SONiC PlugFest 2021

Test Report and Learning Summary

Contents

Executive Summary

This first Software for Open Networking in the Cloud (SONiC) PlugFest brings the community together to put SONiC under the test for both the end users and vendors in this open-source ecosystem. This report shares the results and key findings.

Keysight Technologies and Aviz Networks are neutral members hosting this event to bring users and vendors to one level playing field to test and discuss the present and future of SONiC. Our goal is to accelerate SONiC adoption by answering two questions: What do end users of SONiC want? Is SONiC ready for deployment?

We had an overwhelming response from the end user community with 20+ companies across the globe joining to form the SONiC customer advisory board (CAB) and 6 participating vendors from application-specific integrated circuit (ASIC) to original design manufacturer (ODM) companies.

Why Hold This PlugFest?

SONiC has emerged as a leading network operating system (NOS). The open-source Linux-based NOS offers robust functionality for next-generation data centers and several major cloud-service providers have already successfully deployed it. Clearly, the potential of SONiC to separate the hardware layer to enable greater flexibility, extensibility, and standardization is huge.

Contributors and members of the community are developing and testing SONiC extensively today and the community is doing a great job. However, there are several challenges that must be addressed before SONiC can cross the chasm and become an obvious choice for hyperscale data centers and enterprise networks.

One of those challenges is the need for neutral, open, and standardized testing. Why? Because end-users need an authoritative source of truth for what they can expect when they deploy hardware running SONiC. While most hardware vendors today "support" SONiC, it is not clear or easy to determine what features are and are not supported, how well they work, and can the test results be replicated in independent labs. Because of this ambiguity in functionality and quality, SONiC is not widespread, particularly in enterprise networks – yet.

Industry's First SONiC PlugFest
- Determine SONiC's maturity across vendors
- Present customer use cases and requirements
- Develop standardized test methodologies
- Validate SONiC quality from features to scale to operations

Aviz Networks and Keysight Technologies have come together to help bridge this gap between enterprise expectations and where SONiC is today in terms of being a great community driven NOS. In this PlugFest, our motto is simple – "To accelerate SONiC adoption". To align with this, we are focusing on the following key attributes for open-source NOS quality, which we believe should accelerate the adoption:

- Expand width and depth of the testing to properly simulate the deployments and needs of private cloud enterprise customers – by taking inputs from SONiC end users.

- Create and execute the tests in a trusted environment by neutral engineers in an automated repeatable manner, and by using consistent toolsets for running the tests.

- Keep it neutral and transparent by focusing on SONiC NOS and SONiC ecosystem readiness instead of focusing on competitive analysis between vendors.

- Publish a SONiC ecosystem map that details SONiC readiness as an open-source NOS on various dimensions that are relevant for end user deployments.

- Set the industry standard for open-source NOS validation and deployment readiness.
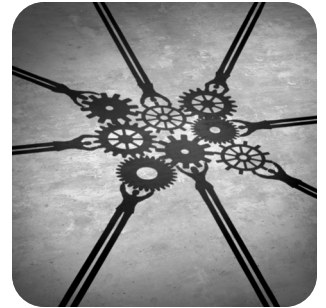
PlugFest Participants

Neutral Community Members

Keysight and Aviz Networks have partnered with the community to drive this PlugFest as neutral third-party members. The neutral community members are responsible for defining the tests used in the PlugFest to validate vendor SONiC network gear.

Customer Advisory Board

Keysight and Aviz Networks have partnered with the community to drive this PlugFest as neutral third-party members.

The customer advisory board (CAB) is composed of hyperscalers, financial institutions, advanced enterprises, social platforms, and others interested in building data center networking with open-source solutions like SONiC. CAB members were instrumental in shaping and defining test cases that capture aspects of networking performance important to potential SONiC users and customers. The CAB is comprised of industry-leading organizations that include:

Industry	Company
Cloud Service Providers	• LinkedIn • Meituan • Microsoft • Tencent • Yahoo Japan
Network Operators	• Internet Initiative Japan (IIJ) • Line • Ucloud • DMM • Zheijang lab
System Integrators	• Apresia Systems • CTC • Macnica • Nissho electronics • WWT

The CAB comprises hyperscalers, financial institutions, enterprises, and social platforms interested in building data center networking with SONiC.

