Ribbon Communications SBC 5400
Performance and Security Assessment

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Miercom

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Contents

1 - Executive Summary

Ribbon Communications (formerly Sonus Networks, Inc.) engaged Miercom to conduct independent performance and security testing of its mid-range, expandable session border controller, the SBC 5400. Testing focused on call handling, media transcoding and registration performance for three different licensable SBC 5400 configurations, which are keyed to concurrently active traffic-bearing interfaces: one 10-Gigabit Ethernet (10-GbE), two 1-GbE interfaces and four 1-GbE interfaces.

Security vulnerabilities of the system were assessed by probing all accessible ports on the SBC 5400 to solicit system responses and identify possible attack vectors, and by delivering network attacks and observing any impact on performance.

In addition, the resiliency of a high-availability (dual-node) SBC 5400 configuration was tested to observe recovery and to determine the impact of an unexpected system interruption.

Key Findings and Observations:

- **Capacity scaling – up to 75,000 concurrent sessions**: Testing showed that the capacity of the same SBC 5400 hardware platform can be expanded by simply upgrading the media-interface license. All necessary processing power and modules were already included in the base 2x1-Gigabit model with 10,000 sessions capacity. Applying the software license enabled the 1x10GB media Port to achieve up to 75,000 sessions capacity on the same hardware.
- **No capacity degradation with secure media streams (SRTP)**: Our testing found that the SBC 5400 supported just as many encrypted Secure RTP streams, up to 75,000 concurrent sessions, as normal unencrypted RTP media streams. Many competitive SBCs lose as much as half their call capacity by encrypting VoIP media streams. This was a testament to the structure of the encryption processing of the SBC 5400.
- **Superior signaling performance**: SBC 5400 1x10-GbE interface, processed 700 calls per second (cps) full 24-Message SIP calls, with SIP Message manipulation (SMM) applied on each SIP Message, with no dropped calls and ample CPU and memory headroom.
- **Bidirectional Transcoding**: SBC 5400 sustained 23,000 concurrent G.711μ - G.729ab transcoded media sessions with no dropped or rejected calls utilizing only 17 percent of its CPU threshold.

- **Effective Denial-of-Service (DoS) protection**: We launched DoS flood attacks at the SBC 5400's SIP-signaling and then at the media port, while the SBC was handling high call volumes. Delivered at 1,000 packets per second, the attacks were effectively deflected, and no legitimate calls were dropped.
- **Excellent access performance, handling registration avalanche**: The SBC 5400 sustained 600,000 routine SIP-endpoint registrations and handled 1,250 new routine registrations per second (rps). In the event of a registration avalanche, such as after a system reboot, the SBC 5400 could handle up to 2,400 rps.

Based on the results of our testing, we proudly award the Miercom Performance Verified Certification to the Ribbon SBC 5400.

Robert Smithers

CEO

Miercom

2 - About the Product Tested

The Ribbon SBC 5400, a member of their SBC Core product portfolio, serves primarily to secure, mediate and control IP communications between a private/internal network and the public Internet/PSTN. It was designed to provide a high-end platform for enterprises, handling up to 75,000 concurrent, IP-telephony sessions as well as provide a full-featured SBC platform for service providers.

Given a typical 10:1 load rate, a single SBC 5400 could handle a population of some 320,000 users – a city the size of Pittsburgh, PA or Tampa, FL. Ribbon, it should be noted, offers lower-end SBCs, as well as its current high-end SBC 7000, supporting 150,000 concurrent sessions (if all G.729 vocoding) or 100,000 G.711 sessions.

What's different about the 2U, rack-mount SBC 5400, in addition to its high capacity, is its future-proof scalability. With the exact same hardware platform, the SBC 5400 can scale from a maximum of 10,000 to the high-end of 75,000 concurrent sessions. It does this through an interface-capacity license. The system's four SFP/optical interfaces can each handle a one Gigabit per second Ethernet (1-GbE) interface traffic load, or a single 10-GbE interface.

Below is a summary of the interface-capacity license options for the SBC 5400.

Interface-capacity license	Max session capacity, if all G.729 vocoding	Max session capacity, if all G.711 vocoding
2 x 1-GbE (default)	10,000 sessions	10,000 sessions
4 x 1-GbE	64,000 sessions	20,000 sessions
1 x 10-GbE	75,000 sessions	50,000 sessions

Version v5.1.0R0 of the SBC 5400 software/code was tested, and these capacities were independently verified and detailed in this report.

