Isocore Technical Report

Validation of Cisco SCE8000

ISOCORE Internetworking Lab
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About Isocore
Isocore provides technology validation, certification and product evaluation services in emerging and next generation Internet and wireless technologies. Isocore is leading validation and interoperability of novel technologies including Carrier Ethernet, IPv6, IP Optical Integration, wireless backhauling and Layer-2/3 Virtual Private Networks (VPNs) and currently focuses on IPTV service deployment architecture validation and design. Major router and switch vendors, Service Providers, and test equipment suppliers participate in Isocore activities. Isocore has major offices in the USA (the Washington DC area), Europe (Paris, France) and Asia (Tokyo, Japan).

1 EXECUTIVE SUMMARY

This report summarizes the key findings of an independent product evaluation of Cisco SCE 8000 Service Control Engine. SCE 8000 is the hardware component of Cisco service control solution. Recently, Cisco engaged Isocore to comprehensively evaluate the performance of the SCE 8000 platform for throughput, latency, connection scalability, bandwidth control, application classification, and high-availability. All tests were carried out at Isocore's facility in Washington metro areas in a completely independent environment with Cisco engineers supporting live through remote sessions.

The primary motivation of the test was to ensure that by inserting SCE 8000 in an inline network insertion mode no network performance degradation is observed while maintaining the same level of reliability offered by the network. The testbed was created as single device under test (DUT) environment, where all flows, subscribers were created and emulated by the test device. For this evaluation we chose Ixia XM2 test solution.

Key Findings and Conclusions:

The Cisco SCE8000 met the specifications provided to Isocore prior to the testing. The key highlights of the evaluation include:

1. Maximum Capacity Tests (with 64Byte packets)
   - 8 Million bidirectional flows across 4 ports and 250,000 subscribers
   - Total of 12 Million packets per second, with 64 byte packets
2. Maximum Capacity Tests (with Internet Mix (IMIX))
   - Total of 15Gbps(L1) bandwidth and 8 million bidirectional flows across 4 ports
   - The traffic pattern comprising of 7 services from 250,000 subscribers
3. SCE 8000 successfully demonstrated the support for 1 million subscribers and successfully detected over a million UDP/TCP flows/second
4. High-Availability
   - 6.2 ms recovery time, when reboot was issued using command line interface (CLI) with service/forwarding mode
   - 6 ms recovery time, when reboot was issued using the CLI without service (bypass mode)
   - No service interruption times observed while transitioning between link modes; from bypass to SCE 8000 service mode (bypass to forwarding mode) and vice versa
5. SCE 8000 successfully classified application traffic categories including encrypted or unencrypted peer-to-peer (P2P) traffic, web applications such as browsing, instant messaging separation etc
6. SCE 8000 provided layer-7 and bandwidth management in subscriber prioritization mode

Based on the observations made during the entire evaluation effort, the Cisco SCE 8000 platform successfully scaled and supported large number of subscribers, concurrent sessions met all the specifications put forth for this test. SCE 8000 also gracefully handled the failure scenarios with minimal service interruption. The platform also offered no-service interruption when the traffic is transitioned from bypass to the forwarding mode. Last but not least, SCE 8000 successfully passed all the tests verifying application classification and bandwidth management capabilities of an SCE inline solution.

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2 TEST OVERVIEW AND SUMMARY

For this evaluation, a test setup was prepared to offer both high capacity forwarding, and emulate large number of flows and endpoints (or subscribers). Testing focused on determining the maximum capacity of the SCE 8000, ability to support large subscribers and connection establishment rate while auditing the high-availability feature-set of the platform. Although throughput and high-availability were prime focus of this effort, additional tests for measuring latency introduced by inline insertion of the SCE 8000, and verifying the capability to provide bandwidth control and to classify different applications and protocols were executed.

The test setup included one SCE 8000 with 4 10-Gigabit Ethernet interfaces, and one Ixia XM2 test platform. Table 1 provides a summary of the test results, which were verified during the testing at Isocore.