As end-users of SONiC, CAB members sought valuable data not previously available such as:

- understand what current SONiC vendors are doing
- get a neutral third-party test report on SONiC performance
- discuss use cases within the community
- better plan data center infrastructure acquisition efforts

Participating Vendors

Another essential part of the PlugFest were the vendors who provided the switches used to build the various testbeds for the event. Since SONiC system-level test standards have been scarce, this PlugFest presented an opportunity for confident vendors to put their switches to the test in a third-party validation. The resulting test reports enable vendors to improve SONiC quality and demonstrate the readiness for deployment.

The SONiC PlugFest presented network vendors with a rare opportunity to:

- understand what current SONiC customers are looking for
- get a neutral third party verified report on SONiC validation
- showcase their switches in a SONiC ecosystem and in this public report
- get a detailed private report to help improve their SONiC implementation

Following are the switch platforms that were tested with hardware and software details.

Vendor	Hardware SKU	Switch ASIC	SONiC Version
Edgecore	Accton-AS7726-32X	Broadcom Trident	Enterprise SONiC Distribution by Edgecore (202006)
Edgecore	Accton-Wedge100BF-32X	Intel Tofino	
Intel	Accton-Wedge100BF-32X	Intel Tofino	Community 202012
Cameo	esqc610-56sq	Innovium TERALYNX 5	Community 201911
Delta	Delta-ag9032v1, Delta-ag9032v2	Broadcom Tomahawk	Community 202012
Innovium	ICS7700-32D (Spine) Celestica Midstone (Leaf)	Innovium TERALYNX 7	Community 201911
NVIDIA	SN2100	NVIDIA Spectrum-1	Community 201911 (hash: e2eb4e49)

Open Verification Lab and Testbed

Participating vendors had access to an open verification lab hosted by Keysight and Aviz in three California locations. All test traffic generation hardware and software was provided by Keysight. This included the Ixia UHD100T32, Novus 100GE, IxNetwork, and Ixia Open NOS Validation Suite. A standard test methodology, co-developed by Keysight and Aviz, was used across all vendor switches. Each vendor provided four switches for testing in a T1 / T0 testbed topology.

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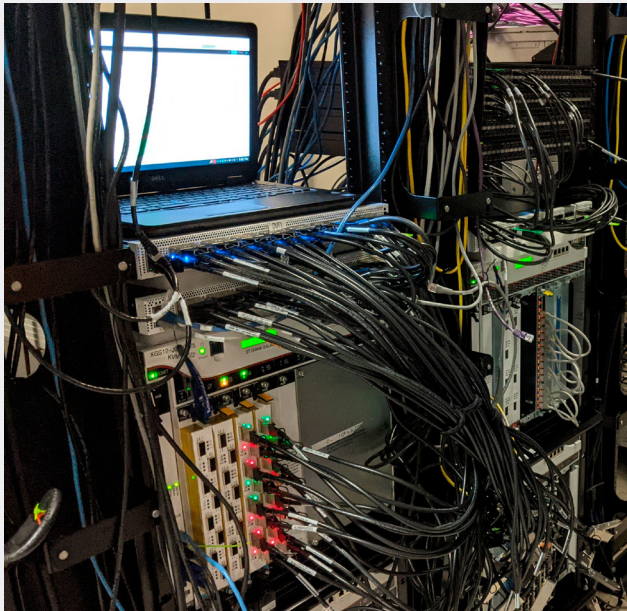
SONiC testing in Keysight's Calabasas location

Keysight Test Suite

Ixia Open NOS Validation Suite is a commercially available set of comprehensive tests covering functionality to deployment readiness across multi-device under test (DUT) environments. As part of the PlugFest, we executed 105 unique test cases offered by this solution.

In addition, we included test scenarios for:

- Border Gateway Protocol (BGP) scale and resiliency in an IPCLOS network
- Equal-Cost Multi-Path (ECMP) convergence and failover
- Various reboot scenarios

The physical test environment consists of 4 switches interconnected with each other and with Keysight traffic generator / protocol emulator ports (marked as "Ixia" in the following diagrams). This testbed allows execution of all the testing required in the T1, T0 or TOR-Leaf logical scenarios.

