RICOH

Understanding IP Faxing (Fax over IP)

A detailed technical overview of how VoIP technology and IP Faxing (Fax over IP) are changing the way organizations utilize existing network infrastructures for voice and data communications.

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Executive Summary

Today, a rapidly growing number of organizations are including Voice over IP (VoIP) in their total communications strategy. IP Faxing is one of the most important applications of VoIP technology. It has enormous potential to reduce communications costs, especially in large organizations.

With IP Faxing (also known as Fax over IP, or FoIP), the destination for a fax transmission is an IP address, instead of a regular fax number. An IP address, or host name, is the series of numbers that designates a specific device connected to a specific network.

IP Faxing offers a number of advantages. Most important, communication costs can be reduced because an IP Fax can transfer data directly to another IP Fax over the Web or intranet, without using analog phone lines. In other words, the cost of sending a fax is reduced to zero — essentially the same as sending an email. In addition, IP Faxing can achieve extremely high-speed transactions because it operates via Ethernet. With this speed, IP Faxing is suitable for exchanging larger-than-average amounts of data — such as 600 dpi images or 11" x 17" documents. IP Faxing is also very easy to manage from an IT standpoint. Installation is simple, and IP Fax machines can be managed remotely like network printers.

Companies considering IP Faxing have a variety of options when it comes to hardware and network architecture. Make sure to choose a fax provider that clearly understands the specific advantages of IP Faxing and offers a range of cost-effective, IP-enabled fax systems — so you can select the best equipment for your environment and maximize return on investment.

Section 2.0

Introduction

"At the end of 2002, approximately 260,000 U.S. firms (2% percent of all American companies) were using some type of IP telephony. This number should reach 2.2 million (19% of all companies) by 2007."

— In-Stat/MDR, "Technology Adoption Panel"

With the latest improvements in Voice over IP (VoIP) technology, combined with rapid growth in IP telephony offerings, more and more organizations are including VoIP — and related applications, including IP Faxing — in their total communications strategy.

According to In-Stat/MDR, a leading provider of market research for advanced communications equipment, 2% of all U.S. companies used some type of IP telephony in 2002, and this number should grow to 19% within five years, or 2.2 million organizations. The real market opportunity could be even larger, because these estimates include businesses implementing their own IP telephony solutions — not those using IP telephony offerings from third-party service providers.

The primary market driver for VoIP technology is cost savings. VoIP allows organizations to leverage a significant investment in Wide Area Networks (WANs), because it allows them to use the same network infrastructure for both voice and data transmission. Additional savings come from staff reductions, because IP telephony allows companies to combine many of the functions handled by the internal telecom and IT teams.

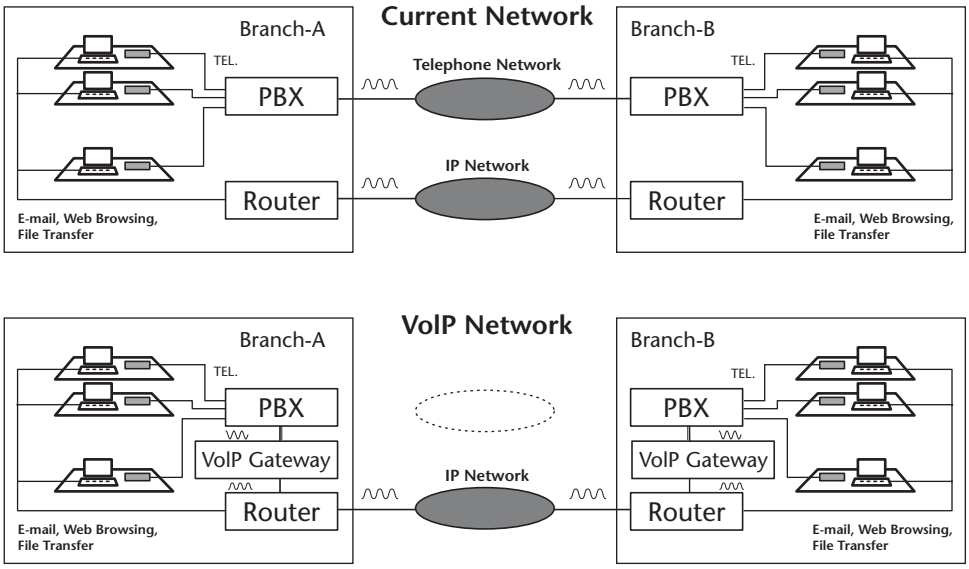
One of the most important applications of VoIP technology is IP Faxing. It has enormous potential to reduce communications costs, especially in large organizations. In this white paper, we will explore how IP Faxing works, discuss its strengths and weaknesses, and examine several different ways to use IP Faxing solutions within existing telecommunications architecture.

Fundamentals of IP Faxing

IP Faxing starts with VoIP, a new technology that transfers voice communications over IP networks by compressing the voice data into IP packets and sending them to a destination designated by an IP address.

