



How Many Phone Lines Does Your Fax Server Need?

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Executive Summary

One of the most difficult assessments IT buyers must make when buying a fax server is how many fax server phone lines to install. Although some rough industry guidelines exist—anywhere from seven to 25 fax users per phone line—they may be either ill-suited or just too vague to be applied successfully to some specific fax server installations. Ultimately, this becomes a decision that hinges on the specifics of each fax server installation.

Given the potential variances for each installation, the number of lines needed for each fax server should be assessed according to factors specific to each business, department and/or workgroup that the fax server will support. Below are a few questions to consider when determining how many phone lines a particular installation will require:

- How much existing fax traffic will the fax server have to support?
- How much new fax traffic will the existence of a fax server create?
- How much fax traffic must be handled during peak hours and/or the execution of major fax applications, like broadcasts?
- Can fax server features be used to manage peak-hour volumes?
- What kind of fax boards will be used and what are the relative throughput speeds they support—and, to complete this equation, (a) what throughput speeds are supported by the installed base of fax devices to which the fax server will transmit, and (b) what are the page densities of the faxes the fax server will process?
- How much queuing delay is tolerable for outbound faxes?
- Are faxes being received as well as transmitted? If so, how many lines or how much line time is required to effectively handle inbound fax volume?

Although, in most cases, VARs, systems integrators or fax server vendors will analyze the factors at work relative to specific installations and then make their best recommendations, buyers are still advised to understand and scrutinize fax server sizing dynamics to make an informed decision.

Estimating How Much Existing and New Fax Traffic a Fax Server Must Support

A fax server must have capacity to support:

Existing fax traffic that will migrate to the fax server, including how much faxing a business does before it installs the fax server, via PC fax systems and fax machines, that subsequently will be handled through the fax server. Calculating overall existing fax traffic sometimes can be done by analyzing telephone system call-detail records. Lacking that resource, fax traffic levels can be roughly estimated by printing periodic reports at fax machines and then extrapolating load levels. Assessing how much existing fax traffic will migrate to a fax server can be tricky because it depends on (a) how much of the traffic originates as computer files and how much originates as paper, and (b) the computer skills and resources of individual users, with users with strong computer skills more likely to computer-fax more often and those with limited computer skills more likely to continue extensively using fax machines.

New fax traffic, as in fax traffic involving calls that were not made prior to the installation of a fax server. New fax traffic typically increases upon installing fax servers because:

- Many users find that computer-based fax makes it easier and quicker to send 'everyday' faxes, so they send more faxes.
- Fax broadcast traffic often picks up as end users discover that initiating ad hoc fax broadcasts via fax servers is as simple as clicking on multiple recipients in a computer-based address book—and this can lead, for example, to doing a single fax broadcast to six recipients rather than sequentially making six phone calls.
- Businesses often use fax servers to fax-enable one or more relatively high-volume strategic applications (for example, auto faxing purchase orders, financial statements, inventory lists and other regularly generated paper documents that previously had been distributed as physical mail). This can add hundreds or thousands of fax pages to overall daily volumes.

Amounts of new fax traffic obviously can only be estimated, although, relative to automating specific applications, it may at least be possible to extrapolate from existing volumes of document pages already generated for the application, for example, relative to its traditional delivery by physical mail.

Factoring in Peak Hour Requirements

The number of lines a fax server should support may be substantially impacted by strategic needs to meet peak-hour traffic delivery requirements. For example, a financial institution may receive a particular set of information every morning at 10 am—that it must then turn around and transmit in as timely and equitably a fashion as possible to 100 customers. Although the company’s fax server might perform well at all other hours of the day with just four lines, that single 10 am broadcast could create both a need and cost-justification for a server with 16 lines (with 12 lines used to complete the broadcast in just 20 to 30 minutes, while the other 4 lines continue to support normal business-hour fax volume). Meanwhile, if the company tries to handle that same broadcast with just the four lines that would otherwise suffice (assuming that the broadcast would take over two of the four lines), the results would include:

- The broadcast would then last two to three hours, losing its timeliness.
- During those two to three hours, other fax traffic would have access to only two lines instead of four. That could mean (a) that 50% of such ad hoc faxing could get backlogged over that two to three hour period, with those backlogs possibly not working themselves back to levels of tolerable delay until several hours after the two to three hour broadcast finally ends, and/or (b) the fax server could become so highly utilized with outbound traffic that it becomes nearly impossible to receive inbound traffic.