Physical Testbed

Figure 1: Physical testbed
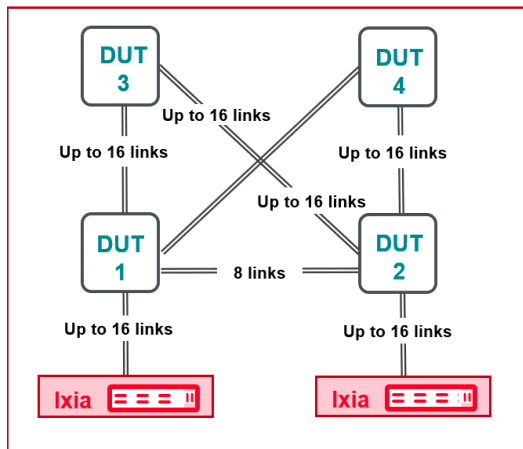
Test cases included verifying features, functions, scalability, and operational deployment.

Tests were written with three different logical test environments in mind:

- Essential: Feature/functional test cases
- Scale: Scaling each of the functional areas
- Operation: Real network operator deployment use cases
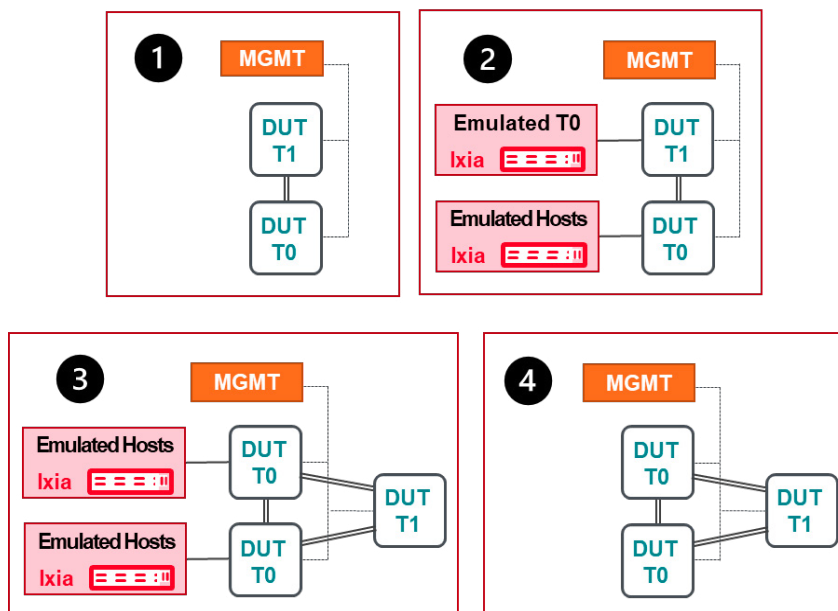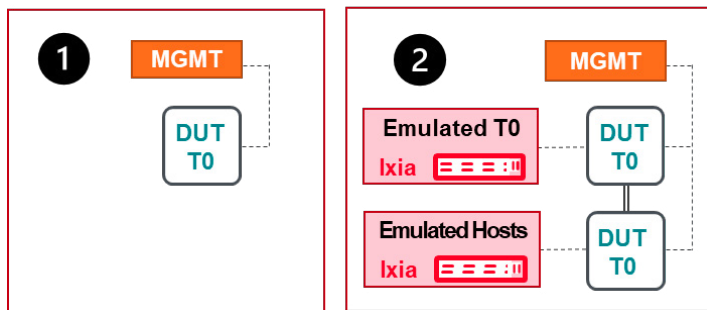
Essential Test Suite Topologies

Figure 2: Logical testbeds for the "Essential" test suite

Scale Test Suite Topologies

Figure 3: Logical testbeds for the "Scale" test suite

Operation Test Suite Topology

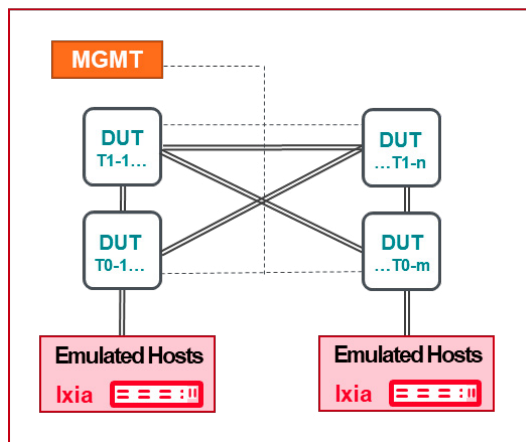Figure 4: Logical testbeds for the "Operation" test suite