Verified Capabilities	Observations/Measured Results
Maximum Capacity Tests (with 64 bytes and IMIX) and Latency	• **Total Throughput across SCE8000** o Maximum Throughput measured with 64 byte packets: 6.09 Gbps(L2) o with a total of 11.9 Mpps o Maximum Throughput measured with IMIX packets: 14.17 Gbps (L2) o with a total of 5 Mpps o 8,000,000 concurrent flows o 250,000 emulated subscribers • **Latency with Service** o Measured latency of 17.73µs for a 64 byte packet stream o Measure latency of 31.93µs for 1518 byte packet stream
Maximum Subscribers and Connection establishment rate	• **Maximum Subscribers** o 10 streams of 250,000 unique IP addresses on each port with a total of 1 Million subscribers o Total throughput verified at 14.24 Gbps(L2) o Tests carried out with IMIX traffic type • **Maximum Connections/Second** o Successfully discovered 1.1 million UDP connections/second

	o Successfully discovered 1.1 million TCP connections/second o Successfully discovered 1.13 million ICMP connections/second
High-Availability	• **Recovery Times from a Reload** o Service interruption time measured when reloading the SCE 8000 with service (forwarding mode): 6.25 ms o Service interruption time measured when reloading the SCE 8000 without service (bypass mode): 6.0 ms • **Recovery Times for Transitioning the flows** o No service interruption observed while moving the traffic from bypass to forwarding link-modes o No service interruption observed while moving the traffic from forwarding mode to bypass
Bandwidth Control and Application Classification	o L7 classification and bandwidth management in subscriber prioritization mode o Successfully differentiated a mix of P2P traffic, messaging services, web applications such as browser traffic and downloads

The results summarized in table 1 demonstrates both the connection scalability, and ability of the SCE 8000 to perform deep packet inspection at both high speed without affecting the deployed business and residential services in a carrier network. Furthermore, considering the criticality of the high-availability feature in any in-line DPI deployment, the results observed during this evaluation establishes SCE 8000 a reliable platform.

2.1 CISCO SCE 8000 –DEVICE UNDER TEST

Cisco service control engine (SCE 8000) performs stateful application classification and offers deep packet inspection of IP network traffic. Cisco SCE platform is available in 3 form factors SCE 1000, 2000 and 8000 with SCE 8000 being the highest performing of the SCE family.

The Cisco Service Control solution consists of four main components, the Service Control Engine (SCE) platform, Service Control Management Suite (SCMS) Subscriber Manager (SM), the Quota Manager (QM), Collection Manager (CM) and The Service Control Application (SCA) Reporter. The SM is used where dynamic binding of subscriber information and policies are required. The CM collects the usage information and statistics from the SCE platform and converts the collected data into simple files for further processing and collection by external servers. Lastly the SCA report, is a software component that process the data stored by CM, and provides reports from this data.

For this test Cisco offered one SCE 8000 along with CM, and SCA reporter console. In out tests we did not use the Subscriber manager. Instead we used the supplied SCE Subscriber Application Programming Internet (API). Cisco SCE 8000 was loaded with 4 SPA-1X10GE-L-V2 SPA interface processors, redundant AC power supply, SCE8000 service control module (SCM) and external optical bypass module. SCE8000 was loaded with software version 3.5.0 with SCA-BB console running compatible version.

2.2 TEST ENVIRONMENT AND SETUP

Figure 1 provides an overview of the test network setup that was used for all the tests accept the application classification tests, which required attaching real-world client application platforms. The DUT was connected to the XM2 test system mimicking the network and subscriber sides. Only 10-Gigabit Ethernet (10GE) interfaces were used in the test.

Figure 1: Cisco SCE8000 Physical Setup

In the setup only one (1) SCE 8000 was used, with 4x10-Gigabit Ethernet ports. The Ixia XM2 two-slot chassis was used for the setup, with a total of six (6) 10-Gigabit Ethernet ports; however, only four (4) were actually used during the tests.