A few other notable features of the Ribbon SBC 5400:

Ribbon SBC 5400

- Modular DSP cards, for transcoding and other specialty media processing
- High-Availability (HA), redundant-node configuration; IP and MAC move on failover
- Straightforward management, four management access ports
- Full security support including DoS deflection, encrypted SRTP and TLS/IPsec signaling
- No additional hardware required nor loss of scale/performance for encryption of media (SRTP) or signaling (TLS/IPSec)

3 - How We Did It

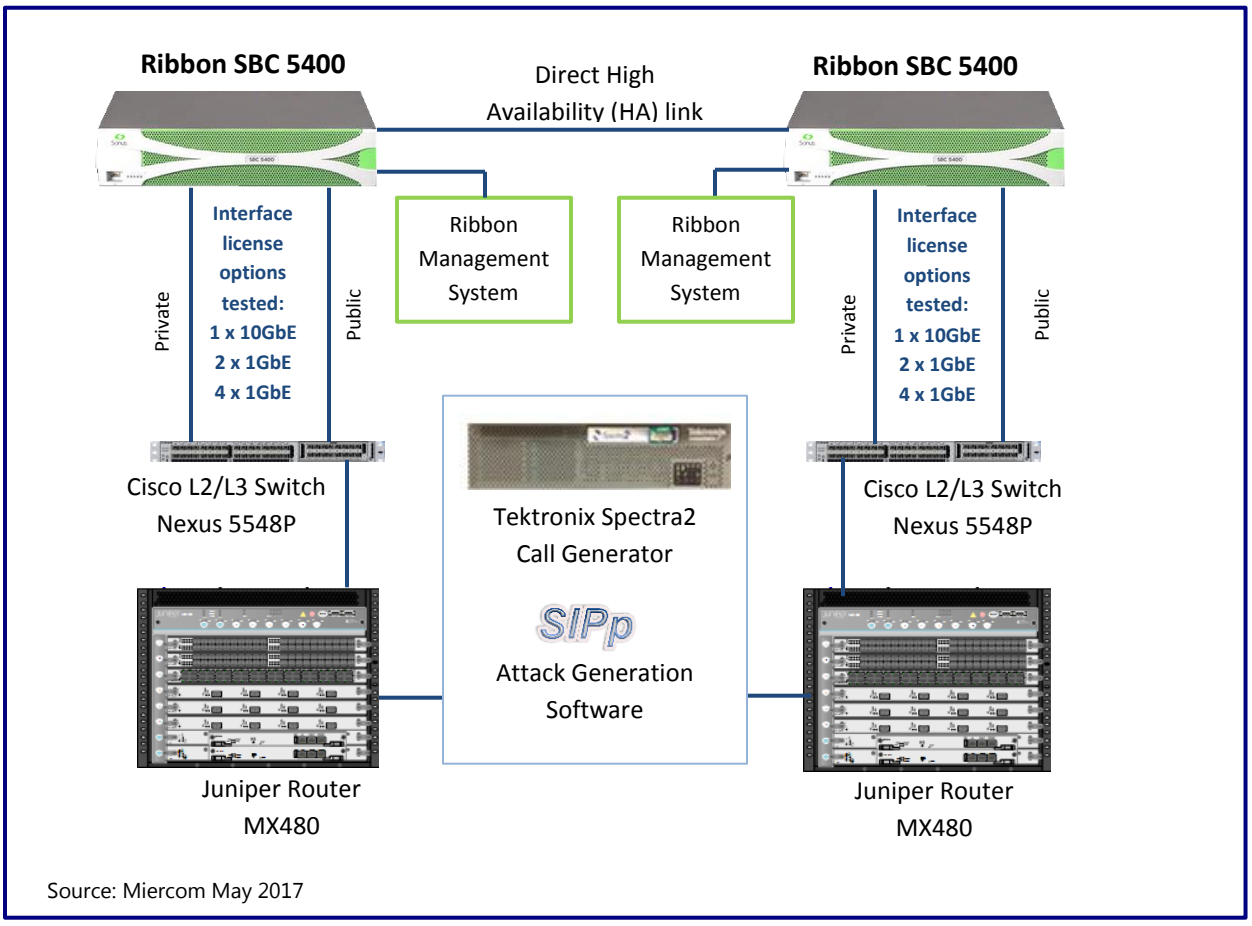
The methodology used in testing was jointly developed by Miercom and Ribbon to assess call-handling performance, inherent security and resiliency of the Ribbon SBC 5400.

Performance of calls, media transcoding and registration handling were assessed for effectiveness, CPU and memory usage. Security testing checked the SBC 5400's inherent protection against DoS attacks, and resiliency testing confirmed the high availability support of dual-redundancy for two SBC 5400 controllers.