All test cases are automated and run as part of IxSuiteStore test management system (included in the Ixia Open NOS Validation Suite), which offers a web-based UI to drive the testing.
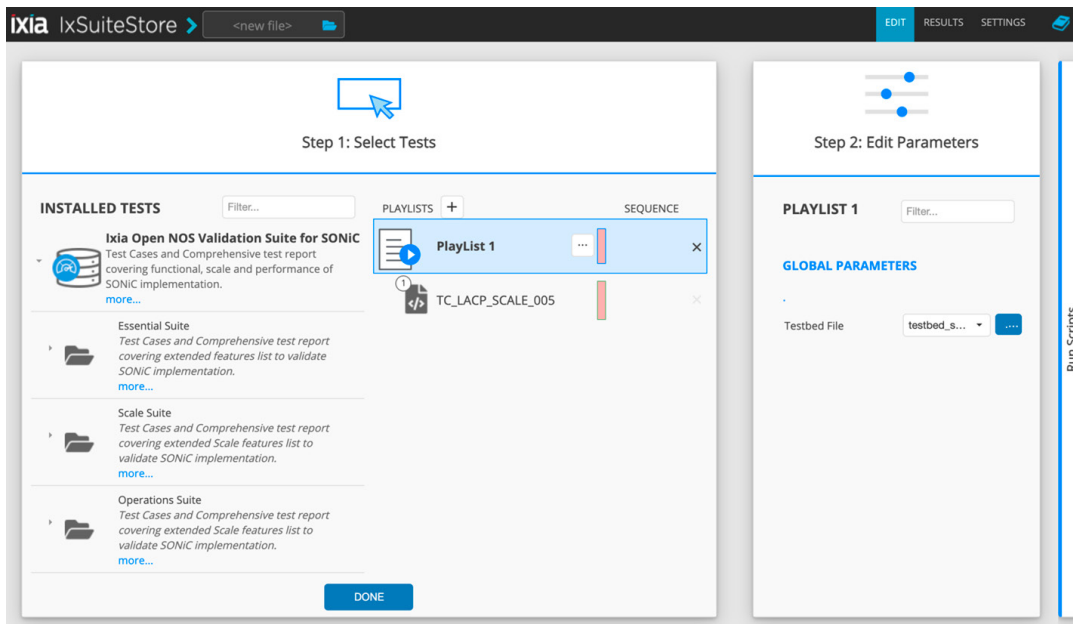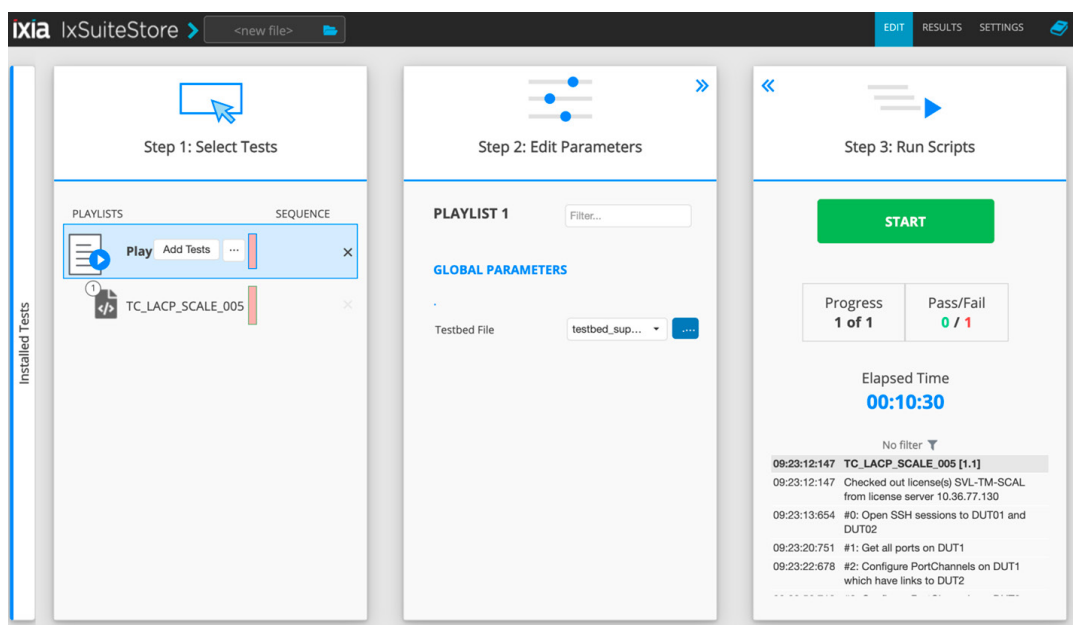
The IxSuiteStore web UI was used to drive all testing in the SONiC PlugFest.

