

Intel® Open Network Platform Release 2.0 Release Notes

Release Notes

**Document Revision 1.1
April 2016**



Revision History

Date	Revision	Comments
January 22, 2016	1.0	Initial release for Intel® Open Network Platform Release 2.0
April 6, 2016	1.1	Minor clarifications and typo corrections in hardware and software specifications



Contents

1.0 Introduction	6
2.0 System Overview.....	7
2.1 Release 2.0 Highlights.....	7
2.2 Intel® ONP Release 2.0 Distribution.....	7
2.3 Reference Architecture Environment.....	8
2.4 Network Elements.....	9
2.4.1 Compute Node Software	9
2.4.2 Controller Node Software	10
2.4.3 Reference Platform Hardware.....	11
3.0 Functionality Highlights and Limitations.....	14
3.1 New Functionalities Contributed by Intel® to Open-Source Projects introduced in Intel® ONP Reference Architecture Release 2.0.....	14
3.2 Release 2.0 Limitations	32
4.0 Node Software Installation	33



Figures

Figure 2–1 Intel® ONP Test and Validation Environment.....8



Tables

Table 2-1 Compute Node Software	9
Table 2-2 Controller Node Software	10
Table 2-3 Intel® Xeon® processor E5-2600 v3 product family-based platforms - hardware ingredients used in integration tests.....	11
Table 2-4 Intel® Xeon® processor D-1500 family-based SoC platforms - hardware ingredients used in integration tests.....	12
Table 2-5 Intel® Atom™ processor C2000 product family-based SoC platforms - hardware ingredients used in integration tests.....	13
Table 3-1 New features/bug fixes included in ONP Release 2.0	14
Table 3-2 Release 2.0 Limitations.....	32
Table 4-1 Intel® ONP Release 2.0 Scripts	33



1.0 Introduction

This document describes the Release 2.0 of the Intel® Open Network Platform (Intel® ONP). The Intel® ONP reference architecture provides an engineering guidance and ecosystem support to enable widespread adoption of Software Defined Networking (SDN) and Network Functions Virtualization (NFV) solutions across telecommunications, cloud, and enterprise sectors. The deployment of this reference architecture is done mainly using DevStack. DevStack does not make the deployment production-ready, but it does afford developers a good option to experiment with Intel's software and hardware stack.

The Intel® ONP defines the integration of hardware and software components, providing a framework to deliver the many benefits of Intel® Architecture to SDN and NFV. The reference architecture is based on a standard high-volume server (SHVS) and an Intel® ONP open-source software stack. The software stack itself is built on open-source software created by open-standard communities like Open vSwitch (OvS), Data Plane Development Kit (DPDK), OpenDaylight (ODL), OpenStack, and Kernel-based Virtual Machine (KVM). Intel® is working closely with these communities and is contributing to the evolution of their open-standard projects.

The Intel® ONP provides a SDN/NFV reference solution that defines three main network elements: networking compute nodes, ODL controller, and OpenStack manager. An SDN/NFV lab environment comprised of those network elements is the basis for ONP software integration and customer use-case validation.

This document describes the main functionalities contributed by Intel® to open-source community projects that are now integrated into Intel® ONP Release 2.0 and details major solution limitations that remain.



2.0 System Overview

2.1 Release 2.0 Highlights

Intel® ONP Release 2.0 is now enabled on lately introduced Intel® SoC product families:

- Intel® Xeon® processor D-1500 family which is suitable for virtual environment and price sensitive use case deployments like vE-CPE.
- Intel® Atom™ processor C2000 product family, extending the scalability of Intel® Architecture into smaller footprint and energy-efficient communications infrastructure systems.

Intel® ONP Release 2.0 introduces new capabilities, software upgrades, and integration with the following open-source software releases:

- Upgrade to OpenStack Liberty Release (2015-10-15) now supporting Enhanced Platform Awareness (EPA) capabilities exposing Intel® technology for better workloads and introducing new features of Liberty as detailed in section 3.0.
- Integration with Data Plane Development Kit release 2.1.0.
- Upgrade to a newer Open vSwitch version 2.4.9.
- Upgrade to the OpenDaylight Lithium SR3 release.
- Upgrade to Fedora 22 enabling the installation of new kernel versions, including the support of the Real-Time Linux Kernel (v3.18.16-rt13) installation.
- Added CentOS-7.1 support with the Real-Time Linux Kernel v3.10.93-rt101-rebase installation capability – an additional to Fedora operating system, making the Intel® ONP Release 2.0 closer to typical commercial deployments.

Intel ONP Release 2.0 features new use cases:

- Virtual Enterprise Customer Premises Equipment (vE-CPE)
- Gateway Internet Local Area Network

2.2 Intel® ONP Release 2.0 Distribution

Intel® ONP Release 2.0 is delivered in the form of a Reference Architecture Guide. Access to the documentation is under [Intel® ONP Release 2.0 Scripts](#).

The Intel® ONP Reference Architecture Guide document provides instructions on how to build Intel® ONP software, set the functionality test environment, and perform the tests.

2.3 Reference Architecture Environment

The Intel® ONP Reference Architecture defines a test environment composed of the server, a control layer, and an OpenStack layer as presented in Figure 2–1. OpenStack and OpenDaylight provide the management and controller platforms. The compute nodes consist of network interface controller cards, the Open vSwitch functionality, DPDK, and supplier-specific applications executing in virtual machines.

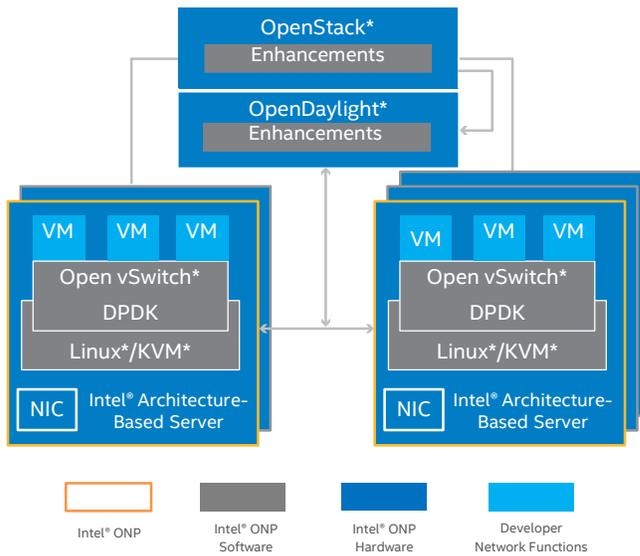


Figure 2–1 Intel® ONP Test and Validation Environment



2.4 Network Elements

2.4.1 Compute Node Software

Table 2-1 shows the Compute Node software components used during the testing of VNF components – vIPS and vBNG with OpenStack.