Today, many companies use conventional telephone networks (also known as Public Switched Telephone Networks, or PSTN) and IP networks. Typically, telephone networks are dedicated to voice and fax communications, while IP networks are dedicated to communications among servers and PC workstations (file transfer, Web access, email).

VoIP technology — through IP faxing and other applications — allows companies to use a single IP network to serve all of these functions, including fax communications.



How does IP Faxing work?

IP Faxing (also known as Fax over IP, or FoIP) transmits documents in compliance with the T.38 Recommendation of the ITU-T over any IP network.

ITU-T is the International Telecommunication Union, the regulatory organization that establishes worldwide standards for electronic communication technology, including faxing. Recommendation T.38 regulates how to convert fax and image data into packet formats. Prior to the T.38 Recommendation, traditional facsimile systems — also known as ITU-T Group 3 or G3 systems — could communicate only through a conventional dial-up connection via PSTN.

With IP Faxing, the destination for the fax transmission is an IP address, instead of a regular fax number. An IP address, or host name, is the series of numbers that designates a specific device connected to a specific network, usually a TCP/IP network. (TCP is one of two upper protocols to IP. The other is UDP, which is faster but less reliable.)

If the IP network employs a gatekeeper — a device that converts telephone numbers into IP addresses — an alias telephone number can also be used as the destination (instead of an IP address or host name).

Unlike email transmission, IP Faxing does not require a server to route messages. Instead, the IP-enabled fax machine connects directly to another IP-enabled fax machine. This direct connection enables real-time transmission of data and instant confirmation of reception.

IP-enabled fax machines can also transmit fax documents to conventional, non-IP G3 fax machines as well. To do this, they use a VoIP Gateway, which is a device located on the IP network that connects to PSTN.

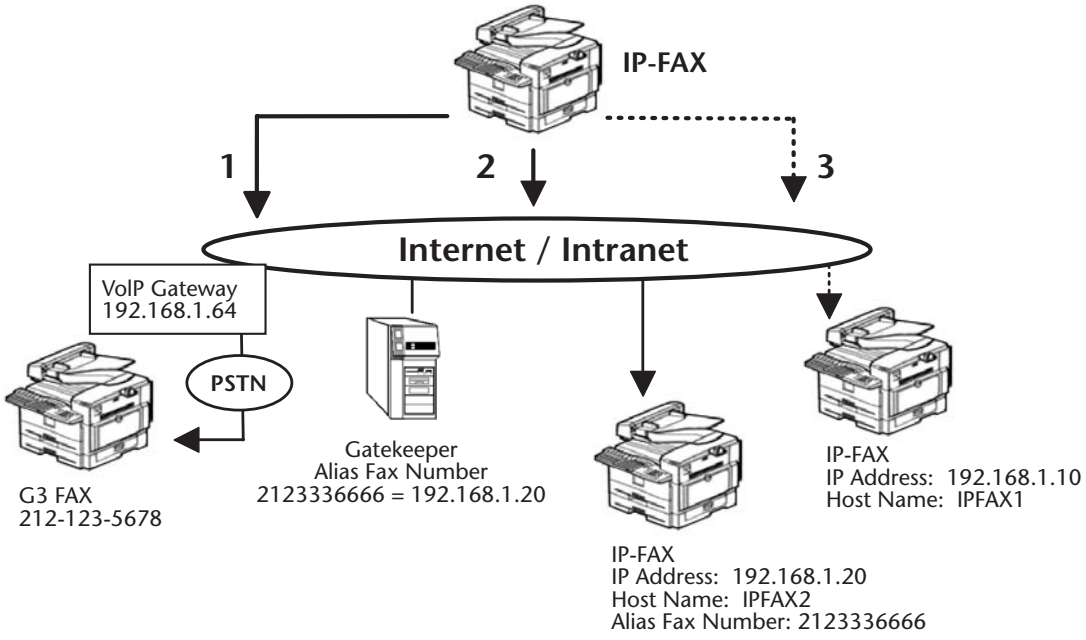
IP Fax transmission

The chart below illustrates three methods of data transmission available with an IP-enabled fax machine connected to the Internet (or an intranet) via an IP network.

In example 1, the IP Fax machine designates the IP address of the VoIP Gateway (192.168.1.64). The gateway receives the packet, "sees" the destination fax number (212-123-5678) and transmits the fax over the PSTN.

In example 2, the IP Fax designates the alias number of the destination fax (2123336666). The gatekeeper device converts the alias to an IP address and delivers the fax document to the correct machine.

In example 3 the IP Fax designates an IP address (192.168.1.10, or the Host Name, IPFAX1) and sends directly to the destination fax.



Advantages of IP Faxing

IP Faxing offers a number of advantages. Most important, communication costs can be reduced because an IP Fax can transfer data directly to another IP Fax over the Web or intranet, without using PSTN. In other words, the cost of sending a fax is reduced to zero — or the same as sending an email.