Figure 5: IxSuiteStore test case selection

Figure 6: IxSuiteStore test case execution

Figure 7: IxSuiteStore test results database

Test Report

In the SONiC PlugFest we took a multi-dimensional view on SONiC quality. These dimensions were defined keeping various stakeholders like vendors and end users in mind.

In line with the test modules described above, the results were categorized into three high-level categories.

- Feature
- Scale
- Operations

The results were then further segmented into a detailed deployment view and categorized into:

- Platform
- Management
- Layer 2
- Layer 3
- System/Ops

To determine SONiC readiness scoring per dimension, we took a holistic approach by defining the maximum and minimum scores for each of the platforms evaluated. We understand that the deployments can be multi-vendor and what matters is how SONiC is doing across different ASIC and switches. Aligned to our motivation of accelerating SONiC adoption and making a strong community, this report focuses on SONiC quality overall rather than vendor comparison and interoperability.

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High Level Evaluation	Component Level Evaluation	Protocol Level Evaluation
1. SONiC Features 2. SONiC Scale 3. SONiC Ops	1. Platform 2. Management 3. Layer2 Function & Scale 4. Layer3 Function & Scale 5. Day 2 operations	1. Platform [2] 2. Management [4] 3. Layer 2 Func & Scale [5] 4. Layer 3 Func & Scale [8] 5. Day 2 ops [15]
Vendor - 1 Scores for 3 Categories	Scores for 5 sub-categories	Scores for 34 sub-categories
Vendor - 2 Scores for 3 Categories	Scores for 5 sub-categories	Scores for 34 sub-categories
Vendor -n Scores for 3 Categories	Scores for 5 sub-categories	Scores for 34 sub-categories
Max | Min | Avg *(Across Vendors)*	Max | Min | Avg *(Across Vendors)*	Max | Min | Avg *(Across Vendors)*

Figure 8. Test data is aggregated to focus on SONiC quality rather than vendor comparisons

First, we will look at the high-level results.

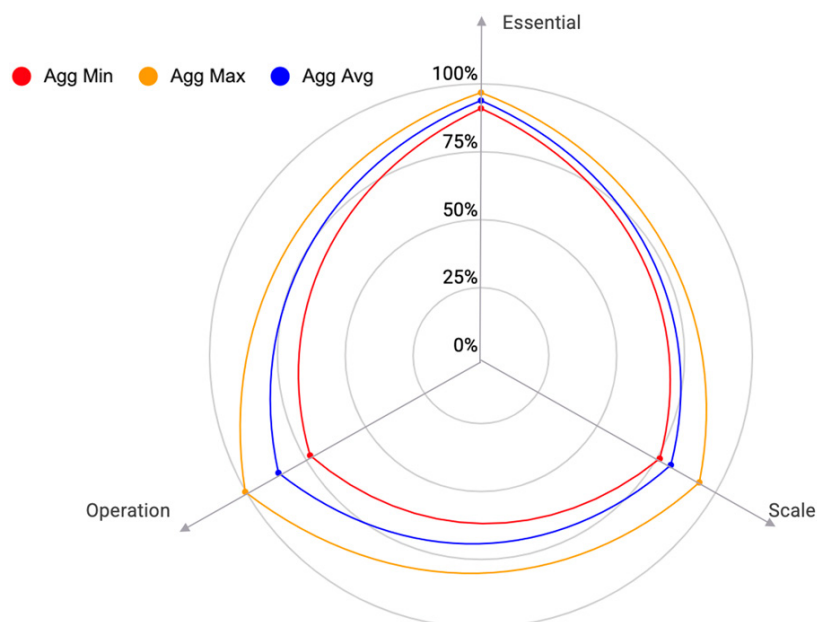| Category	Agg Min	Agg Max	Agg Avg
Feature	91%	97%	94%
Scale	76%	93%	81%
Operation	73%	100%	86%

Figure 9: High-level summary scores

The above scores tell the story of excellent work from the SONiC community on features as the functional testing of the features yielded very good results. However, when we pushed the features to limits and scaled the numbers, we ran into some failures. Tests were also designed to simulate actual deployment scenarios of well-known Day 2 operations. This is very critical as most network operators track this as the most important KPI when it comes to SONiC's success.

