Guide to Intelligent Least-Cost Routing

Award-Winning Fax Server Technology
from RightFAX, Inc.

RightFAX®

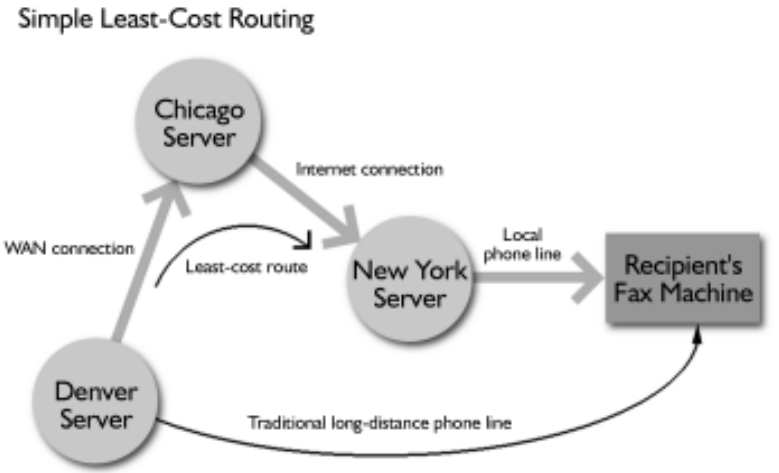
Introduction

All organizations want a fax server that saves them money. Least-cost routing (LCR) is the tool that accomplishes this end. It's no secret that least-cost routing is the computer-based fax industry's hottest technology, but not all fax servers offer the same LCR benefits.

This guide describes the features and functionality of least-cost routing technology as offered by RightFAX and other fax server developers. Designed for network administrators and other information systems professionals, this guide will provide the information you need to make an intelligent decision when purchasing a fax server for the enterprise.

What is Least-Cost Routing?

Least-cost routing is technology that routes data by the least expensive path. In the fax industry, this defines the process of routing faxes among fax servers on a network. The goal is to save money by reducing traffic over public phone lines wherever possible. By using an organization's Internet or existing intranet connections, faxes can be routed to the server closest to the fax destination, potentially reducing a fax from a long-distance to a local call.



As demonstrated in the diagram above, the server determines the route a fax will take. But fax servers don't actually "make" decisions based on price structures or tariff algorithms. The fax administrator creates rules that appropriately reflect a company's faxing habits and phone carrier rates.

Intelligent LCR vs. Simple LCR

LCR tests the limitations of most fax servers. Administrators should be able to create routing rules that match the number dialed by the user, and take into account time of day, fax priority, server availability and server work load. Routing rules should be flexible enough that the administrator need not create individual rules for every combination of numbers. Administrators also need tools, preferably intuitive ones, that help manage and troubleshoot complex systems.

Users want a fax to arrive at its destination in a timely manner. They do not care how it gets there nor whether LCR rules are involved in its transmission. LCR should be transparent to users, and they should not have to do anything to initiate its action.

Fax servers with simple LCR systems cannot fulfill these administrator/user needs. **Intelligent Least-Cost Routing™** from RightFAX can and does.

Why Do You Need Intelligent LCR?

If your business is like most, you send a combination of intrastate, interstate and international faxes. According to a Gallup estimate, the average Fortune 500 Company spends 40% of its long-distance telephone bill, or $15 million per year, on fax calls. Your organization's phone bills probably reflect proportionately heavy expenditures. Because telephone companies specialize in many types of services, you're not likely to find any one carrier with consistently low rates in every market. An east coast-based, long-distance company may offer competitive intrastate rates in New York but higher rates on calls between New York and Washington, D.C. That same carrier might offer competitive rates to England and France but higher rates to Japan. Searching for and keeping track of the best value requires effort, but that information, when used in conjunction with even simple LCR systems, can pay high dividends. When you're sending many faxes daily, saving only a few cents per page adds up to a significantly lower phone bill.

