



Lab Testing Summary Report

July 2015

Report 150707C

Product Category:

Session Border Controller

Vendor Tested:



Product Tested:

Mediant 4000B Session Border Controller



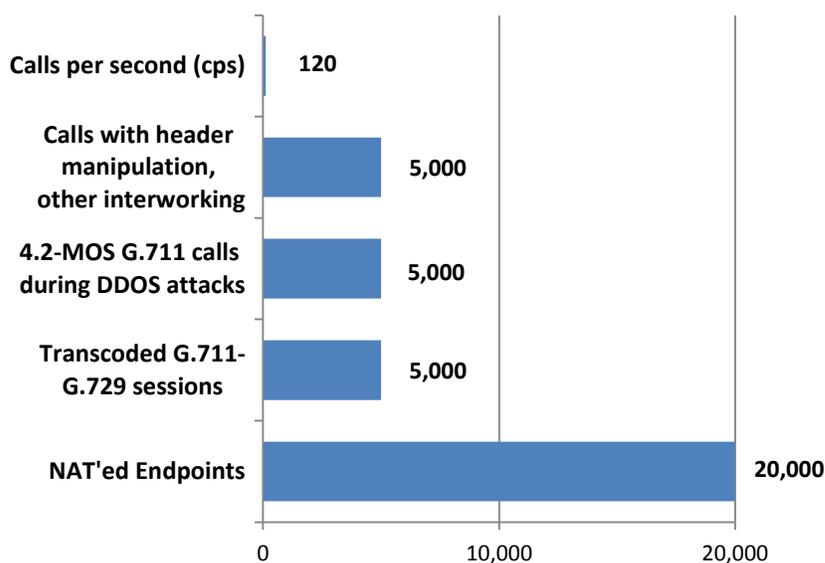
Key findings and conclusions:

- AudioCodes Mediant 4000B exhibits rich interoperability and impressive resiliency and performance. Testing found that the Mediant 4000B can readily sustain 5,000 concurrent calls, with no call drops or loss, successfully completing 120cps in most scenarios.
- The Mediant 4000B effectively controls call overloads; the SBC successfully completed 190cps from an applied load of 500cps – 50 percent over the normal call-processing rate.
- The Mediant 4000B proved fully resilient against Distributed Denial of Service (DDoS) attacks on both signaling and RTP streams, maintaining excellent Mean Opinion Score (MOS) ratings and without dropped calls or system degradation.
- The Mediant 4000B can sustain 5,000 concurrent G.711 - G.729A transcoded media sessions, which is its full session capacity, with no dropped or rejected calls.
- The Mediant 4000B supported 20,000 registered users at 300 registrations per second (rps), and successfully withstood a registration avalanche.

AudioCodes Ltd. engaged Miercom to conduct an independent performance assessment of its Mediant 4000B, a Session Border Controller (SBC) designed for large organizations and for service providers. Miercom tested this recently launched 1U, Linux-based Mediant 4000B model running software version 7.00A.014.004.

The Mediant 4000B produced some of the most impressive results: efficiently handling differences in VoIP calls through SIP header manipulation, interworking IPv4-IPv6, UDP-TCP, etc., encrypting UDP-

Figure 1: Mediant 4000B Session Border Controller Key Tested Capacities and Concurrent Capabilities



Source: Miercom, July 2015

Versatility. Miercom found the Mediant 4000B highly interoperable, supporting header manipulation, transcoding and rich interworking capabilities – including real-time UDP-TCP, IPv4-IPv6, RTP-Secure RTP conversion.

TLS, RTP-SRTP, and transcoding between a half-dozen popular codecs, including G.711 (a/mu-law), G.729, G.722, AMR NB/WB (narrow-band/wideband), Opus NB/WB and SILK NB/WB.

In addition, testing verified capacity specifications in various demanding scenarios, including bursts of heavy call overload and resiliency, Denial-of-Service (DoS) attack survival, media redirection to a redundant port, and failover to a hot-standby Mediant 4000B in a High Availability (HA) configuration.

