TEST REPORT

Tolly.

#213129

July 2013

Commissioned by
Hughes Network Systems, LLC.

HughesON Network Solutions with Hughes Active Technologies

Broadband Quality-of-Service (QoS) and Bandwidth Capacity Evaluation

EXECUTIVE SUMMARY

Today's distributed organizations require networking solutions that deliver high capacity and excellent application performance. Common approaches to addressing these challenges include the addition of a WAN optimization appliance and/or provisioning Ethernet access to each branch location. However, this approach, while suitable for large sites, is too costly and complex for wide deployment to smaller branch locations.

HughesON Managed Network Solutions integrate proprietary QoS, data compression and link bonding technologies to provide broadband customers with enterprise-class application performance. Hughes Network Systems commissioned Tolly to evaluate the effectiveness of Hughes ActiveQoS™, ActiveCompression™ and ActiveBonding™ technologies on live broadband networks.

Tolly found that Hughes ActiveQoS™ technology effectively prioritized transaction traffic on an oversubscribed link. Coupled with Hughes ActiveCompression™, this results in excellent application performance for latency-sensitive traffic. See Figure 1. In addition, Tolly found that Hughes ActiveBonding™ broadband aggregation provided a cost-effective method of delivering high capacity to branch sites. See Figure 4.

THE BOTTOM LINE

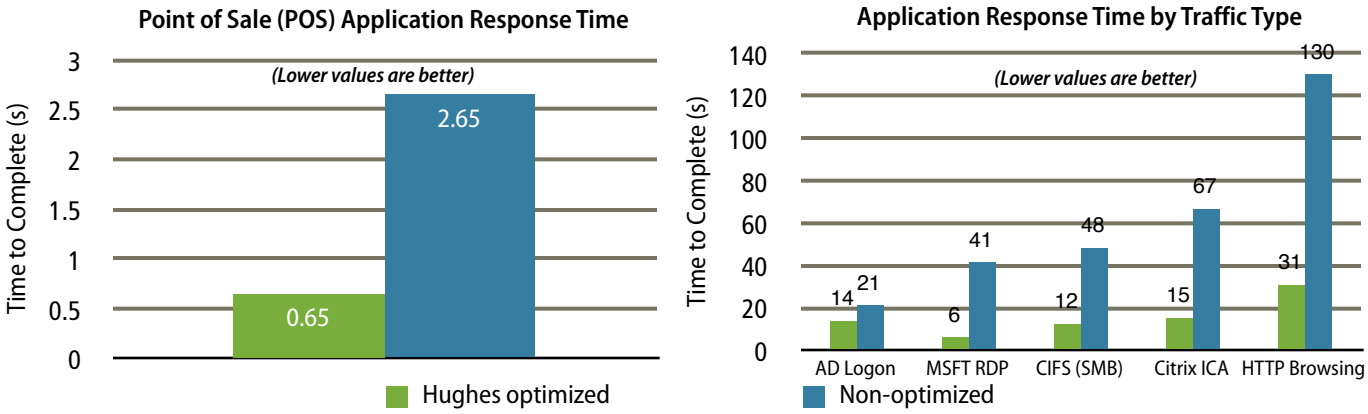
Hughes Active Technologies provide:

1. Scalable high capacity by aggregating multiple broadband lines
2. The ability to transform multiple low bandwidth links into a high-performance, fault tolerant WAN
3. Up to a 5X improvement in response time and application throughput under load
4. The ability to deliver toll-quality voice over broadband
5. The ability to adapt dynamically as new applications are added

Hughes ActiveQoS™/ActiveCompression™ Performance for Various Traffic Types

Across Single Oversubscribed ADSL Link

as Reported by Ixia IxChariot 7.30 EA



Notes: Link oversubscribed to simulate load. ADSL line provisioned at 3Mbps down, 512Kbps up.

Source: Tolly, April 2013

Figure 1

QoS/Compression

Assuring good application response time for remote users is essential for ensuring user productivity. Unfortunately, broadband links can't differentiate between, say, a critical order transaction and a file backup. Without some kind of bandwidth optimization in place, bandwidth intensive applications like file transfer can easily overwhelm the link and degrade the performance of important business transactions.

