

An Introduction to SONiC on Cisco 8000

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Agenda

- Introduction to SONiC, Design Goals, and Use Cases
- Architecture and Components Deep-dive
- SONiC Operational Considerations
- SONiC and Cisco 8000 routers
- Conclusion

Introduction to SONiC, Design Goals, and Use Cases





The SONiC Network Operating System

- SONiC Software for Open Networking in the Cloud is an open-source network operating system based on Debian Linux.
- Initially created by Microsoft for use in their Azure datacenters. Opensourced by Microsoft in 2016.
- It became part of the Linux Foundation in 2022 which focuses on the software components of SONiC and partners with Open Compute Platform (OCP) on aligning hardware and specifications like the Switch Abstraction Interface.
- <u>https://github.com/sonic-net/SONiC/wiki</u>
- <u>https://sonicfoundation.dev/</u>



SONiC Design Goals

- Open-Source Software: Open-source approach to network operating systems.
- Hardware Agnostic: Creating a Network Operating System can be integrated with different ASICs and NPUs.
- Modularity: Network Operating System functions separated as docker containers.
- Operational Ease: Simplify network operations with support for APIs and configuration management tools.

Use Cases

- Hyperscaler datacenters
 - IP/BGP Datacenter fabric
 - Overlay fabric with static VXLAN
 - ToR, Leaf, and Fixed-Chassis (or Multi Instance) Spine roles.
- AI/ML Frontend and backend networks
 - Backend clusters
 - RDMA over Converged Ethernet v2 (RoCEv2)
 - QoS with Priority Flow Control (PFC) and Explicit Congestion Notification (ECN).
 - BGP Routing, ECMP load balancing
 - Frontend clusters
 - IP/BGP Routing and VXLAN

Architecture and Components Deep-dive

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SONiC Architecture



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SONiC Architecture

- Networking Operating System (NOS) running on Debian Linux
- NOS components implemented as separate docker containers.
- In-memory Redis databases used by all containers for of application state, configuration state, operational state, ASIC state and counters.





SONiC Components: Switch State Service

- Switch State Service (SwSS) container: This container exists to provide communication services between all SONiC modules.
 - Orchagent: Reads relevant state from daemons in other containers that need to program the ASIC (fpmsyncd, lldp_syncd, teamsyncd), process it and writes it to the ASIC_DB database in the Redis container.





SONiC Components: syncd

- syncd container: Responsible for synchronizing the state present at the SONiC NOS layer and the actual forwarding ASIC in the platform.
 - *SAI API:* Switch Abstraction Interface API defines a vendor-agnostic set of endpoints for managing the forwarding ASIC in the platform.
 - syncd: Subscribes to the ASIC_DB database (which is updated by the SWSS container) and programs the ASIC using the ASIC SDK.





SONiC Components: bgp

- bgp container: The SONiC routing stack is implemented in this container. It is based on the open-source Free Range Routing (FRR) protocol suite.
 - bgpd: Collects routing updates updates from BGP neighbors.
 - *zebra:* Provides kernel routing table updates, interface lookups, and redistribution of routes between different routing protocols.
 - fpmsyncd: Writes FIB state calculated by zebra to the Redis container.





SONiC Components: Other containers

- Platform Monitor (pmon) container: Collects sensor readings from platform sensors. Raises alarms (if any) and controls fan speeds on the basis of sensor readings.
- SNMP (snmp) container: Implements an SNMP server for SONiC.
- Teamd (teamd) container: Provides link aggregation functionality in SONiC. Based on teamd, an open-source LAG protocol.
- LLDP (IIdp) container: Implements Link Layer Discovery Protocol for SONiC.

SONiC Operational Considerations





SONiC Install

- Open Network Install Environment (ONIE) is SONiC's supported install environment.
- It combines a boot loader with a Linux kernel and Busybox and Provides boot options such as iPXE.
- The busybox environment allows user-configurable install actions
 as well as password recovery
- SONiC CLI also supports install upgrade and rollback actions.