In measuring call and registration-handling capacity, the tests achieved the highest traffic level that could be sustained by the SBC 5400, given the interface-capacity license, without call failures or system instability.

Most of the testing was conducted with the highest SBC 5400 interface-capacity license, supporting a single 10-GbE link into the test bed shown below. For some call-capacity testing, the SBC 5400 was reconfigured for two and four 1-GbE links.

Test Bed Configuration



Source: Miercom May 2017

VLAN tagging was enabled in all test configurations, to logically segregate call-traffic flows.

For all test configurations the SBC 5400 Embedded Routing Engine (ERE) policy was enabled.

The Ribbon Baseboard Management Controller (BMC) element management platform was used throughout testing for configuration, and receiving alarms.

Test Tools

An assortment of test tools was applied during the course of this testing, as shown below.

Source: Miercom May 2017

Device	Purpose	Software Version	Network connection(s)
Ribbon SBC 5400 (two systems in a high-avail-ability, or HA, configuration)	Device Under Test (DUT)	V05.01.00R000	Private/Public
Ribbon NetScore	Ribbon session analytics software for assessing Ribbon components and network behavior	5.0.1	Private/Public
Tektronix Spectra2 XL3	SIP traffic generator, Call generator, Call analyzer, SIP Registration flood generator	8.7.0.0.R.1	Private /Public
SIPp	SIP call-signaling and RTP-stream flood generator	3.3.990	Public
Nmap	Port scanning (“probing”) software	7.12	Public

Tektronix Spectra2 XL3 the primary test tool for this testing; generates and maintains up to 1 million concurrent SIP-signaling calls, with or without media, and provides an easy to use test suite, with customizable scripts. It features a real-time display that gives excellent visibility of all tests. The tool is designed for analyzing VoIP and SIP communications and supports over a dozen SIP protocols.

Nmap a free and open source utility for conducting security audits; probes active IP addresses for vulnerabilities using its database of over 2,000 known services to corresponding ports (e.g. SMTP for mail server, HTTP for webserver). The software package also has 6,500 pattern matches for more than 650 protocols.

SIPp a free and open source utility for generating SIP traffic to test signaling and media attacks. SIPp establishes and releases multiple calls with the INVITE and BYE methods, sends audio and video media via RTP and generates SIP authentication and registration traffic. SIPp was used in this testing primarily for SIP INVITE (signaling) and RTP (media) DoS flood attacks.

Test Plan

Ribbon SBC 5400 testing was conducted in four sections:

1. **Call Performance**: To ascertain maximum supported call rates for regular G.711 calls, for regular G.729 calls, G.711-G.729 bidirectional transcoded calls, G.729 with Secure RTP, Call Rate Overload, and for calls translated between IPv4 and IPv6. Using low-bit-rate G.729 vocoding, separate tests checked that the maximum sessions could be attained with two 1-GbE interfaces (10,000 sessions), four 1-GbE interfaces (64,000 sessions) and one 10-GbE interface (75,000 sessions).
2. **Registration Performance**: To ascertain maximum registration capacity and rates supported for routine registration, for an overload avalanche of registrations, for registration refreshing after a reboot, NAT'ed registrations with background load, and registration via encrypted TLS connections.
3. **Security**: To ascertain how DoS attacks affect the operation of the SBC 5400. Separate DoS flood attacks were launched against the SIP signaling and the RTP media ports.
4. **High-Availability**: Tests confirmed the effect on call performance of a failover between two dual-redundant SBC 5400 controllers in a high-availability configuration.

4 - Call Performance

The following sections detail a variety of test case scenarios. Results define the performance, resource utilization and efficacy of SBC 5400 call handling. Given the different license options, three different interface configurations were used. For example, to achieve a maximum call load specification of 75,000 calls, a 1 x 10-GbE license was needed.

The following metrics were measured for each configuration:

- Calls per second (cps)
- Transcoding (simultaneous, bi-directional G.711 μ-law-to-G.729AB and G.729AB-to-G.711 μ-law conversion)
- Maximum concurrent calls using G.729 (the vocoder used to confirm the maximum call load, per license-interface configuration)
- Maximum concurrent calls using G.711
- Maximum encrypted sessions (Secure RTP)

A few important aspects of this testing which deserve attention by readers:

Call scalability: The licenses reflected different interface capacities and addressed the ability of the SBC to deal with enterprise environments which invariably increase in size. All calls were generated using the Spectra2 XL3 call generator, connected to both the public and private networks. Each call was placed between endpoints on the public and private networks.