Quality-of-Service technology is required to provide the intelligence to differentiate among different traffic types and to allocate bandwidth resource appropriately.

Tolly benchmarked the response time of eight different latency-sensitive traffic types including business transactions, VoIP, streaming video and remote desktop access running on oversubscribed links with and without Hughes ActiveQoS and ActiveCompression technology as implemented in the Hughes HS1200 Broadband Optimization Appliance (also available in the Hughes HR4700 Branch Gateway).

In every case, the response time of the critical application improved dramatically when optimized by the Hughes Active Technologies. See Figures 1 through 3.

High Capacity

While broadband data rates continue to grow, there are times when even the highest-capacity broadband link will not suffice for a branch location.

Simply deploying multiple broadband connections will not solve the problem as an application will be able to see just a single link. Hughes ActiveBonding, implemented in its broadband modems, solves this problem by logically bonding together multiple, separate broadband circuits into a single logical pipe, thus offering any individual user application capacity that exceeds that of any single link. Tolly benchmarked up to a four circuit scenario and confirmed uplink capacity of 1.8Mbps and downlink capacity of 11.03Mbps. See Figure 4.

Hughes Network Systems, LLC

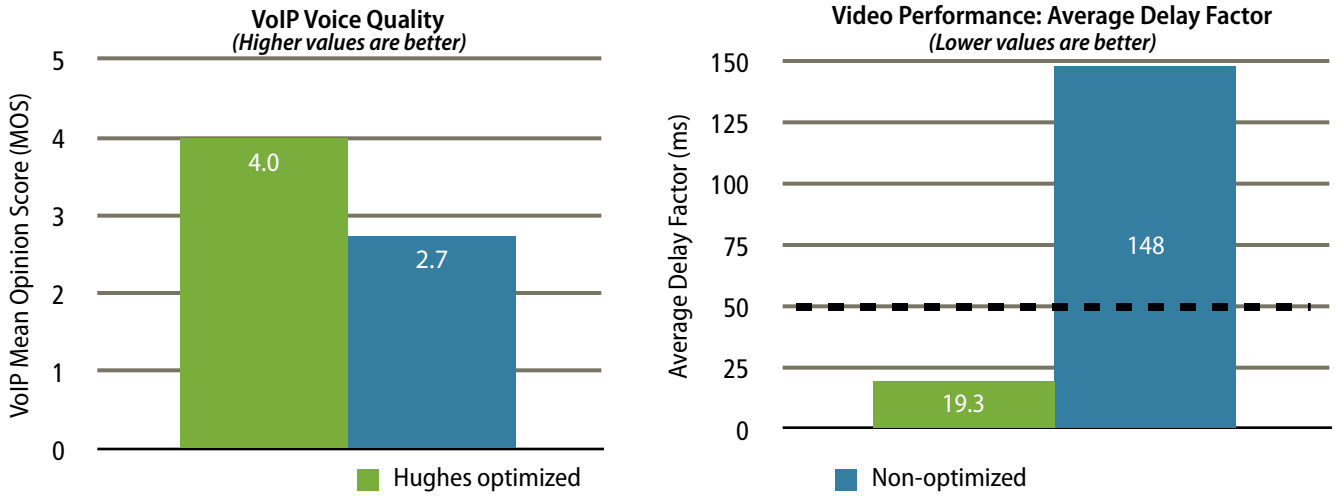
HughesON Network Solutions with Hughes Active Technologies

Performance and Capacity Evaluation

Tolly. Certified

Tested April 2013

VoIP and Streaming Video Performance with Hughes ActiveQoS™/ActiveCompression™
Across Single Oversubscribed ADSL Link
as Reported by Ixia IxChariot 7.30 EA



Notes: Link oversubscribed to simulate load.. ADSL link provisioned at 3Mbps down, 512kbps up.

Source: Tolly, April 2013

Max. acceptable value for delay factor per Agilent Technologies.

Figure 2

Detailed Test Results

ActiveQoS

Tolly evaluated the HughesON Performance Optimization technologies on the Hughes HS1200 Broadband Optimization Appliance with ActiveQoS and ActiveCompression. These technologies optimize available bandwidth thus increasing throughput and reducing the response times of applications.