Another advantage is that IP Fax machines can exchange functional capabilities (such as 11" x 17" output or duplex printing) because they connect directly, just like G3 fax machines. Direct connection also enables instant confirmation of reception (unlike email).

Speed is another benefit. IP Faxing can attain extremely high-speed transactions because it operates over a 10Base-T/100Base-TX LAN. With this speed, IP Faxing is suitable for exchanging larger-than-average amounts of data — such as 600 dpi images or 11" x 17" documents.

IP Faxing is also very easy to manage from an IT standpoint. Installation is easy and requires no configuration of mail server settings. Integration with VoIP system equipment is also trouble-free. Data packets for IP faxing are highly compressed, which helps minimize network traffic. IP Fax machines can be managed remotely, via SNMP or a Web browser application, just like network printers. And these machines offer higher security than email, because the transmitted documents are not stored on a server or exchanged between PCs.

Drawbacks of IP Faxing

There are very few disadvantages to IP Faxing. Under ordinary conditions, an IP Fax machine cannot communicate with another IP Fax machine through a firewall. (Technically, it is possible to do this if necessary ports are opened, but this requires special arrangements to be made with the IT department.) With current technology, it is impossible to send fax documents directly to a PC. Also, IP Faxing is not available for Token Ring Networks. Finally, some normal fax features are unavailable with IP Faxing, such as memory file transfer, batch transmission and batch reception.

Technology comparison

The following chart provides a cross-platform comparison of capabilities among IP Faxing, T.37 Internet Faxing and Scan-to-Email technology.

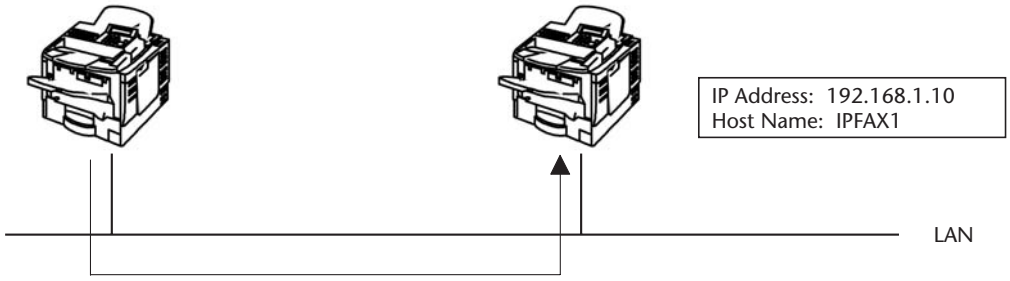
"Exchanging transmission capability during handshaking" refers to the ability of the transmission device and the reception device to exchange information about their capabilities, such as paper size, resolution and compression method.

"Confirmation procedure for transmission" refers to the ability of the transmission device to confirm whether the data were successfully transmitted to the reception device.

Technology	T.38 IP Fax	T.37 Internet Fax	Scan-to-Email
Confirmation procedure for transmission	T.38 provides real-time confirmation of delivery, similar to conventional fax confirmation Confirmation format is consistent Confirmation information is consistent	No confirmation standards for email Receiver Internet fax may respond with confirmation if enabled for T.37 Full Mode Return receipt responses between unlike email systems are inconsistent and frequently not returned Return receipt responses are latent and turnaround time is variable Inconsistent formatting and information contained in audit trial	No confirmation standards for email Return receipt responses between unlike email systems are inconsistent and frequently not returned Return receipt responses are latent and turnaround time is variable Inconsistent formatting and information contained in audit trial
Exchanging transmission capability during handshaking	Sender and receiver identify themselves Sender and receiver agree on protocol rules and capabilities prior to data transfer Sender and receiver agree on document attributes for printing (paper size, resolution, duplex)	Email systems have no facilities for exchanging capabilities or adjusting to instructions by sender Receiver Internet fax (with T.37 Full Mode) may respond with capabilities in a confirmation, which may be used by the sender for future communications	Email systems have no facilities for exchanging capabilities or adjusting to instructions by sender
High-speed transaction	Communicates at the full speed of the IP network Communications are in real time	Communicates at network speed but Store and Forward email technology delays delivery Delivery time is variable	Communicates at network speed but Store and Forward email technology delays delivery Delivery time is variable
Send to second party outside the intranet (firewall)	Requires VoIP gatekeeper	Any compatible email destination	Any compatible email destination
Address	IP address (host name) Alias telephone number	Email address	Email address
Sends to	IP Fax machine	Internet Fax machine Desktop PC	Internet Fax machine Desktop PC
Color transmission	No	No	Yes Desktop PC
Resolution	200 x 100 200 x 200 400 x 400 600 x 600 (with optional memory)	200 x 100 200 x 200	100 x 100 (color) 200 x 100 (b/w) 200 x 200 300 x 300 400 x 400 600 x 600 (with optional memory)
Original size (max.)	Ledger 11" x 17"	Letter	Ledger 11" x 17"
Attached file type	None	TIFF-F	TIFF-F or PDF (monochrome) JPEG or PDF (color)