Resource utilization: Computation processes for calls, transcoding and encryption were performed in real-time, which placed a load on the CPU of the SBC. Particularly as call loads approached the maximum, we took periodic readings of CPU and memory utilization by observing the SBC 5400 user interface.

Maximum G.711 Media Call Rate using SMM with 24-Message Call Flow

The longtime standard, G.711 codec, compresses digital voice audio at a rate of 64 kbits/s (kbps) at 10 millisecond (ms) packet intervals.

Using the 10-GbE interface, calls were run with G.711 media starting at 0 cps, and ramping up to the SBC 5400 specified maximum call rate of 700 cps. The 700 cps call rate was achieved and maintained for 10 minutes, during which time the occurrence of call failures was carefully monitored. A flow of 24-Message SIP calls was used with SMM applied.

End-to-end latency was verified using the Ribbon NetScore tool, and found to be below 50 ms for 95 percent of calls. Latency and Post Dial Delay (PDD) are real-time Key Performance Indicators (KPI) measured and reported by NetScore.

Results

Test results showed:

- A maximum rate of 700 cps, comfortably above the advertised rate.
- 60 percent CPU usage at this maximum rate.
- 25 percent memory usage at this maximum rate.

Maximum G.711 Media Call Rate Performance

Test	Maximum G.711 media cps performance
Metrics	700 cps, 10 minute hold
Max Call Processing Rate (cps)	700
Max Accepted Call Rate (acps)	700
Calls Dropped	None
CPU (%)	60 (average for 700 cps)
Memory (%)	25
Quality (MOS Score: 1-5)	4.18

Conclusion

The 700 cps call-processing rate of the SBC 5400, with full G.711 media using SMM with 24-Message SIP calls, was verified.

Maximum G.711-G.729 Bidirectional Transcoding

Transcoding introduces loss when decoding from one format, de-compressing and then re-encoding into another format. Additionally, the difference in bit rates of G.711 (64 kbps) and G.729 (8 kbps) necessitates sample rate conversion. These factors are expected to lower quality.

Using the SBC 5400 configuration with the 10-GbE interface, G.711µ media calls were generated with 40 ms sample sizes and transcoded to G.729AB media, also for 40ms. Then G.729AB calls were transcoded back to G.711µ, also for 40ms. This test was run using 24-Message SIP calls for five minutes to reach a maximum of 23,000 sustained concurrent sessions.

Results

Test results showed:

- A 400 cps maximum call set-up rate.
- 17 percent CPU usage.
- 34 percent Memory usage.

Maximum G.711 to G.729 Bidirectional Transcoding Performance

Test	G.711µ-G.729AB bi-directional transcoding
Metrics	40-ms voice samples for each codec, bidirectionally, for 5 minute test duration, until 23,000 session peak is reached
Max Call Processing Rate (cps)	400
Max Accepted Call Rate (acps)	400
Calls Dropped	None
CPU (%)	17
DSP (%)	98
Memory (%)	34
Quality (MOS Score: 1-5)	4.05 (average MOS)
EMS Notifications	Max DSP Threshold Utilized

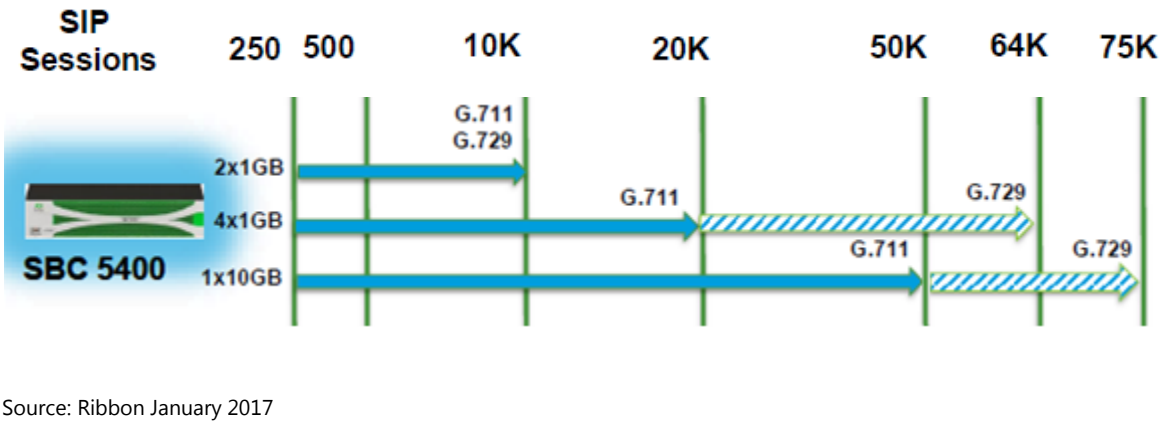
Conclusions

Tests confirmed the SBC 5400's support for 23,000 concurrent, sustained transcoding media sessions, G.711 µ-law to/from G.729AB, and a call set-up rate of 400 calls per second.