Table 2-1 Compute Node Software

Software Component	Function	Version/Configuration
Fedora 22	Host Operating System	Fedora 22 Server x86_64 Kernel version: 4.1.10-200.fc22.x86_64
CentOS-7.1	Host Operating System	CentOS-7 (1503) x86_64 DVD ISO Kernel version: 3.10.0-229.el7.x86_64
Real-Time Kernel	Targeted towards the Telco environment, which is sensitive to low latency	Fedora 22 Real-Time Kernel version: 3.18.24-rt22 CentOS-7.1 Real-Time Kernel version: 3.10.93-rt101-rebase
QEMU-KVM	Virtualization technology	QEMU-KVM version: 2.3.1-7.fc22.x86_64 libvirt version: 1.2.13.1-3.fc22.x86_64
DPDK	Network stack bypass and libraries for packet processing; includes user space vhost drivers	DPDK 2.1.0
Open vSwitch	vSwitch	Open vSwitch 2.4.9 Commit ID 88058f19ed9aadb1b22d26d93e46b3fd5eb1ad32 used for: Open vSwitch (non-DPDK nodes) Open vSwitch with DPDK
Intel® Ethernet Drivers	Ethernet drivers	ixgbe-4.3.9 (Intel® Xeon® processor D-1500 family deployments) Inbox i40e driver (Intel® Ethernet Converged Network Adapters X710-DA4 and XL710-QDA2) igb-5.2.15-k (Intel® Atom™ processor C2000 family deployments)



2.4.2 Controller Node Software

Table 2-2 shows the Controller Node software components that were used during the testing of VNF components – vIPS and vBNG using OpenStack.

Table 2-2 Controller Node Software

Software Component	Function	Version/Configuration
Fedora 22	Host Operating System	Fedora 22 Server x86_64 Kernel version: 4.1.10-200.fc22.x86_64
CentOS-7.1	Host Operating System	CentOS-7 (1503) x86_64 DVD ISO Kernel version: 3.10.0-229.el7.x86_64
Real-Time Kernel	Targeted towards the Telco environment, which is sensitive to low latency	Fedora 22 Real-Time Kernel version: 3.18.24-rt22 CentOS-7.1 Real-Time Kernel version: 3.10.93-rt101-rebase
Open vSwitch	vSwitch	Open vSwitch 2.4.9 Commit ID 88058f19ed9aadb1b22d26d93e46b3fd5eb1ad32 used for: Open vSwitch (non-DPDK nodes) Open vSwitch with DPDK
OpenStack	SDN orchestrator	OpenStack Liberty Release (2015-10-15)
OpenDaylight	SDN controller	OpenDaylight Lithium-SR3 (2015-12-03)
Intel® Ethernet Drivers	Ethernet drivers	ixgbe-4.3.9 (Intel® Xeon® processor D-1500 family deployments) Inbox i40e driver (Intel® Ethernet Converged Network Adapters X710-DA4 and XL710-QDA2) igb-5.2.15-k (Intel® Atom™ processor C2000 family deployments)



2.4.3 Reference Platform Hardware

Table 2-3 Intel® Xeon® processor E5-2600 v3 product family-based platforms - hardware ingredients used in integration tests

Item	Description	Notes
Platform	Intel® Server Board S2600WTT	Intel® Xeon® processor-based DP server (Formerly Wildcat Pass) 2 x 10GbE integrated LAN ports, 120 GB SSD 2.5in SATA 6GB/s Intel® Wolfsville SSDSC2BB120G4 Supports SR-IOV
Processors	Dual Intel® Xeon® processor E5-2697 v3	Formerly Haswell 14 cores, 28 threads, 2.6-3.6 GHz, 145 W, 35 MB total cache per processor, 9.6 GT/s QPI, DDR4-1600/1866/2133, 28 hyper-threaded cores per CPU for 56 total cores.
	Dual Intel® Xeon® processor E5-2699 v3	Formerly Haswell 18 cores, 36 threads, 2.3-3.6 GHz, 145 W, 45 MB total cache per processor, 9.6 GT/s QPI, DDR4-1600/1866/2133, 36 hyper-threaded cores per CPU for 72 total cores.
Memory	64 GB total; Crucial CT8G4RFS4213	8x DDR4 RDIMM 2133 MHz, 8 GB
NICs	Intel® Ethernet Converged Network Adapter X710-DA4	Intel® Ethernet Controller XL710-AM1 (Formerly Fortville) 4 x 10 GbE ports Firmware version f4.33 a1.2 n04.42 Tested with Intel® FTLX8571D3BCV-IT and AFBR-703sDZ-IN2 transceivers
	Intel® Ethernet Converged Network Adapter XL710-QDA2	Intel® Ethernet Controller XL710-AM2 (Formerly Fortville) 2 x 40 GbE ports Firmware version f4.33 a1.2 n04.42 Tested with Intel® E40QSFPSR transceiver
Intel® QuickAssist Technology	Intel® QuickAssist Adapter 8950	Intel® QuickAssist Adapter 8950 (Formerly Walnut Hill) Provides IPSec, SSL Acceleration and Compression services Support for SR-IOV PCIe Gen 3 (8GT/s)
BIOS	SE5C610.86B.01.01.0009.060120151350 Release Date: 03/19/2015	Hyper-Threading enabled Intel® Virtualization Technology (Intel® VT-x) enabled Intel® VT for Directed I/O (Intel® VT-d) enabled



Table 2-4 Intel® Xeon® processor D-1500 family-based SoC platforms - hardware ingredients used in integration tests

Item	Description	Notes
Platform	SuperMicro SuperServer 5018D-FN4T	Intel® Xeon® processor-based SOC server Motherboard: SuperMicro X10SDV-8C-TLN4F Dual LAN via Intel® i350-AM2 Gigabit Ethernet Dual LAN via SoC 10GBase-T 500 GB HDD 3.5in SATA 6GB/s 7200RPM 16MB Seagate Barracuda ST500DM002
Processors	Intel® Xeon® processor D-1540	Formerly Broadwell-DE 8 cores, 16 threads, 2-2.6 GHz, 12 MB cache Single Socket FCBGA 1667 supported CPU TDP 45W System-on-Chip
	Intel® Xeon® processor D-1520	Formerly Broadwell-DE 4 cores, 8 threads, 2.2-2.6 GHz, 6 MB cache Single Socket FCBGA 1667 CPU TDP 45W System-on-Chip
Memory	32 GB total; Kingston KVR21R15S4/8	4x DDR4 RDIMM 2133 MHz, 8 GB
BIOS	AMIBIOS Version: 1.0a Release Date: 05/27/2015	Hyper-Threading enabled Intel® Virtualization Technology (Intel® VT-x) enabled Intel® VT for Directed I/O (Intel® VT-d) enabled