Conversely, however, users can take advantage of the capabilities of fax servers to schedule non-critical faxes and fax broadcasts for after-hours transmission in order to even out hourly traffic loads and enable the same amount of fax traffic to be supported by fewer overall telephone lines.

Transmission Rates and Compression Methods

How quickly faxes are transmitted can vary tremendously depending on the page transmission speeds (for example, 9.6, 14.4 or 33.6 Kbps) supported by both the sending and receiving fax devices involved in a fax phone call. If both fax systems transmit at 33.6 Kbps, pages will be faxed at that speed. If a fax server is equipped with a 33.6 Kbps intelligent fax board, it will fax at 33.6 Kbps with other 33.6 Kbps fax devices (as of 2003, about 33% of corporate fax traffic in the US was transmitting at 33.6 Kbps) or drop down to 14.4 Kbps when faxing to receive-end devices that only support that slower speed. If equipped with only 9.6 Kbps fax modems, fax servers can transmit no faster than 9.6 Kbps, regardless of whether receive-end fax machines can transmit at 33.6 Kbps.

Although not nearly as widely known about or understood as transmission speed, fax compression methods can lengthen or reduce fax phone call times more dramatically than transmission speed. Compression is used to “squeeze down” the amount of data to be faxed prior to transmission; the less data that needs to be faxed, the more quickly the fax phone call can be completed. Virtually all fax machines and computer-based fax systems used today are Group 3 (G/3) devices, which all use the mandatory standard G/3 compression method, Modified Huffman (MH). However, MH compression is less efficient than two other optional G/3 compression methods, known as Modified Read (MR) and Modified Modified Read (MMR). Table 1 below shows fax page transmission times depending on combinations of transmission speed plus the three different compression methods.

Table 1:
Page Throughput By Transmission Speed + Compression Method *(Estimated times to fax a benchmark page)*

	MH	MR	MMR
9.6 Kbps	45 seconds	30 seconds	15 seconds
14.4 Kbps	30 seconds	20 seconds	9 seconds
33.6 Kbps	N/A	N/A	5 seconds

Source: Davidson Consulting, 2003

Fax Board Selection: Running the Numbers

The type of fax board selected for the fax server installation (9.6/14.4/33.6 Kbps, as well as MH, MR or MMR compression) can have a significant effect on the number of phone lines that will need to be ordered. Fax traffic handled by the estimated 125 million fax machines in the US, (as shown in Table 2,) is dominated by MMR fax devices and by MR and/or MMR units, which generated 75% of all 2002 US-based fax traffic.

Using the data in Table 2, you can calculate that a 14.4 Kbps/MH fax server line takes 23 hours to process 500 four-page faxes, whereas the faster compression of a 14.4 Kbps/MMR fax server line only takes 16 and two third hours to process the same amount of faxes (see calculations in Table 3). A 33.6 Kbps/ MMR system can process the faxes at a slightly faster 16 and one third hours. This translates into fewer lines required for a 14.4 Kbps/MMR and 33.6 Kbps/MMR system to support the same amount of traffic as a 16-line 14.4 Kbps/MH system. Typically, today's intelligent fax boards supporting mid-volume or higher systems are 33.6/MMR (or V.34) and 14.4/MMR devices, while most Class 1 and Class 2 fax modems cards are 14.4/MH or 9.6/MR devices.

