THE TOLLY GROUP

No. 8263 March 1998

Ascend Communications, Inc.

MAX 6000

Remote Access Concentrators: Analog and ISDN Throughput

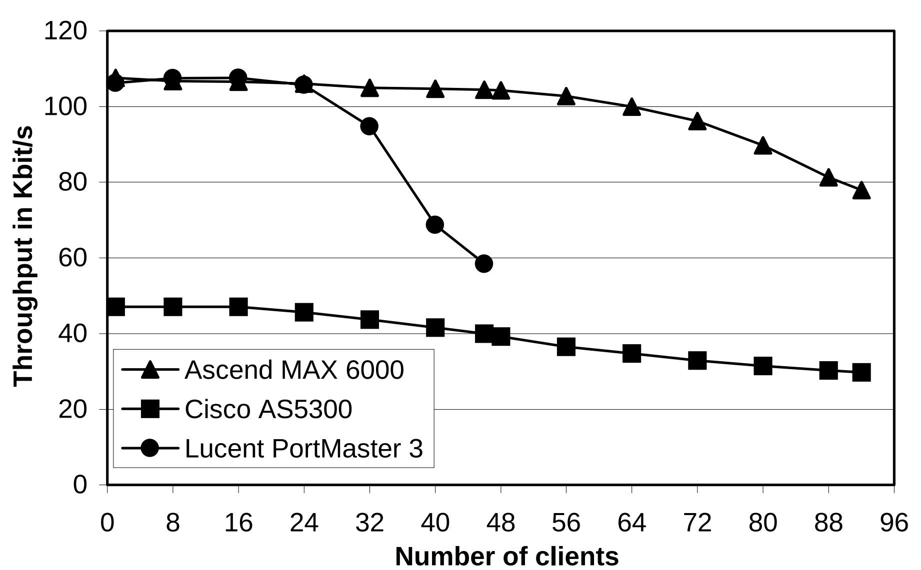
Test Summary

Given the business imperative to support remote workers, network managers are determined to learn how they can best utilize PC dial-up lines today. With that premise in mind, Ascend Communications commissioned The Tolly Group to evaluate its MAX™ 6000 remote access concentrator against Cisco Systems, Inc.'s Access Server 5300 (AS5300) and Lucent Technologies Inc.'s PortMaster 3.

The Tolly Group conducted benchmarks which measured effective application performance using Ganymede Software's Chariot test tool to transmit large files across all three products at 56 Kbit/s. Both analog and digital 56 Kbit/s modems were used, provided the vendors supported them. Testing was performed in February 1998.

Test Highlights

- Outperforms Cisco Systems' AS5300 and Lucent Technologies' PortMaster 3 across analog and digital connections loaded with 24 or more clients
- Offers solid and consistent performance even when fully loaded at 92 connections
- Delivers a maximum aggregate throughput of 4,942 Kbit/s for 56 Kbit/s analog modem connections when fully loaded compared to 2,037 Kbit/s for the PortMaster 3 at 46 connections
- Provides a maximum aggregate throughput of 7,164 Kbit/s for 56 Kbit/s ISDN modem connections when fully loaded compared to 2,739 Kbit/s for the Cisco AS5300 and 3,029 Kbit/s for the PortMaster 3



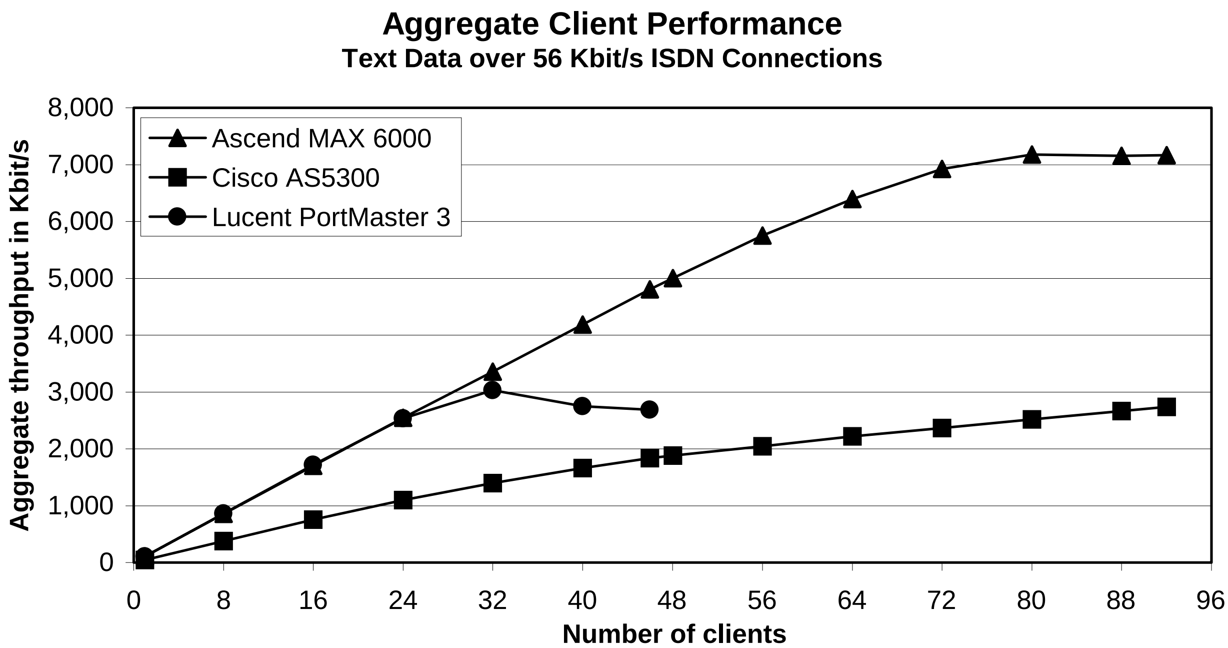
Source: The Tolly Group, March 1998 *Figure 1*