The basic features of LCR include:

- reduction of long-distance charges
- use of the Internet instead of the public switched telephone network (PSTN)
- full preservation of sending options (cover sheets, rules, billing codes)
- transparency to users – no need to adjust the way fax numbers are entered

Intelligent LCR from RightFAX, Inc. extends the functionality of basic LCR systems, offering more sophisticated features and options for even greater returns. In addition to cost savings, you can leverage the power of multiple servers on your network, increasing server efficiency by sharing resources and work loads. Instead of investing in a 24-channel server at every site in your organization to ensure you have enough power at peak times, you can purchase more fax channels for sites that are busier and fewer for sites typically less busy. When you need extra bandwidth, you can distribute faxes to an available server. With this arrangement, servers are more productive with less overhead invested. Only RightFAX fax servers offer these Intelligent LCR benefits:

- capacity sharing (load balancing)
- dynamic capacity tuning
- priority, time and day restrictions
- cascading route combinations
- integration with service bureaus (enhanced fax service providers)
- automatic error recognition and immediate re-routing
- centralized management and testing tools

With Intelligent LCR, management sees a dramatic reduction in long-distance charges. Administrators enjoy intuitive management features. Users continue faxing the way they always did because nothing on the client side changes. And Intelligent LCR pays for itself in just a few short months.

How Does Intelligent LCR work?

Intelligent LCR consists of dialing plans, testing tools and management utilities. Each is described in detail below.

Dialing Plans

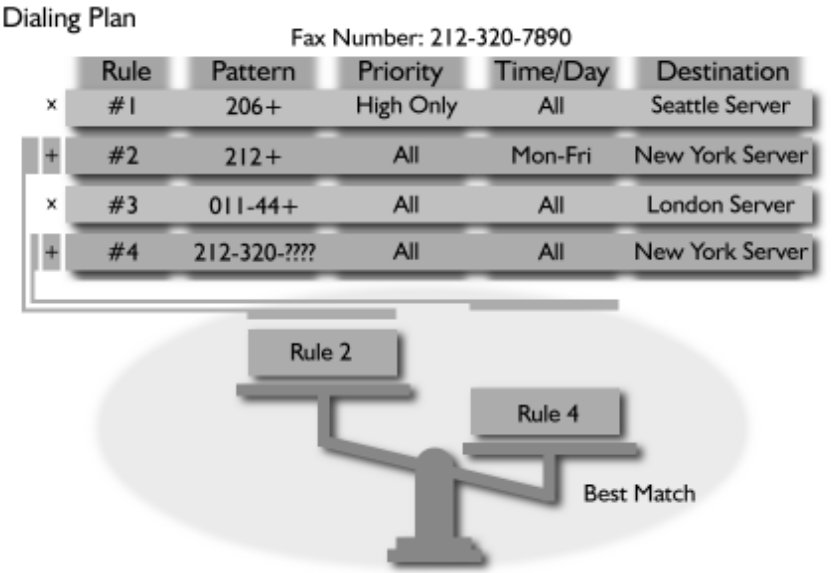
Dialing plans let the fax server make sophisticated decisions about a fax's destination, based on the phone number, time of day, day of week, fax priority and fax source. The dialing plan is a key component in fax server technology and is useful even on single fax server installations.

A fax server's dialing plan is made up of several dialing rules. Most fax servers compare the fax number entered to the list of dialing rules and stop when they find the first match. This first match may or may not be the best match, so the fax may be routed inefficiently. Because a restrictive dialing plan allows only one rule to match a number, the administrator faces the difficult task of creating individual rules to match every possible scenario for each number.

Using defined rules set by the administrator, the server evaluates each fax number entered by users on a network. Intelligent LCR saves the administrator from trying to anticipate every combination entered by users. After comparing the fax number and conditions (time, day, priority) to each rule, a "weight" or measurement is assigned by the server. A number can match more than one rule at a time. The more closely the number matches a rule, the higher the weighted value the rule is assigned. The fax server employs the rule with the highest weight to send the fax.

Example:

Company XYZ creates dialing rules as described in the diagram below.



On Tuesday, user Bob sends a high-priority fax to 212-320-7890. The fax number is compared among the four dialing rules and matches both Rule #2 and #4. Rule #2 matches any number that begins with 212, sent between Monday and Friday. Rule #4 matches any 10-digit number that begins with 212-320. Because Rule #4 is more specific (matching the actual number of digits in the fax number), it is the best match. Using Rule #4, the fax server routes the fax to the New York server.