3 TEST DETAILS AND OBSERVATIONS

The details of the tests executed and results observed are provided in this section. The testing focused on evaluating the following aspects of SCE8000 platform:

1. Maximum capacity benchmarking
2. Maximum subscribers and connection establishment rate
3. Latency with Service
4. Bandwidth control and application classification

The following sections provide summary overview of the test methodologies, objectives, and results of each of these tests.

3.1 MAXIMUM CAPACITY TESTS

The objective of the maximum capacity test was to determine the ability of the SCE8000 to sustain maximum traffic with service at different packet sizes. This testing was performed in two parts, the first one focused in pushing 8 million flows with 64 bytes and the second one with Internet mix (IMIX) packet sizes. For both tests, one of the key verification points was to validate ability of SCE8000 to support 8 million flows.

For the test the tester ports connected to the SCE8000 were configured with 8 million flows across 4 ports comprising of 64 bytes packets at a rate of 12 million packets per second. The traffic was classified for 32 different services, transmitted from 250,000 emulated subscribers. The subscribers were emulated in a way that each subscriber uses all 32 services. Figure 2 shows the live captured graphs from the test confirming the 8 million flows, and 250,00 subscribers.

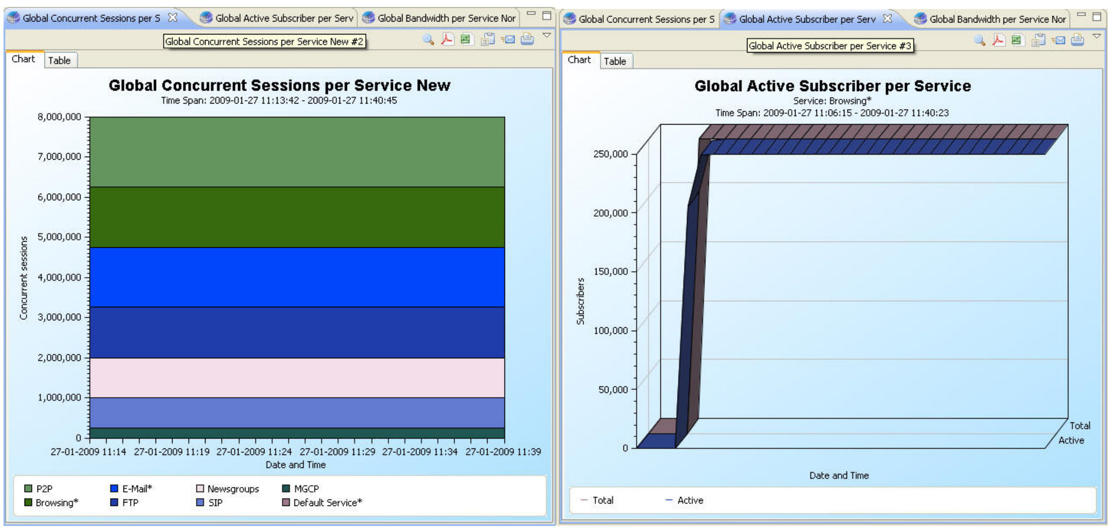


Figure 2: Global concurrent sessions (left) and maximum subscribers with 64 byte frames (right)

The test was repeated with IMIX packet size however for this case, the traffic was classified for 7 different services and transmitted from 250,000 different subscribers.