Table 2-5 Intel® Atom™ processor C2000 product family-based SoC platforms - hardware ingredients used in integration tests

Item	Description	Notes
Platform	SuperMicro SuperServer 5018A-FTN4	Intel® Atom™ processor-based SoC server Motherboard: SuperMicro A1Sri-2758F 4 x 1GbE integrated Intel® Ethernet C2000 SoC I354 Quad GbE LAN ports, 120 GB SSD 2.5in SATA 6GB/s Intel® Wolfsville SSDSC2BB120G4
Processor	Intel® Atom™ processor C2758	8 core, 8 threads, 2.4 GHz, 4 MB cache CPU TDP 20W (8-Core) FCBGA 1283 System-on-Chip
Memory	32 GB Total; 1600MHZ DDR3L ECC CL11 SODIMM 1.35V	4x 204-pin DDR3 SO-DIMM slots
BIOS	AMIBIOS Version: 1.1 Release Date: 01/09/2015	Hyper-Threading not applicable Intel® Virtualization Technology (Intel® VT-x) enabled



3.0 Functionality Highlights and Limitations

3.1 New Functionalities Contributed by Intel® to Open-Source Projects introduced in Intel® ONP Reference Architecture Release 2.0

Table 3-1 summarizes new software features/bug fixes that Intel® has contributed to open-source projects included in release 2.0, along with commit IDs. Upstreamed commit IDs are shown in the last column.

Table 3-1 New features/bug fixes included in ONP Release 2.0

No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
1.	vhost-cuse	Feature	vSwitch	Support for a new port type to the user space data path called dpdkvhost. This allows KVM (QEMU) to offload the servicing of virtio-net devices to its associated dpdkvhost port.	An accelerated interface from the host into the guest OS using DPDK. Enables high through-put network I/O into the guest.	58397e6c1e6c0b68a0f3f32ded463df8087021d8
2.	vhost-user	Feature	vSwitch	Support for a new port type to the user space data path called dpdkvhostuser. It adds to the existing infrastructure of vhost-cuse, but disables vhost-cuse port as the default port type in favor of vhost-user ports. Refer to the documentation for enabling vhost-cuse ports. A new dpdkvhost-user port will create a unix domain socket, which, when provided to QEMU, is used to facilitate communication between the virtio-net device on the VM and the OvS port on the host.	An accelerated interface from the host into the guest OS using DPDK. Enables high through-put network I/O into the guest.	7d1ced01772de541d6692c7d5604210e274bcd3



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
3.	Various performance improvements	Performance improvement	vSwitch	<p>Various (ONP 1.5):</p> <ul style="list-style-type: none"> 9154f798ef0011ea9d1d7fb1dc91b51b60da82d3 netdev-dpdk: Use default NIC configuration. fc82e877efc03400e65b44588fb40eb507a98bf4 dpif-netdev: Increase the number of EMC entries. 95e9881f843896751a76481cfe7869e2c0c1270b netdev-dpdk: Add vhost enqueue retries. 4345e1b5bf563ebfd7a7dcf489eac0fdf68135cf netdev-dpdk: Change phy Rx burst size. 115f248163e1651ef932e1210cc4e49e3ebf61c5 miniflow: Fix miniflow push of L4 port numbers. 	Show the best possible performance on Intel® Architecture	N/A
4.	Various Bug Fixes	Bug fix	vSwitch	<p>Various (ONP 1.5):</p> <ul style="list-style-type: none"> 1e77bbe565bbf5ae7f4c47f481a4097d666d3d68 INSTALL.DPDK.md: Add details of XL710 restrictions for DPDK 7dd671f08e03ba2d133389aa25680baf fd2ce0d5 dpif-netdev: log port/core affinity 84072381c60d112c49ecbb634898069d682e23cb docs: Fix alignment for diagram in native-tunneling.md 3bcc10c0701c241ef62bdb32c5d21c060ad7590b dpif-netdev: Fix non-pmd thread queue id. 1b99bb055218e56603cff764df6dd2f1d166a48d netdev-dpdk: Reset RSS hash on transmit 		N/A



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
				<ul style="list-style-type: none"> • 3088fab7cb5caf2308dfda3f2d713c87ac4f35df INSTALL.DPDK.md: Update ivshmem page size restrictions • dbde55e7fa21881af18a48502c91168be269482a INSTALL.DPDK.md: Fix whitespace. • 418d2485aa029015389768bbc2f66a50c6281880 travis: fix errors • 618f44f7a406d6c3e90110420a7fd183d40f1bff netdev-dpdk: Put cuse thread into quies-cent state. • c876a4bb9bcc881befac5647a1e311b5af09d549 netdev: Fix user space tunneling for set_tunnel action. • 58be9c9fd732b5bdd3d4c2e9b8cc2313f570094d automake.mk: Improve schema checksum error message. <p>Various (Not up-streamed):</p> <ul style="list-style-type: none"> • http://openvswitch.org/pipermail/dev/2015-September/059806.html Documentation: Expand performance tuning section in INSTALL.DPDK.md • http://openvswitch.org/pipermail/dev/2015-June/056586.html Documentation netdev IVSHMEM shared memory usage • http://openvswitch.org/pipermail/dev/2015-August/058861.html fix match issue for decap when the remote_ip=flow in user space implementation 		
5.	DPDK 2.0 support	Feature	vSwitch	This patch ports the OvS data path to use DPDK 2.0	Update OvS to use the latest version of DPDK. This allows users to take advantage of the latest DPDK features and	543342a41cbceffaac30ace2c66b6e489eb359c8