SONiC Install: ONIE

GNU GRUB version 2.02~beta2+e4a1fe391	(+)
<pre>*ONIE: Install OS ONIE: Rescue ONIE: Uninstall OS ONIE: Update ONIE ONIE: Embed ONIE +</pre>	
Use the ^ and v keys to select which entry is highlighted. Press enter to boot the selected OS, `e' to edit the commands before booting or `c' for a command-line.	

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SONiC Install: sonic-installer

root@sonic:/home/admin# sonic-installer list

Current: SONiC-OS-202305.1.2-6514cfa26 Next: SONiC-OS-202205.3.3-7c68be04e Available: SONiC-OS-202205.3.3-7c68be04e SONiC-OS-202305.1.2-6514cfa26





SONiC Install: sonic-installer

root@sonic:/home/admin# sonic-installer install http://1.63.51.21/sonic/sonic-cisco-8000.202205.3.3/sonic-cisco-8000.202205.3.3.bi

New image will be installed, continue? [y/N]: y Downloading image... ...99%, 1567 MB, 11301 KB/s, 0 seconds left... efi not supported - exiting without verification Installing image SONiC-OS-202205.3.3-7c68be04e and setting it as default... Command: bash /tmp/sonic_image Verifying image checksum ... OK. Preparing image archive ... OK. Installing SONiC in SONiC ONIE Installer: platform: x86_64-cisco-8000-r0 onie_platform: x86_64-8201_32fh_o-r0 Installing SONiC to /host/image-202205.3.3-7c68be04e Archive: fs.zip creating: /host/image-202205.3.3-7c68be04e/boot/ inflatina: /host/image-202205.3.3-7c68be04e/boot/vmlinuz-5.10.0-18-2-amd64 inflating: /host/image-202205.3.3-7c68be04e/boot/initrd.img-5.10.0-18-2-amd64 inflating: /host/image-202205.3.3-7c68be04e/boot/System.map-5.10.0-18-2-amd64 inflating: /host/image-202205.3.3-7c68be04e/boot/config-5.10.0-18-2-amd64 extracting: /host/image-202205.3.3-7c68be04e/fs.squashfs Switch CPU vendor is: GenuineIntel Switch CPU cstates are: disabled EXTRA_CMDLINE_LINUX= Installed SONiC base image SONiC-OS successfully

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SONiC Install: sonic-installer

root@sonic:/home/admin# sonic-installer set-next-boot SONiC-OS-202305.1.2-6514cfa26 Command: grub-reboot --boot-directory=/host 1

root@sonic:/home/admin#

Sets the image to be loaded on the next router reload

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SONiC Configuration

- The device configuration is stored as a json file and can be accessed from /etc/sonic/config_db.json
- Contents of /etc/sonic/config_db.json are loaded into the Redis database on startup or by issuing a config load or config reload command
- SONiC also has a simple Python Click based CLI interface.
- "show" commands can be executed by any user whereas configuration commands require sudo privileges

- Configuration actions can be made by either:
 - Modifying the config_db.json file using the sonic-cfggen utility
 - CLI commands in the Linux shell
 - vty shell in FRR
- SONiC configuration management can be simplified by using open-source tooling such as Ansible and Terraform.
- gRPC/gNMI also supported, however, gNMI implementation is recent and does not cover all endpoints

SONiC show CLI examples

admin@sonic:~\$ show platform summary

Platform: x86_64-8201_32fh_o-r0 HwSKU: 32x400Gb ASIC: cisco-8000 ASIC Count: 1 Serial Number: FLM27200ADU Model Number: 8201-32FH-0 Hardware Revision: 1.0



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SONiC show CLI examples

admin@sonic:~\$ show version

SONiC Software Version: SONiC.202305.1.2-6514cfa26 SONiC OS Version: 11 Distribution: Debian 11.9 Kernel: 5.10.0-23-2-amd64 Build commit: 6514cfa26 Build date: Wed Mar 13 09:33:29 UTC 2024 Built by: sonicci@sonic-ci-8-lnx