Business Transactions

To evaluate the effectiveness of Active QoS, Tolly engineers benchmarked the response time of a Point-of-sale (POS) application both on a network using Hughes ActiveQoS and ActiveCompression technology versus a non-optimized network.

The Hughes optimized network delivered 75% faster response times than the non-optimized network. See Figure 1.

This performance improvement extends to other applications as well. Tolly tested five additional office application workloads such as Microsoft Active Directory (AD) logons, Microsoft and Citrix remote sessions, and a series of HTTP transactions.

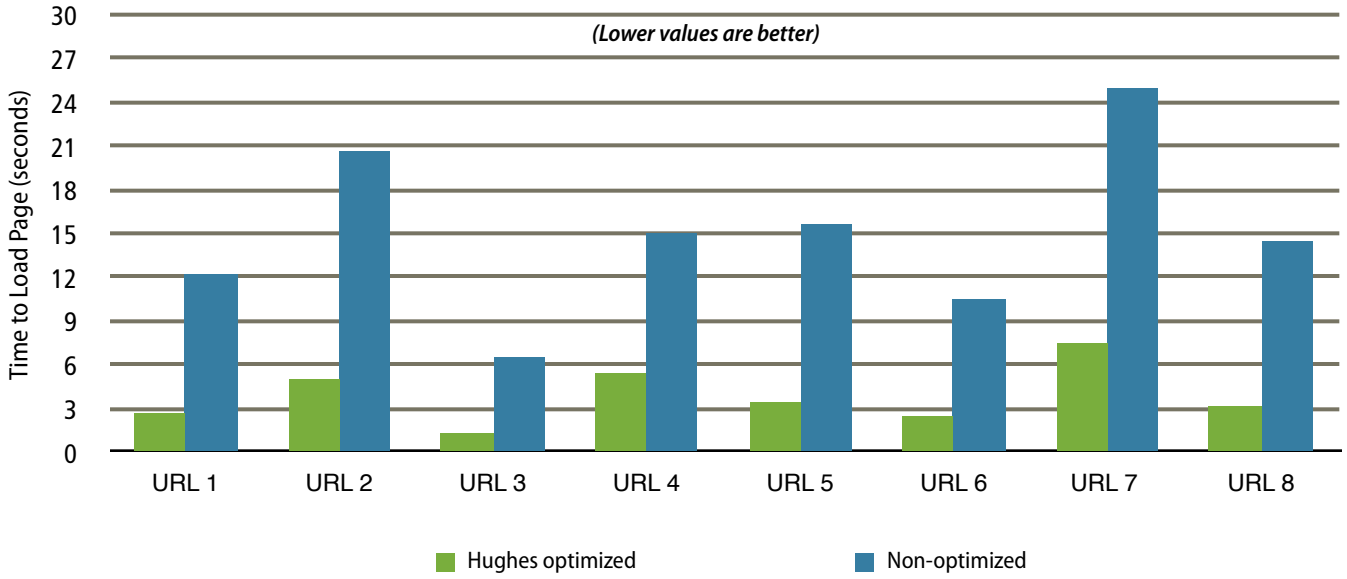
In Figure 1, the HS1200 demonstrates that the combination of ActiveQoS, and ActiveCompression (not benchmarked separately), can greatly reduce the time to complete business-oriented transactions. Optimizing connections with the HS1200 allowed AD logons to conclude in 33% less time, and downstream file transfers completed 75% faster than a standard, non-optimized DSL link.

Interactive network transactions are typically most affected by high latency and poor connections. A Microsoft Remote Desktop (RDP) workload, simulating user login and opening an application, took 41 seconds on a typical connection, flooded with background traffic. On the same connection, optimized with HughesON technologies, that same workload completed in just 6 seconds, 7 times faster.

VoIP and Streaming Video

Streaming media is quickly-becoming a standard requirement for branch connectivity, the ability to implement

Web Browsing Performance with Hughes ActiveQoS™/ActiveCompression™
Across Single Oversubscribed ADSL Link
as Reported by Ixia IxChariot 7.30 EA



Notes: Link oversubscribed to simulate load.. ADSL link provisioned at 3Mbps down, 512kbps up.

Source: Tolly, April 2013

Figure 3

realtime voice and video is often limited by the link quality.