Intelligent fax boards also offer additional throughput advantages over Class 1 and 2 modems relative to (a) more efficient bit-stuffing and (b) more efficient handling of image-conversion and other associated overhead processing tasks than Class 2 modems.

Table 2:
Page Throughput by Transmission Speed + Compression Method (Estimated times to fax a benchmark page in seconds)

	% of Traffic	Modes and Per-Page Speeds for 14.4/MH Units	Modes and Per-Page Speeds for 14.4/MMR Units	Modes and Per-Page Speeds for 33.6/MMR Units
9.6/MH	11%	9.6/MH 45 Seconds	9.6/MH 45 Seconds	9.6/MH 45 Seconds
9.6/MR	29%	9.6/MH 45 Seconds	9.6/MR 30 Seconds	9.6/MR 30 Seconds
14.4/MH	7%	14.4/MH 30 Seconds	14.4/MH 30 Seconds	14.4/MH 30 Seconds
14.4/MR	10%	14.4/MH 30 Seconds	14.4/MR 20 Seconds	14.4/MR 20 Seconds
14.4/MMR	28%	14.4/MH 30 Seconds	14.4/MMR 9 Seconds	14.4/MMR 9 Seconds
33.6/MMR	15%	14.4/MH 20 Seconds	14.4/MMR 9 Seconds	33.6/MMR 5 Seconds

Source: Davidson Consulting, 2003

Table 3
Volume of 2003 US Fax Traffic Speed + Compression (plus modes supported and seconds-per-page by mode)

	% of Traffic	Modes and Per-Page Speeds for 14.4/MH Units	Modes and Per-Page Speeds for 14.4/MMR Units	Modes and Per-Page Speeds for 33.6/MMR Units
9.6/MH	11%	212 Seconds/Call 11,660 Seconds Total	212 Seconds/Call 11,660 Seconds Total	212 Seconds/Call 11,660 Seconds Total
9.6/MR	29%	212 Seconds/Call 30,740 Seconds Total	152 Seconds/Call 22,040 Seconds Total	152 Seconds/Call 22,040 Seconds Total
14.4/MH	7%	152 Seconds/Call 5,320 Seconds Total	152 Seconds/Call 5,320 Seconds Total	152 Seconds/Call 5,320 Seconds Total
14.4/MR	10%	152 Seconds/Call 7,600 Seconds Total	112 Seconds/Call 5,600 Seconds Total	112 Seconds/Call 5,600 Seconds Total
14.4/MMR	28%	152 Seconds/Call 21,280 Seconds Total	68 Seconds/Call 9,520 Seconds Total	68 Seconds/Call 9,520 Seconds Total
33.6/MMR	15%	112 Seconds/Call 8,400 Seconds Total	68 Seconds/Call 5,100 Seconds Total	52 Seconds/Call 3,900 Seconds Total
TOTALS		85,000 Seconds Total 23.61 Hours Approx./Day	59,240 Seconds Total 16.46 Hours Approx./Day	58,040 Seconds Total 16.12 Hours Approx./Day

Source: Davidson Consulting, 2003

How Much Queuing Delay Is Tolerable?

With outbound faxes, fax servers whose phone lines are already busy handling fax calls can manage additional fax job submissions by storing them in memory (for example, on a hard drive), where they are “queued.” Then, as phone lines become free, the stored faxes are relayed to the fax server’s phone lines for transmission. Due to this kind of capability, it is possible, for example, to have a 2-line fax server support 100 active users. If we assume that each active user submits two 2-minute fax jobs per hour during every hour of an eight-hour day, here’s what happens:

- At the end of the first hour, assuming 120 minutes of faxes have been processed (60 minutes times 2 lines), 80 minutes of the total of 200 minutes of fax jobs submitted will still be queued up. A fax job initiated right at the end of the first hour, then, won’t actually be transmitted until after 40 minutes has passed, because the fax server will have to work through the 80 minutes of queued jobs first, which it will do in 40 minutes due to its two phone lines.
- Each successive hour throughout the day, the length of queue delays will double. At the end of two hours, the delay will be 80 minutes; after three hours, a two-hour delay will exist. At the end of eight hours, a 5-hour-and-20-minute delay will exist. And, about 5 hours and 20 minutes after closing time, the last of the queued faxes would finally be delivered.