The areas that were tested in this section were failover/failback scenarios to mimic production environments. The scale and operations aspects are closer to maturity and this PlugFest has actually helped them to become better as we worked with vendors to fix some of the issues that presented.

In summary, we found that SONiC needs hardening in these areas:

1. Performance

2. Resiliency

3. Scale

4. Failover/Failback convergence

The good news is that in addition to our Ixia Open NOS Validation Suite, we contributed some of these important test cases into the SONiC community. Taking a deeper dive on some of the important areas, we saw the below results.

> The scale and operations aspects are closer to maturity and this PlugFest has actually helped them to become better as we worked with vendors to fix some of the issues that were found.

Category	Agg Min	Agg Max	Agg Avg
SONiC Platform	64%	100%	89%
Management	100%	100%	100%
L2 Functional & Scale	70%	96%	84%
L3 Functional & Scale	92%	100%	93%
Day-2 OP	73%	100%	86%

Figure 10. Component-level scores
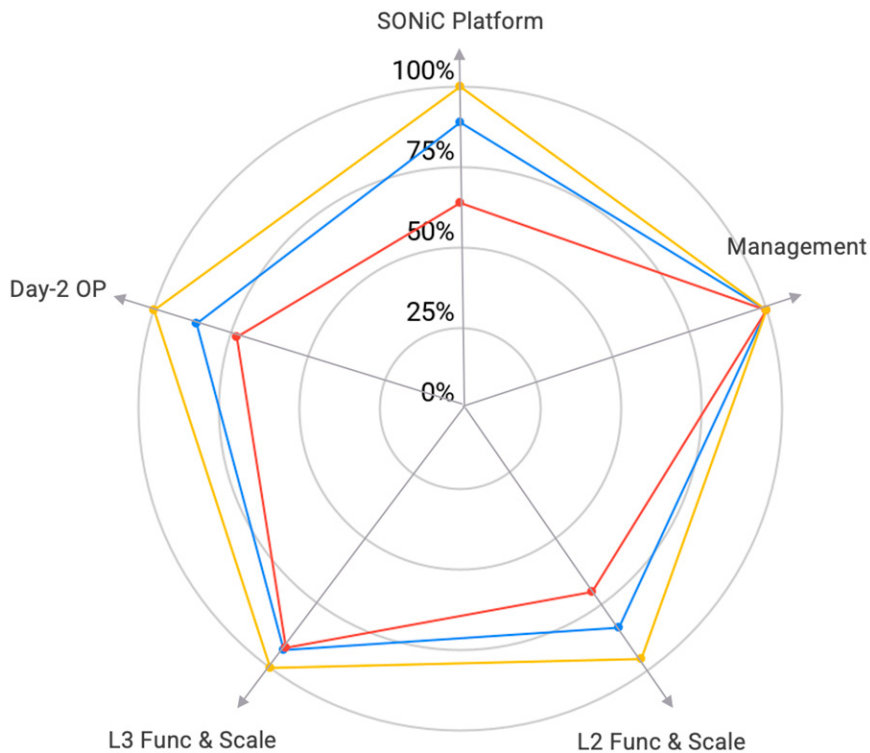
Since the focus for SONiC has been on cloud data centers, Layer 3 looks very robust.

The SONiC focus has been on cloud data centers, so quite evidently, the Layer 3 (L3) area looks very robust. With a lot of traction around the SONiC platform, management areas are also hardened. We are now seeing SONiC evolving and expanding into enterprise, campus, and edge as well. Layer 2 (L2) features will eventually gain more traction as adoption picks up in these areas.

There is scope of improvement in L2 areas. Finally, as also seen in the previous breakdown, there are some challenges that we see in the Day-2 operations. This area needs focused testing in real-world system test environments for quick success in deployment. Community tests are designed on single-switch functionality and are missing this coverage. This area can be enhanced by using commercial traffic generators and advanced test methodologies with high-precision test and measurement tools. Areas of convergence in ECMP failover scenarios and various reboot scenarios are examples of these critical areas that provide the much needed redundancy to modern data centers.

As we completed our testing on the various platforms, we did see variances in the pass rate across different ASICs and switches. The data is from a pool of 118 test cases that we did.

Common areas of failure we found in multiple platforms include:

1. Inconsistent forwarding database entries.

2. Inconsistent use of command line interface (CLI). This is a major challenge for network operators. Especially when it comes to testing and monitoring devices.