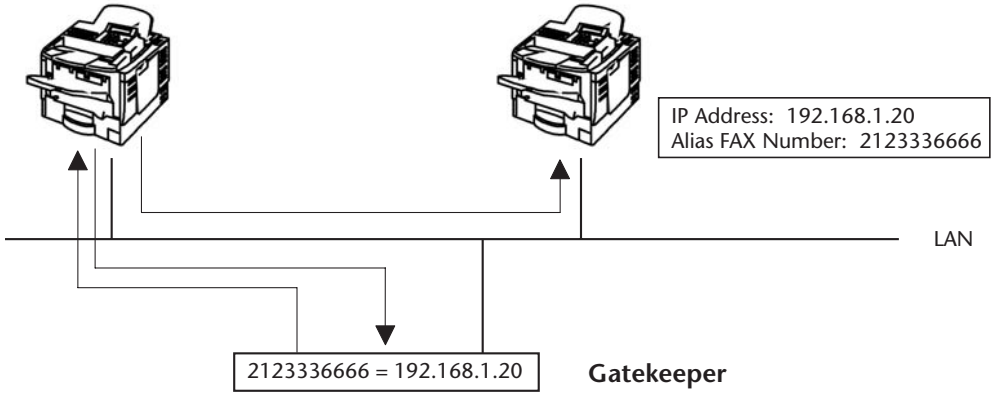
Examples of IP Fax Transmission

IP Fax to IP Fax (Without Gatekeeper)



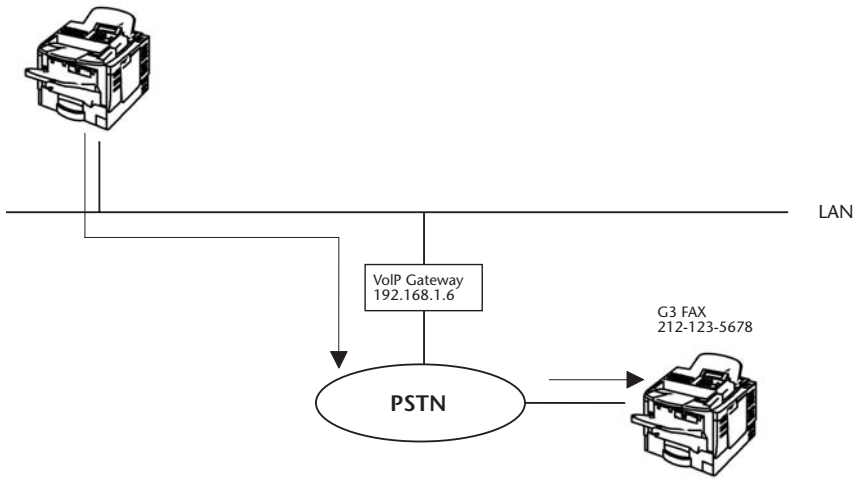
Sender designates an IP address (192.168.1.10) or host name (IPFAX1).

IP Fax to IP Fax (With Gatekeeper)



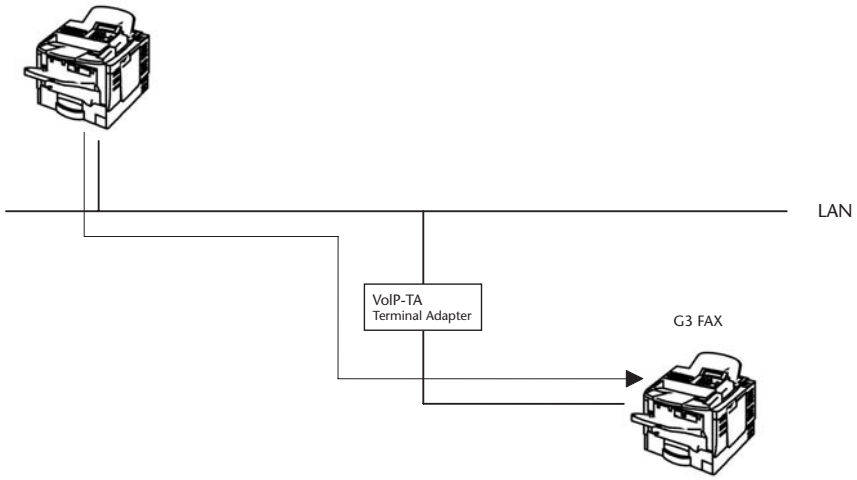
Sender designates an alias fax number of the gatekeeper, then the gatekeeper identifies the IP address for reception.