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
					performance improvements.	
6.	DPDK 2.1 support	Feature	vSwitch	This patch ports the OvS data path to use DPDK 2.1.	Update OvS to use the latest version of DPDK. This allows users to take advantage of the latest DDPK features and performance improvements.	18f777b2870a12431741ad37f95316bfe78989e5
7.	vSwitch Detection	Feature	vSwitch	At startup, enumerate data path and port types and add this information to the datapath_types and port_types columns in the ovssdb. This allows an ovssdb client to query the data path to determine if certain data path and port types exist. E.g., by querying the port_types column, an ovssdb client can determine if this instance of ovs-vswitchd was compiled with DPDK support.	Allows orchestration and control of OvS with DPDK netdev. This enables ODL and OpenStack.	842733c37ccb51d574795782143ed99b0a76a44d
8.	Bonding	Feature	vSwitch	Unlike system interfaces, DPDK-enabled interfaces must have their interface type explicitly set when used to create bonded ports.	Allows bonding of DPDK ports	77c180cea6f646229c88e47be632ca7c29248c0a
9.	VFIO	Feature	vSwitch	Since DPDK 1.7, VFIO is supported in place of UIO. This allows a user to avoid having to insert a non-standard kernel module.	Allows a user to use DPDK ports without having to insert a non-standard Linux kernel module.	491c2ea3230f53ecbe65a556a0a1cc68647d7b99
10.	toit	Feature	vSwitch	An open-source standard test methodology and test framework for vSwitches.	Showcase performance of DPDK vSwitches. Determine bottlenecks.	https://wiki.opnfv.org/characterize_vswitch_performance_for_telco_nfv_use_cases
11.	OVN Support	Feature	vSwitch	Support for DPDK ports through OVN. This was not pushed, but provoked discussion within the OVS community. A different approach is now being	Enable detection of DPDK-enabled nodes when using OVN.	http://openvswitch.org/pipermail/dev/2015-August/059101.html



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
				investigated.		
12.	Statistics	Feature	vSwitch	Add missing statistics from vhost type ports.	Improves the usability of vhost-user and vhost-cuse	9e3ddd45eb4b40e2e73c230e20f41e09e51e73f3
13.	Large pages metadefinition	Feature	OpenStack:glance	Support for requesting hugepages in Horizon	Enable easy configuration of hugepage flavor	https://review.openstack.org/#/c/218869
14.	Support for requesting hugepages in Horizon	Feature	OpenStack:glance	CPU pinning request support in Horizon Dashboard	Enable easy configuration of cpu pinning flavors	https://review.openstack.org/204129
15.	Intel® NFV CI improvements	Ci	OpenStack: openstack/intel-nfv-ci-tests	Creation of a pulic ci system to test epa feature on Intel® platforms.	Improved testing of epa features on IA	https://review.openstack.org/#/c/218928/ https://review.openstack.org/#/c/192658/ https://review.openstack.org/#/c/191924/
16.	Regression: git is required to build from source on Ubuntu	Bug fix	Openstak:kolla	Regression: git is required to build from source on Ubuntu <ul style="list-style-type: none"> Fixes a regression of bug/1481560 Re-adds git to the OpenStack base image when building images from source on Ubuntu Removed explicit git install from kolla-ansible 	NA	https://review.openstack.org/#/c/224288
17.	Support delegation of bind_port to networking-odl backend driver.	Feature	OpenStack:networking-odl	The OpenDaylightMechanism Driver delegates bind_port to networking-odl backend driver. Moved check_segment together with bind_port as is used only there. This will enable extension of bind_port to support other port types such as vhost-user in a separated patch-set to networking-odl without requiring further changes to the front end	NA	https://review.openstack.org/#/c/205102/ https://review.openstack.org/#/c/205078/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
				component in neutron.		
18.	Fixed documentation of non-configurable variables	Documentation	OpenStack: networking-ovs-dpdk			https://review.openstack.org/#/c/242480
19.	Adapting vcpu_pin_set in nova.conf to avoid performance issues	Feature	OpenStack: networking-ovs-dpdk	In order to avoid performance issues nova will launch VM's just on CPU cores not used by Ovs	Increase performance VM running by isolating core used by ovs-dpdk from the vcpu pinset.	https://review.openstack.org/#/c/241668 https://review.openstack.org/#/c/202506
20.	Added support for configuring tunnel endpoint IP	Feature	OpenStack: networking-ovs-dpdk	Introduces a new OVS_TUNNEL_CIDR_MAPPING parameter to enable assignment of the tunnel endpoint IP to a specified interface.	This change enables ovs-dpdk to be managed by the Ovs neutron agent in a VXLAN configuration.	https://review.openstack.org/#/c/230069/ https://review.openstack.org/#/c/235876
21.	Added support for installation mode option	Feature	OpenStack: networking-ovs-dpdk	Adds the following config options to the local.conf <ul style="list-style-type: none"> • OVS_DPDK_MODE(controller_ovs controller_ovs_dpdk compute) • OVS_DPDK_INSTALL(True False) 	This change enabled a user to choose a default profile for Ovs DPDK integration and easily configure if ovs-dpdk should be installed by DevStack.	https://review.openstack.org/#/c/223451/ https://review.openstack.org/#/c/233574
22.	Added contact information for questions	Documentation	OpenStack: networking-ovs-dpdk	Added contact information for getting support via the mailing list.	Informs user of the networking-ovs-dpdk repository on how to contact the development team for support.	https://review.openstack.org/#/c/232624 https://review.openstack.org/#/c/232619
23.	Added IPv6 support to Security Groups in OVS DPDK firewall.	Feature	OpenStack: networking-ovs-dpdk	Added support for IPv6 to the SG OVS DPDK firewall and UTs testing the new functionality.	Extend ovs-dpdk security group driver impentation to support IPv6 ACLs	https://review.openstack.org/#/c/231016



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
24.	Adding bonding support for ovs-dpdk service	Feature	OpenStack: networking-ovs-dpdk	Support for bonding of ovs-dpdk physical NICs to DevStack	This enables link aggregation support for failover or increased bandwidth.	https://review.openstack.org/#/c/241579/ https://review.openstack.org/#/c/234017
25.	Changes required by VHOST USER in latest Open vSwitch	Feature/bug fix	OpenStack: networking-ovs-dpdk	<ul style="list-style-type: none">• Changed SOCKET_DIR to location used by OvS• Updated OVS GIT TAG to one with VHOST USER (that also removed dependency on patches)• Updated example local.conf accordingly• Updated README.rst with correct and new links	This enables support for the final version of vhost-user support that was merged into OvS. Previous support was based on rfe patches.	https://review.openstack.org/#/c/195046
26.	convert mech_ovs_dpdk to use neutron vhost-user constants	Feature/bug fix	OpenStack: networking-ovs-dpdk	<ul style="list-style-type: none">• Updates the ovsdpdk mech driver to use the vhost-user constants provided by the neutron portbinding extension.•	NA	https://review.openstack.org/#/c/224884/
27.	Create br-int during ovs-dpdk install instead of agent start.	Feature/bug fix	OpenStack: networking-ovs-dpdk	<ul style="list-style-type: none">• Reorders the bridge creation to allow for ODL integration.	ODL enabling	https://review.openstack.org/#/c/214685/2
28.	Disable offloads for virtio device.	Feature/bug fix	OpenStack: networking-ovs-dpdk	Disable offloading on virtio device to prevent packet corruption.	This prevents issues with qemu 2.1 where offloads are not correctly detected and disabled.	https://review.openstack.org/#/c/241668/ https://review.openstack.org/#/c/241545/ https://review.openstack.org/#/c/241530