Test Results

Ascend's MAX 6000 delivered high throughput for both analog and digital connections and scaled as additional clients were added. Competing products tested exhibit either lower performance than the MAX 6000, rapid performance degradation as clients are added, or both. Chariot supported up to 92 simultaneous data transfers from servers on a central LAN to remote dial-up Windows 95 clients running MS-STAC compression.

When using remote access concentrators, the effective application throughput is maximized by utilizing a compression algorithm prior to introducing any data to the wide area network. This compression can be done between the workstation and the remote access concentrator or between the modems. With Windows 95, Microsoft provides a compression routine that uses the Windows 95 operating system and CPU to compress data prior to transport over the WAN.

In cases of ASCII files, this can dramatically increase effective throughput. In a worst case scenario, when data is already in a compressed form, the Windows compression routine provides no additional benefit. (MS-STAC compression remained enabled in all the tests, even those where



Source: The Tolly Group, March 1998

Figure 2

previously-compressed data was transferred.) In the tests, both conditions were examined, with up to 92 simultaneous client downloads to stress the products under test by creating a situation in which rapid client performance degradation could occur.

56 Kbit/s ISDN Tests

All three products — the Ascend MAX 6000, the Cisco AS5300 and the Lucent PortMaster 3 — were tested for 56 Kbit/s ISDN performance. A 56 Kbit/s ISDN speed was used instead of 64 Kbit/s, because the ISDN equipment used for testing was set up for the 56 Kbit/s connection speed. Normally, ISDN runs at 64 Kbit/s per ISDN Basic Rate Interface, but there is only a minimal difference in performance between the 64 Kbit/s speed and the 56 Kbit/s speed used in testing.

One factor that does impact effective throughput is data compression, and that became evident during testing. Cisco's AS5300 currently does not support MS-STAC compression (Microsoft's enhanced STAC compression algorithm) for Windows 95 dial-up clients. MS-STAC is commonly used for Windows 95 client-side compression. Cisco's remote access concentrator does support STAC compression for connecting the AS5300 to a router-based wide area network. Consequently, AS5300 results lag both the MAX 6000 and the PortMaster 3.

Lucent's PortMaster 3 supports a maximum of two Primary Rate Interfaces (PRI) that together support only 46 concurrent calls (either analog or ISDN). Both the MAX 6000 and AS5300 support four PRI connections for a total of 92 concurrent ISDN calls.

In order to test the performance of the remote access concentrators using ISDN connections, two tests were run. The first test consisted of a text file transfer; the second test employed a compressed file transfer. Both the average per client and aggregate throughput were calculated for each test. (All performance data was transmitted using IP. Each remote access concentrator under test routed (layer 3) traffic from Windows NT servers to the dial-up clients.)

ISDN File Transfer Performance using a Text File

Because data can be compressed prior to reaching the WAN, effective compression rates can and often do exceed the rated speed of the WAN link.

The MAX 6000 outperforms the PortMaster 3, which degrades at 24 clients, and the AS5300, which does not support MS-STAC compression. While compression was a performance factor, it wasn't the only contributor because the AS5300 continued to degrade as the load increased.

In figure 1, PortMaster 3 performance degrades at 24 concurrent client connections, while MAX 6000 performance is consistent through 64 client connections. The MAX 6000 averaged client throughput of 77.88 Kbit/s at 92 client connections, while the AS5300 turned in a per client throughput of 29.78 Kbit/s at 92 clients. The PortMaster 3 averaged client throughput of 58.46 Kbit/s at 46 clients (the maximum number of clients it supports) compared to 104.47 Kbit/s for the MAX 6000 and 39.97 Kbit/s for the AS5300 over the same 46 clients.

The MAX 6000 reaches a maximum aggregate performance of 7,150 Kbit/s at and beyond 80 client connections (see figure 2). The PortMaster 3 has an aggregate performance of 3,029 Kbit/s and begins to trail off beyond 32 clients. The Cisco AS5300 was only able to deliver a maximum aggregate throughput of 2,739 Kbit/s.

ISDN File Transfer Performance using a Compressed File

The purpose of transferring a compressed file is to establish a baseline showing the application performance without MS-STAC affecting the transfer. These results demonstrate the frame streaming capabilities of the remote access concentrators without performance degradation due to compression.