There are situations where it is acceptable for faxes to be delivered after considerable delays (for example, where next-day delivery suffices). If the fax server is installed in a region, such as in an underdeveloped country, where phone lines are very expensive to install or it may require months or even years to get additional phone lines installed, then it may be understandable for a fax server to be equipped with so few phone lines relative to its traffic volume. But Davidson Consulting, while recognizing that such situations can be understandable, does not ever recommend under-powering fax servers in this manner. Here’s why:

- Faxes often involve documents that drive business transactions; delaying faxes risks losing business represented by those transactional documents.

- Delayed faxes can interrupt the work processes of a company's own workforce, lowering worker productivity by repeatedly causing workflow to be disjointed and high numbers of tasks to be pending for longer than necessary periods of time.
- Delayed fax deliveries can create negative impressions in the minds of business partners.

Special Considerations Relative to Receiving Faxes

Some fax servers are used predominately or totally to send outbound faxes; assessing the number of lines they need simply involves figuring out how many lines are necessary to handle peak-hour traffic and to maintain queue delays within tolerable limits. Having outbound-only fax server phone lines highly utilized most of the time is a goal, not a problem.

When fax servers also receive faxes, the situation changes. Fax lines cannot be highly utilized for outbound faxing and be ready to receive faxes. It's one or the other:

- If a fax line is busy 75% of the time, most inbound fax calls will initially receive busy signals and unacceptably high numbers of calls—more than one-third—will not be received, even if they automatically redial three times.
- In order for fax server phone lines to be ready to receive faxes, they cannot be busy almost all the time or even most of the time. A single fax server line used for reception should be free to receive calls more than half the time during all fax-reception time periods.

With multi-line fax servers, important considerations include:

- That adequate percentages of lines (for example, 25%–50%) be free to receive faxes at any given time.
- In many cases, to prevent outbound fax broadcasts and the like from monopolizing all of a fax server's phone lines, it can make sense to dedicate some lines solely to receiving faxes. For one, this allows the company to fine-tune queue delays on outbound faxes without diminishing the ability to receive faxes efficiently. On the other hand, the overall efficiency with which a fax server can expedite the sum total of all fax calls passing through it is greater when most or all lines can be used for both sending and receiving.

It is strongly recommended that all but the very lowest-volume fax servers, when used to receive as well as send faxes, be equipped with at least two lines so faxes can be received even while others are being transmitted outbound.

Direct Inward Dialing (DID), which is the most widely used form of automated inbound routing (whereby faxes received at a fax server are automatically routed to LAN-based inboxes of individual recipients), creates an additional consideration because DID lines are receive-only.

Consequences of Too Many or Too Few Phone Lines

Although line capacity can be managed and optimized after the initial implementation of a fax server, a business may pay a price for installing too many or too few fax server phone lines. If too few lines are installed, typical results include:

- Outbound message delivery is delayed by many minutes or hours, potentially disrupting, delaying or even occasionally undermining certain business endeavors. For instance, although a delivery delay of 45 minutes for an accounting report being faxed to a regional office usually is insignificant, if the same delay occurs when faxing back an approval for a retail credit request or loan application, the delay itself can cause a loss of business.
- Inbound faxes frequently may be blocked if all lines are often busy—which may usually cause relatively trivial delays, but in worst-case scenarios, for example, can completely block the reception of sales orders, with the result that senders of those sales orders eventually fax them to competitors instead of the company with the overloaded fax server.
- If a fax server is generally heavily loaded, it may become problematic to execute business-hour fax broadcasts, creating a lost opportunity in which potential time and money savings go by the wayside.
- The ability to fax something immediately, such as when called with an urgent information request, may become unpredictable at best, and impossible at worst. A business can project a negative image to customers by being unable to fax information quickly. For example, the airline that can only promise that faxes containing ticket-less flight information will arrive within 24 hours may lose business with frequent flyers that often buy same-day and next-day tickets (or may just create a subtle level of mistrust in such frequent flyers that, down the road, may feed into their being quicker to decide to switch their allegiance to another airline).

