THE TOLLY GROUP

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Symbol Technologies, Inc.

Wireless Switch System 5000

802.11b Performance Evaluation versus Cisco Systems Aironet 1220 Access Point

1989 - 2004 15 Years TOLLY

Test Summary

Premise: *The chief factors in any wireless LAN purchase decision today hover around mobility performance, strong security, and easier network management while supporting a mixed environment of mobile and portable devices. Functionality and scalability of the solution are also important with the need for a seamless adaptation of the emerging wireless standards and technological developments.*

Symbol Technologies commissioned The Tolly Group to evaluate its Wireless Switch System, which is comprised of the WS 5000 Wireless Switch and one or more AP100 Access Ports. The WS 5000 is a wireless switch that centralizes unified access, security, policy management and Quality of Service for the wireless network, while the Access Port consists of the wireless LAN radio and antenna. In this wireless switch architecture, the intelligence usually reserved for access points is relocated to a centralized switch and the Access Port handles radio functions only.

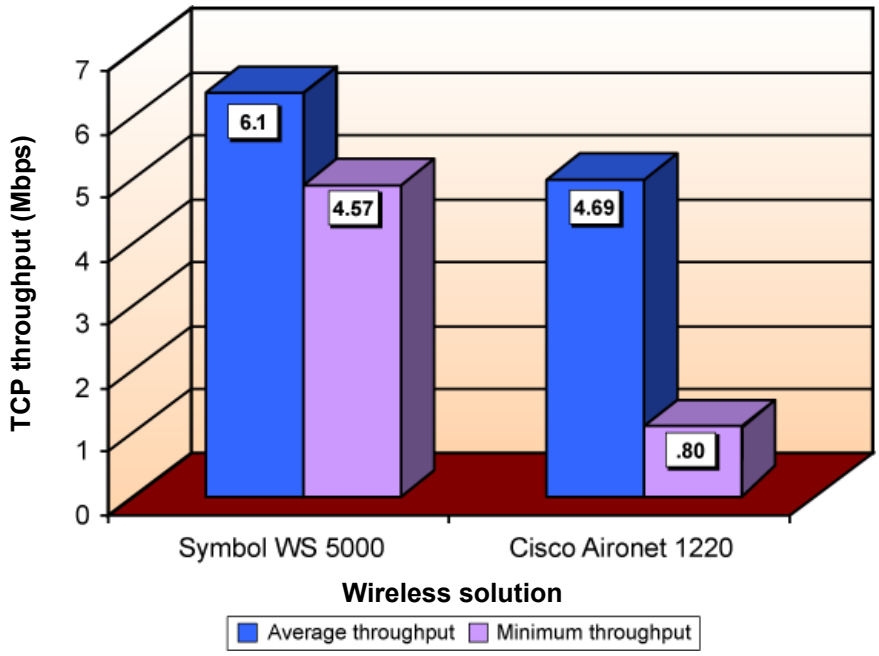
Tolly Group engineers tested the WS 5000 and Access Port against a Cisco Systems Aironet 1220 Access Point, which represents a 'fat' AP design in which intelligence is located in the access point.

Engineers measured the raw throughput and latency of devices under test using Chariot software. A multi-SSID performance test proved the performance advantages of assigning each SSID to a unique BSSID while implementing virtual WLANs. Another test measured the throughput with virtual WLANs enabled

Test Highlights

- Prolongs battery life of Pocket PC by 2.5 times versus Cisco Aironet 1220 by reducing amount of time handheld PC needs to go from idle mode to active mode
- Provides up to 27% greater throughput than the Cisco Aironet 1220 AP when supporting multiple BSSIDs and multiple applications through virtual WLANs
- Delivers 30% greater unidirectional upstream TCP throughput than the Cisco Aironet 1220 AP as wireless mobile clients roam from AP to AP
- Allocates bandwidth according to parameters set by QoS policies

Impact of Roaming on TCP Throughput During File Upload
(as Reported by Chariot)



Source: The Tolly Group, December 2003

Figure 1

and in the presence of background broadcast traffic on a separate virtual WLAN. A baseline test measured the TCP throughput of both systems under test configured to provide a WLAN with a single SSID and no background traffic.

Engineers also validated the security options available in both the systems and The Tolly Group validated the Symbol Wireless LAN System's QoS facilities by prioritizing traffic by application or by WLAN. Tests were conducted during December 2003.