The MAX 6000 delivered consistent performance in excess of 48.5 Kbit/s in the compressed file test, all the way through 92 clients. Cisco's AS5300, meanwhile, initially delivered performance on par with other devices when transferring pre-compressed files, but degraded quickly as the client load increased.

As seen in figure 3, the AS5300 started at 48 Kbit/s per client, but performance sank to 27.3 Kbit/s at 92 clients. At 24 clients, the AS5300 and PortMaster3 kept pace with the MAX 6000, although both devices' performance began to drop off as clients were added. After 24 client connections, the performance of the PortMaster 3 begins to degrade slightly to 47.36 Kbit/s. At 92 client connections, the per client performance of the AS5300 is almost half of what it was at one client. The performance of the MAX 6000 at 92 clients, meanwhile, is almost identical to the MAX 6000's performance with a single client.

The aggregate performance of the MAX 6000 in figure 4 shows that there was no degradation for this test. The PortMaster 3 exhibits a slight degradation in performance, although it largely parallels the MAX 6000 up through 46 client connections. The AS5300 shows a fairly steady curve, which indicates the device hadn't reached a performance plateau, but exhibited a loss in performance as clients were added.

56 Kbit/s Analog Tests

Only the MAX 6000 and the PortMaster 3 were tested for 56 Kbit/s analog performance; Cisco currently does not support 56 Kbit/s speeds with its Modem ISDN Channel Aggregation (MICA) modem boards that were used.

Like the ISDN performance testing, two tests were conducted to determine the performance of the remote access concentrators for analog connections. The first test consisted of a text file transfer, while the second test used a compressed file transfer. Both the average throughput per client and aggregate throughput were calculated for each test.

Analog File Transfer Performance using a Text File

The average client performance for the PortMaster 3 shows a sharp degradation beyond 24 concurrent client connections (see figure 5). The PortMaster 3 started with a throughput of 106.55 Kbit/s at one client and at 46 client connections produced an average client throughput of less than 45 Kbit/s. At one client, the MAX 6000 generated throughput of 96.36 Kbit/s and at 46 client connections the MAX 6000 produced an average client throughput of 78 Kbit/s. At the full 92 simultaneous connections, the MAX 6000 has an average client throughput of 53.72 Kbit/s.

Aggregate throughput results (see figure 6) clearly show that the PortMaster 3 hits a plateau of about 2,037 Kbit/s at 24 client connections. The MAX 6000 increases aggregate throughput up to 80 connections before the device appears to reach a limit of 4,900 Kbit/s.

Ascend Communications, Inc.

MAX 6000

56 Kbit/s Throughput

THE TOLLY GROUP Up to Spec CERTIFIED

Ascend Communications, Inc. MAX 6000 Product Specifications*

High performance
- Supports 4 T1/E1/PRI ports
- Supports an autosensing 10/100BaseT Ethernet port

LAN protocol support
- TCP/IP via RIP, RIP2, OSPF
- Optional: AppleTalk, IPX

Bridged protocol support
- Included with IntragyAccess software option

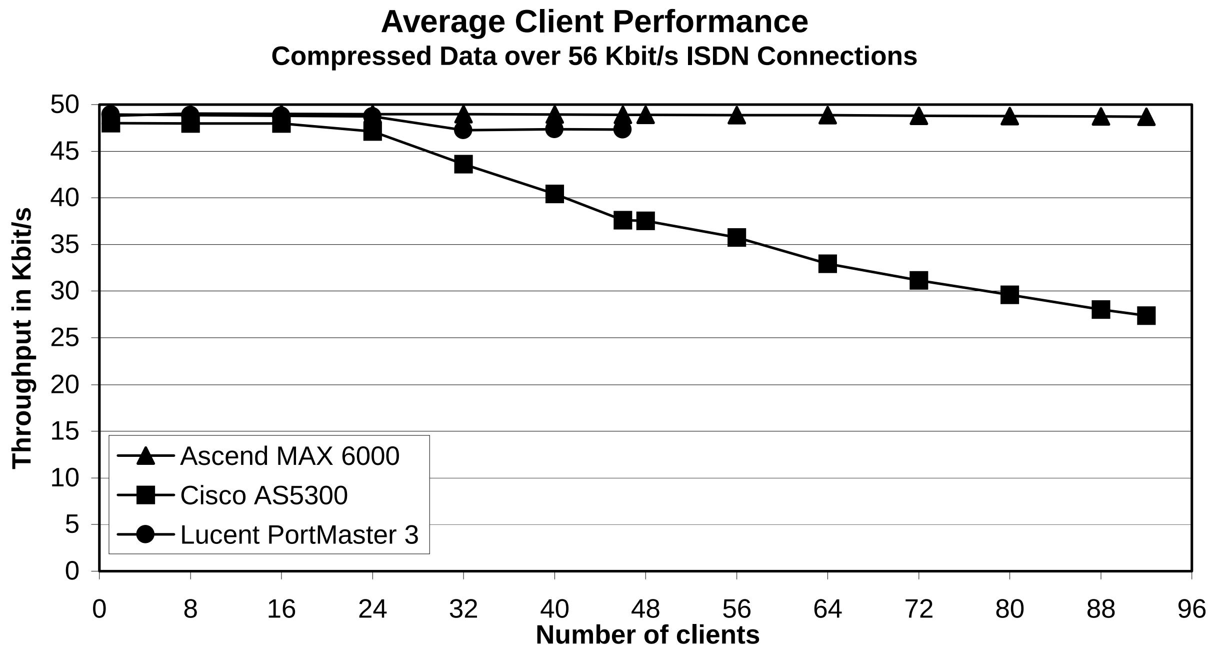
Scalability
- 96 analog and 120 digital calls on a single chassis
- MAX 6000s can be linked to support a single virtual access switch