Maximum G.729 Media Sessions

The narrowband G.729 codec compresses a voice audio conversation into an 8 kbps digital stream which when wrapped in IP packets with 20 ms of voice payload per packet, comprises a traffic flow of about 3 kbps. The algorithm employed by this codec requires intense processing but delivers high voice quality.

Using the different SBC 5400 interface-capacity license options, the maximum of G.729AB media sessions concurrently supported was assessed. The number of sessions was determined by the configuration since each license supports a different, codec-dependent, maximum.



Source: Ribbon January 2017

The SBC 5400 was configured with a 10-GbE interface to support the highest call handling capacity, up to 75,000 sessions. The configuration with two 1-GbE interfaces supported the lowest capacity, only 10,000 sessions. The configuration with four 1-GbE interfaces was capable of handling up to 64,000 concurrent G.729 media sessions.

One x 10-GbE: 75,000 Sessions

A single 10-GbE media interface is the highest-capacity license available for the SBC 5400, supporting 75,000 sessions with G.729AB media. During testing, calls were run for 10 minutes to reach this maximum.

Results

Test results showed:

- A maximum call-set-up rate of 500 cps.
- 47 percent CPU usage.
- 57 percent memory usage.

One x 10-GbE: Maximum G.729AB Media Session Performance

Test	Maximum 1 x 10GbE G.729AB media session performance
Metrics	75,000 sessions, 10 minute test duration
Max Call Processing Rate (cps)	500
Max Accepted Call Rate (acps)	500
Calls Dropped	None
CPU (%)	47
Memory (%)	57
EMS Notifications	None

Conclusions

The SBC 5400 supported 75,000 concurrent sustained sessions with full G.729AB media streams. Our testing also confirmed that the SBC also supports the advertised call set-up rate of 500 cps.

Two x 1-GbE: 10,000 Sessions

This configuration used two 1-GbE media interfaces to support 10,000 sessions for G.729AB media. One interface connected to the internal/trusted network and the other to the external/Internet network. Calls were run for five minutes to reach this maximum number of sustained calls.

Results

Test results showed:

- A maximum call-set-up rate of 200 cps.
- 20 percent CPU usage.
- 46 percent memory usage.

Two x 1-GbE: Maximum G.729AB Media Session Performance

Test	Maximum 2 x 1GbE G.729AB media session performance
Metrics	10,000 sessions, 5 minute test duration
Max Call Processing Rate (cps)	200
Max Accepted Call Rate (acps)	200
Calls Dropped	None
CPU (%)	20
Memory (%)	46
EMS Notifications	None

Conclusions

Configured with the license for two 1-GbE interfaces, the SBC 5400 supported a sustained load of 10,000 concurrent sessions with G.729AB media. In this configuration the SBC supported a maximum call set-up rate of 200 cps.

Four x 1-GbE: 64,000 Sessions

When configured with the license for four 1-GbE media interfaces, tests confirmed support for 64,000 concurrent sessions using G.729AB media. Calls were run for five minutes to reach this maximum.

Results

Test results showed:

- A maximum call-set-up rate of 400 cps.
- 40 percent CPU usage.
- 57 percent memory usage.

Four x 1-GbE: Maximum G.729AB Media Session Performance

Test	Maximum 4 x 1-GbE G.729AB media session performance
Metrics	64,000 sessions, 5 minute test duration
Max Call Processing Rate (cps)	400
Max Accepted Call Rate (acps)	400
Calls Dropped	None
CPU (%)	40
Memory (%)	57
EMS Notifications	None

Conclusions

Configured with the license for four 1-GbE interfaces, the SBC 5400 supported a sustained load of 64,000 concurrent sessions with G.729AB media. In this configuration, the SBC supported a call set-up rate of 400 cps.

Maximum G.711 Media Sessions

With the license and configuration for one 10-GbE interface, tests determined call performance of a maximum of 50,000 G.711 media calls for ten minutes.

Results

Tests results showed:

- A maximum call-set-up rate of 500 cps.
- 48 percent CPU usage.
- 44 percent memory usage.