Pattern Matching

While other fax servers' simple LCR systems may allow simple pattern matching of phone numbers, Intelligent LCR permits complex pattern matching. For example, a product may allow only a single match — every wild card character (e.g. 415+). Intelligent LCR has four different wild cards as shown below, which permits ultimate flexibility (e.g. 415+, 415???????, 6?5+, ~415+, ????? and more).

Wildcard	Definition	Examples
+	Matches zero or more digits; must always appear at the end of number string; this character is the assumed default and is recommended to be sent to the local server.	+ = matches any fax number entered, including 320-7000, 100, and 011-44-75653442. 415+ = matches any number that begins with 415, including 415-320-7000, 415-4455, and 4151.
~	Matches zero or one digit; can be placed anywhere in the number string.	~415+ = matches any number beginning with 415 or digit -415, including 415-320-7000, 415-3222, 1-415-320-7000, and 2520. ~~415+ = matches 1-415-320-7000, 9-1-415-320-7000, and 415-320-7000.
?	Matches exactly one digit.	415-320-7??? = matches any number that has final four digits between 7000-7999. 415-???-???? = matches any number within the area code 415.
% [*table name, number of digits to match*]	Matches digits defined in a prefix table to the number of digits specified. (Refer to "Prefix Tables" on page 10.)	415-% [East,3]+ = matches all numbers that begin with 415 and have a 3-digit prefix defined in the table called EAST.

Example 1:

A user at San Francisco-based Company XYZ wants to send two faxes: one to another user in the company with an internal extension of 41543; and one to the local sales office at 415-555-1234. Because the sales office is a local call, the area code should not be dialed.

With most fax servers, you could create the following dialing rules:

Rule #1	415+	remove first three digits
Rule #2	+	remove no digits

The fax to the sales office may succeed. However, the fax to the internal extension will fail. The server follows rule #1 and improperly changes the phone number to 43 (it removes the first three digits), resulting in an invalid number.

But Intelligent LCR can be configured with the following rules:

Rule #1	415+	remove first three digits
Rule #2	?????	remove no digits
Rule #3	+	remove no digits

When the fax is sent to 41543, it matches all three rules. However, it matches the rule "?????" best because that rule specifies the exact number of digits, so the server does not remove any digits. The server successfully transmits the fax to the internal extension.

When the fax is sent to 415-555-1234, it matches rule #1 and #3. However, it matches rule #1 best because that rule is more specific. Intelligent LCR follows rule #1 and removes the first three digits for the local call.

Example 2:

Rules can also direct outgoing faxes to other fax servers. For example, the following rule could be defined on the San Francisco server:

Rule #1	01144+	route fax to London server

If a user on the San Francisco server sends a fax to 011-44-1329-44323, the San Francisco server actually directs the fax to the London server. From there, the London server determines whether to place a local call to send the fax or to handle it according to the London server's dialing rules. Such a rule avoids a long-distance call from San Francisco to London over the PSTN.

Prefix Tables

Intelligent LCR lets the administrator create prefix tables to store and organize groups of numbers such as prefixes or area codes. Rather than creating a separate rule for each number pattern, the administrator creates a few rules that reference this prefix table, saving considerable time without compromising functionality.

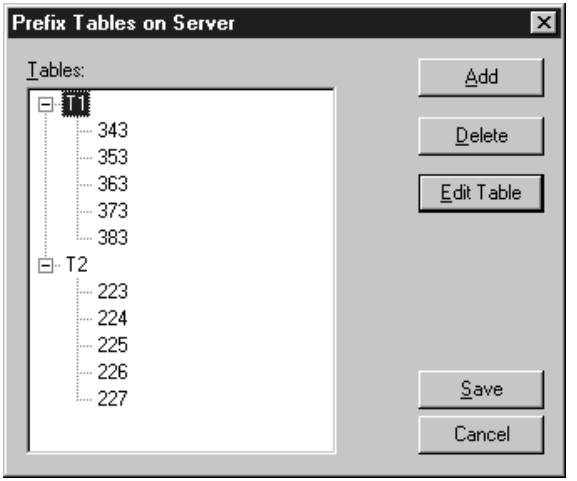
Example:

The following five rules can easily be replaced by two rules that reference the prefix table T1:

Rule #1	415-343-????	Strip 3 digits, add ‘1’
Rule #2	415-353-????	Strip 3 digits, add ‘1’
Rule #3	415-363-????	Strip 3 digits, add ‘1’
Rule #4	415-373-????	Strip 3 digits, add ‘1’
Rule #5	415+	Strip 3 digits

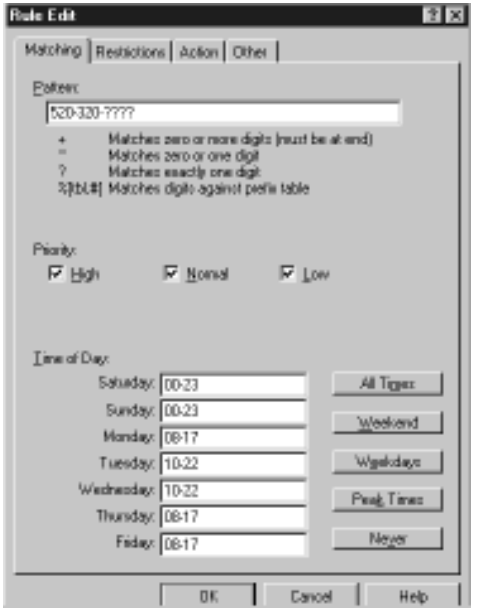
The better way…

Rule #1	415-%[T1,3]-????	Strip 3 digits, add ‘1’
Rule #2	415+	Strip 3 digits



Time Sensitivity

The Intelligent LCR dialing plan can also be tailored by using time-of-day and day-of-week settings. That is, a dialing rule may be effective only during certain times of the day and certain days of the week. At other times, the rule does not apply.



Example :

Company XYZ creates the following rules:

Rule #1	011+	Sat-Fri, 7:00 pm to 5:00 am	Server1
Rule #2	+	All times	Local server

The first rule matches all international faxes sent between 7:00 pm and 5:00 am daily. If a fax is sent to any number beginning with 011 during those hours, it will be routed to Server1 for sending. At other times the first rule is not valid, so faxes match rule #2 and are sent from the local server.

Priority Sensitivity

The sophisticated dialing plan of RightFAX Intelligent LCR lets the system administrator define rules stating that faxes of certain priority levels can be routed via specific servers.

Example 1:

Company XYZ considers high-priority faxes of the utmost importance. With Intelligent LCR, a dialing rule could be set up to direct all high-priority faxes to send locally, while normal and low-priority faxes transmit over the WAN or Internet for cost savings. The company should add the following rules to its dialing plan:

Rule #1	+	High	Send via Server1 (local server)
Rule #2	+	Normal	Send via Server2 (New York)
Rule #3	+	Low	Send via Server3 (Boston)

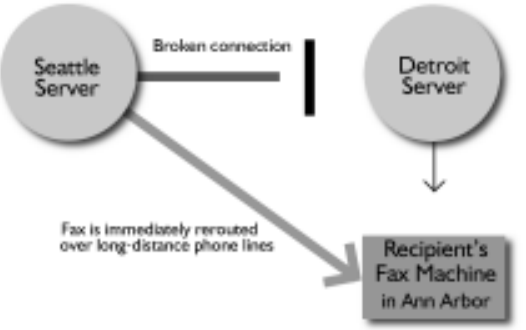
When a user sends a high-priority fax, the fax will always go out via local phone lines. The company feels that any cost saving from LCR is easily lost if the fax is not delivered due to a WAN link or remote server failure. In other words, saving 50 cents while sending a customer a $50,000 proposal is considered too risky.

These rules are also useful if Company XYZ schedules a low-priority fax broadcast to 20,000 people but doesn't want to interfere with normal and high-priority fax traffic. Intelligent LCR can route the broadcast to Server3 in Boston, leaving New York and the local server available for other fax traffic.

Redundancy

Intelligent LCR takes extra precautions to ensure that every fax is successfully delivered in a timely manner. To accomplish this, the server makes "intelligent decisions" when it detects faults. Two problems may arise when using LCR: WAN-link failure or remote-server failure.