Bandwidth management support:
- Multilink PPP (MP)
- Multilink Protocol Plus™ (MP+)
- Bandwidth Allocation Control Protocol (BACP)
- TCP and IPX header compression
- ARA smart buffering
- Ascend/Microsoft STAC V9 data compression

Network management:
- NavisAccess, Java Configurator, Telnet, NASI, SNMP MIB II, PPP LQM, Frame Relay Annex D, ISDN event log, Syslog

Security support:
- Secure Access Firewall (optional), RADIUS, Ascend Access Control (extended RADIUS), TACACS, Password Authentication Protocol, Challenge Authentication Protocol (CHAP), Token card, Calling Line ID (CLID), Packet filtering, SNMP, PPP callback, user authentication

Vendor-supplied information not verified by The Tolly Group



Source: The Tolly Group, March 1998

Figure 3

Analog File Transfer Performance using a Compressed File

As expected, the effective per client performance is lower for compressed files than for text files (see figure 7). The PortMaster 3 again starts off with a higher throughput (44.85 Kbit/s at one connection compared to 29.49 Kbit/s for the MAX 6000) but degrades quickly after 32 client connections. The MAX 6000 may start off slower, but with eight or more concurrent clients, it delivers very consistent performance (in excess of 35 Kbit/s) for the compressed file transfer, showing no performance degradation as the device is loaded to 92 client connections.

The PortMaster 3 scales slightly farther for the compressed file than it did for the text file, beginning to show performance degradation after only 32 client connections and ends up with throughput of only 28.46 Kbit/s for 46 connections.

The aggregate client performance chart (figure 8) shows that the MAX 6000 continues to scale up to 92 client connections with no performance degradation. The PortMaster 3 meanwhile, hits an aggregate throughput plateau, this time between 40 and 46 client connections.

Test Configuration and Methodology

Systems Under Test

The Ascend MAX 6000 (software version 6.0B4) was outfitted with 96 56 Kbit/s modems (supporting both analog and digital connections), four PRIs (limiting the MAX 6000 to 92 active connections) and a Fast Ethernet port.

Cisco Systems' AS5300 (version 11.2.10ap1) was outfitted with 96 digital modems, four PRIs (again, only 92 active connections were supported) and a Fast Ethernet port. Lucent Technologies' PortMaster 3 (version 3.7.2C3) supported 48 modems (both analog and digital), two PRIs (for a total of only 46 concurrent connections) and a 10 Mbit/s Ethernet port.

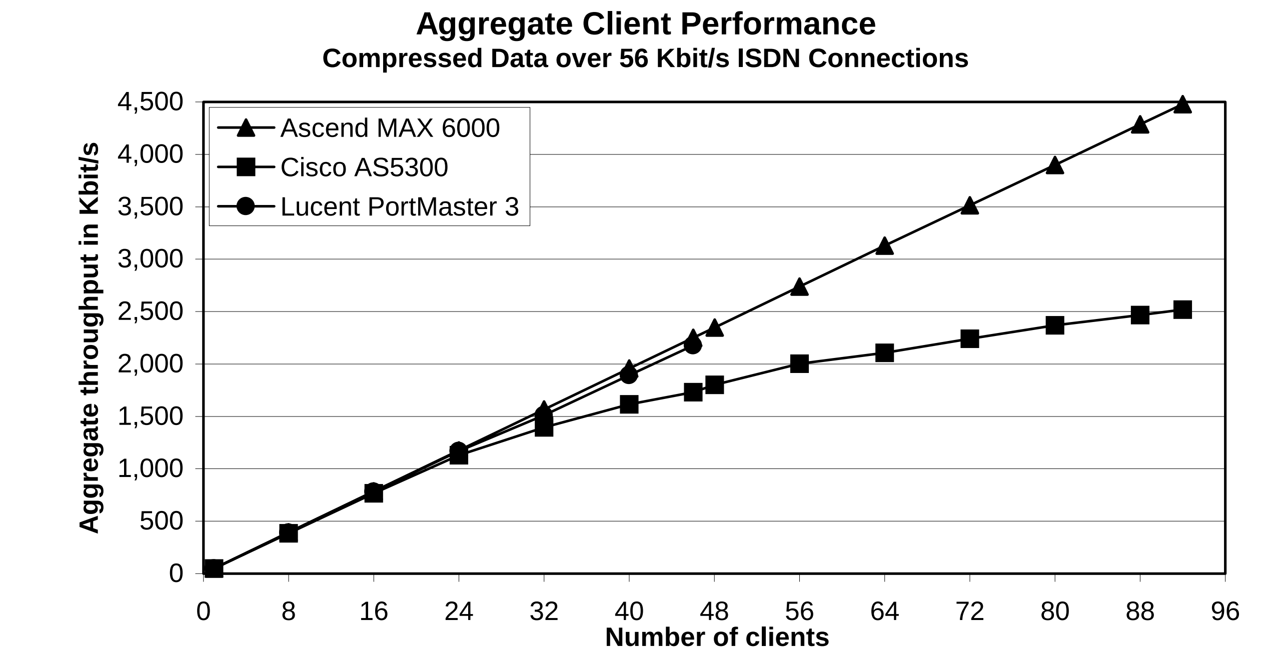
The fact that the PortMaster 3 operated with only a 10 Mbit/s port was not an issue, since the maximum theoretical bandwidth from the WAN onto the LAN is barely in excess of 3 Mbit/s, and is easily supported using the 10 Mbit/s Ethernet with no performance constraints.