Overall, tests show the Symbol WS 5000 Wireless Switch and Access Port offer greater performance and more flexible mobility than provided by the Cisco Aironet 1220 AP.

Results

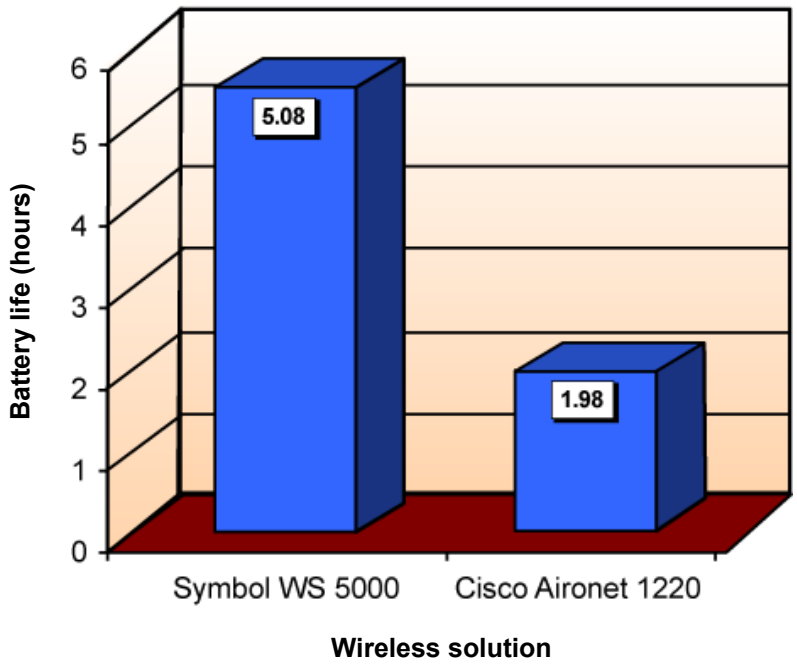
Mobility Performance

The Symbol WS 5000 and the Cisco Aironet 1220 were measured for TCP throughput in a scenario in which the wireless device roams in the WLAN.

The Symbol WS 5000 achieved 30% greater unidirectional upstream TCP throughput (as measured by Chariot) than the Cisco Aironet 1220. The average throughput observed for the WS 5000 Switch System was 6.10 Mbps versus 4.69 Mbps for the Cisco Aironet 1220-based 802.11b WLANs.

The effect of roaming on the tested devices is visible when minimum throughput plotted by Chariot is evaluated. Throughput degraded at the point where the wireless access for the user changed transparently from one access point to another with both the systems. For the WS 5000, throughput degraded 25% to 4.57 Mbps while the Cisco Aironet 1220 performance degraded 83% to 0.80 Mbps during the roaming exercise. (See Figure 1.)

Battery Life of Mobile RF Device Connected to Tested Devices



Source: The Tolly Group, December 2003 *Figure 2*

Battery Life

A Symbol Technologies pocket PC-based mobile companion demonstrated a battery life of 5.08 hours with the WS 5000-based WLAN versus 1.98 hours with the Cisco Aironet 1220-based WLAN in an environment of background broadcast traffic that was set at 0.15% of the 100-Mbps backbone. (See Figure 2.)

Mobile Security Verification

The Symbol WS 5000 has a security suite with advanced security options such as KeyGuard™ (encryption) and Kerberos (authentication) for portable devices apart from the industry standard options like WEP, WPA-TKIP, EAP/802.1x and PEAP. The Tolly Group validated Symbol's claim that a mobile device such as the pocket PC may associate with the WLAN via a suitable security mechanism such as KeyGuard.

Throughput

Throughput tests measured the maximum data rate that the systems are capable of providing under ideal conditions with 802.11b wireless access mode.

The raw TCP throughput with both systems under test demonstrated Enterprise-class performance with the Symbol WS 5000 handling 6.24 Mbps and the Cisco Aironet 1220 handling 6.21 of bidirectional Chariot traffic between a wireless device and a wired device. The test was conducted with the wireless data rate mode set to 11 Mbps only for both the systems under test. (See Figure 3.)

Engineers also measured the upstream unidirectional TCP throughput from the wireless device to the wired device in the network, with two different wireless data rate

settings of 11 Mbps only and 5.5 Mbps/11Mbps (where the device steps down to 5.5 Mbps if 11 Mbps is unavailable). At the 11 Mbps-only rate, the WS 5000 achieved 6.31 Mbps and the Cisco Aironet 1220 handled 6.26 Mbps. At the 5.5 Mbps/11 Mbps rate, the WS 5000 achieved 6.26 Mbps versus 6.09 Mbps for the Cisco AP.