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
29.	Documentation for OVS_DPDK_RTE_LIBRTE_VHOST	Documentation	OpenStack: networking-ovs-dpdk	Documentation added for the OVS_DPDK_RTE_LIBRTE_VHOST config option.	Usability	https://review.openstack.org/#/c/191128
30.	Fail to bind NIC to kernel driver during unstack process.	Stability/bug fix	OpenStack: networking-ovs-dpdk	Removed the duplicated call to 'stop_ovs_dpdk' during unstack process. This function is called during the halt of the plugins. If this function is called twice, the second one will unbind the NIC interface but won't bind this interface to the kernel driver.	Usability	https://review.openstack.org/#/c/197010/ https://review.openstack.org/#/c/188809/
31.	Fix typo on variable name	Stability/bug fix	OpenStack: networking-ovs-dpdk	Rename NETWORKING_OVS_DPDK_DIR variable to NETWORKING_OVS_DPDK_DIR	Usability	https://review.openstack.org/#/c/242471/
32.	Fixing Active NICs not bound to DPDK driver issue	Stability/bug fix	OpenStack: networking-ovs-dpdk	Enables correct handling of interface when "ACTIVE", e.g. having IP and are up in the kernel	Usability	https://review.openstack.org/#/c/232699/ https://review.openstack.org/#/c/194186/
33.	Fixing incorrect handling of error situations in init script	Stability/bug fix	OpenStack: networking-ovs-dpdk	Major problems should break stacking instead of just printing error message. <ul style="list-style-type: none"> Error values are now correctly propagated Merging local function err() into local die(). 	Usability	https://review.openstack.org/#/c/241971/
34.	Fixing issue with disable	Stability/bug fix	OpenStack: networking-	Alters the debug output of the networking-ovs-dpdk devstack plugin.	Usability	https://review.openstack.org/#/c/230372/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
	debugging		ovs-dpdk			
35.	Fixing ovsdb-server issue with database connectivity	Stability/bug fix	OpenStack: networking-ovs-dpdk	Resolves an issue on CentOS and Ubuntu where ovs-dpdk cannot be restarted correctly using the ovs-dpdk service file.	Usability	https://review.openstack.org/#/c/244130/
36.	Fixing wrong variable definition	Stability/bug fix	OpenStack: networking-ovs-dpdk	Fixing dollar sign incorrect on the left hand side of a variable definition.	Usability	https://review.openstack.org/#/c/204642/
37.	Force deletion of compilation folder/symlink in DPDK folder	Stability/bug fix	OpenStack: networking-ovs-dpdk	Resolves an issue where the symlink to the dpdk configuration directory would not be removed, causing issues on rebuild.	Usability	https://review.openstack.org/#/c/214148/1
38.	Getting started guide for Openstack and OVSDPDK	Documentation	OpenStack: networking-ovs-dpdk	Getting started guide and provides reference local.confs for Fedora	Usability	https://review.openstack.org/#/c/214156/
39.	Security Groups in OvS DPDK driver	Feature	OpenStack: networking-ovs-dpdk	Introduces a learn action based openflow security group driver for ovs-dpdk	Enables use of the security groups API to impended ACLs when using ovs with dpdk and vhost-user	https://review.openstack.org/#/c/216627/
40.	OvS core mask and PMD core mask	Feature	OpenStack: networking-ovs-dpdk	New config variables: <ul style="list-style-type: none"> • OVS_CORE_MASK - used for CPU cores selection for ovs-vswitchd process (-c param) • OVS_PMD_CORE_MASK - other_config:pmd-cpu-mask parameter 	Enables optimization of the ovs-dpdk development by core-affinities used by ovs.	https://review.openstack.org/200549 https://review.openstack.org/202506 https://review.openstack.org/202508



