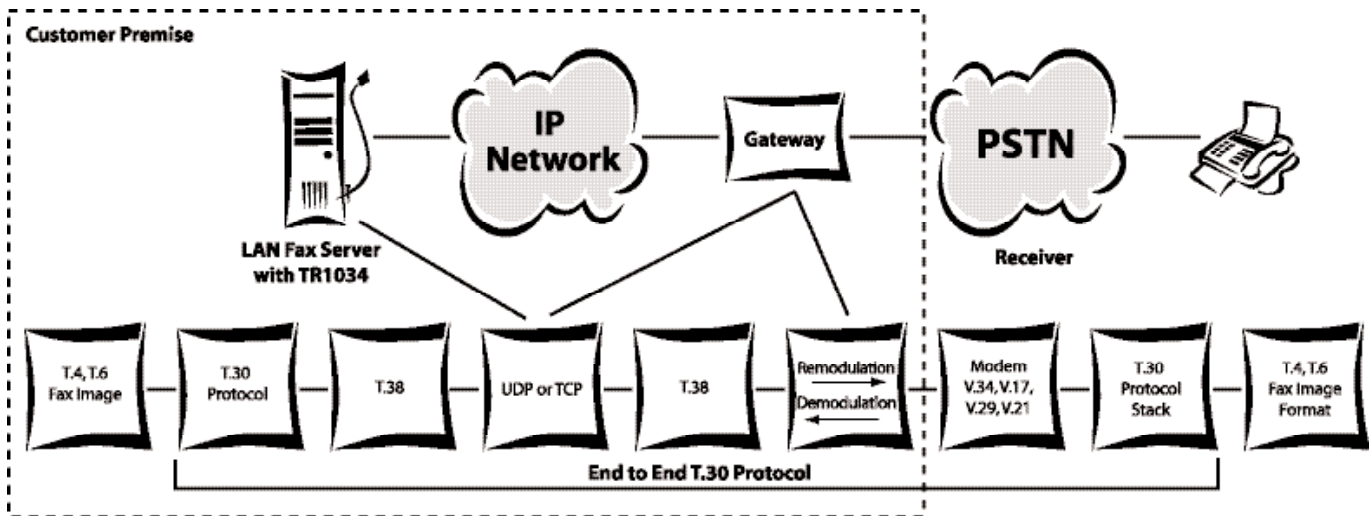
With T.38 in an endpoint, the T.38 fax server is connected to an IP network and transmits the T.30 protocol and fax image data using T.38 packets over the IP network to the receiving gateway. The receiving T.38 gateway, in turn, translates the T.38 packets and repackages them into T.30 protocol signals and transfers them to the receiving fax machine using modem modulation. The receiving fax machine has a T.30 protocol engine that communicates with the T.30 protocol engine in the fax server through the gateway.

With T.38 in a gateway, the sending fax machine sends a fax using modem modulation to transport T.30 protocol and image data to a gateway via the PSTN. The gateway demodulates the incoming T.30 fax signals and image data and repackages them into T.38 packets. The gateway then sends the T.38 packets to a T.38 endpoint, which then delivers the packets in T.30 protocol so the endpoint can receive the fax.

Gateway-to-gateway scenarios are also possible where two fax machines communicate via two gateways. In that case the T.30 protocol engines in the two fax machines are transported across the packet network using T.38.

The diagram below shows how the protocols work together during the call:

Figure 3



In all cases the calls must be established first using an IP call control protocol. The call control protocol is responsible for the initial call set up and tear down. Today's most popular IP call control protocol is SIP (Session Initiation Protocol), although the H.323 protocol is still widely used.

T.30 Remains Key in Real-Time Fax Over IP

As we've seen, no matter whether faxes are sent real-time over the PSTN or over IP, T.30 remains at the heart of fax connection and session management. Even calls between two T.38 endpoint devices require a good T.30 implementation.

A robust T.30 protocol engine is essential for reliable T.38 real-time fax over IP faxing.

A critical issue that is not widely recognized with PSTN-based faxing is that many of the fax machines currently in use around the world only loosely follow the T.30 standard. Some older fax machines may have numerous bugs in the way they respond to T.30 fax signals, particularly during negotiations and training. This can lead to dropped calls and missed faxes. As a result of this, a robust and forgiving T.30 protocol engine is required to compensate for errors that may occur during the negotiation and training phase of T.30. The more forgiving the T.30 protocol engine, the greater the ability to connect to a much higher percentage of fax machines that do not handle network or protocol problems very well. Over time various techniques have been developed for "keeping alive" fax sessions with problematic fax machines, which are referred to as "fax spoofing". In the case of real-time fax over IP, spoofing becomes a function in the gateway, which comes in to play when the T.30 end-to-end protocols start to fall down because of IP network failures such as packet loss and delay.

As a result of more than 10 years experience developing and supporting intelligent fax boards that are deployed in a wide variety of enterprise and service provider environments, Brooktrout has continually refined and enhanced its T.30 implementation to a level that is unsurpassed in the industry and, frankly, is unachievable without this extensive degree of field experience. Brooktrout has invested to adapt to and accommodate fax machines that do not adhere to ITU Fax standards, of which there are many. The result is a robust T.30 implementation that can easily connect and transmit to virtually every fax machine.

What to Consider When Implementing Real-Time Fax Over IP

Real-time fax over IP shows great promise as an effective solution for bringing fax fully into the age of converged networks. Like traditional PSTN-based fax, a successful real-time fax over IP implementation will both follow the standards and be able to operate under less than perfect conditions. A network whose packet loss and delay characteristics can properly support Voice over IP should also prove sufficient for support of real-time Fax over IP. As today's fax solution providers add IP fax support and the quality of the underlying packet network also improves, the transition from traditional PSTN based fax to real time fax over IP should become much smoother. As the move to IP PBXs continues to accelerate, a wide variety of options for bringing real-time fax over IP into the organization without disrupting existing business processes should soon be available.