The primary tool employed in this testing was Tektronix Communications' Spectra2, running software v8.5.0.1. The Spectra2 can simulate all of the key processing elements in today's advanced service-provider networks: Load for simultaneous sessions, call rate, registration rate and also measures the quality of the media provided by Mediant 4000B.

Call Performance

A battery of tests measured the Mediant 4000B's call handling performance. The first set measured call setup performance of signaling sessions, with added processing applied by the Mediant 4000B to each SIP signaling session. These included:

- **SIP Header Manipulation:** The Mediant 4000B adds a new header, deletes an existing header and modifies the content of a third header, of each SIP message.
- **UDP-TCP Interworking:** The SBC converts each message's transport between connectionless UDP and connection-oriented TCP.
- **UDP-TLS Interworking:** The SBC converts each call setup message flow between an open, unsecure UDP stream and an encrypted Transport Layer Secure (TLS) connection.

The results, shown in Figure 2, confirm that, in each scenario, the Mediant 4000B accepted and successfully processed 120cps while sustaining 5,000 signaling sessions, with no calls dropped or rejected.

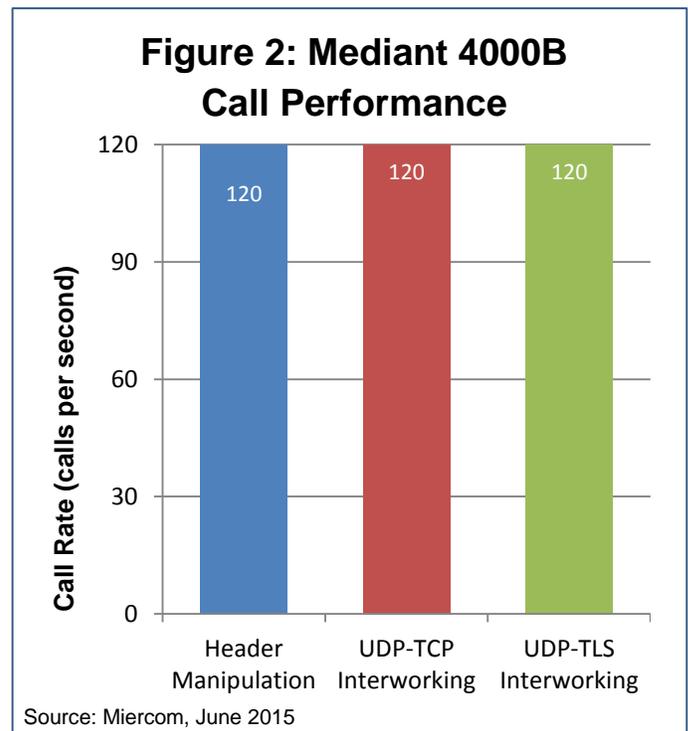
Call Admission Control (CAC). The Mediant 4000B allows the administrator to set limits on the call capacity available to specified SIP users or user groups. CAC capabilities prevent a SIP entity, such as a call center, from consuming all available capacity, leaving none for other users.

To test this feature, we defined a CAC policy that allotted a maximum of 70cps to a particular source IP address – the Spectra2. We then had the Spectra2 initiate calls at a rate of 100cps to the Mediant 4000B – 30 cps more than the configured CAC limit.

The result: The Mediant 4000B successfully limited the call capacity allotted to the Spectra2 to 70cps, rejecting the rest of the SIP INVITES.

Call Overload Performance. The Mediant 4000B typically handles 120cps in normal call environments, and in some cases even when performing considerable additional processing, as shown in Figure 2 on page 2 (SIP header manipulation, UDP-TCP or UDP-TLS interworking).

We performed several tests to see what happens if the Mediant 4000B is inundated with transient overloads. We delivered 500cps – four times the nominal call handling capacity for a 10-second overload-burst period. The result: The Mediant 4000B utilized its CPU to maximum signaling processing power and successfully processed 190 cps during the overload; in practice, 50% more than normal call processing.