Platform: x86_64-8201_32fh_o-r0 HwSKU: 32x400Gb ASIC: cisco-8000 ASIC Count: 1 Serial Number: FLM27200ADU Model Number: 8201-32FH-0 Hardware Revision: 1.0 Uptime: 22:25:57 up 31 days, 4:27, 1 user, load average: 1.32, 1.14, 1.04 Date: Fri 31 May 2024 22:25:57

<...>

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<...>

Docker images: REPOSITORY docker-macsec docker-dhcp-relay docker-ipxeserver-cisco docker-ipxeserver-cisco docker-gbsyncd-cisco docker-gbsyncd-cisco docker-sonic-telemetry docker-sonic-telemetrv docker-teamd docker-teamd docker-snmp docker-snmp docker-sflow docker-sflow docker-router-advertiser docker-router-advertiser docker-platform-monitor docker-platform-monitor docker-orchagent docker-orchagent docker-nat docker-nat docker-mux docker-mux docker-11dp docker-lldp docker-fpm-frr docker-fpm-frr docker-eventd docker-eventd docker-database docker-database docker-svncd-cisco docker-syncd-cisco docker-sonic-mgmt-framework docker-sonic-mgmt-framework

TAG latest latest 202305.1.2-6514cfa26 latest

IMAGE ID ST7F f7a9a7d4ff58 340MB 4bc1d2cc1192 328MB 6d594511b9ea 352MB 6d594511b9ea 352MB 29a320c79090 386MB 386MB 29a320c79090 0974c2d9654e 407MB 0974c2d9654e 407MB e8e364924112 338MB e8e364924112 338MB a498e1e14b1c 359MB 359MB a498e1e14b1c bfd6484d7a6d 339MB bfd6484d7a6d 339MB a4ab1e96403f 320MB 320MB a4ab1e96403f 087a1cb73d85 443MB 087a1cb73d85 443MB 40b5f419bfd3 350MB 40b5f419bfd3 350MB 3fb6329dc917 341MB 341MB 3fb6329dc917 fcaa4514b7af 369MB fcaa4514b7af 369MB da9e0a1f94c9 363MB 363MB da9e0a1f94c9 369MB bf63f51bab81 bf63f51bab81 369MB 6fc2fd9a7bc4 320MB 6fc2fd9a7bc4 320MB 320MB 52c1c0481fdf 320MB 52c1c0481fdf fa836211e367 812MB fa836211e367 812MB 415MB 45c7465d9c8b 45c7465d9c8b 415MB

SONiC Containers

admin@sonic:/home/admin# docker container ls								
CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES		
945bcbff6d13	<pre>docker-sonic-telemetry:latest</pre>	"/usr/local/bin/supe…"	4 weeks ago	Up 4 weeks		telemetry		
5ccef97df9b4	docker-snmp:latest	"/usr/local/bin/supe…"	4 weeks ago	Up 4 weeks		snmp		
8a9a6b19e1cc	<pre>docker-platform-monitor:latest</pre>	"/usr/bin/docker_ini…"	4 weeks ago	Up 4 weeks		pmon		
f8fa2d960729	<pre>docker-sonic-mgmt-framework:latest</pre>	"/usr/local/bin/supe…"	4 weeks ago	Up 4 weeks		mgmt-framework		
aacff75b4d6c	docker-lldp:latest	"/usr/bin/docker-lld…"	4 weeks ago	Up 4 weeks		lldp		
f96849265f1a	4bc1d2cc1192	"/usr/bin/docker_ini…"	4 weeks ago	Up 4 weeks		dhcp_relay		
4e44e2828dbf	docker-fpm-frr:latest	"/usr/bin/docker_ini…"	4 weeks ago	Up 4 weeks		bgp		
7fe7884038ba	docker-router-advertiser:latest	"/usr/bin/docker-ini…"	4 weeks ago	Up 4 weeks		radv		
cbb436366c53	<pre>docker-syncd-cisco:latest</pre>	"/usr/local/bin/supe…"	4 weeks ago	Up 4 weeks		syncd		
ce9b7d9b6b0f	docker-teamd:latest	"/usr/local/bin/supe…"	4 weeks ago	Up 4 weeks		teamd		
9aa4cffb8175	docker-orchagent:latest	"/usr/bin/docker-ini…"	4 weeks ago	Up 4 weeks		SWSS		
499884e6c90f	docker-eventd:latest	"/usr/local/bin/supe…"	4 weeks ago	Up 4 weeks		eventd		
91474e3f9111	docker-database:latest	"/usr/local/bin/dock…"	4 weeks ago	Up 4 weeks		database		