Nevertheless, there are a number of business issues to consider when deploying real-time fax over IP. The main issue is that real-time fax over IP with T.38 is still relatively new and maturing as a technology and, in addition, may not be uniformly supported by various gateway hardware vendors. This means that there are potentially serious reliability, performance, and scalability issues to consider when deploying an IP based fax server, which need to be weighed against the potential benefits. Some of these key issues that businesses need to take into consideration when implementing a real-time fax over IP based solution are:

- **Interoperability.** Due to the relative immaturity of IP fax as a technology, potential interoperability issues exist in the following three different areas:
 - T.38 implementations. Recent movements in the industry for “T.38 Interop Sessions” support the notion that the technology is still in its early stages.
 - IP call control implementations. Especially for SIP which is evolving quickly and was recently revised.
 - T.30 based fax machines. This is the issue requiring traditional PSTN fax expertise.

Brooktrout's initial focus is ensuring interoperability with the leading gateway vendors today to ensure issues do not exist.

- **Delay.** T.30 interoperability and reliability may also be compromised by the variable and non-deterministic delay characteristics typical of an IP network. Experienced fax vendors have a long history with delay issues on a PSTN network and can utilize this experience to bring reliable solutions to market. For example, within a real-time fax over IP endpoint implementation, such as a fax server containing a Brooktrout intelligent fax board, packetization delay is minimized. This helps to minimize missed fax signals during the critical negotiation phases of the Group 3 fax protocol, where timeouts will occur every three seconds. By contrast, gateway implementations that simply pass through fax signals may not sufficiently account for packet delays, which can result in dropped calls.
- **Security.** Businesses need to consider the possibility of network attack when implementing a real-time fax over IP solution. Neither the T.30 nor T.38 protocols allow for the processing of data or the transmission of data¹. Both protocols only allow for the transfer of T.4 and T.6 fax images. For example, if a malicious packet was sent over IP to a Brooktrout TR1034 series intelligent fax board, the on-board processing will immediately recognize the non-T.38 packet and drop it. If it is not a valid T.30 or T.38 packet, there is no communication path to the network. In addition, security from network attacks is not directly a T.38 issue, but more of a gateway issue for setting up the call control and then the media channels. Brooktrout's real-time fax over IP implementation is designed to work behind firewalls and not go through them, with the expectation being that the gateway to the PSTN is on the LAN and not on the public network. This will negate any network attack threats.

Real-Time Fax Over IP with the TR1034 Series Intelligent Fax Board: Not Your Father's Fax Over IP

Businesses looking to migrate to real time fax over IP need to work with a company that has extensive knowledge in both the traditional PSTN-based faxing, as well as IP fax. Brooktrout Technology has a long history in both real-time PSTN and packet-based fax, beginning in the 1980s with Brooktrout's development of X.38 products, an ITU recommendation defining the transmission of fax over X.25, a wide-area networking protocol.

Brooktrout Technology's co-founder and CTO, David Duehren, is the primary editor and contributing author of the T.38 real-time fax over IP protocol specification, which he began to develop in the mid 1990s. Mr. Duehren incorporated many of the lessons learned from the real-world implementation of X.38 products into the development of T.38.

Brooktrout Technology's product roadmap calls for a real-time fax over IP ready version of the TR1034 to be available in 2004 and a host based implementation by 2005. The TR1034 will be a dual mode intelligent Fax board that supports both PSTN and IP Faxing.

In addition to T.30 and call control provided on the TR1034 series, a valuable feature of Brooktrout's intelligent fax boards is the onboard "image processing", which off-loads a number of processing functions from the host. This onboard processing functionality will be incorporated into Brooktrout's IP products which will further extend the benefit and, since the IP products will use the same programming interface as the PSTN products, provide "transparency" for applications that have been written to use these functions.

The first step toward support of real-time fax over IP is by providing an 'IP-ready' version of Brooktrout's flagship TR1034 T1/E1 PRI product that has an Ethernet connection right on the board. The next step will be T.38 and SIP/H.323 software implementations that are on par with Brooktrout's industry-leading PSTN products. Customers will then be able to upgrade their existing hardware to real-time fax over IP with a simple software upgrade. The 'IP-ready' TR1034 allows customers to run a PSTN fax solution today, and provides investment protection with a painless upgrade path on the same hardware to migrate to IP in the future.

The TR1034 series offers customers both an onboard T1/E1 interface for PSTN-based faxing and an Ethernet interface for IP based faxing. Onboard T.38 support on the TR1034 series of intelligent fax boards provides Brooktrout customers with:

- **Investment Protection:** Purchasing a TR1034 series intelligent fax board today is a safe investment, as customers can continue to use their intelligent fax board regardless if their network fax solution is PSTN or IP based.
- **Migration Path to IP:** Customers can begin by deploying a PSTN-based network fax solution and migrate to IP when their IT environment dictates.
- **Reliable Faxing:** Tried and true reliable faxing from Brooktrout Technology, the market leader in fax platforms.

By offering customers the first intelligent fax board to feature onboard real-time fax over IP fax origination and reception, Brooktrout Technology continues to meet the evolving technology and customer demands of the fax market.

Summary

While current implementations of real-time fax over IP with T.38 may not be ready for serious faxing today, Brooktrout Technology believes the benefits of real-time fax over IP will be significant and that over time, as the technology matures and reliability and security issues are resolved, T.38 will dominate the fax landscape. Brooktrout is working to address many of the deficiencies that exist with T.38 implementations today, and plans to offer industry-leading T.38 solutions in 2004.