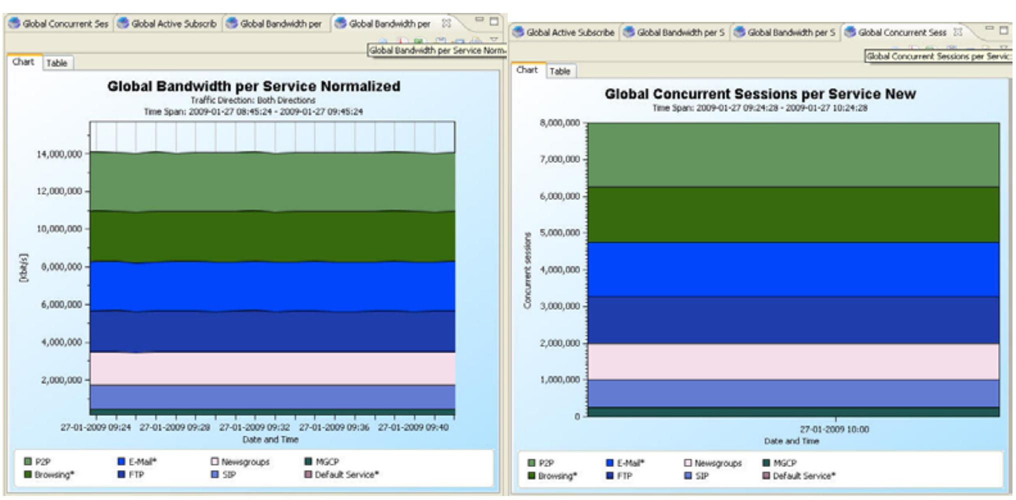


Table 2 presents the summary of capacity tests

Table 2: Results of the SCE 8000

Packet Size (Bytes)	Aggregate Throughput Achieved (L2 Gbps)	Total Packet Loss	Total number of flows used	Total number of Subscribers verified
64	6.09	0	8,000,000	250,000
IMIX (avg packet size 354)	14.17	0	8,000,000	250,000

The test results confirmed the capability of SCE8000 in supporting open 8,000,000 flows originating from 250,000 subscribers and its ability to service 15Gbps throughput.

3.2 MAXIMUM SUBSCRIBER AND CONNECTION ESTABLISHMENT RATE

The objective of this test was to verify the Cisco SCE 8000 capacity to support maximum number of subscribers. For the test the Ixia was configured to transmit IMIX traffic with simulated end subscribers. For the test the Ixia was configured to transmit IMIX traffic with simulated end subscribers. 10 streams were configured with unique 250,000 IP addresses on every port making the total end hosts/subscribers to reach 1 million unique end points/subscribers. These end hosts/ subscribers were introduced to the SCE using the SCE Subscriber Application Programming Internet (API) to minimize the configuration time. SCE subscriber API offers simplified subscriber provisioning which includes updating the network IDs, policy profile, and quota characteristics of the subscribers using the Subscriber ID for identification.

Figures 3 and 4 presents live capture from Cisco Service Control Application for broadband (SCA) reporter.

Figure 3: Max Subscriber with IMIX packet distribution

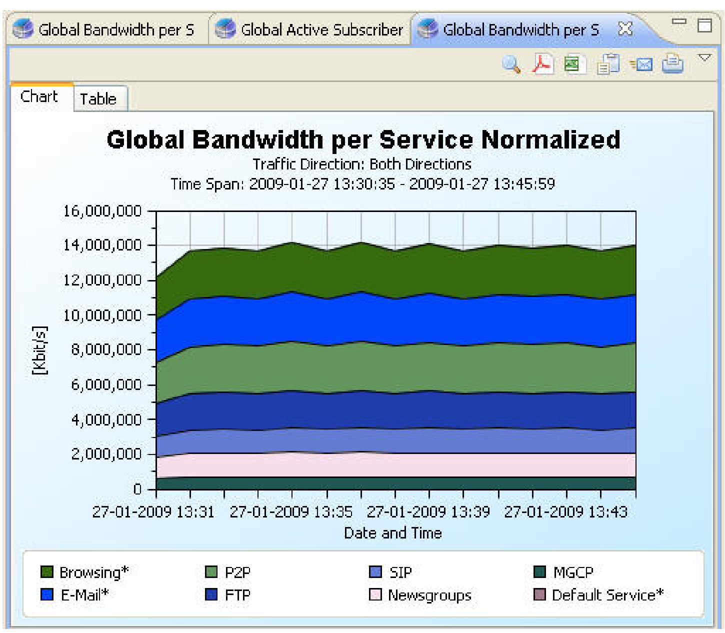


Figure 4: Max Subscriber with IMIX packet distribution

For benchmarking the maximum connection establishment rate supported by SCE 8000 platform, Ixia IxExplorer was configured to send a burst of traffic with 1.2M flows per port per second and SCE8000 was monitored for the number of flows that were opened and provided services. The number of flows opened on the SCE was verified by using “cscTpActiveFlows” Cisco MIB (*cisco-service-control-tp-stats) for* monitoring the number of open flows. Table 3 presents the overall summation of number of flows obtained from all processors.