IP Fax to G3 Fax (via VoIP Gateway)



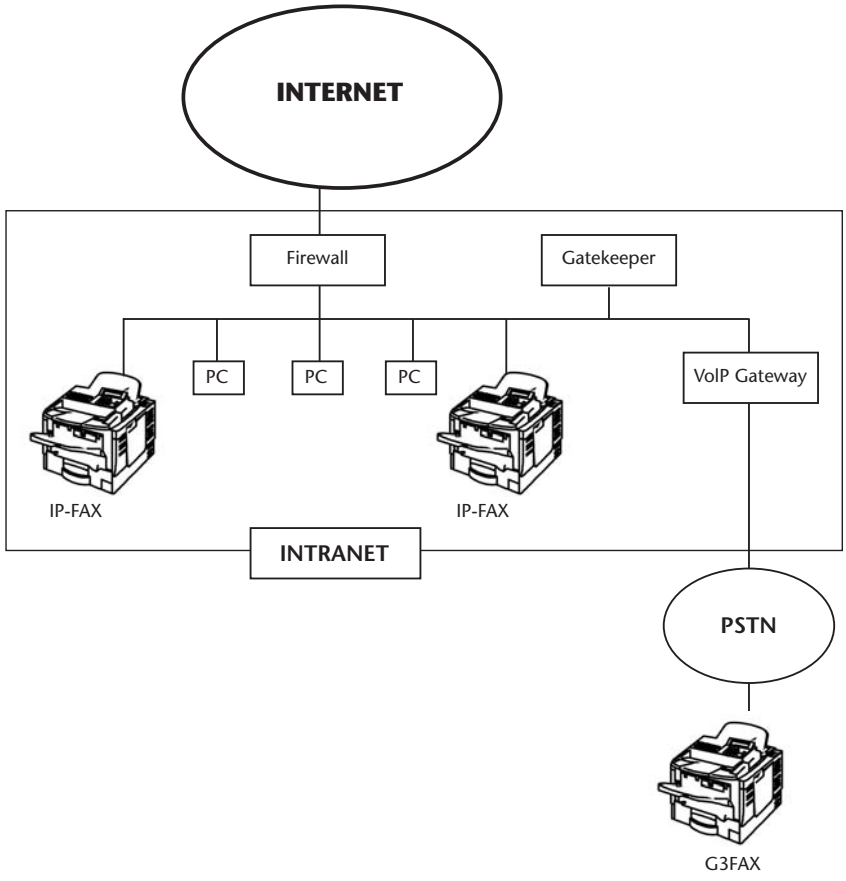
Sender designates fax number for G3 machine, which receives fax over PSTN via VoIP gateway.

IP Fax to G3 Fax (via VoIP-TA)



Sender designates the fax number of the G3 reception device. VoIP-TA stands for Voice over IP Terminal Adapter, a device that connects a G3 fax to the IP network.