Solid cps performer. Show above are the calls-per-second rates achieved during heavy added processing, with no lost or dropped calls. The numbers shown are signaling sessions, without media.

Media Handling Performance

Measuring calls with media examines the Mediant 4000B handling of both call-control signaling and the corresponding bi-directional media streams, which collectively comprise the call.

In the VoIP world, media streams can be sent directly between SIP endpoint clients, bypassing the call controller (typically, the IP-PBX or SBC) completely. However, for any special handling to be performed on the media streams, they have to traverse the Mediant 4000B, which then acts as a relay point. This naturally imposes more load on the SBC than if media streams bypassed the SBC altogether.

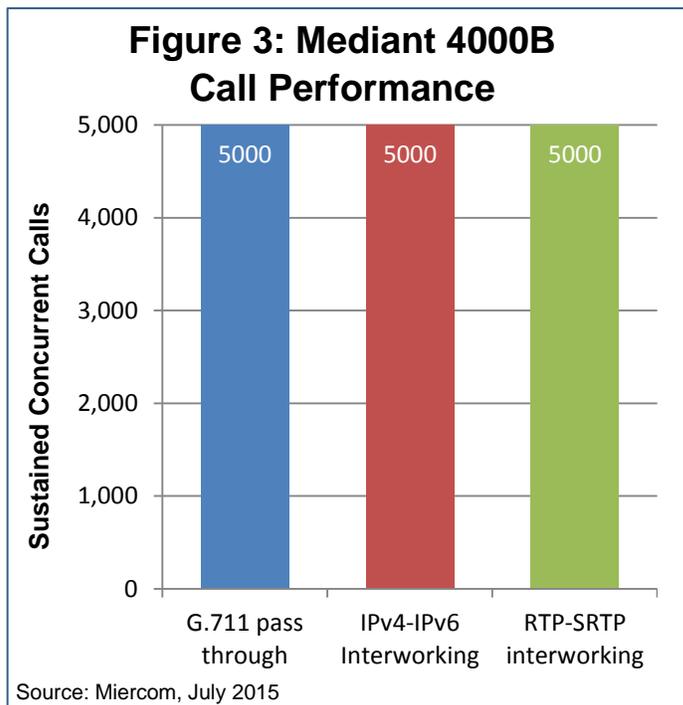
Our testing of calls with media examined several real-world scenarios where the media passed through the Mediant 4000B. Tests were done with network separation of trusted and untrusted network interfaces, both with 1+1, redundant Ethernet ports for increased resiliency. All MOS measurements were done based on PESQ methodology, which is considered the most reliable and complete media-quality rating in the industry.

Results are shown in Figure 3 for these scenarios:

- **G.711 call pass through**, where basic G.711 calls are relayed through the Mediant 4000B, without any additional special processing.
- **IPv4-IPv6 interworking**, where the Mediant 4000B converts every packet of the signaling messages *and* media streams of every call between IPv4 and IPv6 transports.
- **RTP-SRTP interworking**, where the Mediant 4000B converts the media streams bi-directionally between basic Real-time Transport Protocol (RTP) and encrypted Secure RTP (SRTP), including the corresponding RTP Control Protocol (RTCP) and Secure RTCP (SRTCP) messages.

As shown in Figure 3, the Mediant 4000B readily handles the signaling and media of 5,000 regular G.711-based calls (tested with typical 20-ms voice samples per packet).

Test results showed, too, that the Mediant 4000B can handle, on a sustained basis, the real-time conversion of 5,000 concurrent calls – both SIP signaling message flows and all RTP media packets – between IPv4 and IPv6.



With no failed, rejected or dropped calls.