Maximum G.711 Media Sessions

Test	Maximum G.711 Media Sessions
Metrics	50,000 sessions, 10 minute test duration
Max Call Processing Rate (cps)	500
Max Accepted Call Rate (acps)	500
Calls Dropped	None
CPU (%)	48
Memory (%)	44
EMS Notifications	None

Conclusions

Configured with the license for one 10-GbE interface, the SBC 5400 supported a sustained load of 50,000 concurrent sessions with full G.711 media. In this configuration, the SBC supported a call set-up rate of 500 cps.

Maximum G.729AB Sessions with Secure RTP

Using the 10-GbE interface, Secure Real-time Transport Protocol (SRTP) was enabled. The SBC 5400 used SRTP to encrypt and authenticate 75,000 sustained G.729AB-media sessions for enhanced security. Encryption used 128-bit AES and SHA-1. The test was run for 10 minutes at 500 cps to determine SRTP call handling performance and resource usage.

Results

Test results showed:

- A maximum call-set-up rate of 500 cps.
- 50 percent CPU usage.
- 57 percent memory usage.

Maximum G.729AB Sessions with SRTP Performance

Test	Maximum G.729AB SRTP Sessions
Metrics	75,000 sessions, 10 minute test duration
Max Call Processing Rate (cps)	500
Max Accepted Call Rate (acps)	500
Calls Dropped	None
CPU (%)	50
Memory (%)	57
EMS Notifications	None

Conclusions

Configured with the license for one 10-GbE interface, the SBC 5400 supported a sustained load of 75,000 concurrent sessions with G.729AB media, encrypted via Secure RTP with 128-bit AES and SHA-1. In this configuration, the SBC supported a call set-up rate of 500 cps.

Call Rate Overload

SIP calls were generated and the call rate was ramped up to determine how the SBC 5400 responded to a call-request rate well above its specified maximum of 700 cps. All calls consisted of G.711µ media in pass-through mode, where the SBC 5400 did no additional processing to the media streams. Call hold time was 10 seconds.

Call load began at 0 cps and ramped up to the system's specified capacity of 700 cps for five minutes. Then an overload of 2,100 cps was delivered for three minutes. The call load was then returned to 700 cps for five minutes.

Results

Test results showed:

- The maximum load rate delivered to the SBC 5400 in this test was 2,100 cps.
- 94 percent CPU usage.
- 52 percent memory usage.

Call Rate Overload Performance

Test	Maximum G.711µ media session performance with overload
Metrics	700 cps load for 5 minutes. Rate increased to 2,100 cps for 3 minutes. Then rate decreased back to 700 cps for 5 minutes.
Max Call Processing Rate (cps)	2,100
Max Accepted Call Rate (acps)	1,400
Calls Dropped	210,000 (during 3 minute overload)
CPU (%)	94
Memory (%)	52
EMS Notifications	Level 2 alert: 8 percent calls dropped

Conclusions

With an overload three times the engineered capacity of the SBC 5400, as many as 2,100 G.711 calls were offered per second. Completed calls continued to deliver the engineered load of 700 cps and were sustained throughout the overload.

IPv4-IPv6 Protocol/Call Translation

G.729AB SIP calls were generated and the call rate was ramped up to 500 cps. A load of 37,500 sessions was delivered from the "untrusted" IPv6 network and translated by the SBC 5400 to the "trusted" IPv4 internal network. Similarly, the same number of sessions originated from the "trusted" IPv4 side and were translated to the "untrusted" IPv6 side, using the SBC 5400 to perform simultaneous, real-time bi-directional conversion between IPv4 and IPv6. Call duration was 150 seconds.

Results

Test results showed:

- The maximum load rate delivered to the SBC 5400 in this test was 500 cps.
- 45 percent CPU usage.
- 61 percent memory usage.

IPv4-IPv6 Call Translation Performance

Test	IPv4-IPv6 translation with maximum call load
Metrics	Calls are delivered from IPv4 and IPv6 networks simultaneously, at 500 cps, up to 75,000 sessions, with SBC translating all calls
Max Call Processing Rate (cps)	500
Max Accepted Call Rate (acps)	500
Calls Dropped	None
CPU (%)	45
Memory (%)	61
EMS Notifications	None

Conclusions

Configured with the license for one 10-GbE interface, the SBC 5400 handled a full load of 75,000 sessions for G.729AB calls while translating between IPv4 and IPv6 networks.

5 - Maximum Registrations

Registration requests and calls were generated by the Tektronix Spectra2 XL3 tool during this testing. The purpose was to show the effect of registration loads on SBC 5400 operation.