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
				in ovssdb		
41.	Modified initialization of ovs-dpdk to remove symbolic link	Stability/bug fix	OpenStack: networking-ovs-dpdk	<ul style="list-style-type: none"> Removed symbolic link from devstack/setting Adds --db=OVS_DB_SOCKET to ovs-vsctl init Updated ovs-vswitchd start string to include vhost-user socket directory Removed warnings regarding unary operators 	Helps standardize deployment of ovs-dpdk across different operating systems.	https://review.openstack.org/#/c/238652/ https://review.openstack.org/#/c/238658/ https://review.openstack.org/#/c/238653/
42.	OVS bridges are created always	Stability/bug fix	OpenStack: networking-ovs-dpdk	<ul style="list-style-type: none"> Creates all bridges as specified by OVS_BRIDGE_MAPPINGS Binds all interfaces to bridges as specified by OVS_BRIDGE_MAPPINGS 	This change fixes an edge case where if interface where not bound to the kernel driver, the bridges would not be created.	https://review.openstack.org/#/c/188423/
43.	OVS_PMD_CORE_MASK should reflect hyper threading	Stability/bug fix	OpenStack: networking-ovs-dpdk	Leverages hyper thread siblings when creating the default OVS_PMD_CORE_MASK to increase performance of ovs-dpdk	Performance enhancement	https://review.openstack.org/#/c/204056/ https://review.openstack.org/#/c/202508/
44.	Single NUMA node server support	Feature	OpenStack: networking-ovs-dpdk	Added support for systems with a single NUMA node such as avton which were not previously supported.	This change refactors the PCI address parsing logic to support systems with a single NUMA node.	https://review.openstack.org/#/c/208934/ https://review.openstack.org/#/c/207815/
45.	Removes forked ovs-dpdk neutron agent	Feature	OpenStack: networking-ovs-dpdk	Removes the modified ovs neutron open vSwitch agent and its deployment code. Updates the sample local.conf files to configure the standard neutron OvS agent to manage ovs-dpdk	Note this implementation was also refactored in the liberty cycle to use a subclass implementation, but that was removed by this change when the out of tree changes were accepted into neutron.	https://review.openstack.org/#/c/218331/ https://review.openstack.org/#/c/230111/
46.	Support for deployment of ovs-dpdk on Ubuntu and	Feature	OpenStack: networking-ovs-dpdk	<ul style="list-style-type: none"> Install libvirt and qemu on CentOS: default qemu was incompatible with ovs-dpdk Removed unbind from bind command: 	This change enables the networking-ovs-dpdk devstack plugin to install ovs with dpdk on Ubuntu 14.04 and centos 7.1	https://review.openstack.org/#/c/229440/ https://review.openstack.org/#/c/229440/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
	CentOS 7			<p>does not rebind kernel driver on Ubuntu + CentOS</p> <ul style="list-style-type: none"> • su -g -> sg: su -g not valid on Ubuntu • Renamed qemu group on Ubuntu: group was renamed on Ubuntu, code updated to reflect that • Added check for log dir: log dir was not created on Ubuntu • Created symlinks for /var/run/openvswitch: Ubuntu and Centos use /var/run/openvswitch for some commands 		g/#/c/223741/
47.	Support for DPDK 2.1	Feature	OpenStack: networking-ovs-dpdk	Reworks cp command to copy dpdk lib with old or new default name.	Enables support for the latest version of DPDK	https://review.openstack.org/#/c/231585/
48.	Config option to specify OvS data path	Feature	OpenStack: neutron	<ul style="list-style-type: none"> • New datapath_type parameter to allow specification of the OvS data path to be used. • New functional and unit tests. 	This change is required to enable the standard OvS neutron agent to manage ovs-dpdk with VXLAN or other tunneling protocols.	https://review.openstack.org/#/c/197209/
49.	Added constants for vhost-user vif	Feature	OpenStack: neutron	Amendments to the portbinding extension to include definitions of the VIF_TYPE_VHOST_USER and its related VIF_DETAILS attributes.	This change is required to enable vhost-user with arbitrary ml2 backends.	https://review.openstack.org/#/c/200587/ https://review.openstack.org/#/c/224880/
50.	Added configurable agent type	Feature	OpenStack: neutron	New agent_type config option which allows the OvS agent to be reused by out of tree mechanism drivers.	This change enabled the standard OvS neutron agent to fully manage ovs-dpdk	https://review.openstack.org/#/c/197210/
51.	Changed function call order in ovs_neutron_agent	Stability/bug fix	OpenStack: neutron	Changed function call order in ovs_neutron_agent during the creation or modification of a port, in order to fulfill the the VLAN OVS tag information in the "port"	This change is required to enable the openflow security group driver for ovs-dpdk	https://review.openstack.org/#/c/241156/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
				register before calling the SG agent. This information is needed in some SG agent implementations.		
52.	Support for delegation of bind_port to networking-odl backend driver.	Feature	OpenStack: neutron	The OpenDaylightMechanismDriver delegates bind_port to networking-odl backend driver. Moved check_segment together with bind_port as is used only there. This will enable extension of bind_port to support other port types such as vhost-user in a separated patch-set to networking-odl without requiring further changes to the front-end component in neutron.	Required to enabled ovs-dpdk support with ODL in OpenStack	https://review.openstack.org/#/c/205102/
53.	Added AggregateType AffinityFilter multi values support	Feature	OpenStack: nova	This change allows the AggregateTypeAffinityFilter to function when multiple instance_type names are set in the Aggregate Metadata. This change implements and documents a new comma separated syntax for the aggregate instance_type metadata attribute. The legacy syntax is still supported when a single instace_type is specified, e.g. 'm1.nano' or "m1.nano,m1.small"	This change allows operators of openstack to associate mutable flavors with a single host aggregate.	https://review.openstack.org/#/c/141883/
54.	Added support for specifying units to hw:mem_page_size	Feature	OpenStack: nova	Added support for specifying units for flavor extra spec option hw:mem_page_size={KB MB GB} Options were documented in specification but not implemented for Kilo.		https://review.openstack.org/#/c/209564/
55.	libvirt: Disable NUMA for broken libvirt	Feature	OpenStack: nova	Ensure versions of libvirt with broken NUMA tuning support are not used for said feature.		https://review.openstack.org/#/c/178188/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
56.	Store correct VirtCPUTopology	Feature	OpenStack: nova	When booting a NUMA-enabled instance, the scheduler generates and stores a meaningless VirtCPUTopology as part of the InstanceNumaCell objects. A correct value is later generated and used in libvirt XML generation but this is not stored. Fix this by skipping the initial generation and storing of the VirtCPUTopology in favor of storing the correctly generated version.		https://review.openstack.org/#/c/197125/
57.	Propagated OVS_DATAPATH_TYPE to ml2_conf.ini	Feature	OpenStack: devstack	If OVS_DATAPATH_TYPE is configured it should be visible in ML2 config Changed OVS_DATAPATH_TYPE default value to 'system' from "	This enables configuration of the ovs-dpdk data path in the neutron ml2_conf.ini.	https://review.openstack.org/#/c/226973/
58.	Various bug fixes	Stability/bug fix	openstack	General small bug fixes to improve stability and usability	N/A	https://review.openstack.org/#/c/194061/ https://review.openstack.org/#/c/194185/ https://review.openstack.org/#/c/235366/ https://review.openstack.org/#/c/235361/ https://review.openstack.org/#/c/193648/ https://review.openstack.org/#/c/219260/ https://review.openstack.org/#/c/212781/ https://review.openstack.org/#/c/209961/ https://review.openstack.org/#/c/195950/ https://review.openstack.org/#/c/195950/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
						g/#/c/223523/ https://review.openstack.org/#/c/233395/ https://review.openstack.org/#/c/229997/ https://review.openstack.org/#/c/190328/ https://review.openstack.org/#/c/194062/
59.	OpenStack ODL support for ovs-dpdk and vhost user	Feature	OpenStack: Networking-odl	This change enabled vhost-user integration with OpenStack and ovs-dpdk when managed by ODL.	This change was completed in the Liberty cycles but not merged upstream and is currently out of tree.	https://github.com/FedericoRessi/networking-odl/tree/bug/1477611-liberty
60.	New scheduler filter: AggregateTypeExtraSpecsAffinityFilter	Feature	OpenStack: nova	The flavor_extra_spec metadata pair will be consumed by the AggregateTypeExtraSpecsAffinityFilter to allow operators to define a set of extra specs key value pairs that are required to schedule to the aggregate, e.g.: standard memory backing aggregate: flavor_extra_spec: "mem_page_size=small,mem_page_size=any" high bandwidth memory backing aggregate: flavor_extra_spec: "mem_page_size=2M,mem_page_size=1G,mem_page_size=large"	This filter enables reservation of resources for needy vms.	https://review.openstack.org/#/c/189279/
61.	CPU thread policy	Feature	OpenStack:nova	This feature enables control of the vCPU to pCPU mapping by enabled a set of thread pinning polices.	This will allow fine tuning of VM CPU placement for optimal resource utilization and performance.	https://review.openstack.org/#/q/status:open+project:openstack/nova+branch:master+topic:bp/virt-driver-cpu-thread-pinning,n,z