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SONiC show CLI examples

admin@sonic:	<pre>:~\$ show interfaces status</pre>									(
Interface	Lanes	Speed	MTU	FEC	Alias	Vlan	Oper	Admin	Туре	Asym PFC
Ethernet0	2304,2305,2306,2307,2308,2309,2310,2311	400G	9100	N/A	etp0	routed	down	up	N/A	N/A
Ethernet8	2320,2321,2322,2323,2324,2325,2326,2327	400G	9100	N/A	etp1	routed	down	up	N/A	N/A
Ethernet16	2312,2313,2314,2315,2316,2317,2318,2319	400G	9100	N/A	etp2	routed	down	up	N/A	N/A
Ethernet24	2056,2057,2058,2059,2060,2061,2062,2063	400G	9100	N/A	etp3	routed	down	up	N/A	N/A
Ethernet32	1792,1793,1794,1795,1796,1797,1798,1799	400G	9100	N/A	etp4	routed	down	up	N/A	N/A
Ethernet40	2048,2049,2050,2051,2052,2053,2054,2055	400G	9100	N/A	etp5	routed	down	up	N/A	N/A
Ethernet48	2560,2561,2562,2563,2564,2565,2566,2567	400G	9100	N/A	etp6	routed	down	up	N/A	N/A
Ethernet56	2824,2825,2826,2827,2828,2829,2830,2831	400G	9100	N/A	etp7	routed	down	up	N/A	N/A
Ethernet64	2832,2833,2834,2835,2836,2837,2838,2839	400G	9100	N/A	etp8	routed	down	up	N/A	N/A
Ethernet72	2816,2817,2818,2819,2820,2821,2822,2823	400G	9100	N/A	etp9	routed	down	up	N/A	N/A
Ethernet80	2568,2569,2570,2571,2572,2573,2574,2575	400G	9100	N/A	etp10	routed	down	up	N/A	N/A
Ethernet88	2576,2577,2578,2579,2580,2581,2582,2583	400G	9100	N/A	etp11	routed	down	up	N/A	N/A
Ethernet96	1536,1537,1538,1539,1540,1541,1542,1543	400G	9100	N/A	etp12	routed	down	up	N/A	N/A
Ethernet104	1800,1801,1802,1803,1804,1805,1806,1807	400G	9100	N/A	etp13	routed	down	up	N/A	N/A
Ethernet112	1552,1553,1554,1555,1556,1557,1558,1559	400G	9100	N/A	etp14	routed	down	up	N/A	N/A
Ethernet120	1544,1545,1546,1547,1548,1549,1550,1551	400G	9100	N/A	etp15	routed	down	up	N/A	N/A
Ethernet128	1296,1297,1298,1299,1300,1301,1302,1303	400G	9100	N/A	etp16	routed	down	up	N/A	N/A
Ethernet136	1288,1289,1290,1291,1292,1293,1294,1295	400G	9100	N/A	etp17	routed	down	up	N/A	N/A
Ethernet144	1280,1281,1282,1283,1284,1285,1286,1287	400G	9100	N/A	etp18	routed	down	up	N/A	N/A
Ethernet152	1032,1033,1034,1035,1036,1037,1038,1039	400G	9100	N/A	etp19	routed	down	up	N/A	N/A
Ethernet160	264,265,266,267,268,269,270,271	400G	9100	N/A	etp20	routed	down	up	N/A	N/A
Ethernet168	272,273,274,275,276,277,278,279	400G	9100	N/A	etp21	routed	down	up	N/A	N/A
Ethernet176	16,17,18,19,20,21,22,23	400G	9100	N/A	etp22	routed	down	up	N/A	N/A
Ethernet184	0,1,2,3,4,5,6,7	400G	9100	N/A	etp23	routed	down	up	N/A	N/A
Ethernet192	256,257,258,259,260,261,262,263	400G	9100	N/A	etp24	routed	down	up	N/A	N/A
Ethernet200	8,9,10,11,12,13,14,15	400G	9100	N/A	etp25	routed	down	up	N/A	N/A
Ethernet208	1024,1025,1026,1027,1028,1029,1030,1031	400G	9100	N/A	etp26	routed	down	up	N/A	N/A
Ethernet216	768,769,770,771,772,773,774,775	400G	9100	N/A	etp27	routed	down	up	N/A	N/A
Ethernet224	520,521,522,523,524,525,526,527	400G	9100	N/A	etp28	routed	down	up	N/A	N/A
Ethernet232	776,777,778,779,780,781,782,783	400G	9100	N/A	etp29	routed	down	up	N/A	N/A
Ethernet240	512,513,514,515,516,517,518,519	400G	9100	N/A	etp30	routed	down	up	N/A	N/A
Ethernet248	528,529,530,531,532,533,534,535	400G	9100	N/A	etp31	routed	down	up	N/A	N/A