Table 3: Connection Establishment Rate: Results

Protocol Tested	Measured/Calculated Connection Rate
TCP	1103322
UDP	1102962
ICMP	1135044

3.3 LATENCY BENCHMARKING

The objective of this test was to measure latency of the SCE8000 platform at varying frame sizes. For this test the tester was configured to send frames for fixed duration. The tester compares the time stamp when the frames were transmitted with the timestamp when frames were received. The difference between the two timestamps is considered latency introduced by the device under test.

For this test a port pair was used and 8 streams were configured on each port. Each stream was configured with different frame size. The frame sizes that were considered included 64, 128, 256, 512, 1024, 1518 bytes and IMIX traffic. All packets are tagged with the timestamp.

Figure 5 shows the live latency distribution across all frame sizes as captured live from Ixia IxExplorer.

PGID	Total # Frames Rec.	Cut Through Min (µs)	Cut Through Max (µs)	Cut Through Max-Min	Cut Through Avg (µs)	Bit Rate (/sec)	Byte Count	First Timestamp	Last Timestamp	
										Packet Size
1	288,730,573	14.60	19.56	4.96	17.63		18,478,756,	00:00:00.000000000	00:00:48.506742740	64
2	160,000,000	15.44	21.02	5.58	18.77		20,480,000,	00:00:00.000000000	00:00:37.888010700	128
3	80,000,000	17.24	22.94	5.70	19.77		20,480,000,	00:00:00.000000000	00:00:35.327989080	256
4	40,000,000	20.16	23.40	3.24	21.65		20,480,000,	00:00:00.000000000	00:00:34.048002600	512
5	20,000,000	26.02	30.70	4.68	28.21		20,480,000,	00:00:00.000000000	00:00:33.407998500	1024
6	20,000,000	28.96	33.72	4.76	31.82		25,600,000,	00:00:00.000000000	00:00:41.600001020	1280
7	10,000,000	30.48	32.92	2.44	31.18		15,180,000,	00:00:00.000000000	00:00:24.639999840	1518
8	60,000,000	15.38	82.22	66.84	29.30		21,231,854,	00:00:00.000000000	00:00:35.968054560	IMIX

Figure 5: Latency test summary

The results demonstrate average cut through latency at different frame sizes that were passed through the SCE8000 for this test. The measured latency varied from 17.63µs for a 64 byte frame to 31.18µs for stream containing 1518 byte frames.

3.4 HIGH AVAILABILITY

The objective of these tests was to determine the service interruption time during reload using administrative command line interface and when changing between different link modes (service, or bypass mode).

The traffic generator was configured to send traffic at a fixed rate on all 4 ports. The service interruption time was calculated as the number of lost packets/packets per seconds. Table 4 presents the results of the high-availability tests and service interruption times for various test scenarios executed. No hardware failures were simulated during the test.