3. Memory spikes in longevity testing. These are part of our "Scale" package of tests where we saw memory spikes in multiple platforms.

4. All vendors passed BGP/ECMP failover convergence tests, however a large variance in convergence time was contributed to by various components such as CPU, memory, ASIC, and NOS version

5. Various reboot scenario failures. A key feature where Keysight has contributed advanced test methodology to the community are various reboot scenarios like warm, fast, cold reboot functionalities. These features are becoming popular to ensure non-stop forwarding. In our attempt to test this area in detail we simulated T1-server and server-T1 scenarios.

   - There was a lot of variation observed across platforms in the reboot convergence times
   - Failed tests because convergence times were above the test threshold
   - Re-establishing BGP sessions took longer than expected in case of fast/cold reboot
   - Warm-reboot command fails in the 202012 community SONiC release

RIB-IN convergence times vary with number of routes. The RIB-IN capacity varied among devices, but what is also important to note is that the ability of the test gear to measure convergence times accurately showed there are tradeoffs between RIB capacity versus convergence times.

Category	Agg Min	Agg Max
RIB-IN Capacity(Routes)	49K	148K
RIB-IN convergence (sec)	15	39

With bulk use cases at ~50K routes in a modern-day data center, SONiC performed well in this area.

With high-precision time measurements for various failure conditions, we were able to determine failover times for link failure and route convergence.

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Scenario	Agg Min (seconds)	Agg Max (seconds)	Agg Avg (seconds)
Simulate local link failure 4K routes	0.9	5.0	2.1
Simulate local link failure 16K routes	3.2	22.0	8.3
Simulate remote link failure 4k routes	1.0	5.0	2.1
Simulate remote link failure 4k routes	3.3	24.4	8.9
RIB-IN convergence with 4K routes	1.1	8.3	3.1
RIB-IN convergence with 16K routes	3.9	17.7	7.7

Conclusion

Keysight and Aviz Networks are committed to driving SONiC quality improvements and will continue on this endeavor with dedicated support to the SONiC community and future PlugFests. As we conclude this first PlugFest, here are some key facts and takeaways from our learnings so far.

PlugFest Facts

One of the most important steps for any technology adoption is to have a customer voice that helps to define key characteristics for multiple use cases. The formation of the SONiC CAB is such a key milestone for this PlugFest event. The CAB is currently comprised of 20+ companies who intend to use SONiC for their network infrastructure and are looking for quality, ecosystem, and protocol coverage readiness. The CAB was instrumental in this PlugFest, delivering 64 inputs that improved our test coverage. Their input on required features will also help the SONiC community implement faster deployments. These inputs also helped to set the roadmap for next PlugFest event.

Apart from the CAB formation, having strong commercial and neutral entities are essential for any open-source adoption. Keysight and Aviz both are neutral, and the aim of PlugFest is to accelerate the adoption of SONiC. This is the first time in SONiC's history that two neutral and independent entities in the industry have endeavored to evaluate and publish the report for SONiC readiness. As part of the PlugFest, we executed a total of 1000+ test cases across 6 different testbeds located in 3 different labs. This effort resulted in 50+ bugs reported to the vendors. As vendors address these issues, nearly half of which are already fixed, SONiC quality will improve.

The CAB was instrumental in this PlugFest, delivering 64 inputs that improved our test coverage and their input on required features will help the SONiC community implement the right features for the end users.

PlugFest Takeaways

The previous sections of this report offer discussion of many test details. However, CAB members received more detailed analysis and statistics than reported here. Let us review the takeaways from the PlugFest tests.

Ecosystem is ready with multiple SONiC solutions. As part of the PlugFest event, we saw great interest from ASIC and switch vendors, as well as from the customer organizations researching and investing in SONiC solutions. In a short 3-month time period, we were able to move from idea concept to this final report. This would not have been possible without strong support of the SONiC community and a thriving ecosystem.

Community SONiC version is consistent across multiple vendors. As part of the PlugFest event, we used the same set of automated scripts for all six vendors. The fact that we were able to use the same test to evaluate six different vendors shows that SONiC is ready in a consistent manner and is delivering its promise of a true open-source-based disaggregated NOS.

Layer 3 is ready with a few gaps. As the detailed result section shows the L3 worked really well for most of the vendors, however one of the important inputs from the CAB was feature gaps in L3, mainly for EVPN VXLAN and BGP Unnumbered.

This input is well-discussed in the community and we believe that by the time we organize the next PlugFest, vendors will have these features available. For now, we are working to add test cases for these features.