Tolly engineers tested VoIP and streaming video performance over both connections. Using the G.711u voice codec, HughesON was able to provide a MOS of 4.0 (Good), versus a 2.7 without optimization. See Figure 2.

For streaming video, HughesON was able to deliver a delay factor of under 20ms, while the non-optimized connection was nearly 7 times longer which impacts video quality adversely, by injecting unnecessary amounts of latency in the application.

Web Browsing

Tolly evaluated the performance of HughesON ActiveQoS technology pertaining to Web browsing by testing the amount of time needed to load a Web page for eight different URLs under test.

A fully loaded network leveraging HughesON ActiveQoS technology loaded the Web pages, on average, in 3.8 seconds, 74% faster than a fully loaded network without optimization. The loaded network without Hughes ActiveQoS Technology required an average of 15 seconds to load the URLs under test. See Figure 3.

High Capacity

ActiveBonding

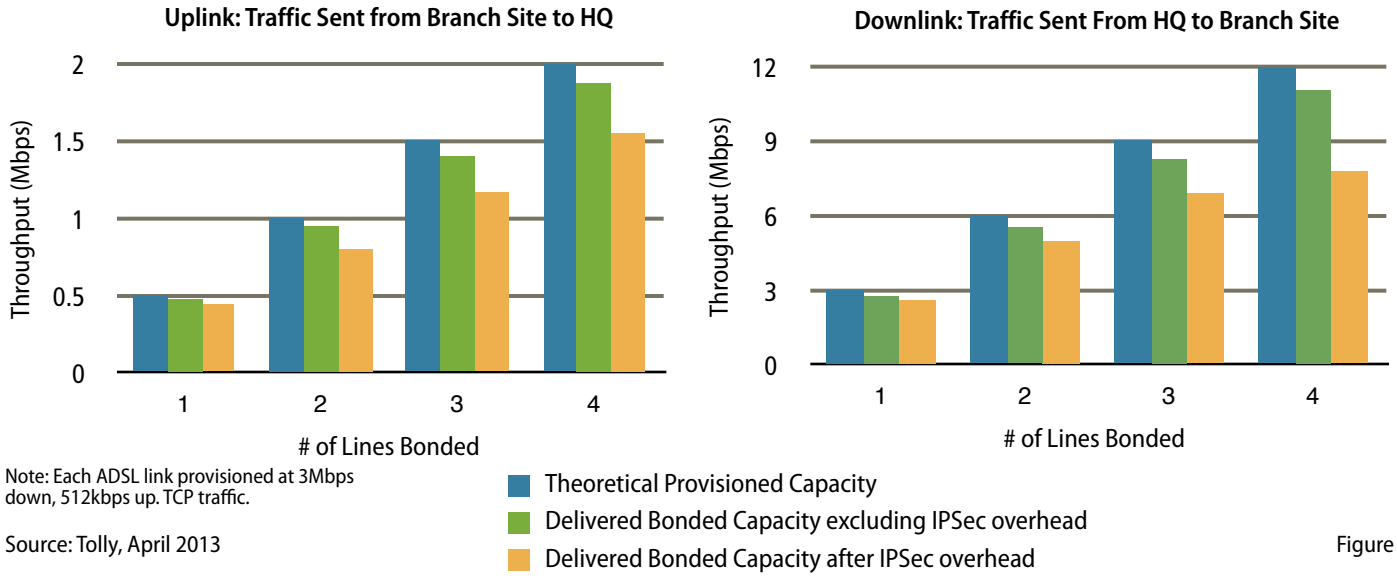
In scenarios where higher bandwidth is required, and a single broadband link will not suffice, Hughes offers ActiveBonding, a service coupled with specialized modems which aggregates the available bandwidth from one or more DSL circuits and forms them into a single, fault-tolerant logical link.

Hughes ActiveBonding is delivered in the form of modems or pairs of modems that can be stacked together to create a secure remote connection, allowing large video streams and file downloads to use all available bandwidth.

All traffic is delivered via an IPSec tunnel, transmitting over all links in the stack. At the backend, the tunnel terminates at Hughes' NOC where the traffic continues on to its destination. Additionally, if a customer has multiple sites deployed with Hughes, the traffic can be bridged within the Hughes network operations center (NOC).