LCR When Connections Fail



Example:

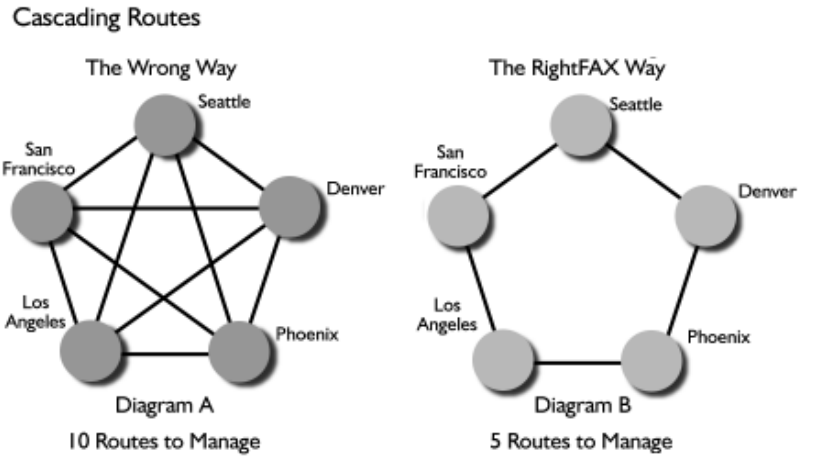
Company XYZ creates a rule that routes a fax from the Seattle server via a WAN link to the Detroit server. After the fax is successfully scheduled for transmission in Detroit, the WAN link fails, but the Seattle server has no way of detecting the fault at the Detroit server.

Traditional fax servers wait up to eight hours (or some definable delay) for confirmation from the Detroit server. Only after the confirmation does not arrive will the Seattle server try again to send the fax. However, users will not tolerate such lengthy delays.

Intelligent LCR detects the WAN link failure within minutes and temporarily disables all dialing rules that direct a fax to the downed server. If alternate routes exist, they are automatically used according to weights and server loads. If no alternate routes exist, the local fax server sends the fax directly over regular phone lines. The fax always goes through — and in a timely manner.

Cascading Routes

With basic fax servers, setting up routes between three or more fax servers becomes tedious because these servers force the administrator to define routes for all possible combinations of servers. For example, in a five-server system, ten combinations of routes must be maintained as depicted in diagram A below.



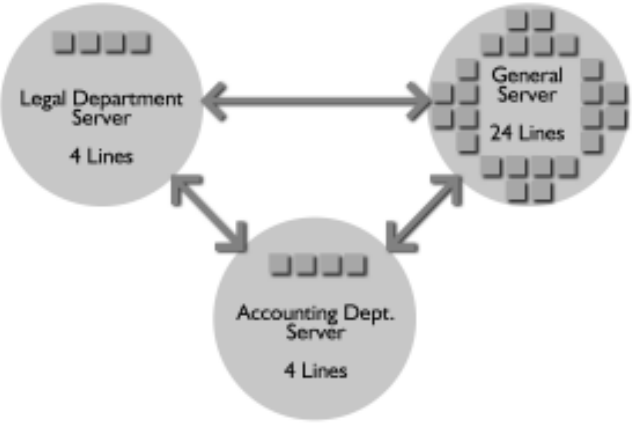
To avoid the problem of exponentially growing route combinations, Intelligent LCR uses cascading routes as shown in diagram B. That is, Intelligent LCR servers can re-route faxes scheduled from remote servers.

Example:

User Bob in Phoenix creates a fax to be sent to San Francisco. Server1 (Phoenix) may route the fax through Server2 (Los Angeles), but Server2 can re-route the fax through Server4 (San Francisco). Because routes cascade, the administrator of a five-server system need only define/maintain four or five routes.

Load Balancing

Load balancing lets multiple servers share work loads for outbound faxes. Intelligent LCR permits multiple destination servers in the dialing plan and allows more than one rule to match a number. If the local server is busy sending or receiving faxes, the rule permits the routing of faxes to a less busy server for immediate transmission. Because traditional LCR systems can match only one rule per number, there is no way to balance work loads. With simple LCR, overhead costs increase and server efficiency decreases because more fax lines are required to handle traffic.