Test Bed Description

The test bed consisted of three Windows NT (Version 4.0) servers connected to a routed Fast Ethernet backbone. From a remote device perspective, 92 Windows 95 (OEM Release using the native Microsoft IP stack) PCs each were connected to either a 56 Kbit/s analog or digital modem and simulated remote clients dialing into the central LAN. The clients were set up for IP networking and all clients were configured from a pre-assigned pool of addresses on the remote access concentrator. For the 56 Kbit/s analog testing, Diamond Multimedia Supra Express 56E modems (version 1.000-003) were used and Motorola, Inc. BitSurfer Pro digital modems were used for ISDN testing.

Client PCs dialed the remote access concentrator under test through a Lucent Definity PBX. The remote access concentrator communicated with the NT server on the central LAN via an Ascend GRF Fast Ethernet router. The Ascend GRF was configured for RIP.

A Network Associates Ethernet Sniffer (Version 5.02) was connected to the Fast Ethernet LAN between the



Source: The Tolly Group, March 1998 *Figure 4*

system under test and the Windows NT server, so that the correct operation of tests could be verified easily. A Shomiti Systems Century LAN analyzer running Surveyor software (Version 2.1) was connected to the central LAN and was also used to verify tests.

A Ganymede Chariot console (Version 2.11) was connected to the central LAN and Chariot end points were installed on all servers and clients to run the test performance scripts.

Methodology

Performance tests were based on file transfers from the servers, through the products under test, to the clients and consisted of either ASCII text or compressed files. The ASCII text file represented a best case scenario since it was compressible, while the pre-compressed file represented the worst case performance scenario and ensured that the performance test wouldn't simply be dependent upon the products' compression algorithms.

The testing measured the client/server throughput of remote PC clients receiving files from a central Windows NT server through multiple concurrent connections. The tests show the aggregate and per client throughput of PCs communicating through a remote access concentrator to a central server over 56 Kbit/s analog and digital connections. Results were obtained from running a Ganymede Software Chariot test script and are presented in Kbit/s per client as well as aggregate Kbit/s.

Tests were run using 1, 8, 16, 24, 32, 40, and 46 PCs for all three devices under test and additional tests run at 48, 56, 64, 72, 80, 88, and 92 connections for the MAX 6000 and the AS5300.

Procedure

The clients logged onto the servers through the remote access concentrators and once the connection was established, the Chariot "File Transfer Long" script was started. A Network General Expert Sniffer and a Shomiti Century LAN analyzer verified correct operation of the Chariot script throughout the testing.