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Configuring SONiC: CLI

root@sonic:/home/admin# config interface ip add Ethernet0 192.1.2.2/30 root@sonic:/home/admin# config interface ip add Ethernet8 192.1.2.6/30 root@sonic:/home/admin# config interface ip add Ethernet16 192.1.2.10/30 root@sonic:/home/admin# config interface ip add Ethernet24 192.1.2.14/30

root@sonic:/home/admin# config route add prefix 10.0.0.1/24 nexthop
192.1.2.1

root@sonic:/home/admin# config save -y

Saves modified config into /etc/sonic/config_db.json to preserve it across device reloads

Configuring SONiC: sonic-cfggen utility

• The sonic-cfggen is a utility to read SONiC config from various input types and then write the config to the config database in Redis, print as a json or render a jinja2 config template.

root@sonic:/home/admin# sonic-cfggen -j config.json --write-to-db

root@sonic:/home/admin# config save -y

Saves modified config into /etc/sonic/config_db.json to preserve it across device reloads



Configuring SONiC: sonic-cfggen utility

```
{} sample-cfg.json ×
Users > suhahmad > Library > CloudStorage > OneDrive-Cisco > clus-24 > {} sample-cfg.json > ...
  1
       {
            "INTERFACE": {
  4
              "Ethernet0": {},
              "Ethernet0|192.1.2.2/30": {},
              "Ethernet8": {},
              "Ethernet8|192.1.2.6/30": {},
              "Ethernet16": {},
               "Ethernet16|192.1.2.10/30": {},
              "Ethernet24": {},
               "Ethernet24|192.1.2.14/30": {}
           "MGMT_INTERFACE": {
                                                            sonic-cfggen -j config.json --write-to-db
               "eth0|172.24.1.2/24": {
                                                            will write this config to config_db.json
                   "gwaddr": "172.24.1.1"
           ł,
           "MGMT VRF CONFIG": {
               "vrf_global": {
                   "mgmtVrfEnabled": "true"
 23
       }
```