Example:

In its simplest form, two dialing rules may be defined:

Rule #1	+	Server1 (local server)
Rule #2	+	Server2 (server in another department)

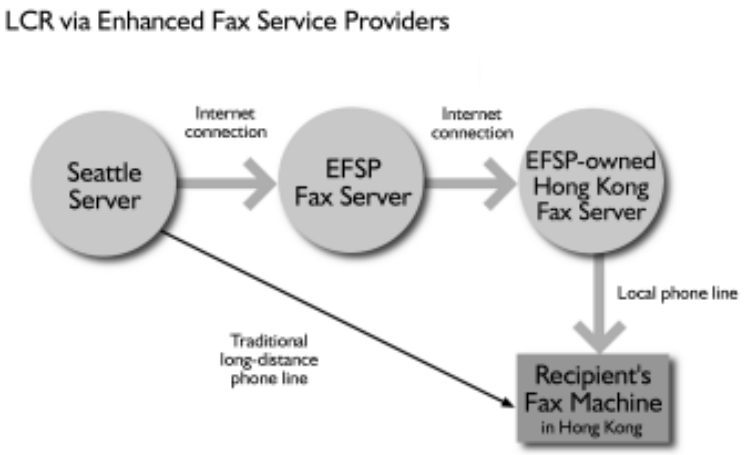
The first has a pattern of + so it matches all phone numbers. The first rule also has a destination of “Server1” (local server). The second rule also has a pattern of “+” so it too matches all phone numbers. However, the second rule specifies a destination of “Server2.” Whenever a user sends a fax to any phone number, both rules match.

When multiple rules match a phone number with **equal** weight, Intelligent LCR directs the fax to the server with the most available phone lines. If both servers have all outbound fax lines in use, the fax goes to the server with the first free phone line. For example, Server1 and Server2 both have 10 outbound phone lines, but all are busy. However, Server1 has 200 faxes in the queue, while Server2 has only 10. Because Server2 will probably have an available phone line before Server1, the server directs the fax to Server2.

Connection to Enhanced Fax Service Providers (EFSPs)

Intelligent LCR offers the unique ability to route faxes to external service bureaus, also known as enhanced fax service providers. EFSPs offer high throughput, guaranteed delivery, high quality, and reduced costs when compared to the public switched telephone network. An EFSP can usually deliver thousands of faxes in a matter of minutes or hours because it maintains hundreds or thousands of fax ports in concurrent operation.

Additionally, EFSPs have developed a large global network. In many cases, their infrastructures extends to thousands of sites. Many companies rely on their services because it is not feasible to maintain an internally owned and operated server in every country, state or city to which they send faxes. EFSPs offer a reasonable alternative.



Central Management

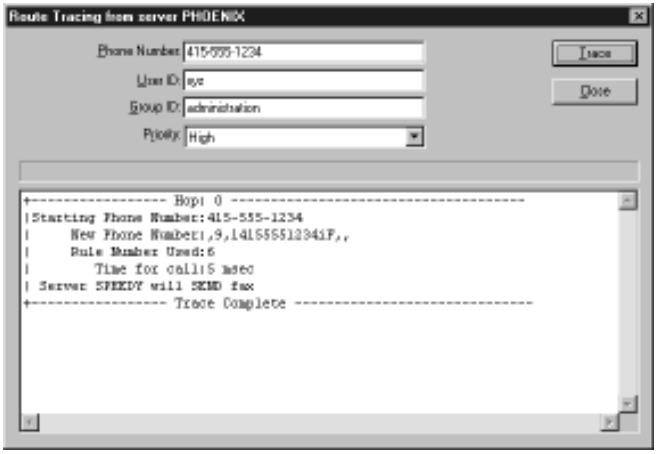
Multiple, physically separate servers can be difficult to manage. To alleviate this problem, Intelligent LCR provides administrative tools for Windows 95/98 and Windows NT® workstations that let an administrator manage all fax servers from a central location. Communication can occur using IPX/SPX or TCP/IP protocol sets over the LAN, WAN, remote access link (RAS) or the Internet. An administrator in Phoenix can configure and revise dialing plans for San Francisco, Seattle and other servers without leaving his/her office. Changes to server configurations and dialing plans take effect almost immediately without the need to stop and restart the fax server software. Simpler and less robust fax servers require the server be cycled, causing severe interruptions in service.

