THE TOLLY GROUP

No. 203123 September 2003

Airespace™, Inc.

Airespace 4000 Wireless Switch/ Airespace 1200 Access Point

Evaluation of Enterprise-Class VoIP over 802.11 Wireless LANs

Test Summary

Premise: *During periods of link level congestion, particularly in shared bandwidth 802.11b wireless networks, Voice over IP (VoIP) calls need to be guaranteed bandwidth precedence over non real-time data sessions. It is imperative that switching components and access points that bridge the wired world to wireless devices, demonstrate that Quality of Service (QoS) can be effective in apportioning bandwidth to wireless users.*

Airespace™, Inc. commissioned The Tolly Group to evaluate its Airespace 4000 Wireless Switch and Airespace 1200 Access Point. The Airespace 4000 Wireless Switch offers up to 24 10/100 Ethernet interfaces to provide Ethernet switching capabilities and communication paths to Airespace 1200 Access Points. The Airespace 1200 AP is an 802.11 a/b/g device that connects to the Airespace 4000 switch via Fast Ethernet and communicated with wireless clients.

Engineers sought to determine the effectiveness of Airespace products at supporting VoIP over 802.11b wireless LAN connections with key capabilities such as: QoS prioritization of VoIP over non real-time traffic, support for maximum VoIP phone loading, acceptable hand-off times for calls roaming between switches, and acceptable latency characteristics.

Tests were conducted during September 2003.

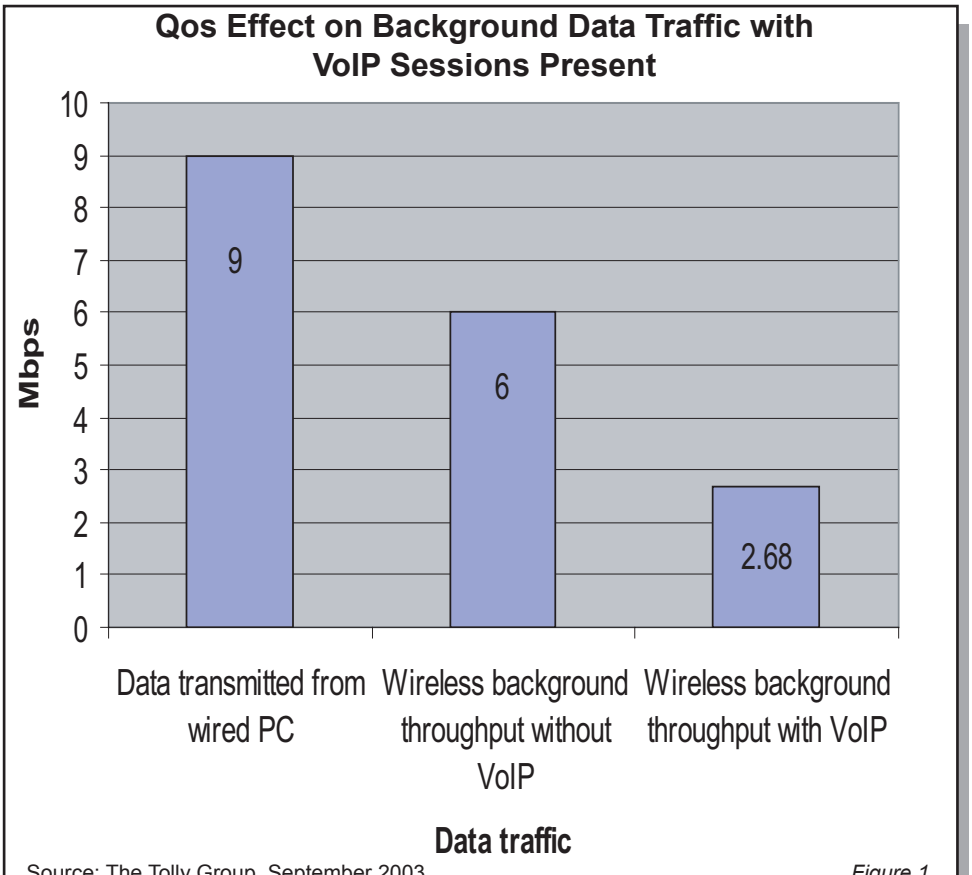
Results

QoS/Prioritization

This test illustrates how the Airespace

Test Highlights

- Throttles back non real-time data with QoS active when VoIP sessions traverse the Airespace 1200 access point
- Supports up to 14 VoIP phones per wireless access point
- Achieves interrupt-free hand-off in same-switch/different switch/different-switch/different-subnet deployments
- Delivers average wireless system latency of 3 milliseconds, proving that infrastructure should not impact wireless session performance