To demonstrate the performance of ActiveBonding, Tolly engineers provisioned multiple 3Mbps down, 512kbps up ADSL links. Using the built-in IxChariot High-

Hughes ActiveBonding Capacity
Across One to Four ADSL Links
as Reported by Ixia IxChariot 7.30 EA



Note: Each ADSL link provisioned at 3Mbps down, 512kbps up. TCP traffic.

Source: Tolly, April 2013

Figure 4

Performance throughput script, engineers evaluated the throughput with 1, 2, 3, and 4 active modems, recording both the upstream and downstream throughput.

With four modems bonded, ActiveBonding was able to provide 1.8Mbps of uplink capacity resulting in 1.55Mbps of VPN bandwidth. In the same scenario, downlink bandwidth was 11.03Mbps with 7.76Mbps available to the VPN tunnel due to the IPSec overhead. See Figure 4.

Test Details

Setup

ActiveQoS and ActiveCompression

For the branch office ActiveQoS setup, Tolly provisioned one 3Mbps down, 512Kbps up ADSL line from AT&T that would be used for both with and without optimization. Engineers configured the modem (Motorola NVG510) in passthrough mode, and connected a single link to a Fortinet FortiGate 60c router, which controlled whether or not the traffic was sent through the Hughes HS1200 appliance.

For the headquarters side, Tolly provisioned a symmetrical 20/20 link, which was connected through a Zentyal 2.2 gateway to an Ixia IxChariot 7.30 EA console, from which the test traffic was run. An IPSec tunnel was configured on both WAN connections, terminating at the Hughes NOC.

Video Quality Measurement

There is no industry standard for measuring video quality, but most agree that a low delay factor (DF) is a key factor. An Agilent Technolgies White Paper on IPTV quality of experience cites 50ms as the maximum acceptable delay factor.[1]

ActiveBonding

Tolly provisioned four additional 3Mbps down, 512Kbps up ADSL lines from AT&T, giving each modem a unique LAN IP, to which four Hughes modems were attached, running Hughes bonding software. Each modem was daisy-chained to the next, and a single Ethernet link was connected to a separate Fortinet FortiGate 60c router, which provided the VPN termination and local addressing. An IxChariot 7.30 EA console was then connected to complete the setup. See Figure 5.

Methodology

ActiveQoS and ActiveCompression

For the ActiveQoS testing, Tolly engineers configured built-in IxChariot scripts for Active Directory, Microsoft RDP, Citrix ICA, HTTP, CIFS, and POS (MSSQL) transaction scripts to send/receive incompressible data with throughput caps added for the smaller POS transactions to emulate a user environment. Bidirectional VoIP (G.711u 64kbps) and Video (MPEG2 1Mbps) traffic was also configured in sets of 3 second timing records to evaluate the differences in streaming media quality.

Each IxChariot endpoint was configured with gigabit ethernet and a 802.11n Wi-Fi card, which was used to connect the endpoints locally for test execution and results polling.

To generate background traffic, engineers set up an FTP server on the Headquarters client and configured the remote client to push and pull large ISO files to and from the server. Additionally, this action ensured that the on-board cache in the HS1200 was continually flushed and not allowed to skew the test results.

Using a set of scripts, Tolly engineers configured the Fortinet appliance to either enable or disable the HS1200. FTP traffic was started, and each traffic type was then executed for two minutes, with a minute of idle time between each traffic type.

ActiveBonding

During the ActiveBonding portion of the evaluation, engineers configured the IxChariot endpoints as in the previous test, only without the HS1200 appliance. The Ixia high performance throughput script (with 1MB stream size) was configured to run in both directions.

Without background traffic, engineers configured the proper number of modems for the test, and ran a set of tests over the configuration. For each connected modem, the script was configured to send 4 pairs downstream and 1 pair upstream, such that it scaled as more modems were added.

The service is implemented as an IPSec VPN. To illustrate the bandwidth provisioning capabilities of the Hughes ActiveBonding technology engineers measured not only the application throughput but also calculated the bandwidth delivered by the Hughes solution when mandatory IPSec headers were factored out.