Testing Tools

Sophisticated LCR systems require intelligent diagnostic tools. RightFAX Intelligent LCR provides several advanced tools to test the performance of an enterprise server: Route Tracer, Server Ping, Rule Execution and Show Downed Server. These tools prove invaluable in building and maintaining a complex dialing system.

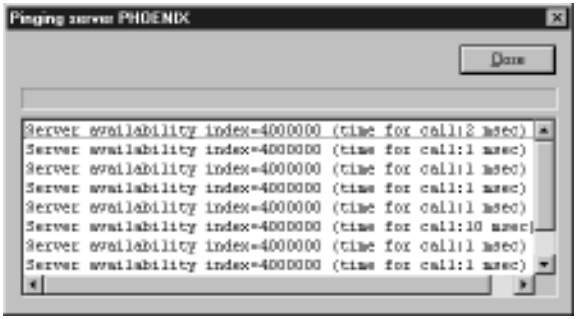
Route Tracer traces the path through which a fax might be sent, detailing:

- each server a fax passes through
- which rules are being used
- how a phone number is manipulated along the way
- hop counts
- hop timings



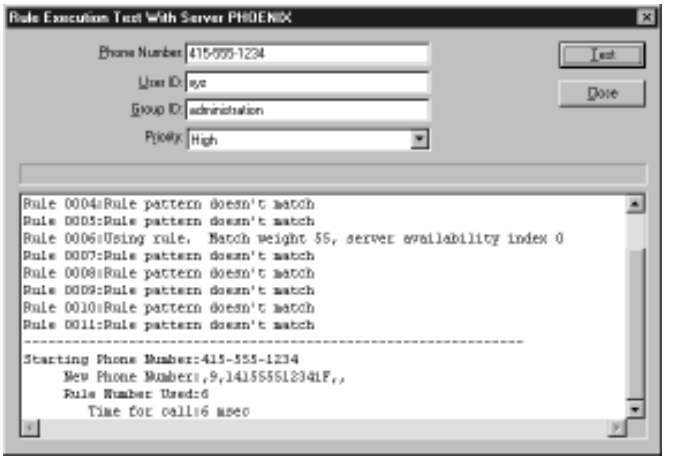
Route tracer lets administrators test the dialing rules with real fax numbers but without actually sending faxes. This diagnoses unexpected fax routes.

Server Ping tests communications with a server over a particular protocol, times the round trip of such packets and shows current server loads.

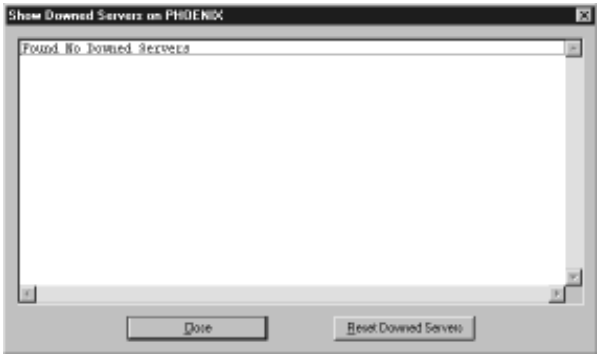


This feature helps the administrator determine the server's availability and indicates if there is a need to redistribute work loads.

Rule Execution determines why a fax uses each rule in a dialing plan. When multiple rules match a particular phone number, Rule Execution shows each one and the weight assigned to each match. This tool helps the administrator determine why a particular number follows a rule and whether the rule needs adjustment.