The SBC 5400 is specified to handle up to 1,250 rps and a maximum of 5,000 refreshes per second. The SBC has a specified 600,000 maximum total registration capacity.

Maximum Normal Registration with Call Load

This test served as the baseline. Deviations from these results highlighted the effect of subsequent avalanche registration, registration reboot, NAT'ed registrations with high call load, and encrypted TLS-based registration tests on the SBC 5400.

Results

Maximum Normal Registration

Test	Maximum Registration Baseline
Metrics	600,000 registrations received at 1,250 rps; background G.729AB calls established at 545 cps with 90 second call hold time
Max Registration Rate (cps)	1,250
Max Accepted Registration rate (acps)	1,250
Calls Dropped	None
CPU (%)	70
Memory (%)	65
EMS Notifications	None

Conclusions

The SBC 5400 readily accepted and sustained 600,000 registrations received at 1,250 rps.

Maximum Avalanche Registrations

The avalanche test delivered 600,000 registration requests at 2,400 rps, nearly double the rate used in the baseline test. All other metrics, including the background call load, remained the same. The purpose was to show the effect of a registration flood on the SBC 5400.

Results

Maximum Avalanche Registrations

Test	Maximum Registration Avalanche
Metrics	600,000 registrations at 2,400 rps, 30 minute refresh time, G.729AB background calls at 545 cps with 90 second hold time
Max Registration Rate (rps)	2,400
Max Accepted Registration Rate (arps)	2,400
Calls Dropped	None
CPU (%)	80
Memory (%)	65
EMS Notifications	None

Conclusions

The SBC 5400 successfully processed registration requests received at the high avalanche rate of 2,400 rps with no adverse effect on background calls in progress.

Maximum Registration Rate on Reboot

This test combined the avalanche test with a reboot. With 600,000 registrations already processed and sustained on the SBC 5400 with background calls running. A reboot of the SBC 5400 was forced and the incoming registration rate was set to 2,400 rps to determine the effect of rebooting on registration handling. The test was run for 15 minutes.

Results

Maximum Registration on Reboot

Test	Maximum Registration on Reboot
Metrics	600,000 registrations established, 2,400 rps rate set after reboot, 30 minute refresh, background calls at 545 cps with 90 second call hold time. Test run for 15 minutes.
Max Registration Rate (rps)	2,400
Max Accepted Registration Rate (arps)	2,400 (interrupted by reboot of SBC)
Calls Status	After the reboot, the SBC was able to handle calls again
CPU (%)	81
Memory (%)	68
EMS Notifications	None

Conclusions

Following a short recovery after the reboot, the SBC 5400 was again able to handle calls and registrations. Registrations were then processed at an impressive rate of 2,400 rps, and background calls were set up, without fail, at a rate of 545 cps.

NAT'ed Registrations with Background Load

Network Address Translation (NAT) registrations are necessary in several environments, including for IPv4 to IPv6 translations. The SBC 5400 resolves translations by storing this information with registrations, either locally or within SIP message headers. Locally stored user IPs require increased processing and memory resources.

To translate, the NAT binds the private and public addresses for the NAT'ed user, refreshing and authenticating at a high frequency since NAT addresses are dynamic. The SBC handles this NAT translation and binding to alleviate the network of the extra processing.

This test incorporated the NAT'ed registrations with a background load to show the effect of this address-translation processing on the SBC 5400.

Results

NAT'ed Registrations

Test	NAT'ed Registrations
Metrics	300,000 NAT'ed registrations are established, and NAT'ed registrations are processed at 1,500 rps, 30 minute refresh, background G.729AB calls are established at 300 cps. Total 27,000 simultaneous calls.
Max Registration Rate (rps)	1,500
Max Accepted Call Rate (acps)	1,500
Calls Dropped	None
CPU (%)	58
Memory (%)	52
EMS Notifications	None

Conclusions

The SBC 5400 successfully processed NAT'ed registrations at a rate of 1,500 rps with no adverse impact on background G.729AB calls being processed at a 300 cps rate.

Maximum TLS Registrations

Transport Layer Security (TLS) is a cryptographic protocol that ensures call set-up information is secure. The SBC 5400 was sent 375,000 registrations from the public network side at a rate of 500 rps while running background calls with G.729AB media. All registrations were encrypted within the TLS protocol. The effect on the SBC 5400 processing and call load was observed.