Latency

Latency tests revealed no additional delay associated with the Symbol centralized intelligence wireless switch architecture compared to the Cisco Aironet 1220 distributed enterprise-class access point architecture. Tests showed a maximum delay of less than 2 milliseconds in each case.

Multi-BSS Performance

This test sought to prove the advantages of assigning multiple BSSIDs while implementing virtual WLANs.

The support for multiple BSSIDs with corresponding beacons results in proper client association to the suitable access point. The baseline test performed with a single BSSID showed the same level of performance for both the systems under test – 6.13 Mbps. However, when engineers introduced multiple

Symbol Technologies, Inc.

Wireless LAN System

Functionality and Performance

TOLLY Up to Spec CERTIFIED

Symbol Technologies, Inc.
Wireless LAN System
Product Specifications*

Features

Scalable radio architecture
- WS 5000 supports 2.4-GHz and 5-GHz frequencies
- Support for 802.11a/b/g, FH, DS, and OFDM radio operations
- Many external antenna options – omni, panel, etc.

Per device QoS with Bandwidth-Weighted Fair Queuing
- Quality of Service (QoS) for each mobile device guarantees bandwidth for applications or users
- Identify and control traffic using Layer 2/3/4 classification, DiffServ and 802.1p packet marking
- Power Save Protocol (PSP) – Per device sleep-stage queues maintain application QoS and extends/maximizes battery life

Wireless traffic engineering
- Wireless VLANs with multi ESS/BSSID
- Bandwidth controls limit broadcast/ multicast/unicast packet forwarding
- Wireless-aware proxy ARP controls client to client visibility and reduces background load from the WLAN
- Extends battery life – improves security

Load balancing
- More consistent network performance – stops annoying pauses in applications

Pre-emptive roaming
- Clients roam before connection quality erodes

Automatic channel selection
- Optimizes radio channel planning and installation, scans and selects the best channel based on noise and signal quality properties

Transmit/output power control
- Minimizes radio interference by enabling RF tuning

Wireless certifications
- WECA/Wi-Fi – 802.11a, 802.11b

Simplified management
- Command line interfaces (telnet, serial), Web-based Java applet, SNMP
- Rule- or policy-based control of switch parameters up to 32 WLANs, either manually or via easy-to-use wizards
- Policy control radio settings, Quality of Service (QoS), VLANs, ESS/BSSID domains, Layer 2/3 filtering, DHCP, NAT, and more

System redundancy
- Exchanges the system configuration and a simple heartbeat message between WS and RS switches
- At failure – redundant switch takes control of the wireless

End-to-End layered security framework
- Complete end-to-end security using rule- or policy-based security classes that control users, applications, and devices
- Controls access, authentication, filtering, encryption

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**Vendor-supplied information not verified by The Tolly Group*

BSSIDs and supported multiple applications enabled through the virtual WLANs, the Symbol WS 5000 maintained its throughput of 6.13 Mbps, providing 27% greater throughput than the Cisco Aironet 1220, which supports just a single BSSID. (See Figure 4.)