The other gap is the readiness of Day-2 operations. These tests included various failover and failback scenarios. In almost all cases, the system recovered but the time it took to recover and the CPU and memory spikes that it is recovering could have been better. A focus is required to push the limits with SONiC and then fix these corner cases to achieve industry standard failover/failback numbers and behavior.

Layer 2 feature and scale gaps. As the detailed results section shows, the L2 functionality worked well for most of the vendors. However, when the scaling was done, failures were observed across vendors. This behavior is mainly related to SONiC readiness with Layer-2 rather the vendor implementations. CAB input indicated concerns about feature gaps in layer-2 mainly for spanning tree protocol and multi-chassis LAG.

Apart from these feature gaps, more focus is required for scaling L2 protocols and fixing any bugs around it.

> The fact that we were able to use the same test to evaluate six different vendors shows that SONiC is ready in a consistent manner and is delivering its promise of a true open-source-based disaggregated NOS.

Call to Action

In any open-source community, there are three pillars that make the adoption of the technology successful.

- Customers
- Vendors
- Enablers

In this section, we will discuss the call to action for each of these three pillars.

Call to Action for Customers

Adoption of open source gives customers more control of their infrastructure as well as savings on total cost of ownership (TCO). But it takes time to become familiar with the technology. If you are looking to deploy SONiC, then now is the time to engage with the community and the CAB. Here are the few steps you can take to get started:

- Select a neutral SONiC partner for SONiC expertise and post-deployment support, removing in-house SONiC expertise as a blocker for SONiC adoption
- Look for readymade SONiC apps for evaluation to post deployment visibility, instead of making everything from scratch
- Start a SONiC POC with a trusted partner

Call to Action for Vendors

Adoption of open source as a primary NOS gives ASIC and Switch vendors a faster time to market, as well as an easier way to showcase differentiations. Having proven and ready-to-deploy solutions will speed adoption of SONiC. Here are few steps to accelerate:

- Focus on quality in your SONiC solution. Improve quality by having an effective in-house test infrastructure, or by using industry standard SONiC test applications
- Focus on having system and day-2 operations readiness. Use the SONiC CAB as an advisory group and push the SONiC limits to those of current proprietary NOS.
- Expand SONiC R&D and sales efforts by partnering with neutral partners. This removes having in-house SONiC expertise as a blocker for SONiC development and sales.

Call to Action for Enablers

To make any open source successful, there is a need of a commercial push from the vendors who are neutral and can openly work with switch/ASIC vendors as well as customers. These enablement companies help to fill the gap with a commercial interest to productize the solution. Here are recommendations to help enablers accelerate SONiC adoption:

- Create SONiC expertise so it can be used to accelerate SONiC development as well as adoption with customers
- Remain neutral and aligned with the SONiC community with a focus on contributions of open source content
- Focus on creating awareness by organizing events as well as making relevant products and offerings

In conclusion we are at a pivotal stage with SONiC. We acknowledge the tremendous work of the huge developer community to coordinate and contribute their expertise into SONiC development. Now we have to take it to the next level with the focused products, support, and services needed for successful deployments by major hyperscalers and enterprises.

About AVIZ Networks

AVIZ enables SONiC deployments for Data Center & Edge networks. AVIZ is an avid contributor in the SONiC community and works with a vast majority of ASIC & Switch vendors to make deployment ready SONiC solutions. AVIZ is further accelerating SONiC adoption by delivering containerized modules for multiple networking use cases. The use cases range from enabling specific protocols, edge networking functions, and network management to monitoring functions for performance and troubleshooting. With AVIZ, customers can swiftly and successfully transition to SONiC, achieve higher agility, and attain better TCO for their network operations. More information is available at www.aviznetworks.com.

About Keysight Technologies

Keysight delivers advanced design and validation solutions that help accelerate innovation to connect and secure the world. Keysight's dedication to speed and precision extends to software-driven insights and analytics that bring tomorrow's technology products to market faster across the development lifecycle, in design simulation, prototype validation, automated software testing, manufacturing analysis, and network performance optimization and visibility in enterprise, service provider and cloud environments. Our customers span the worldwide communications and industrial ecosystems, aerospace and defense, automotive, energy, semiconductor and general electronics markets. Keysight generated revenues of $4.2B in fiscal year 2020. For more information about Keysight Technologies (NYSE: KEYS), visit us at www.keysight.com.

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