Table 4: High availability – service interruption time

Test Description	Service Interruption Time during the failover (milli seconds)

CLI Reload/Reboot with service (forwarding mode)	6.25
CLI reload/Reboot without service (bypass mode)	6.0
Moving from internal bypass to SCE service mode (bypass to forwarding mode)	0
Moving the flows from forwarding mode to bypass	0

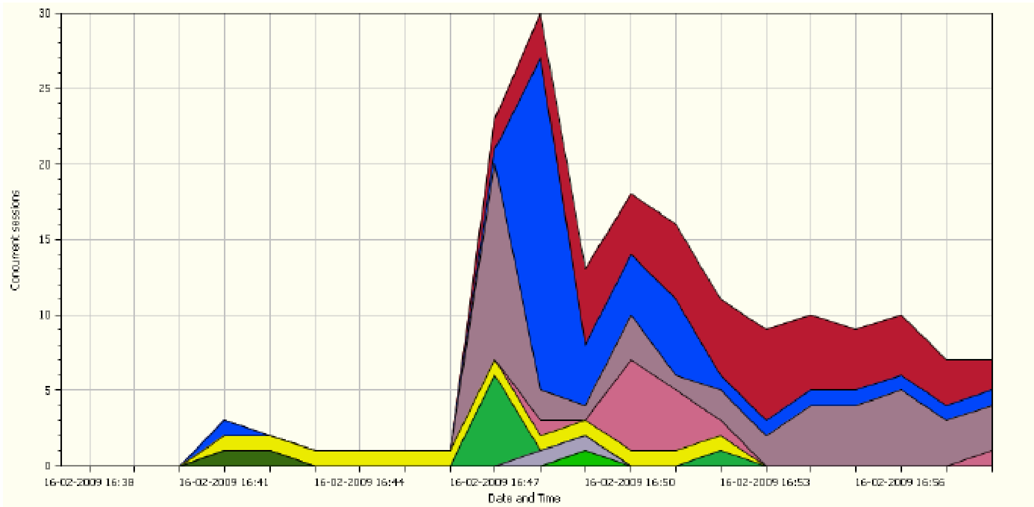
3.5 LAYER 7 CLASSIFICATION AND BANDWIDTH MANAGEMENT

This test comprised of two parts, the first part focused on layer-7 application classification. The second one targeted the ability of the SCE8000 to perform bandwidth control and traffic optimization using DPI features. Both of these tests are critical, as the carriers deploying the DPI solutions would like to gain the ability to help optimize traffic on their network and understand applications that are consuming more bandwidth. Identification of application and controlling the presence of some services is very important advantage of deploying DPI devices. This section important advantage of deploying DPI devices. This section presents observations made during the evaluation of these features. It is also important that the DPI device is able to efficiently identify and prioritize applications that bring revenue to the carriers and help them in meeting strict subscriber level agreements for multimedia and real-time services.

For application identification tests, a different setup shown in Figure 6 was used. The intention was to attach real-world clients to the test bed along to test ability of the SCE8000 to classify multiple applications concurrently. .

Figure 6: Setup for L7-classification

Multiple applications that were pushed through the SCE8000 included encrypted and unencrypted P2P protocols (eMule, μTorrent), Internet messaging services (such as Yahoo messenger IM, voice, video and file transfer), plain HTTP downloads, email and file transfers. Figure 7shows the live capture from the Cisco SCA-BB client showing the number of concurrent sessions per service.



Dataset	Minimum	Average	Maximum	Last
Encrypted Bittorrent	0	1	6	2
HTTP	0	1	22	1
Non-Encrypted eMule	0	1	13	3
Yahoo Messenger VoIP	0	0	6	1
Download over HTTP	0	0	1	0
Encrypted eMule	0	0	6	0
HTTPS	0	0	1	0
Yahoo Messenger	0	0	1	0
Yahoo Messenger Video	0	0	1	0
Total:	**0**	**0**	**22**	

Figure 7: Global concurrent sessions per service

For bandwidth control testing Ixia was configured to transmit traffic across 2 Ixia ports comprising of 512 bytes packets. The traffic was mapped to 4 different services according to layer-7 data patterns, defined as A, B, C and D. On the SCE8000 two different types of service configurations with the following parameters were created with bandwidth prioritization mode set to subscriber prioritization mode:

1. Service configuration (PQB1) with no bandwidth control
    a. New services configured included bad application service (UDP based matching pattern A), standard service (UDP traffic matching pattern B), good application service (UDP traffic matching pattern C) and high priority service (UDP traffic matching D)
    b. 3 packages were defined to offer GOLD, Silver and Bronze
2. Service configuration (PQB2) with bandwidth control
    a. Same services profile as in type 1
    b. 3 packages were configured with different priority levels
        i. Package Gold – configured with relative priority 10
        ii. Package Silver – configured with relative priority 5
        iii. Package Bronze – configured with relative priority 1

The global controller configuration was set as shown in the table 4. The Global Controllers control the bandwidth for the defined services based on the relative priority set for each package such that package Gold has higher priority then package Silver, which has higher priority then service Bronze. During the testing, initially service configuration (PQB1) was applied followed by application of configuration (PQB2). The bandwidth inside the global controller is divided according to the relative priority configured for different packages.

Table 4: Global controller configurations

Bandwidth configuration	Bad application Service (Mbps)	Standard Service (Mbps)	Good Application Service (Mbps)	High Priority Service (Mbps)
Upstream	500	800	1200	1800
Downstream	700	1000	1400	2000

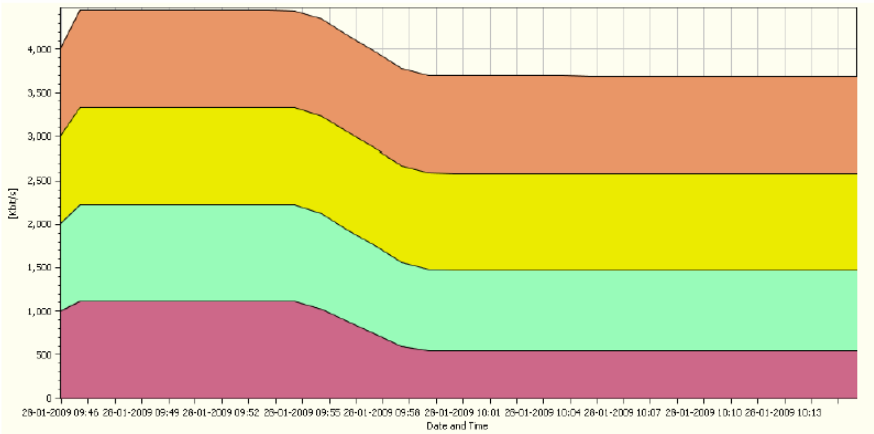
Figure 8, 9, and 10 shows the report generated after the service configuration with control was applied. As represented in the graphs, before the control service configuration was applied, all subscribers had the same throughput. While after the Control service was applied, the Gold subscriber has higher throughput on all services than the Silver subscriber. The Silver subscriber on all services than the Silver subscriber. The Silver subscriber received higher throughput than the bronze subscriber.

Subscriber Bandwidth per Service Normalized #1 *Jan 28, 2009 10:32:49 AM*

Subscriber Bandwidth per Service Normalized

Traffic Direction: Both Directions

Time Span: 2009-01-28 09:27:11 - 2009-01-28 10:27:11



Dataset	Minimum	Average	Maximum	Last
High priority Service	0	1053	1112	1110
Good apps Service	0	1053	1112	1110
Standard Service	0	953	1112	917
Bad apps Service	0	747	1112	586
Total:	**0**	**951**	**1112**	

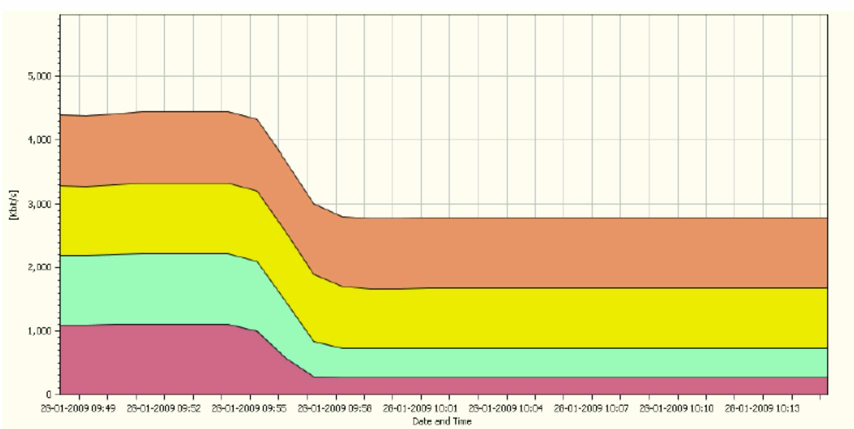
Figure 8: Subscriber bandwidth per service – Gold subscriber