[1] IPTV QoE: Understanding and Interpreting MDI Values, http://cp.literature.agilent.com/litweb/pdf/5989-5088EN.pdf

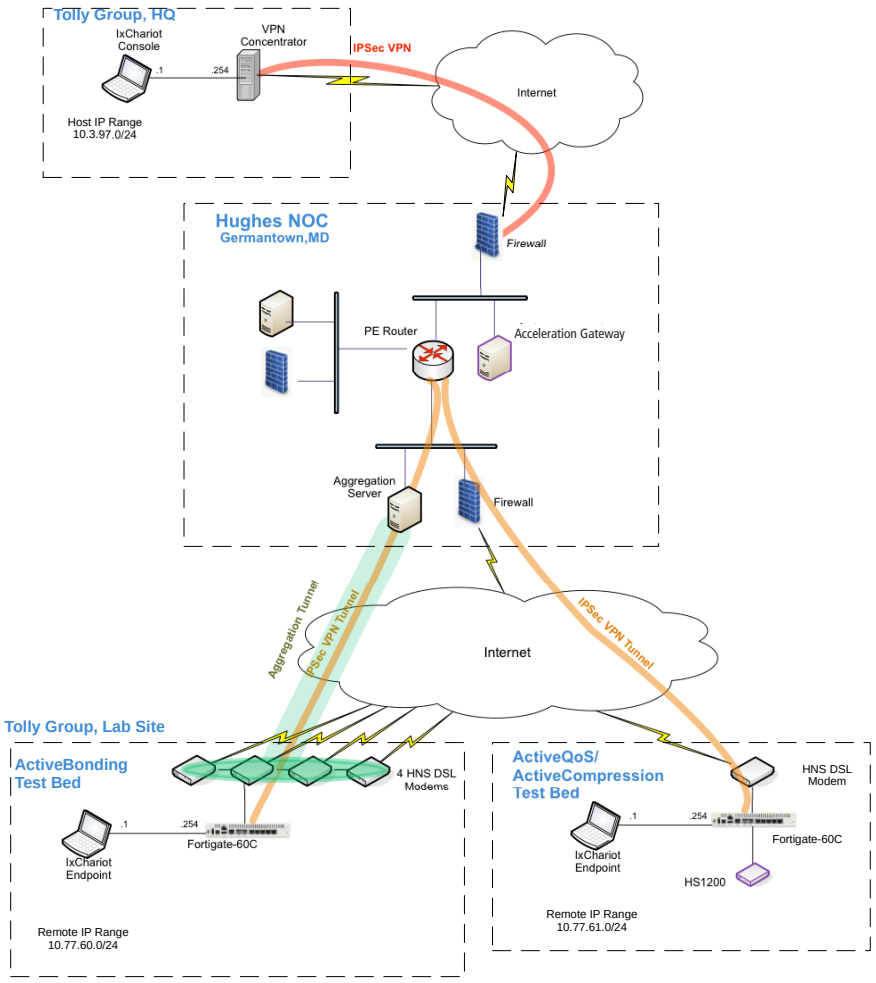
About Hughes

Hughes Network Systems, LLC (Hughes) provides manage network and digital media solutions to distributed enterprises such as retail, restaurant, hospitality, banking and retail petroleum under its HughesON brand. HughesON Managed Solutions enhance the customer experience, increase employee satisfaction and streamline operations. Using its innovative "Active Suite" of technologies, HughesON cost-effectively helps multi-branch companies enjoy faster applications, with greater security and more reliability. HughesON includes network solutions that deliver high-capacity access up to 12Mbps wherever broadband is available as well as high-availability solutions. Other solutions include managed VoIP, managed WiFi and managed security solutions. For more information visit HughesON.com

For more information, scan the QR code to go to the HughesON website.

Source: Hughes, June 2013

Test Bed Topology
Live DSL Links into Hughes NOC Infrastructure



Source: Tolly, April 2013

Figure 5

About Tolly

The Tolly Group companies have been delivering world-class IT services for more than 20 years. Tolly is a leading global provider of third-party validation services for vendors of IT products, components and services.

You can reach the company by E-mail at sales@tolly.com, or by telephone at +1 561.391.5610.

Visit Tolly on the Internet at: http://www.tolly.com

Test Equipment Summary

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

Vendor	Product	Web
Ixia	**IxChariot 7.30 EA**	http://www.ixiacom.com

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