Call handling	G.711 RTP media traffic passes through the SBC	Signaling and media converted between IPv4 & IPv6	Media is translated between RTP & Secure RTP
Avg MOS	4.2	4.2	4.2
CPU load	40%	46%	40%

The Mediant 4000B also handles the bi-directional conversion of 5,000 calls' media streams between the basic RTP media transport and the encrypted Secure RTP, on a sustained basis. In all of these scenarios, there were no call failures or rejections, and call quality remained high with a 4.2 average MOS score.

Transcoding. We tested the ability of the Mediant 4000B to handle the conversion of media streams, bi-directionally and in real-time, from one vocoder to another. This is complex processing, but necessary when one SIP client sends media based on one vocoder and the other SIP client uses or requires another, different vocoder.

We used the G.711 vocoder for one media stream in all the test cases. In the first test the Mediant 4000B converted all media streams between G.711 and the low-bit-rate G.729 vocoder, which is very popular in bandwidth-limited environments. As shown in Figure 4, the Mediant 4000B can handle 5,000 concurrent transcoding sessions, without any call failures and with excellent call quality.

In other tests the Mediant 4000B converted between G.711 and two fairly new, increasingly popular vocoders – SILK and Opus. These are two very complex, open-source vocoders, which deliver excellent voice quality at reduced bit rates. SILK is currently used by Microsoft in Skype for Business. Opus was standardized by the IETF as an RFC in 2012 and is the primary coder for Internet-based communications such as WebRTC.

As shown in Figure 4, the Mediant 4000B can sustain over 4,000 concurrent media transcoding between G.711 and the SILK vocoder, and 2,850 concurrent sessions transcoded between G.711 and Opus, in both cases without call failures or drops and with excellent call quality for both transcoded media streams.

Registration Performance

The Mediant 4000B datasheet states the SBC supports registration of up to 20,000 SIP user endpoints. To test this registration capacity Spectra2 issued registration requests in several scenarios:

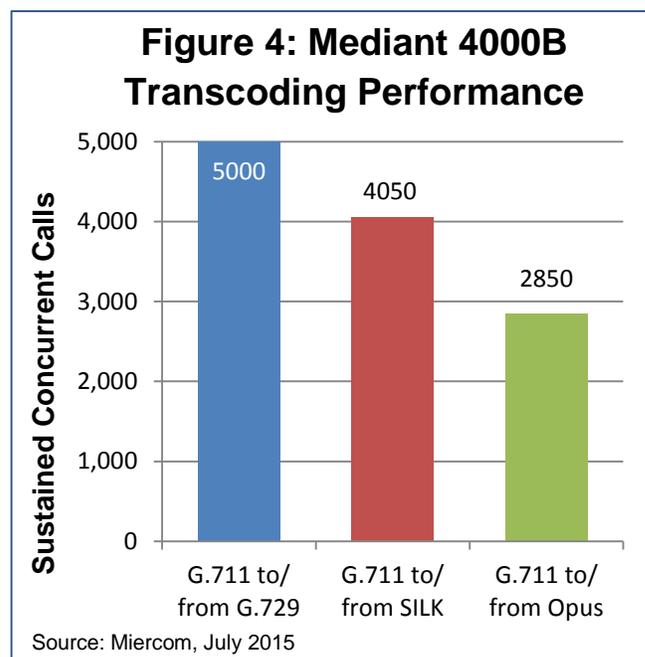
Maximum Endpoint Registrations: The Mediant 4000B was configured in an access role, accepting calls directly from the user endpoints. Result: the Mediant 4000B can readily process and sustain 20,000 registrations – with none rejected or dropped.

Registration Avalanche: The Mediant 4000B was inundated with near-simultaneous registration requests from all clients (as might be the case after a campus- or city-wide power loss/restoral). Result: the Mediant 4000B processed and sustained 20,000 registrations within 67 seconds, at a rate of 300rps.

NAT'ed Clients: When SIP clients communicate to a service provider via a NAT/ firewall, an expedited registration process – called fast registration or re-registration – is used to inform the Mediant 4000B of each client's status and network address. To test this, the simulated NAT'ed endpoints re-registered with the Mediant 4000B every 45 seconds. Result: the Mediant 4000B successfully demonstrated it can register 20,000 NAT'ed user endpoints and then maintain each endpoint using a 45-second refresh interval. The Mediant 4000B handled a maximum registration-refresh rate of 1,000 per second.