- As it becomes clear that additional lines are needed, businesses must install new lines, which means additional installation costs, and often significantly impacts normal business operations during the time the fax server is being upgraded.

If too many lines are installed, typical results include:

- Extra and at least temporarily unnecessary expense for fax card ports—if only for any that are greatly underutilized. Generally, though, computer fax-enabling workers allows them to fax more documents (for example, instead of mail documents or making time-consuming voice calls—or just not communicating the information at all), and having “too much” capacity initially often translates into having enough capacity to grow into as traffic volume rises over time.
- Similarly, in cases where telephone lines are installed directly to a fax server (as opposed to through a PBX relative to shared lines)—and no one figures out to cancel the service for currently unnecessary and extra lines—unnecessarily high and ongoing payments will be disbursed to one's phone company.
- In terms of the effect on fax server performance—well, performance should be terrific, with both outbound and inbound fax calls handled in extremely timely fashion.

Moreover, it is important to understand that initially having extra capacity can make sense because it supports the virtually inevitable growth in fax traffic that occurs with computer-based fax implementations. In fact, there is clearly a market trend whereby businesses, upon calculating that their traffic volumes can be handled satisfactorily by four ports, are instead installing eight-port cards precisely to give themselves room to grow. Finally, relative to having extra capacity to grow into, buyers should remember not only that installing up to twice actual current capacity levels can have value, but that in most situations, any fax server should be scalable to support up to ten times its original actual line requirements. In other words, if it absolutely needs four lines (but you install eight for room to grow in the near-term), the fax server should also support future expansion, whether on one or multiple servers, to support up a minimum of 40 lines (for example, ten times the original four-line volume level).

Conclusion: Making the Decision

Although some rough industry averages exist as to how many fax server users can effectively share a line, optimal ratios of users to lines varies widely according to numerous site-specific factors such as how many pages of fax traffic users generate, peak-hour traffic volumes, fax board efficiency, acceptable levels of queue delay, whether inbound as well as outbound fax traffic is supported, and how much new fax traffic the existence of a fax server will create.

Too few lines can result in delayed communications and lost opportunities and lost sales due to inbound faxes that never reach an open line. Too many lines may cause businesses to incur some unnecessary expenditures, but having ample capacity ensures timely transmissions and provides room to grow as fax traffic volumes increase.

The real task of determining fax server line capacity needs comes down not only to identifying or estimating current fax traffic levels, but also estimating what percentage of that traffic will move to the fax server. In addition, consideration must be given to:

- How much new traffic will emerge.
- What critical peak-hour volumes must be supported.
- How much business-hour fax traffic can be shifted to after-hours delivery through delayed-transmission commands.
- How long it takes, on average, to transmit faxes, which in large part depends on fax board capabilities and the type of installed machines to which you send and receive faxes.
- How much queuing delay is tolerable because, with outbound faxes, fax servers can store transmissions in long queues, eventually faxing out all jobs, but potentially causing delays up to many hours long relative to delivering most or all faxes.
- Whether special factors relating to inbound faxes should be considered, including the fact that adequate percentages of lines (for example, 25%–50%) should be free to receive faxes at any given time.

Businesses must understand that situations arise where even well-intentioned sizing estimates miss the mark and post-installation adjustments must be made. However, if close attention is paid to the factors discussed above, most businesses will be able to select the optimal amount of phone lines for their fax server needs.



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