QoS Validation

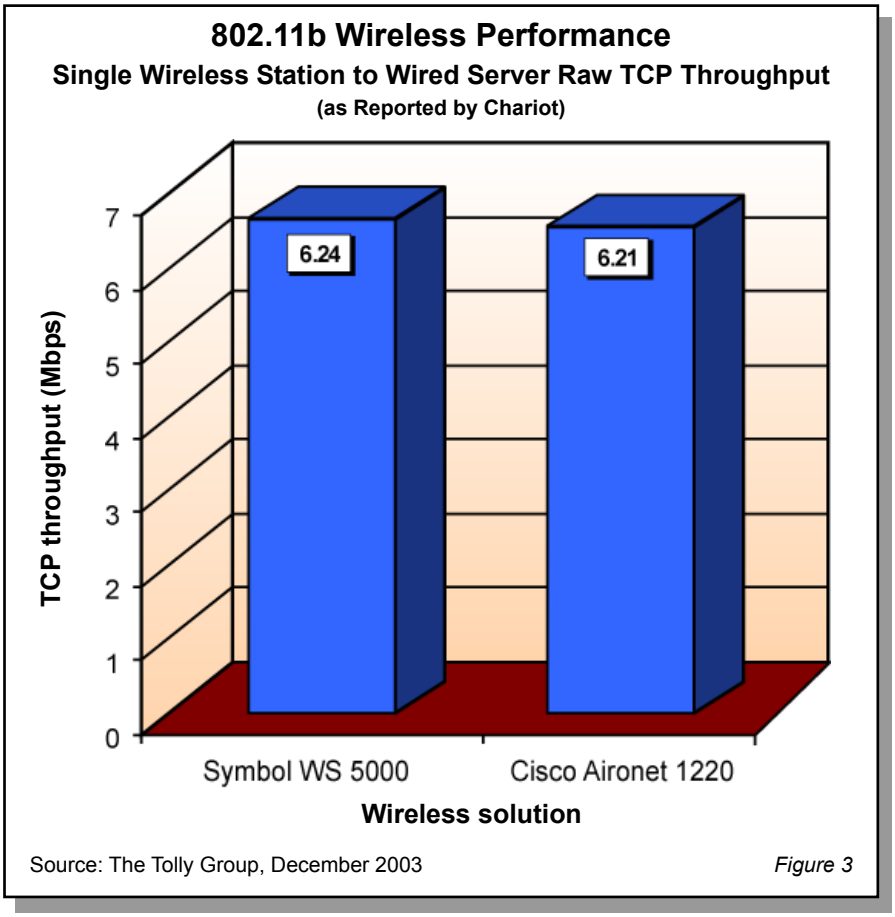
Tests show that lower-priority WLAN traffic flowed across the network initially, but once higher-priority WLAN traffic came in, bandwidth was apportioned according to QoS policy. In another scenario, the WS 5000 was configured to provide two virtual WLANs with bandwidth allocated based on a 9:1 bandwidth allocation split. Tests show that the higher-priority VLAN was reallocated bandwidth from the lower-priority traffic as traffic increased.

Analysis

Throughput results indicate that the centralized intelligence provided by the Symbol WS 5000 delivers the same or better aggregate throughput compared to the traditional AP technology offered by Cisco's Aironet 1220.

Symbol Technologies' support for multiple BSSIDs with corresponding beacons results in proper mobile client association to the suitable access point while implementing virtual WLANs. The baseline test performed with a single BSSID showed the same level of performance for both systems tested. But with multiple applications enabled through the virtual WLANs and multiple BSSIDs, the WS 5000 achieved 27% higher throughput compared to the Cisco Aironet 1220 AP, which assigns just a single BSSID to virtual WLANs.

On the QoS side, one major advantage of the centralized Symbol Technologies architecture is that QoS service functions and policies, along with security management are centrally provided at the switch, which will be particularly beneficial when many access points need to be deployed to provide wireless access in the Enterprise.