Surviving Malicious Attacks

Tests were also run to determine the susceptibility of the Mediant 4000B to malicious network attacks. For this, we employed an Ixia test system - the Ixia 400T



With no calls failed, rejected or dropped.

Media handling	G.711 converted to/from G.729	G.711 converted to/from SILK	G.711 converted to/from Opus
Call hold time (sec)	180	180	180
MOS	4.2 (G.711) 3.88 (G.729)	4.2	4.2

chassis, running IxNetwork v5.30 software.

A total of 15 different malicious attacks were launched against the Mediant 4000B SBC while it was handling a heavy load of calls. Some of the attacks were directed at the SIP signaling interface of the Mediant 4000B, at port 5060. Other attacks were directed at the media ports, during which we checked to see if the attack had any harmful effect on call quality.

The attacks were Denial-of-Service (DoS) attacks in nature – very common in today's private and public networks – in which the target system, the Mediant 4000B, is flooded with bogus traffic to disrupt or shut down normal traffic flow and operations.

In addition, each attack was generated by the Ixia system from multiple simulated sources. Ten different IP sources were used, making these Distributed Denial of Service, or DDoS attacks. These are much harder for target systems to

suppress than DoS attacks from a single source.

The Ixia tester launched the following DDOS attacks:

- ARP Flood
- Evasive UDP
- Land Attack
- Ping-of-Death
- Ping Sweep
- RST Flood
- TCP Scan
- TearDrop
- Surf Attack
- SYN Flood
- UDP Flood
- UDP Scan
- Unreachable Host
- Xmas Tree Attack

In addition, PROTOS, a sophisticated open-source tool that generates malformed SIP packets, was used. The results: None of the malicious attacks, including PROTOS, had any damaging impact on Mediant 4000B operations – to the call load of 122cps being handled or the 5,000 concurrent calls being sustained. Attacks against the Mediant 4000B media ports caused no call drops or failures, and call quality during those DDoS attacks remained excellent.

It turns out the Mediant 4000B has a built-in Intrusion Detection System feature that detects and suppresses malicious attacks directed at it. Reactions include blacklisting the assaulting IP addresses/ports for a user-defined period of time and/or sending alerts – SNMP traps with full details of malicious activity.

Resiliency, High-Availability Testing

This round of tests was designed to assess the resiliency of the Mediant 4000B. In the first test, the resilience of 5,000 active G.711 pass-through media sessions was checked after the fail-over of the primary media link. The Mediant 4000B was first configured for carrier peering. A shutdown command was then issued through the Mediant 4000B command line interface to disable the active 1-Gigabit/s port that was carrying the bi-directional media traffic to and from the Mediant 4000B. All media packets were then redirected to a standby 1-Gbit/s port on the same Mediant 4000B. The Mediant 4000B provides eight Ethernet ports, which allow full separation of trusted and untrusted networks and allow primary and secondary links. Using the Spectra2 call generator, we determined that it took only 10.3 milliseconds for the traffic to re-route and the media streams to re-

Highlights of DDoS Attacks

Attack	Target	Result
SYN Flood	44,000 TCP SYN packets per second (pps) directed at signaling port 5060	No effect on Mediant 4000B while handling 5,000 sustained no-media calls at 122cps
UDP Flood	50,000 UDP pps (400 Mbps) directed at the Mediant 4000B media ports to consume all bandwidth	No effect on Mediant 4000B while handling 5,000 sustained G.711 calls; call MOS was rated at 4.2 during attack
Unknown Source	18,000 bad SIP INVITES per sec from unknown sources directed at port 5060	No effect on Mediant 4000B while handling 5,000 sustained no-media calls at 122cps
SIP Fuzzing	18,000 malformed SIP messages per sec (200 Mbps) directed at port 5060	No effect on Mediant 4000B while handling 5,000 sustained no-media calls at 122cps
ICMP Flood	52,000 ICMP pps (200 Mbps) directed at the Mediant 4000B media ports	No effect on Mediant 4000B while handling 5,000 sustained G.711 calls; call MOS was rated at 4.2 during attack

Notes: All attacks were issued from 10 different IP-address sources. All attacks lasted 5 minutes.

establish. This near-instantaneous failover would not even be noticeable to callers on an active call.