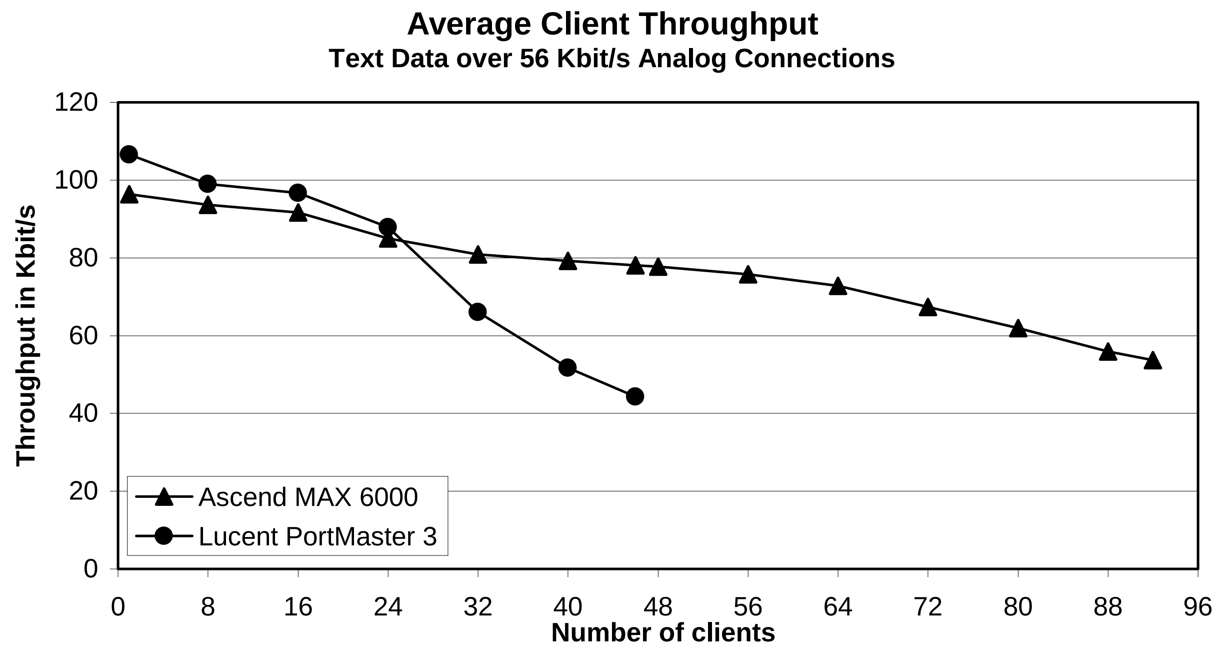
The Chariot console reported both per client throughput and aggregate throughput. The Chariot output also indicated the relative accuracy of the performance data gathered during testing. If the reported accuracy of the gathered data indicated that there was a wide variation in the test results for a single iteration of the test, or if a single client had failed to complete the test successfully, the script was rerun.

If one or more dial-up connections were lost during testing, the results were discarded and the test was rerun. Each test iteration was run for three minutes or longer. At least two iterations were run for each test point and the results were averaged.

After a successful completion of the test script, the script was rerun using the next greater number of clients, until the maximum number of clients tested was reached, or until any dial-up connections were lost. After a successful run through all of the clients, the entire process was started over at one client for the second iteration.

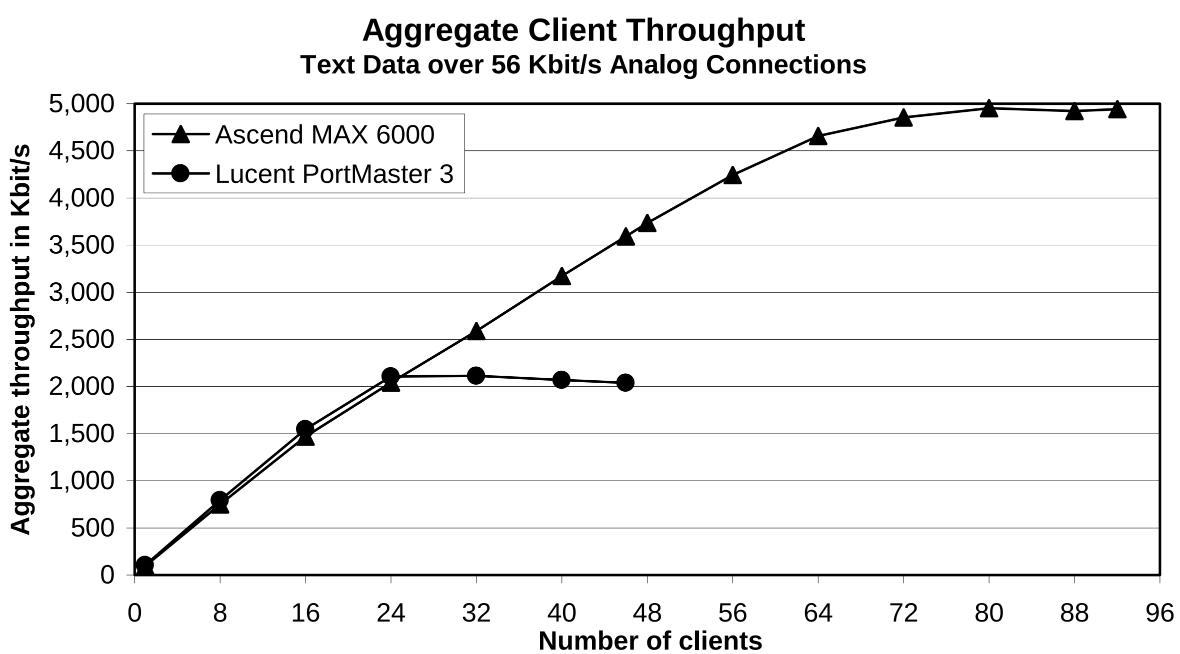
Calculations

Performance results were recorded directly from Chariot, so there were only minimal calculations required throughout the test. All iterations for each result were averaged and reported as the final performance result.