Source: The Tolly Group, September 2003

Figure 1

infrastructure solution, in conjunction with SpectraLink's proprietary "SVP" voice prioritization scheme throttles down background data traffic when VoIP sessions are transiting the wireless network. (See Figure 1.) Note: SpectraLink Corp.'s proprietary SVP QoS mechanism was used in conjunction with Airespace products to provide bandwidth management and ensure VoIP traffic received the bandwidth it needed over the wireless links.

Engineers observed that the wireless infrastructure automatically throttled back non real-time data when VoIP sessions were traversing the access point. Additionally, tests proved that this throttling was dynamic by illustrating that the data traffic, which was generating sufficient traffic to "overload" the access point was throttled back in the presence of VoIP sessions and allowed to consume additional bandwidth as VoIP sessions were removed from the network (i.e. terminated).

Airespace Performance Summary

Test	Description	Result
VoIP Priority over Data	Illustrate AP prioritizing VoIP over data	Passed
VoIP Capacity	Illustrate simultaneous support of 14 VoIP/wireless conversations	Passed
Handoff: Same Switch/Same Subnet	VoIP conversation roams between two APs on the same IP subnet of the same switch	Passed
Handoff: Different Switch/Same Subnet	VoIP conversation roams between two APs on the same IP subnet spanning two different switches	Passed
Handoff: Same Switch/Different Subnet	VoIP conversation roams between two APs on different IP subnets that share the same switch	Passed
System Latency	Measure end-to-end latency of LAN switch and access point	3 ms. average

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

While 9.77 Mbps of traffic was generated by a wired PC, only approximately 2.68 Mbps of traffic was received by the wireless PC while the VoIP sessions were active. By the time each VoIP session was terminated, the wireless PC was receiving roughly 6 Mbps, which approximates the maximum bandwidth that a single station can receive in an 802.11b WLAN. (See Test methodology & Configuration.)

VoIP Wireless Phone Scalability

Users of VoIP/wireless phones need to know the maximum phone load that the wireless infrastructure can handle. In this test, the Airespace infrastructure supported the maximum number of SpectraLink phones that were available for testing, which was 14. (See Figure 2.)

Access Point Session "Hand-off"

By definition, VoIP/wireless users will expect to be able to roam in the workplace and still maintain phone calls, despite moving from AP to AP. This test verified that telephone conversations remain uninterrupted when migrating from AP to AP on various combinations of switch location and IP subnetwork. Engineers determined that the best session "hand-off" time between APs was as low as 31 milliseconds. (See Figure 2.)

System Latency

Using SmartBits, engineers ran a series of latency tests. These tests, ultimately, indicated that the system under test, which included the Airespace 4000 Wireless Switch and the Airespace 1200 Access Point exhibited an average latency of 3,000 microseconds (msec) or 3 ms. (See Figure 2.)

Analysis

The ability to throttle back non real-time traffic and prioritize VoIP is a key element of any Enterprise-class VoIP/wireless solution. Given that IEEE 802.11b networks are relatively slow and implement a shared-bandwidth architecture, providing QoS is far from being just an "academic" feature. While voice quality was not measured during the test, the bandwidth was throttled

down to such a level that there was likely more than sufficient bandwidth available to provide good quality voice service.

QoS is but one of the major factors in wireless switch selection; session scalability is key, too. Users of VoIP/wireless don't want their system scalability limited by the wireless infrastructure. This test illustrated that for all practical purposes, the Airespace wireless infrastructure could support a "maxed out" VoIP/wireless gateway by supporting 14 simultaneous VoIP/wireless conversations.

Roaming is also a must-have feature of any wireless infrastructure. Tests showed that VoIP/wireless conversations can be maintained effectively when moving between APs in different configurations: Same switch/same subnet, different switch/same subnet, different subnet.

Lastly, the average latency of 3ms. illustrates that the wireless infrastructure will not introduce significant latency into the system.

Test Configuration and Methodology

For performance tests, The Tolly Group tested an Airespace 4000 Wireless Switch version 1.2.59.6 (FCS) Fast Ethernet switch with IEEE 802.11b wireless support and an Airespace 1200 Access Point Version 1.2.59.6 (FCS) wireless access point.