High Availability. The ability to deploy two Mediant 4000B's in a high-availability, fail-over pair was also tested. For this test, two Mediant 4000B's were configured for carrier peering (see Test Bed next page). One was deployed in the role of primary; the other as its hot standby.

A full load of 5,000 calls was delivered to the primary Mediant 4000B. The primary Mediant 4000B was then shut down. The standby Mediant 4000B immediately took over as the primary, taking over all media of all calls in progress and the handling of new SIP INVITE call requests.

As a result of the fail-over, calls in progress remained connected and the brief delay for re-directing the media streams was imperceptible to callers. There was some loss of transient calls that were being set up at the moment of fail-over, but all

new calls were again successfully handled after a brief transition.

Testing WebRTC

The Mediant 4000B, our testing showed, is fully supportive of WebRTC – an increasingly popular, free and open project that provides browsers and mobile applications with real-time communications via simple and standardized APIs. Support for WebRTC is already integrated in the Google Chrome, Android Chrome and Mozilla Firefox browsers.

Service providers can use the integrated WebRTC support in the Mediant 4000B to offer business customers an integrated calling service directly from the customer's Web site.

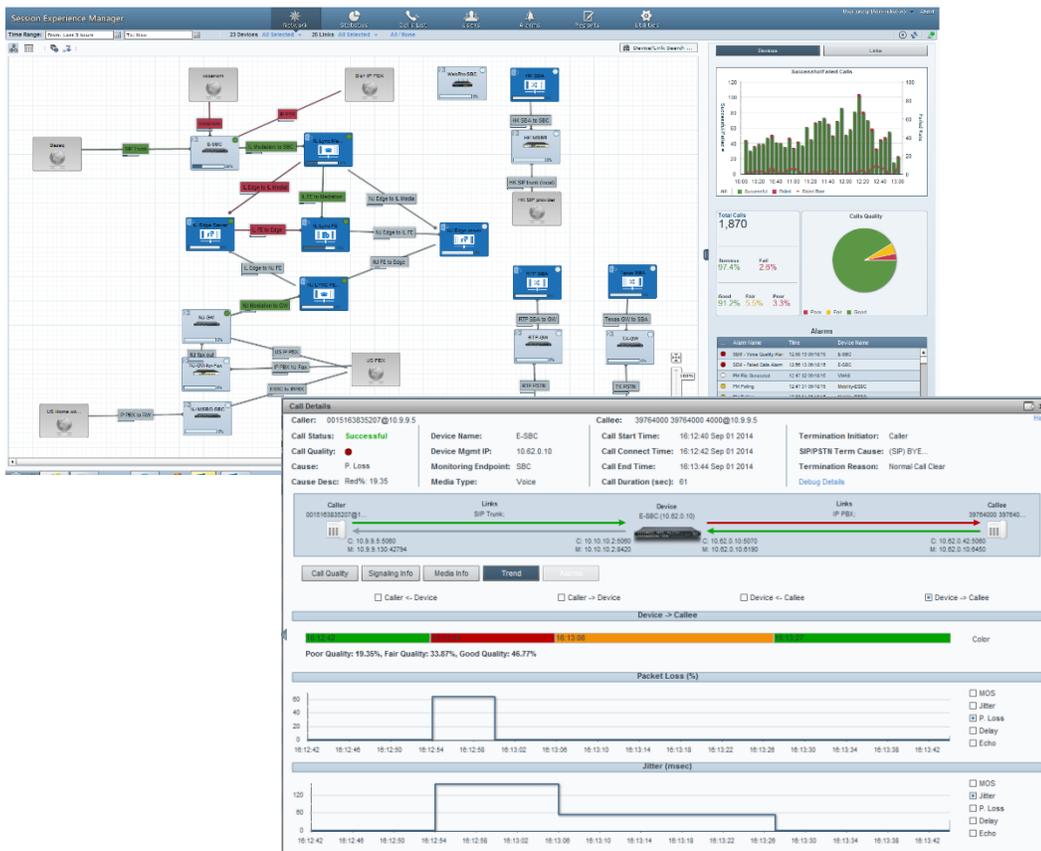
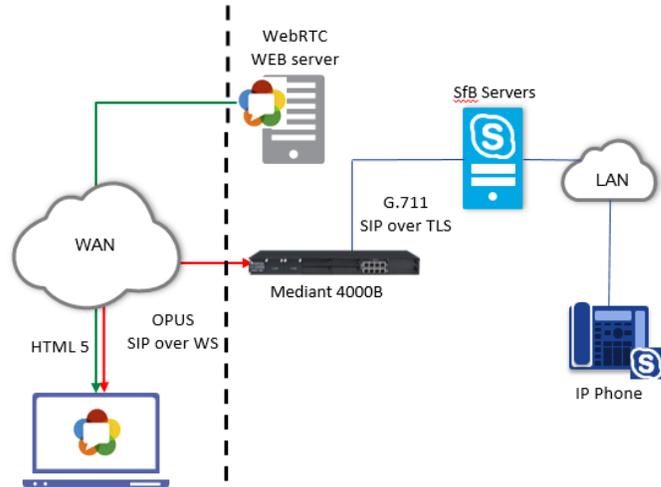
In the first scenario tested (see figure at right), a Mediant 4000B connected to Microsoft Skype for Business (SfB) through the SfB Mediation server, which allows SIP calls into the customer's VoIP network.