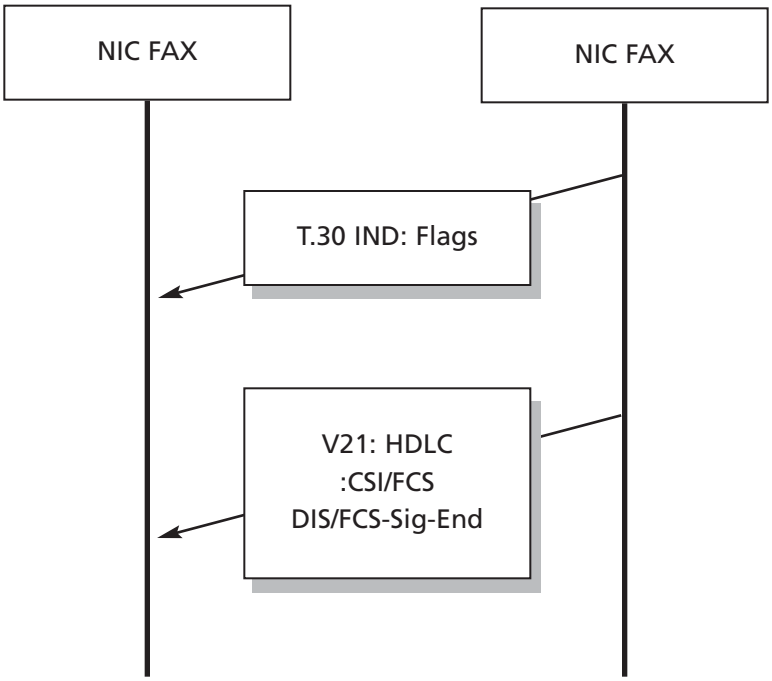
Complete IP Fax Solution



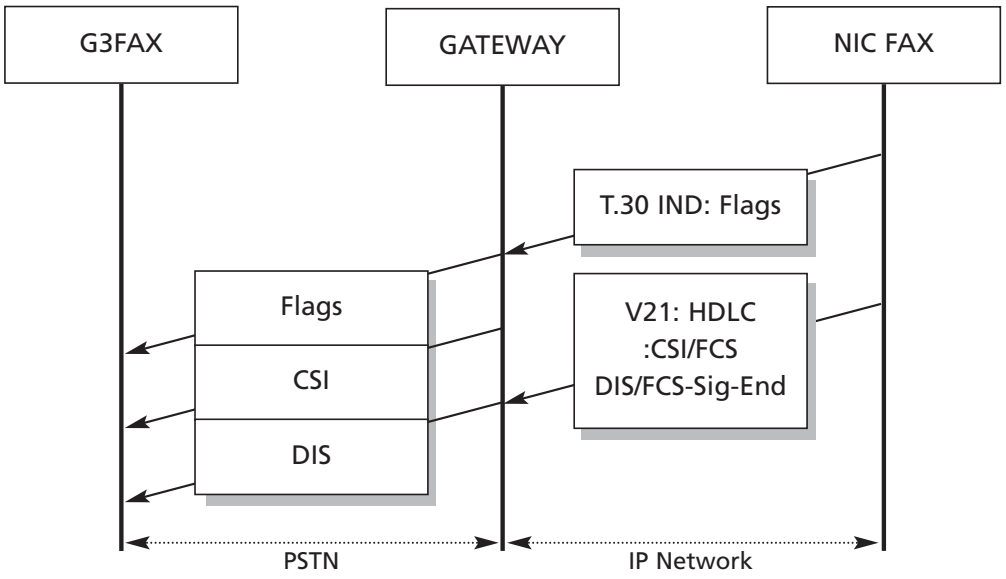
This schematic represents all of the different ways an IP-enabled fax machine can transmit fax data.

The following schematics illustrate various network architectures related to IP Faxing.

Transaction over the Internet/intranet



Transactions between PSTN and intranet



CSI: Called Subscriber Identification

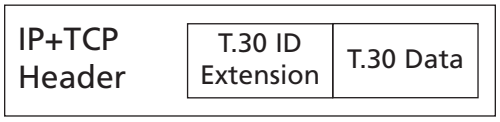
DIS: Digital Identification Signal

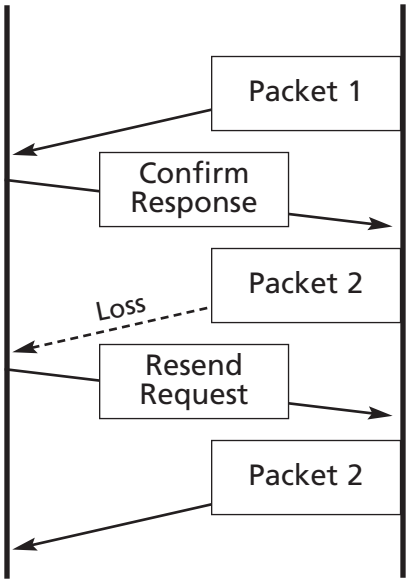
Packet Formats

Fax transmission and reception are conducted with T.38 IFP (Internet Fax Protocol) packet exchange over the Internet. TCP or UDP can be selected for transmission. (Each protocol employs a different packet format.) TCP is the default selection for IP Faxing. Users can change this to UDP by adjusting a CE setting.

TCP packet format

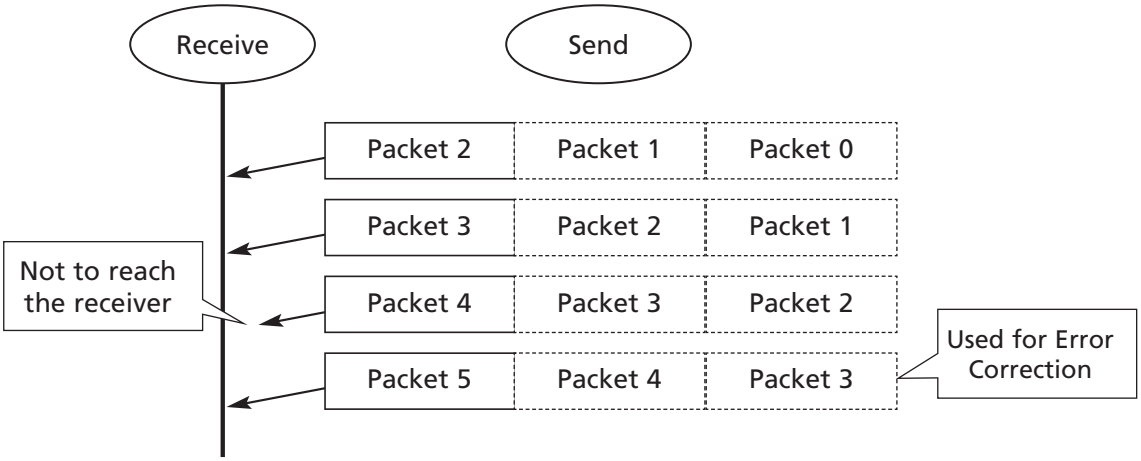
TCP requires more time than UDP because it requires a confirmation response. TCP is more reliable than UDP because TCP always demands an affirmative response and requests a retry in response to an error.