Results

Maximum TLS Registrations

Test	Maximum TLS Registrations
Metrics	375,000 TLS registrations, processed at 500 rps, 30 minute refresh with G.729AB calls at 200 cps. 18,000 simultaneous calls.
Max Registration Rate (rps)	500
Max Accepted Registration Rate (arps)	500
Calls Dropped	None
CPU (%)	43
Memory (%)	46
EMS Notifications	None

Conclusions

The SBC 5400 supported 375,000 sustained, encrypted TLS-based registrations. While processing these registrations at a 500 rps rate, there was no adverse impact on 18,000 sustained background G.729AB calls, set up at 200 cps.

6 - Security: DoS Attack Mitigation

The purpose was to show the effect on the SBC 5400 of applying security rules and defending against DoS attacks, while handling background call loads.

The SIPp software tool was used to send a SIP "INVITE" flood to the SBC's SIP-signaling port 5060 at a rate of 1,000 packets per second (pps). The RTP flood was initiated from a spoofed IP address and attacked media port 3456.

Results

The signaling-flood DoS attack results showed that with 1,000 illegitimate INVITE pps the SBC 5400:

- Could sustain a new call rate of 700 cps at the same time with
- 73 percent CPU usage and
- 21 percent memory usage.

The RTP-stream-flood DoS attack showed that, with 1,000 RTP pps from a spoofed IP address, the SBC 5400:

- Could sustain a new call rate of 200 cps at the same time with
- 72 percent CPU usage and
- 21 percent memory usage.

Summary of DoS Network Attack Tests

Test	Metrics	Calls Dropped	CPU (%)	Memory (%)
SIP INVITE Flood to Port 5060	1,000 pps	None	73	21
RTP Flood to Media Port 3456	1,000 pps	None	72	21

Conclusions

All of the SIP-signaling DoS packets (INVITES) were discarded at the dataplane level, a relatively low processing level. Alarms showed that these packets were discarded. No legitimate calls were dropped as a result of the signaling-port DoS attack, and the SBC 5400 sustained a new call rate of 700 cps during the attack.

None of the RTP media stream floods from the spoofed address were processed. No legitimate calls were dropped as a result of RTP-media-port DoS attack, and the SBC 5400 was able to sustain a new call rate of 200 cps during the attack.

7 - High Availability

As shown in the test bed diagram, two SBC 5400 devices were deployed in tandem to ensure high availability call handling in the event of a system failure and failover. The test was designed to show redundancy and high availability by looking at the steady-state status before and during failover, and the restoration time after failover.

A long-duration, 15 minute call was established between two. Then a node switchover was performed using the command line interface, and the call was checked during and after failover for detectable interruption.

The following results were expected:

- Media interruption time for calls in progress are less than five media frames, or 100 ms.
- Calls in progress are preserved, during and after the failover.
- Signaling restoration time is 4.5 seconds.
- New calls are accepted in 11 seconds.
- Full call acceptance and processing rates occur in 16 seconds.

Results

Test	High Availability – Redundancy for minimal failover impact
Metrics; Call load	Background rolling/cyclic call load: 74,000 G.729AB-media calls are established at 500 cps, 148 second call hold time
Calls in progress impact	All established, stable calls remained intact and connected
New Call Attempts Failed	4,844 (about 500 cps for 10 seconds)
Signaling Restoration Time (seconds)	4.5
New Call Acceptance Time (seconds)	11 (before new calls are accepted)
Full Call Acceptance Time (seconds)	16

Conclusions

Only new call attempts for 11 seconds were not completed. All established, stable calls remained connected.

8 - About Miercom Performance Verified Testing

This report was sponsored by Ribbon Communications. The data was obtained completely and independently by Miercom engineers and lab-test staff as part of our Performance Verified assessment. Testing such as this is based on a methodology that is jointly co-developed with the sponsoring vendor. The test cases are designed to focus on specific claims of the sponsoring vendor, and either validate or repudiate those claims. The results are presented in a report such as this one, independently published by Miercom.

9 - About Miercom

Miercom has published hundreds of network-product-comparison analyses in leading trade periodicals and other publications. Miercom's reputation as the leading, independent product test center is undisputed.

Private test services available from Miercom include competitive product analyses, as well as individual product evaluations. Miercom features comprehensive certification and test programs including: Certified Interoperable, Certified Reliable, Certified Secure and Certified Green. Products may also be evaluated under the Performance Verified program, the industry's most thorough and trusted assessment for product usability and performance.

10 - Use of This Report

Every effort was made to ensure the accuracy of the data contained in this report but errors and/or oversights can occur. The information documented in this report may also rely on various test tools, the accuracy of which is beyond our control. Furthermore, the document relies on certain representations by the vendors that were reasonably verified by Miercom but beyond our control to verify to 100 percent certainty.

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