The Mediant 4000B acts as a WebRTC gateway in the process – terminating signaling and connectivity protocols such as DTLS, ICE light, SIP over Secure WebSocket, RTP and RTCP multiplexing, transcoding between the Opus wideband codec of WebRTC and G.711 where necessary, and

validating the calls with the Active Directory.

In a different test scenario, we used a Google Chrome browser to connect, via the WAN, with AudioCodes IP phones (which natively support the Opus coder) in the simulated customer call center.

In our test bed, high-quality wideband voice media streams passed through the Mediant 4000B unchanged, since both endpoints natively supported the Opus codec. The result: quick-and-easy setup of WebRTC with the Mediant 4000B, and excellent call quality.



AudioCodes' Sessions Experience Manager (SEM). The Mediant SBC family, including the 4000B are monitored by the SEM for Call Control and Voice Quality network analysis. The SEM shows both a high-level quality NOC view, as well as drill-down capabilities into intimate call details such as MOS trends over the call. The SEM also provides powerful reports to detect abnormal user behavior such as call theft and misused user extensions.

Comprehensive Management

An especially noteworthy aspect of the Mediant 4000B observed in our testing was its QoE monitoring system – the Sessions Experience Manager (SEM). SEM lets the Mediant 4000B administrator quickly isolate and remediate real-time problems throughout the VoIP infrastructure. The Mediant 4000B has an integrated session quality probe therefore no external probes are needed. The package addresses several key management aspects:

- **Network:** NOC view designed for proactive monitoring from top down.
- **Alarms:** Easily configurable alarms are issued through e-mail, SMS, syslog and SNMP.
- **Statistics:** Trends over time for KPIs such as network usage and network Voice Quality.
- **Users:** An Active Directory integration to monitor and troubleshoot users QoE satisfaction.
- **Call details:** Drill down into both call control and voice quality metrics of any call.
- **Reports:** Trend reports, problematic users' behavior, network status over time; exportable in CSV to help accommodating for network security breach.