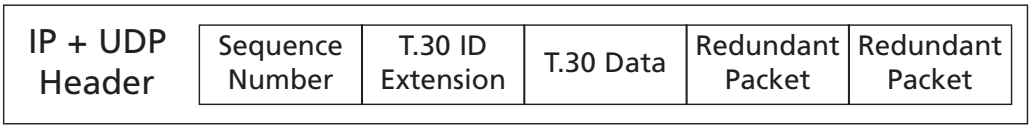


UDP packet format

UDP does not have the handshake overhead of TCP to establish connections, and does not have the same flow control or reliability as TCP. As a general rule, UDP is faster than TCP but slightly less reliable, while TCP is more reliable but slightly slower. The UDP protocol does not correct errors or attempt re-sending. For IP Fax reception, however, speed is automatically reduced to prevent data overflow, making UDP slower.



UDP appends redundant packets to the data packet. With IP Faxing, the redundant packet is affixed to only Phase C and the post message. The number of redundant packets can be changed. (With the CE operation, time margin for T2, T4, T5 for T.30 protocol and the number of redundant packets for UDP can be increased.) However, increasing the number of redundant packets increases the size of the data and slows down the speed of the transmission.



Call Establishment Procedure

Call establishment procedure is done by TCP connection. IP Fax, in stand-by mode, is waiting for the connection on the TCP1720 port, a well-known port of H.323 protocol. (Recommendation H.323 is a procedure to send sound, video, and data using packet format.)

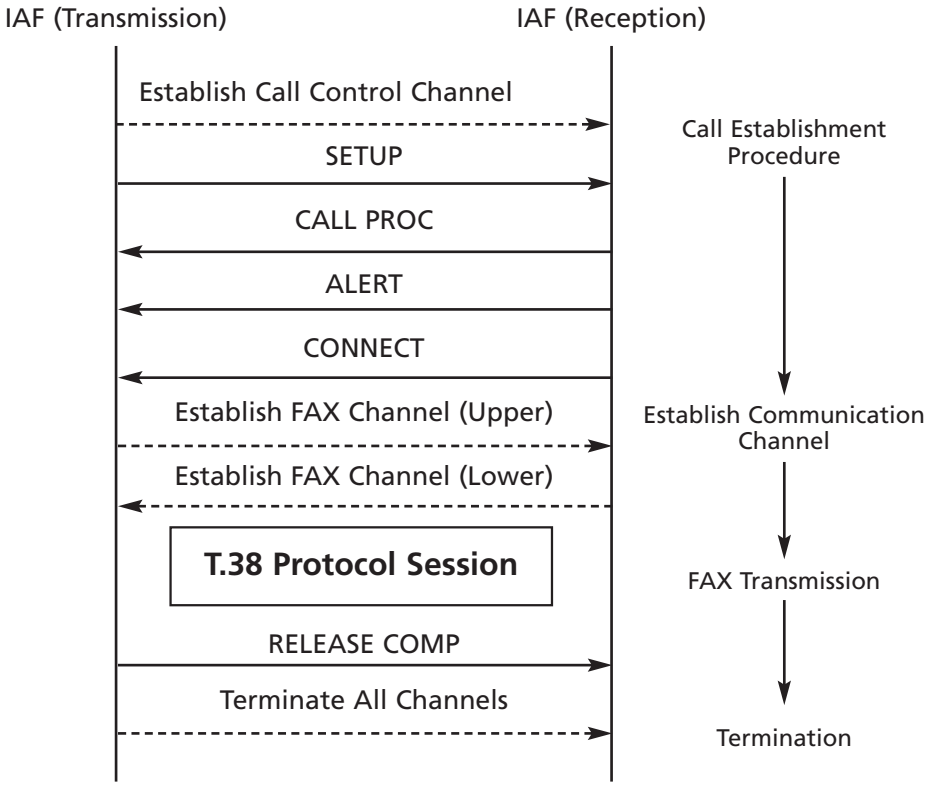
Though TCP connection is continued during T.38 protocol session, it can be aborted at any time by sending RELEASE COMP.

Transport protocol (TCP or UDP) and the port number of T.38 protocol session is determined with SETUP/CONNECT exchange.

When utilizing TCP protocol, two TCP connections are generated after CONNECT, because T.38 protocol requires independent TCP channels for transmission and reception data.

Three (3) ports mode (unidirectional)