Source: The Tolly Group, December 2003 *Figure 3*

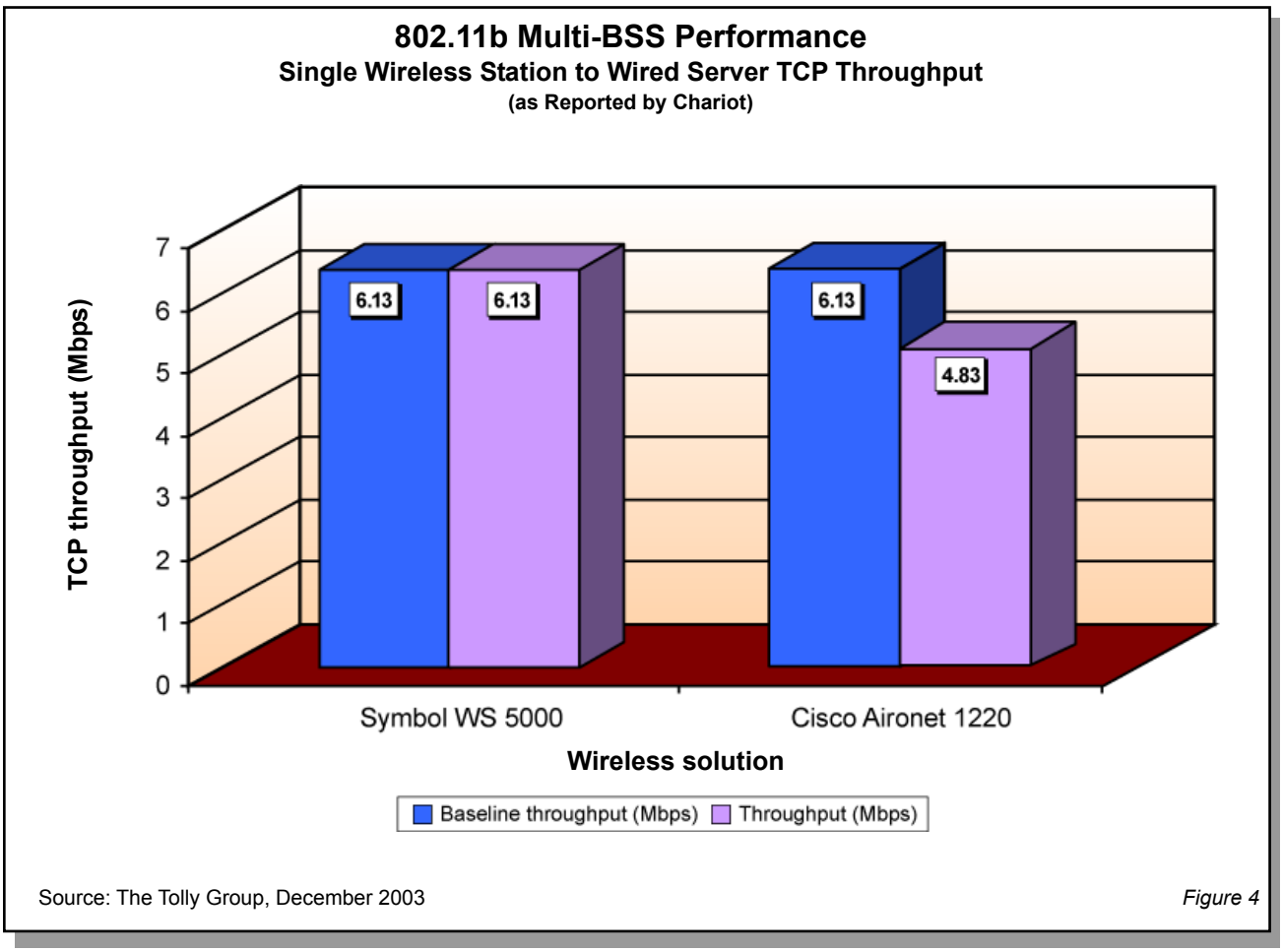
With regards to roaming, maintaining data rate or wireless throughput is very important for smooth running of many applications. As tests bear out, the Symbol Wireless Switch System delivers ample bandwidth to users who roam from one AP to another, while the Cisco APs sizable drop in application throughput would result in serious application interruptions as users roam from one AP to another.

On another mobility front, the significant enhancement in battery life observed for a portable device with the Symbol Wireless Switch System can be attributed to its ability to minimize the impact of broadcast traffic on the network with multiple BSSIDs. With the ability of the Symbol WS 5000 to provide virtual WLANs, these portable devices need not change from their standby modes as often.

Also, the application-specific security options available with the Symbol WS 5000 system such as KeyGuard (Symbol's implementation of Temporal Key Integrity Protocol) helps in an enhanced battery life for portable devices as the computation intensity of the standard security mechanism is one of the major factors that can affect the battery life.

Test Configuration and Methodology

For performance tests, The Tolly Group tested a Symbol WS 5000 Wireless Switch running version 1.1.4.30 SP1 software. The WS 5000 connected to a Nortel Networks BayStack 450 switch that provided connectivity to wired clients running NetIQ Chariot Endpoint ver. 4.5



Source: The Tolly Group, December 2003

Figure 4

analysis software. The BayStack 450, in turn, provided access to Symbol AP100 access ports via Category 5/6 cabling, thereby delivering power over Ethernet to the access port radios. Alternatively, for competitive tests, a Cisco Systems Aironet 1220 access point replaced the Symbol gear connected to the BayStack 450. (See Figure 5.)

PC-based clients tested with Symbol products used Symbol network interfaces; clients tested with Cisco equipment used Cisco NICs.

In various benchmark measurement tests, the TCP throughput was measured as average TCP throughput reported by Chariot for each test run. The aggregate TCP throughput reported represented the average value of three test iterations. Likewise, latency was recorded by Chariot. Chariot also recorded the TCP throughput for the multi-BSS test.