Subscriber Bandwidth per Service Normalized #2 *Jan 28, 2009 10:32:21 AM*

Subscriber Bandwidth per Service Normalized

Traffic Direction: Both Directions

Time Span: 2009-01-28 09:28:50 - 2009-01-28 10:28:50



Dataset	Minimum	Average	Maximum	Last
High priority Service	0	1080	1613	1109
Good apps Service	0	981	1121	924
Standard Service	0	709	1613	451
Bad apps Service	0	591	1613	291
Total:	**0**	**840**	**1613**	

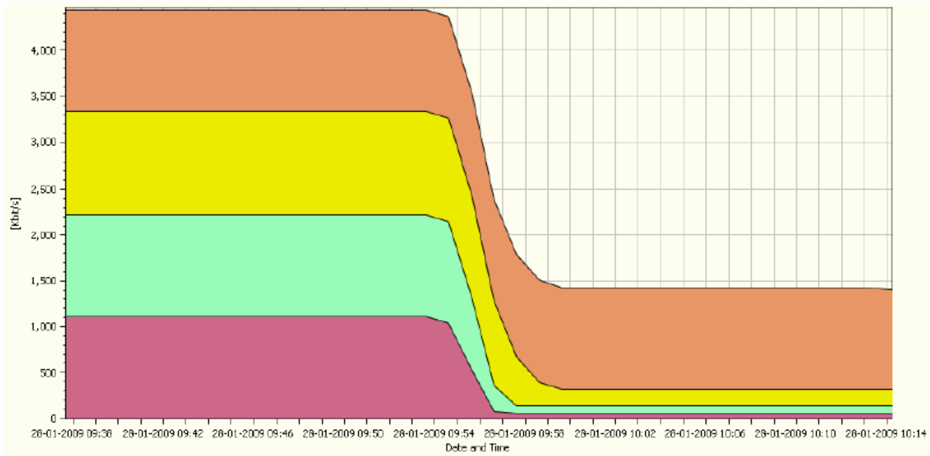
Figure 9: Subscriber bandwidth per service – Silver subscriber

Subscriber Bandwidth per Service Normalized #3 Jan 28, 2009 10:30:18 AM

Subscriber Bandwidth per Service Normalized

Traffic Direction: Both Directions

Time Span: 2009-01-28 09:29:55 - 2009-01-28 10:29:55



Dataset	Minimum	Average	Maximum	Last
High priority Service	0	1053	1111	1030
Good apps Service	0	542	1111	182
Standard Service	0	455	1111	87
Bad apps Service	0	425	1111	52
Total:	**0**	**619**	**1111**	

Figure 10: Subscriber bandwidth per service – Bronze subscriber

4 CONCLUSION

Isocore evaluated the Cisco SCE 8000 series platform as part of its third party validation program of DPI devices. Cisco SCE 8000 evaluation focused on the key aspects that are of concern to service providers considering deployment of any stateful application classification devices for increasing the bandwidth control and monitoring the usage for each subscriber. The focus of the entire testing revolved around verifying the scalability of SCE 8000 in supporting maximum number of connections (flows) and subscribers. The test also verified the SCE 8000 ability in offering high-availability to the sessions passing through it, bandwidth control and application classification. All test executed, and the results collected during the entire evaluation confirmed that Cisco SCE8000 met the requirements set forth for the test and demonstrated its readiness for any prime time carrier-grade deployment.