The Airespace products were tested in conjunction with SpectraLink Corp.'s NetLink Telephony Gateway 150, which served as an interface between wireless and wired telephony switches. The testbed also utilized a SpectraLink Voice Priority Server (SVP Server) that provided proprietary QoS capabilities in the wireless network. (See Figure 3.)

In the QoS tests, engineers ran two tests. In the first, engineers established eight (8) calls from eight different wireless IP phones to eight regular phones (connected to a PBX) and without any background IP traffic. In the second test, engineers established eight calls from different wireless IP phones to eight regular phones (connected to PBX) and set up a PC with LAN traffic to send IP traffic to another PC with Bronze QoS priority. All the VoIP traffic was set to use "Gold" QoS priority. Airespace currently provides proprietary QoS (Gold, Silver and Bronze) that closely models the 802.11e architecture.

Once engineers established the call sessions in each test, they began to generate IP traffic "downstream" from a wired station to a wireless station on the same AP as the phones. Engineers monitored the traffic being received on the wireless PC and verified that it was less than what was being generated.

Then, the engineers began to terminate the VoIP sessions while monitoring the data traffic received on the wireless client. They verified that as each VoIP session terminated, the bandwidth being used to transport the background data traffic increased.

In the VoIP capacity test, engineers established 14 calls and verified that 14 calls remained active - connectivity to SpectraLink gateways was maintained.

In the test of phone hand-off between APs, engineers verified the test results for (1) same switch mobility, (2) inter-switch (same subnet) mobility, and (3) inter-subnet mobility.

Engineers recorded the RF packet trace to report the handoff time of the 802.11b disassociation, 802.11b Authentication, and 802.11b Association (new AP). A Wildpackets, Inc. Airopeek NX Wireless LAN Analyzer was used to observe hand-off times.

For system latency tests, engineers used the SmartBits SmartFlow application to measure latency.

TESTED with SPIRENT

Airespace Inc.

Airespace 4000 Wireless Switch

Airespace 1200 Access Point

Enterprise Class-VoIP over 802.11b Wireless LANS

TOLLY Up to Spec CERTIFIED

Airespace, Inc.
Airespace 4000 Wireless Switch
Airespace 1200 Access Point
Product Specifications*

Airespace 4000 Wireless Switch

- 24 10/100 Mbps-TX ports, one 1000Base-SX with LC connectors or one 1000Base-T port, power over Ethernet, enhanced security module with powerful crypto processor, and WLAN software
- Weight: 11.9 lbs (5.4 kg)
- Dimensions (WxDxH): 17.5 x 13 x 1.75 in. (44.5 x 33.1 x 4.5 cm)
- Power over Ethernet: 48 VDC over CAT5, IEEE 802.3af PoE specification
- Input power
- With POE: 2.6 A at 110 VAC, 60 Hz, 1.3 A at 220 VAC, 50 Hz
- Without POE: 1.4 A at 110 VAC, 60 Hz, 0.8 A at 220 VAC, 50 Hz
- Three LEDs: Status, 1000BaseX activity and alarm. Separate Link and activity LEDs for 1000Base-SX and 1000Base-T modules
- Operating temperature: 0 to 50°C (32 to 122°F)
- Storage temperature: 25 to 70°C (-13 to 158°F)
- Operating humidity:10-95%, non-condensing
- Storage humidity: up to 95%