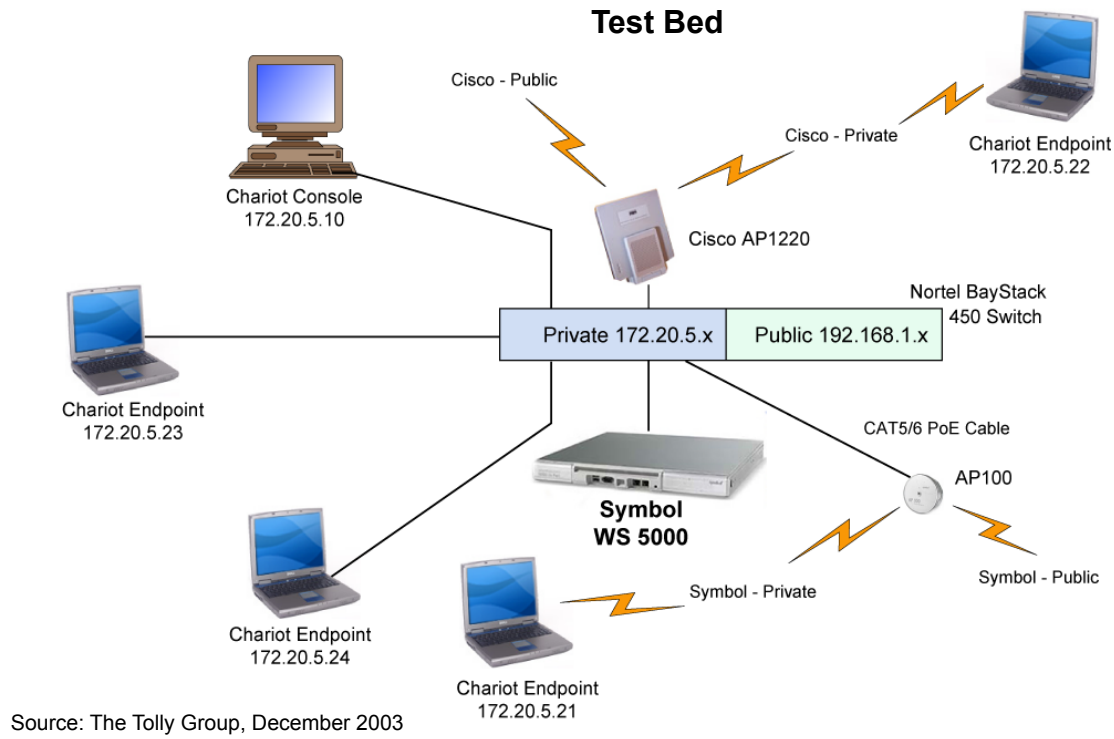
For mobility tests, roaming performance was evaluated in terms of the upstream TCP throughput as measured by Chariot while the wireless device roams in the WLAN. The battery life test was performed using a script capable of sending Ping packets to the wireless device. The device responds to the Ping packet as long as the device is active.

To conduct the roaming performance test, engineers established a WLAN to enable communications between a wireless laptop and a wired device through the test infrastructure with two access points that were about 50 feet apart. The ESSID was set to the same in both the access points. Engineers configured Chariot to run the TCP throughput for the upstream traffic (wireless to wired device) with the script filesndl.scr.

Engineers started the Chariot test while moving the wireless device away from the first AP till the device associates with the second AP. This was counted as one roam. They continued roaming the device between the two access points. At the end of six roaming counts, engineers recorded the average TCP throughput.

Equipment Acquisition and Support

Cisco products used in this test were acquired through normal product distribution channels. As per The Tolly Group's Fair Testing Charter, engineers contacted Cisco and invited the company to participate in the test by reviewing the test methodology and commenting on results. Cisco declined the offer.



Source: The Tolly Group, December 2003

Figure 5

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

Vendor	Product	Web address
NetIQ	Chariot 4.3	http://www.netiq.com
NetIQ	Chariot Endpoint 4.5	http://www.netiq.com

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For info on the Fair Testing Charter, visit: http://www.tolly.com/Corporate/FTC.aspx

Project Profile

Sponsor: Symbol Technologies, Inc.

Document number: 204100

Product class: Wireless LAN system

Products under test:

- Symbol Technologies WS 5000 Wireless Switch 1.1.4.30SP1
- Symbol Technologies AP100 Access Port 1.2.0.3
- Cisco Systems Aironet 1220B 5.02.12

Testing window: December 2003

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