Source: The Tolly Group, March 1998

Figure 5



Source: The Tolly Group, March 1998

Figure 6

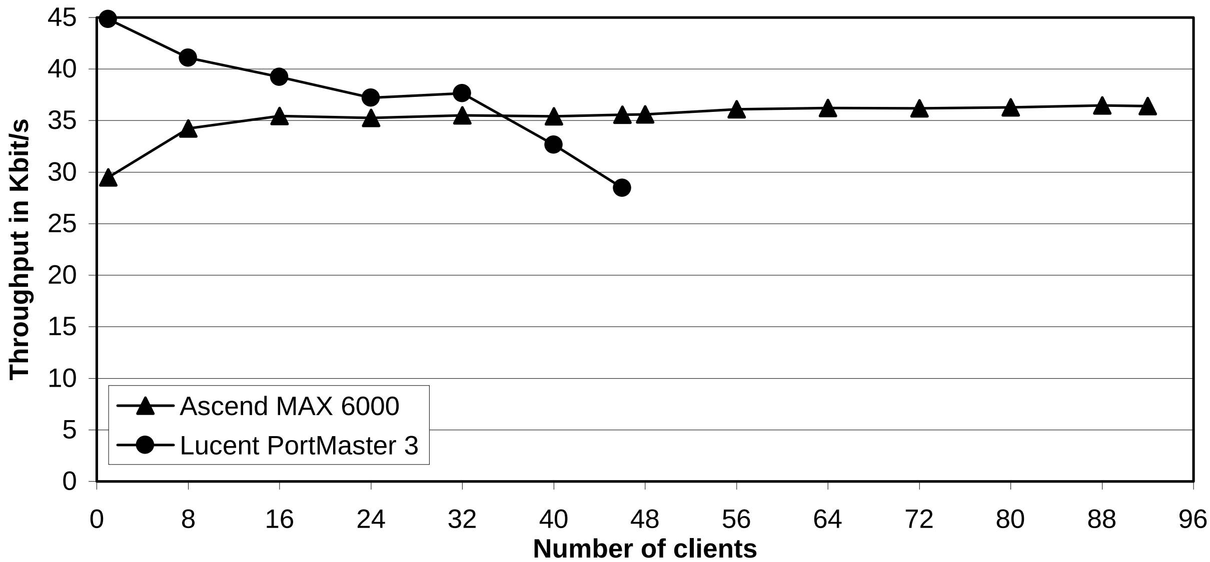
Equipment Acquisition and Support

The Tolly Group proactively took a number of steps to ensure the accuracy and validity of these test results.

Both competitive products were acquired by Ascend Communications through an authorized reseller. The products were initially configured and set up by technicians from the authorized reseller.

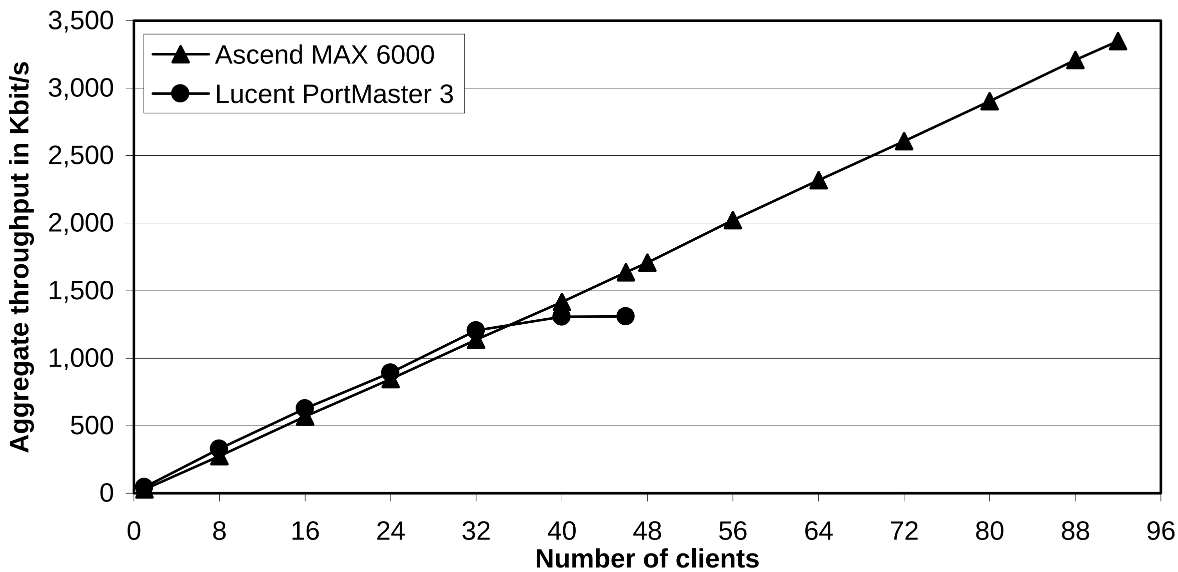
The Tolly Group contacted executives at Cisco Systems and Lucent Technologies and invited them to provide a higher level of support than the normal channels available to the customer that commissioned the testing. The Tolly Group asked high-level executives at these companies to supply the appropriate technical support contacts, so The Tolly Group's engineers could verify software versions and seek clarification about configuring the devices in question.