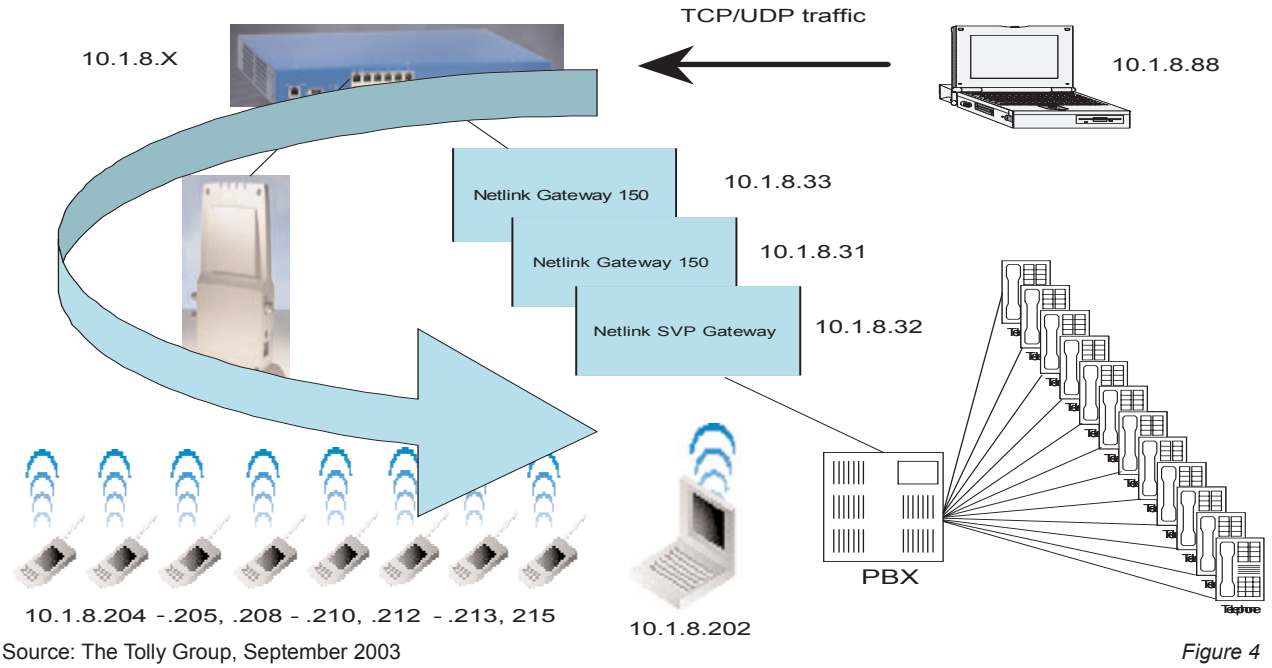
Airespace 1200 Access Point

- Enterprise class multi-band 802.11a/b/g access point, plenum ratable cast aluminum cased, power over Ethernet, internal high gain dual-band antennae with configuration pat tern, external antenna connectors, flexible mounting options
- Weight: 1.6 lbs (0.72 kg)
- Dimensions (WxDxH) - 9 x 5.5 x 1.75 in. (22.9 x 14.0 x 4.4 cm)
- Color: neutral white and paintable to suit your environment
- Four LEDS: power, alarm, 5 GHz activity, 2.4 GHz activity
- Antenna: integrated 2.4 and 5 GHz 8dbi diversity patch, external two 2.4 GHz RP-TNC connectors, one 5 GHz RP-TNC con nector, diversity
- Brackets: multi-purpose ceiling and wall mountable brackets
- Theft deference and locking mechanism
- Power Over Ethernet: 802.3af compliant, 24VDC +/- 10% to 60 VDC
- External Power Adapter: optional 15W, 250mA
- Operating temperature: 0 to 40°C (32 to 104°F)
- Storage temperature: 25 to 70°C (-13 to 158°F)
- Operating humidity: 10 to 95%, non-condensing

For more info, contact: Airespace, Inc., 110 Nortech Parkway, San Jose, CA 95134, Phone: (408) 645-2000, Fax: (408) 635-2020, URL: http://www.airespace.com

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

Test Bed



Source: The Tolly Group, September 2003

Figure 4

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

Vendor	Product	Web address
Spirent Communications	SmartBits	http://www.spirentcom.com

Tolly Group Services

With more than a decade of testing experience of leading-edge network technologies, The Tolly Group employs time-proven test methodologies and fair testing principles to benchmark products and services with the highest degree of accuracy. Plus, unlike narrowly focused testing shops, The Tolly Group combines its vast technology knowledge with focused marketing services to help clients better position product benchmarks for maximum exposure. The company offers an unparalleled array of reports and services including: Test Summaries, Tolly Verifieds, performance certification programs, educational Webcasts, white paper production, proof-of-concept testing, network planning, industry studies, end-user services, strategic consulting and integrated marketing services. Learn more about The Tolly Group services by calling (561) 391-5610, or send E-mail to info@tolly.com.

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

Project Profile

Sponsor: Airespace, Inc.

Document number: 203123

Product Class: 10/100 Mbps Wireless Switch and IEEE 802.11b Access Point

Products under test:

- Airespace 4000 Wireless Switch Version 1.2.59.6 (FCS)
- Airespace 1200 Access Point Version 1.2.59.6 (FCS)

Testing window: September 2003

Sofware Status: Generally Available

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at http://www.tolly.com, send E-mail to info@tolly.com, call (561) 391-5610.

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