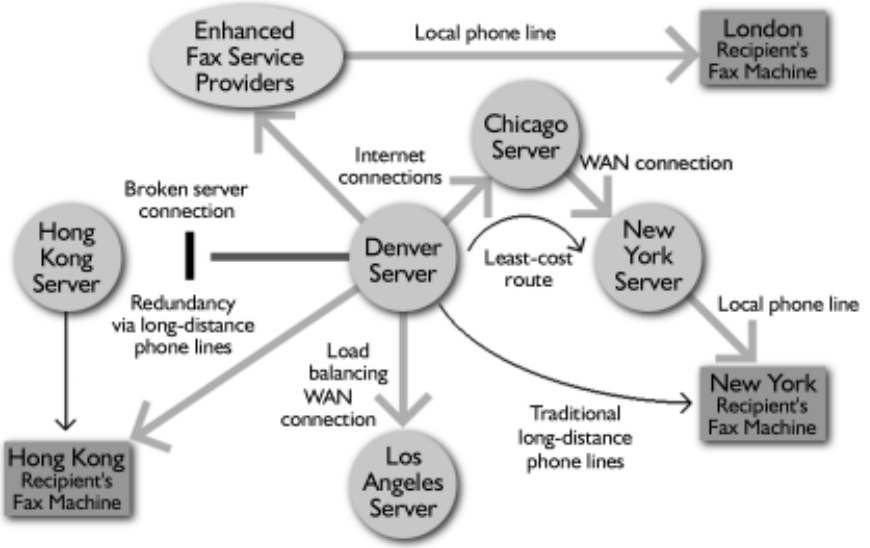
Show Downed Servers displays all rules currently disabled because of communication errors between servers. The error that caused the rule to be disabled is also displayed, letting the administrator easily diagnose the problem.



Making Intelligent LCR Work for You

RightFAX Intelligent LCR, with its sophisticated pattern-matching abilities, built-in cascading route structure, load balancing features and immediate error-detection system, makes decisions that can save businesses time and money. Administrators and users appreciate the power and simplicity of its design. Management appreciates the positive effect on the bottom line. Only RightFAX Enterprise fax server software includes Intelligent LCR. Its installation in your organization can pay for itself in almost no time.

Example of Intelligent Least-Cost Routing for a Distributed Company



About the RightFAX Family of Fax Servers

RightFAX applications are highly integrated network software that streamline the way businesses communicate, saving manpower, time and money.

With RightFAX, users can send faxes quickly and securely from virtually any platform, anywhere in the world; and route received faxes manually or automatically to individual fax mailboxes, or to e-mail or voice mail applications. Hundreds of options help administrators tailor a RightFAX system to meet the demands of the entire organization.

Labor- and Money-Saving Benefits

RightFAX delivers the labor- and money-saving benefits crucial in competitive business environments. Features such as Intelligent LCR and load balancing let you leverage your Internet or intranet to share resources with other RightFAX servers, while saving on long-distance phone charges. Its enhanced technology increases employee productivity, at the same time reducing the waste of paper and printing resources.

The first step in selecting a RightFAX server is deciding which one meets your needs. RightFAX offers four server solutions, each designed for specific situations:

- For companies that want a stand-alone fax server, the original RightFAX v6.0 server is the reliable solution that can be expanded as needs change.
- For companies seeking system-wide control over fax communications, RightFAX Enterprise v6.0 provides the savings and networking benefits that come from connecting two or more servers.
- For companies that want an expanded enterprise-wide fax solution, RightFAX Enterprise Suite v6.0 provides additional functionality and methods of remote access for users through the addition of six useful modules.
- For companies with discrete workgroups or remote branch offices that need the full networking resources available from the main office RightFAX Enterprise installation, RightFAX Satellite Server for up to 15 users provides the benefits of an enterprise server at a much lower price than a full enterprise installation.

RightFAX Server Technology

RightFAX, Inc. is celebrating 11 years of innovation with the introduction of RightFAX v6.0. With more fax servers installed worldwide than any other developer, the company is now the industry standard. The maturity of our product is underscored by highly developed features such as:

- Intelligent LCR with the most sophisticated options in the industry
- Natively integrated Web client for full functionality through any browser
- Server-side native document conversion to better preserve the complicated formatting of many applications and improve office productivity
- True client/server architecture for integrity of fax data no matter how it is accessed
- Multi-mode access to faxes or fax information by e-mail, the Web or touch-tone telephones
- Tracking of department usage and charges for billing purposes
- Full integration of fax with e-mail, voice mail and the Web for a total corporate communications solution

For more information about
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