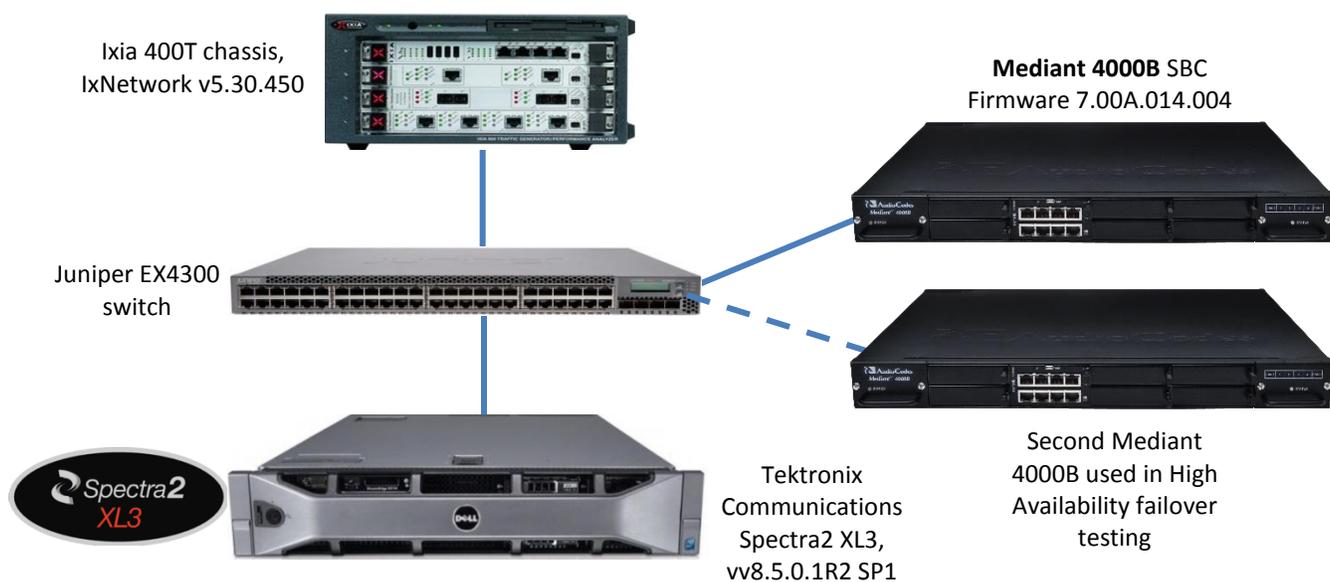
Bottom Line

During this testing, the AudioCodes Mediant 4000B delivered impressive performance, as detailed in this report.

Besides notable conversion capabilities, testing showed the Mediant 4000B to be highly resilient and survivable – able to fend off malicious attacks, with port redundancy and fail-over to a hot-standby Mediant 4000B. This Mediant 4000B SBC is ideally suited for its role as controller and mediator between enterprise and service-provider VoIP networks.

The tests in this report are intended to be reproducible for current or prospective customers who want to recreate them with the appropriate test and measurement equipment. Readers interested in repeating these results can contact reviews@miercom.com for details on the configurations applied to the equipment and test tools used in this evaluation. Miercom recommends that current and prospective customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a product selection.

Figure 8: Test Bed



Source: Miercom, July 2015

Miercom Performance Verified

Based on the results of this testing, Miercom presents AudioCodes with the Miercom Performance Verified Certification for the Mediant 4000B Session Border Controller. The SBC appliance excels at mediating between different VoIP media, protocol and transport environments, and reliably handles the conversion and interworking of thousands of calls concurrently and on a sustained basis.

The compact, 1U, Linux-based Mediant 4000B also exhibits exceptional resiliency and survivability – able to instantly redirect call-control and media traffic to redundant 1-Gbit/s ports, and to fail-over in seconds to a hot-standby Mediant 4000B. We compliment AudioCodes on the versatility of the Mediant 4000B.



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