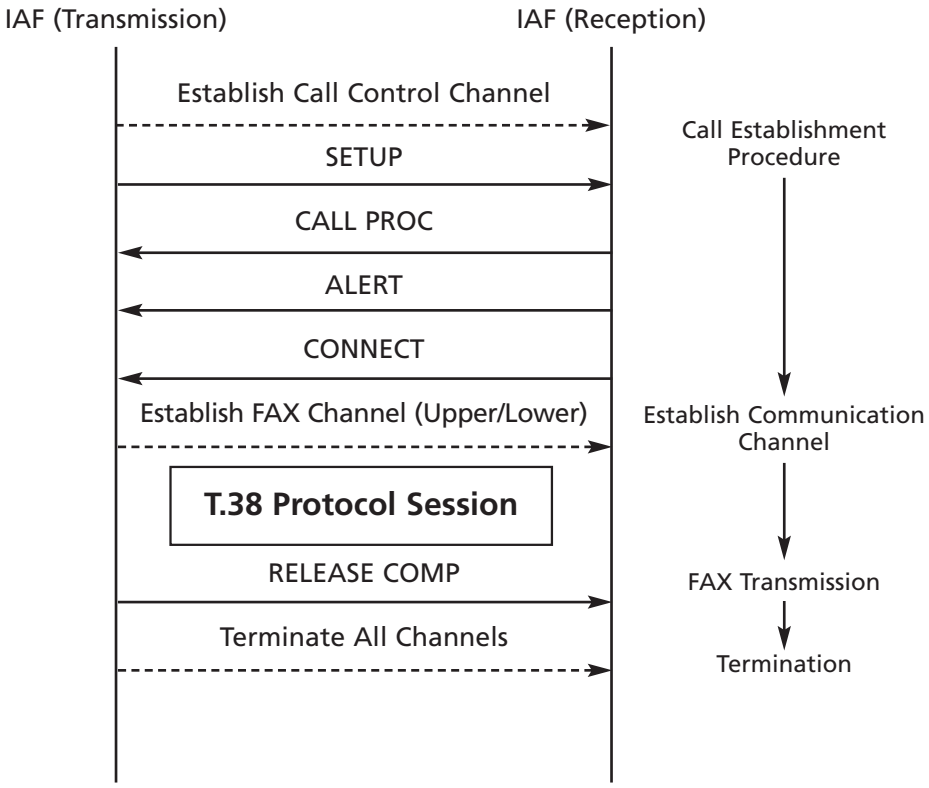
Three (3) ports mode (unidirectional) uses two different channels to exchange fax signals. (DIS and DCS are exchanged through different channels.) Three ports mode (unidirectional) executes T.38 transmission with three ports, such as "call connection," "fax channel (up)," and "fax channel (down)."



Example of call establishment procedure sequence, 3 ports mode (T.38 standard)

Two (2) ports mode (bi-directional)

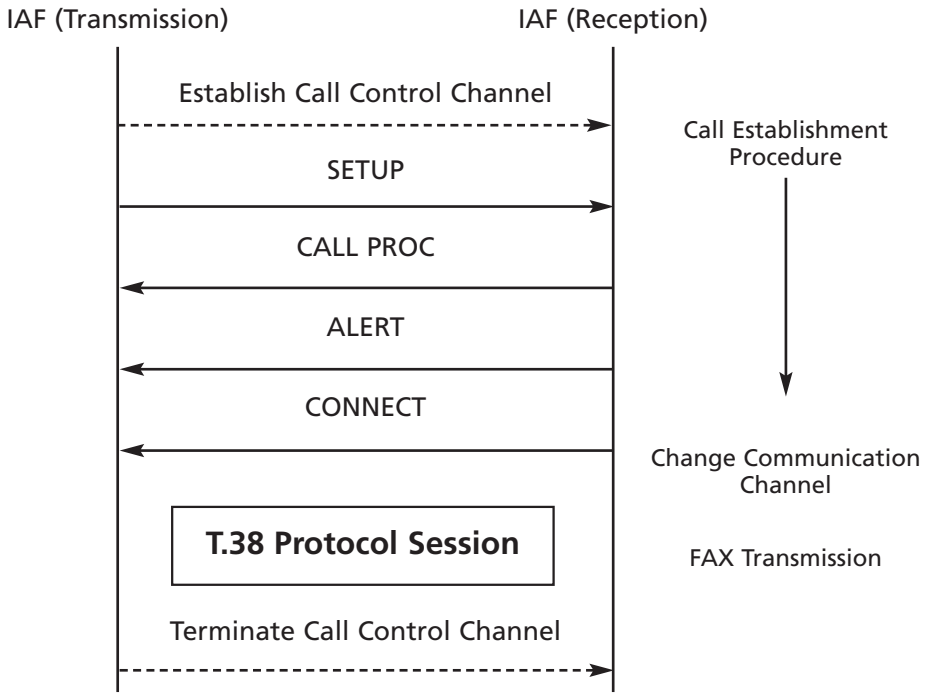
Two (2) ports mode (bi-directional) uses one channel by T.38 recommendation option.



Example of call establishment procedure sequence, 2 ports mode (T.38 Optional)

One (1) port mode (Ricoh original)

One (1) port mode (Ricoh original) exchanges fax signals by utilizing the call control channel. Call control signal cannot be used after T.38 protocol begins, because it is impossible to intermingle fax and call control signals on the same channel.



Example of call establishment procedure sequence, 1 port mode (Ricoh original)

Conclusion

Companies considering IP Faxing have a variety of options when it comes to hardware, network architecture, integration with other document management systems, and service. Make sure to choose a provider that clearly understands the specific advantages of IP Faxing, can provide comprehensive technical support and ongoing maintenance, and offers a range of cost-effective, IP-enabled fax systems — so you can select the best equipment for your environment and maximize return on investment.

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