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
62.	OvS with DPDK support	Integration tests	OpenDaylight:OVSDB	Enhanced integration tests in the OVSDB southbound plugin to include coverage for the netdev data path type and DPDK interface types.	Support for OVS with DPDK	https://git.OpenDaylight.org/gerrit/28828 https://git.OpenDaylight.org/gerrit/28827
63.	OVS with DPDK support	Feature/fix	OpenDaylight:Netvirt	Set the correct data path type for OVS with DPDK When creating bridges from netvirt, check if the OVSDB node supports 'dpdk' interfaces. If it does, then specify the data path type so that the bridge will be created with the 'netdev' data path type.	Support for OVS with DPDK	https://git.OpenDaylight.org/gerrit/25813
64.	OvS with DPDK support	Fix	OpenDaylight:Netvirt	Send a canonical IPv4 prefix in table 60 routing rules Testing with user space OVS with DPDK uncovered that the routing rules that go into table 60 were getting rejected.	Support for OVS with DPDK	https://git.OpenDaylight.org/gerrit/27846
65.	OVSDB Southbound Plugin	Bug fixes	OpenDaylight:OVSDB	Fixes to the OVSDB southbound plugin.	Increase stability and utility of the OpenDaylight OVSDB plugin – which is used by multiple OpenDaylight projects to control Ovs (including OVS with DPDK) hosts.	https://git.OpenDaylight.org/gerrit/25204 https://git.OpenDaylight.org/gerrit/26863
66.	OVSDB Netvirt	Bug fixes	OpenDaylight:Netvirt	Fixes to OVSDB Netvirt project to improve stability.	Increase stability and utility of the OpenDaylight Netvirt project – which is used to integrate ODL control of Ovs hosts (including OVS with DPDK) to OpenStack via Neutron ML2.	https://git.OpenDaylight.org/gerrit/26166
67.	Tempest API	Bug fixes	OpenDaylight:neutron, OVSDB, Netvirt	Bug fixes to improve the ability of OpenDaylight to pass Tempest API tests.	Increases stability and utility of OpenDaylight as an SDN controller which can be integrated with OpenStack.	https://git.OpenDaylight.org/gerrit/28434 https://git.OpenDaylight.org/gerrit/26284 https://git.OpenDaylight.org/gerrit/25588



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
						https://git.OpenDaylight.org/gerrit/25586 https://git.OpenDaylight.org/gerrit/25345 https://git.OpenDaylight.org/gerrit/25344 https://git.OpenDaylight.org/gerrit/24457 https://git.OpenDaylight.org/gerrit/24342
68.	OVSDB Clustering	Feature	OpenDaylight:OVSDB	Added support to OVSDB clustering to allow only the OvS device owner to update the device.	Clustering support for OVSDB in ODL increases the utility of ODL as an SDN controller.	https://git.OpenDaylight.org/gerrit/27556
69.	Group Based Policy	Unit tests	OpenDaylight:GBP	Unit test added in the NeutronMapper part of group based policy.	Improves stability of ODL.	https://git.OpenDaylight.org/gerrit/26251
70.	Group Based Policy	Bug fixes	OpenDaylight:GBP	Bug fixes in the ODL GBP project.	Improves stability of ODL as an SDN controller.	https://git.OpenDaylight.org/gerrit/25804 https://git.OpenDaylight.org/gerrit/25803
71.	SFC	Feature	OpenDaylight:SFC	Added SF extension Yang models including SF's capability and monitoring information.		https://git.OpenDaylight.org/gerrit/#/c/14165/
72.	SFC	Feature	OpenDaylight:SFC	Added get SF's capability and monitoring data and store them into data store.		https://git.OpenDaylight.org/gerrit/#/c/14560/
73.	SFC	Feature	OpenDaylight:SFC	Added new fields for OVS Options		https://git.OpenDaylight.org/gerrit/#/c/25400/
74.	SFC	Feature	OpenDaylight:SFC	Add new type support while mapping		https://git.OpenDaylight.org/gerrit/#/c/25458/
75.	SFC	Feature	OpenDaylight	Add rpc for		https://git.OpenDaylight.org



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
			t:SFC	readRenderedServicePathFirstHop		g/gerrit/#/c/15889/
76.	SFC	Feature	OpenDaylight:SFC	A new API readRspFirstHopBySftList		https://git.opendaylight.org/gerrit/16127
77.	SFC	Feature	OpenDaylight:SFC	Add rpc for readRspFirstHopBySftList		https://git.opendaylight.org/gerrit/16620
78.	SFC	Feature	OpenDaylight:SFC	NSH Support: common APIs for NSH		https://git.opendaylight.org/gerrit/16971
79.	SFC	Feature	OpenDaylight:SFC	NSH Support: configure openflow tables		https://git.opendaylight.org/gerrit/17974
80.	SFC	Feature	OpenDaylight:SFC	Add shortest path algorithm for service function selection		https://git.opendaylight.org/gerrit/18350
81.	SFC	Feature	OpenDaylight:SFC	SFC + GBP Integration Phase II: enhance readRspFirstHopBySftList		https://git.opendaylight.org/gerrit/20094
82.	SFC	Feature	OpenDaylight:SFC	MD-SAL based network topology APIs		https://git.opendaylight.org/gerrit/19994
83.	SFC	Feature	OpenDaylight:SFC	Move netconf-related SF description and monitoring info report into sfc-netconf		https://git.opendaylight.org/gerrit/24755
84.	SFC	Feature	OpenDaylight:SFC	Prototype for IP-less VNFs support – DPPD based VNF.		https://git.opendaylight.org/gerrit/#/c/27331/
85.	SFC	Bug fixes	OpenDaylight:SFC	Fix fail to send edit-config for configuration 80-sfc.xml		https://git.opendaylight.org/gerrit/#/c/16745/
86.	SFC	Bug fixes	OpenDaylight:SFC	Change the netconf deprecated APIs into the latest API in sfc provider		https://git.opendaylight.org/gerrit/#/c/15212/
87.	SFC	Bug fixes	OpenDaylight:SFC	Fix bug 4450 random failure in SfcProviderSfstEntryDataListenerTest		https://git.opendaylight.org/gerrit/#/c/28239/
88.	SFC	Bug fixes	OpenDaylight:SFC	Fix the bug 3574 about listening of Algorithm Type 1. Fix		https://git.opendaylight.org/gerrit/#/c/21914/