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Configuring SONiC: Ansible

≣ sam	ile-playbook.yml ×
leaf >	≡ sample-playbook.yml
	- name: Leaf IP configuration
	gather_facts: false
	hosts: leaf_switches
	- name: Configure IP address for Ethernet0
	ansible.builtin.shell: config interface ip add Ethernet0 192.1.2.2/30
	- name: Configure IP address for Ethernet8
	ansible.builtin.shell: config interface ip add Ethernet8 192.1.2.6/30
	- name: Configure IP address for Ethernet16
12	ansible.builtin.shell: config interface ip add Ethernet16 192.1.2.10/30
	- name: Configure IP address for Ethernet24
	ansible.builtin.shell: config interface ip add Ethernet24 192.1.2.14/30
	- name: Save config
18	ansible.builtin.shell: config save -y

! samp	le-playbook.yml ×
Users >	suhahmad > Library > CloudStorage > OneDrive-Cisco > clus-24 > ! sample-playbook.yml
1	- name: Leaf IP configuration with sonic-cfggen
2	gather_facts: false
3	hosts: leaf_switches
4	tasks:
5	- name: Copy sample-cfg.json
6	ansible.builtin.copy: /home/user/configs/sample-cfg.json
7	<pre>dest: /home/admin/sample-cfg.json</pre>
8	owner: admin
9	mode: '0644'
10	
11	 name: Write sample-cfg.json to running config
12	ansible.builtin.shell: sonic-cfggen -j sample-cfgwrite-to-db
13	args:
14	chdir: /home/admin/
15	
16	- name: Save running config to /etc/sonic/config_db.json
17	ansible.builtin.shell: config save -y

Alternatively, community SONiC collections are also openly available at https://github.com/ansible-collections/community.sonic

SONiC support on Cisco 8000 routers





SONiC on Cisco 8000 routers

- Cisco 8000 is a family of routers based on Cisco's Silicon One ASICs designed for deployment in service provider or hyperscaler environments.
- SONiC is supported on certain routers in the Cisco 8000 family.
- Cisco 8000 routers supporting SONiC come with device drivers and a Base Support Package (BSP) which Controls board, fans, drivers, FPD, LED, etc.
- These routers ship with SONiC installed on them. New images and upgrades are available at <u>www.software.cisco.com</u>
- Cisco is an active participant in SONiC's open-source community and upstreams code into the SONiC open-source project.

Cisco Silicon One ASICs



Cisco 8000 Routers supporting SONiC

	8101-32H	8101-64H	8101-32FH	8111-32EH	8122-64EH
FCS	Shipping	Shipping	Shipping	Shipping	Q3 2024
Ports	32x 100GbE	64x 100GbE	32x 400GbE	32x 800GbE	64x800GbE
Throughput	3.2Tbps	6.4Tbps	12.8Tbps	25.6Tbps	51.2Tbps
ASIC	Q202L (7nm)	Q201L (7nm)	Q200L (7nm)	G100 (7nm)	G200 (5nm)







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Conclusion



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Conclusion

- SONiC is an open-source, hardware agnostic, modular Network Operating System.
- It was created by hyperscale cloud providers for their datacenter and AI/ML environments and the feature support on SONiC is still dominated by these usecases.
- SONiC's open-source approach extends into its components which are based on other popular open-source projects such as FRR, teamd, etc.
- SONiC has support for a variety of management tools. However, advanced configuration may need multiple configuration touchpoints (e.g., ConfigDB, FRR CLI).
- Cisco supports SONiC on certain routers in the 8000 family and ships these routers with the SONiC image.

Further Reading

- SONiC on Cisco 8000 routers:
- <u>https://www.cisco.com/c/en/us/products/routers/8000-series-</u> routers/sonic.html
- SONiC on Cisco 8000 at DevNet:

https://developer.cisco.com/docs/sonic/

• SONiC Learning Lab:

https://developer.cisco.com/learning/labs/sonic-notebooks/gettingstarted-with-notebooks-for-sonic-on-the-cisco-8000-emulator/

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Contact me at: suhahmad@cisco.com



Thank you



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