Average Client Throughput
Compressed Data over 56 Kbit/s Analog Connections



Source: The Tolly Group, March 1998 *Figure 7*

Aggregate Client Throughput
Compressed Data over 56 Kbit/s Analog Connections



Source: The Tolly Group, March 1998 *Figure 8*

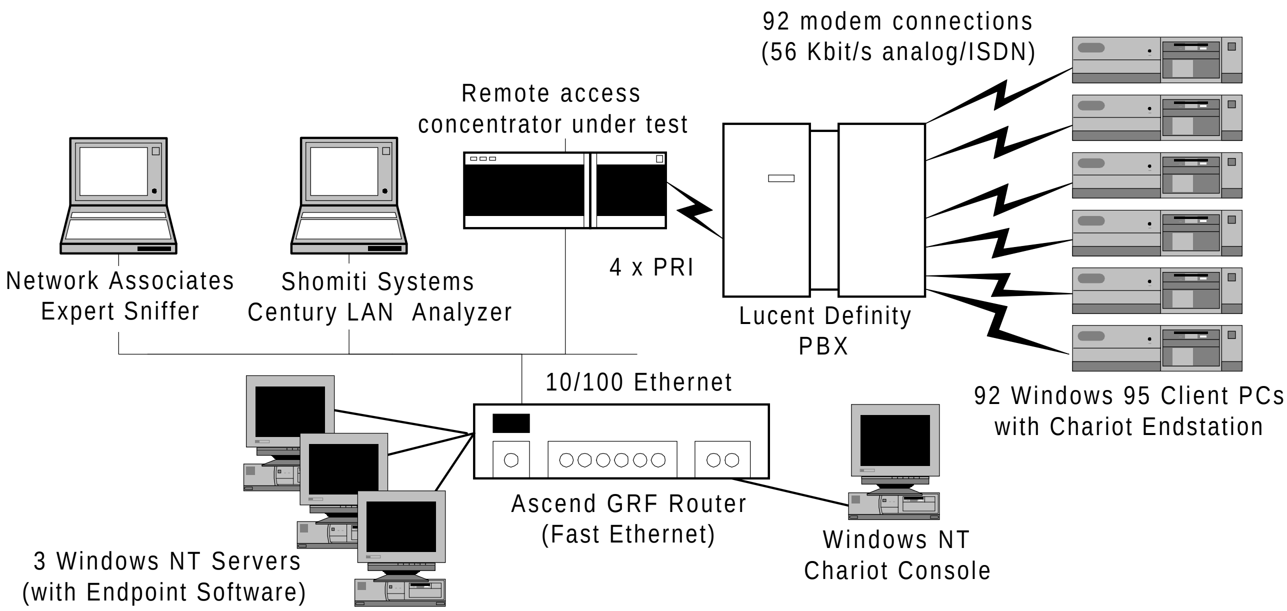
Both Cisco and Lucent provided technical support contacts, although Cisco limited its assistance since it was not permitted to place its own engineer at the customer's testing site.

The Tolly Group contacted vendors to confirm product release levels, and offered the opportunity to share test configurations and optimize the devices for this test. Lucent approved the configuration used; Cisco declined the offer, stating its requirement to place an engineer at the test site to verify the configuration data. (Due to a contractual agreement with the testing client, The Tolly Group could not invite Cisco or Lucent into the test lab.)

Following the testing, The Tolly Group contacted both vendors to review test results. Lucent did not respond, while Cisco said it would not comment on the results since it could not place an engineer at the test site. For a more complete understanding of the interaction between The Tolly Group, Cisco and Lucent, check out the Technical Support Diary posted

Test Bed

File Transfer Performance Testing with up to 92 Remote Clients



Source: The Tolly Group, March 1998 *Figure 8*

on The Tolly Group's World Wide Web site at http://www.tolly.com (see document 8263).

In addition to the diary, The Tolly Group has also posted configuration files for the devices under test, as well as detailed test scripts and results.

About The Tolly Group

The Tolly Group provides strategic consulting, independent testing, and industry analysis. It offers a full range of services designed to furnish both vendor and end-user communities with authoritative, unbiased information. Fortune 1,000 companies look to The Tolly Group for vendor-independent assessments of critical corporate technologies. Leading manufacturers of computer and communications products engage The Tolly Group to test both pre-production and production equipment.

The Tolly Group is recognized worldwide for its expertise in assessing leading-edge technologies. By combining engineering-caliber test methodologies with informed interpretation, The Tolly Group consistently delivers meaningful analyses of technology solutions. The Tolly Group has published more than 400 product evaluations, network design features and columns in the industry's most prestigious publications.

Kevin Tolly is President and CEO of The Tolly Group. He is a leading industry analyst and is responsible for guiding the technology decisions of major vendor and end-user organizations. In his consulting work, Tolly has designed enterprise-wide networks for government agencies, banks, retailers, and manufacturers.

For more information on The Tolly Group's services, visit our World Wide Web site at http://www.tolly.com, E-mail to info@tolly.com, call 800-933-1699 or 732-528-3300, or fax 732-528-1888.

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