No.	Feature Name	Category	Ingredient	Description	IA Value	Commit ID if Upstreamed, Link if Posted as Patch
				SbRestSfstEntryDataListener and SfcProviderSfstEntryDataListener is not registered 2. Fix not to modify the isEnabled status of previous used algorithm type when current used algorithm type is changed.		
89.	SFC	Unit tests	OpenDaylight:SFC	Unit Test of SfcProviderSfstEntryDataListener Unit test for readRenderedServicePathFirstHop and readRspFirstHopBySftList		https://git.OpenDaylight.org/gerrit/#/c/27567/ https://git.OpenDaylight.org/gerrit/19124



3.2 Release 2.0 Limitations

Table 3-2 summarizes the limitations for release 2.0.

Table 3-2 Release 2.0 Limitations

No.	Open Software	Limitation
1.	OpenStack	<p>After the OpenStack installation is successful on the controller and compute nodes, when the user logs in to the OpenStack UI to spawn the VM an error displays: Failed to connect to server (code 1006).</p> <p>The workaround is to flush the iptables on the Compute Node with the following command as stack user:</p> <pre>\$ sudo iptables -F</pre>
2.	OpenDaylight	<p>On the ODL controller, once it is up and running, ODL does not add the manager IP address to the OpenStack bridges br-int and br-ex. A workaround is to add this address to the bridges. Refer to <i>Intel® Open Network Platform Reference Architecture (Release 2.0)</i>, section 6.3.3, for details of the workaround.</p>
3.	OpenDaylight	<p>The default OpenStack tenant network (private network) does not pass traffic. Users are advised to create their own tenant network in order to create a fully functional instance (VM). Refer to <i>Intel® Open Network Platform Reference Architecture (Release 2.0)</i>, section 6.1.2, for how to create a tenant network.</p>
4.	ixgbe	<p>With kernels older than 3.18, adapters formerly Fortville will occasionally fail to bind to the kernel ixgbe driver after they have been unbound from DPDK igb_uio driver. Intel® Open Network Platform Reference Architecture (Release 2.0) support for CentOS-7.1 is based on the 3.10 kernel.</p>
5.	NIC Firmware	<p>NICs formerly Fortville may have factory released firmware version 4.21. A newer version (4.53 onwards) is required. NICs with older firmware may experience:</p> <ul style="list-style-type: none">• Dropped packets when bound to DPDK igb_uio driver• Occasional loss of operational state.
6.	Intel® ONP Scripts	<p>The CPU mask for PMD thread must be correctly set depending on location of the NIC in a servers PCIe slots. Intel® ONP Scripts are configured for NUMA node 0 by default. If the tenant interface is present in slot associated with another NUMA node the OVS_PMD_CORE_MASK setting in local.conf must be updated accordingly before running prepare_stack.sh.</p>
7.	OpenStack-Dev	<p>After devstack is installed user will be prompted to update pip version (see <i>example</i> below). User should continue with pip version 7.1.2. Do not update.</p> <p><i>You are using pip version 7.1.2, however version 8.0.0 is available.</i></p> <p><i>You should consider upgrading via the 'pip install --upgrade pip' command.</i></p>



4.0 Node Software Installation

Intel® ONP software stack can be installed using scripts associated with this release. Download the Intel® ONP Release 2.0 Scripts from 01.org. The scripts bundle contains the files shown in the table below.

Table 4-1 Intel® ONP Release 2.0 Scripts

Files	Description	Notes
prepare_system.sh	Provisions and configures the host system's services and kernel settings	Do not edit
prepare_stack.sh	Installs DevStack and configures the OvS and DPDK parameters	Do not edit
onps_config	Configuration file available for user to choose the type of Intel® ONP deployment	
onps_commit_ids	List of commit IDs of the various open source repositories used for this release	
settings.xml	Settings file used by OpenDaylight controller	
README	Provides instructions on how to update onps_config file	
create_local_conf.sh	Used to create local.conf DevStack configuration file based on options from onps_config file	Do not edit
samples/	A catalog with examples of some DevStack configuration files with different settings	

More details on the configuration and installation process can be found in Intel® ONP 2.0 Reference Architecture Guide available at 01.org.



Legal Information

By using this document, in addition to any agreements you have with Intel, you accept the terms set forth below.

You may not use or facilitate the use of this document in connection with any infringement or other legal analysis concerning Intel products described herein. You agree to grant Intel a non-exclusive, royalty-free license to any patent claim thereafter drafted which includes subject matter disclosed herein.

INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

The products described in this document may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request. Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

Intel technologies may require enabled hardware, specific software, or services activation. Check with your system manufacturer or retailer. Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit <http://www.intel.com/performance>.

All products, computer systems, dates and figures specified are preliminary based on current expectations, and are subject to change without notice. Results have been estimated or simulated using internal Intel analysis or architecture simulation or modeling, and provided to you for informational purposes. Any differences in your system hardware, software or configuration may affect your actual performance.

No computer system can be absolutely secure. Intel does not assume any liability for lost or stolen data or systems or any damages resulting from such losses.

Intel does not control or audit third-party web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.

Intel Corporation may have patents or pending patent applications, trademarks, copyrights, or other intellectual property rights that relate to the presented subject matter. The furnishing of documents and other materials and information does not provide any license, express or implied, by estoppel or otherwise, to any such patents, trademarks, copyrights, or other intellectual property rights.

2016 Intel® Corporation. All rights reserved. Intel, the Intel logo, Core, Xeon, and others are trademarks of Intel Corporation in the U.S. and/or other countries. *Other names and brands may be claimed as the property of others.