Developing innovative, flexible cloud networking solutions as defined by Software Defined Networking (SDN) and Network Functions Virtualization (NFV) is simpler with the Intel® Open Network Platform Server (Intel® ONP Server) Reference Architecture (RA). The Intel ONP Server Reference Architecture provides developers with a validated template for quickly developing and showcasing next-generation, cloud-aware network solutions, using a comprehensive stack of open source software and powerful industry-standard hardware. This white paper provides the information you need to get started developing your own unique applications.

Authors:
Dana Nehama
Senior Product Marketing Manager,
Intel Software Defined Networking Division

Rob Shiveley
Open Source Technology Center,
Intel Software and Services Group

Contributors:
Joseph Gasparakis
Networking Software Engineer,
Intel Software Defined Networking Division

Rob Love
Networking Software Engineer,
Intel Software Defined Networking Division
Table of Contents

Redefining Network Infrastructure.... 2

Intel® Open Network Platform Server Reference Architecture ........... 2

Example Intel® ONP Server Node Hardware and Software Building Blocks in ONP Server Rel. 1.2 ........ 4
Orchestration with OpenStack* ........ 4
Abstracting Network Control with OpenDaylight* ........ 4
VM Traffic Forwarding with Open vSwitch* ....................... 4
Accelerating Packet Processing with Data Plane Development Kit (DPDK) .................. 4
A Complete SDN and NFV Development Environment .......... 4

SDN & NFV Use Case Examples........ 5
Virtualizing the Enterprise CPE (Access Router) into the Operator’s Network .......... 5

Enabling Additional Functionality ...... 6

Summary ................................................... 6

Redefining Network Infrastructure

Today’s cloud services need greater performance, flexibility, and adaptability from the networks that support them. The exponential growth of data and devices—including the expected explosion of the Internet of Things (IoT)—along with business needs for cloud-driven agile solutions, demand that networks respond faster, be more flexible, and cost less.

The Software Defined Networking (SDN) and Network Functions Virtualization (NFV) initiatives redefine how network equipment delivers control and forwarding services within the data center. SDN disintegrates traditional network equipment architecture by separating the networking control layer, where decisions are made, from the data plane that provides forwarding services. Doing so, SDN provides a framework for Cloud Service Providers (CSPs) and enterprises to design software-driven, innovative networking applications and run them on cost-effective standard high-volume servers (SHVS).

Control commands are passed from servers to data plane devices, where forwarding is carried out. NFV allows networking functions to be run on virtual machines, creating highly flexible and adaptable network resources that can be quickly deployed as needed to fulfill changing demands within the cloud data center. By disintegrating control and data planes and introducing virtualization into the network, SDN and NFV enable development of more responsive networks that can meet the needs of today’s cloud computing at lower cost.

Intel® Open Network Platform Server Reference Architecture

The Intel® Open Network Platform Server (Intel® ONP Server) is a Reference Architecture (RA) server that provides a hardware/software template for creating and showcasing SDN and NFV server solutions. The Intel ONP Server Reference Architecture is released on a quarterly basis in the format of a reference architecture guide which is posted on 01.org. The Intel ONP Server Reference Architecture Guide provides instructions for building the ONP Server system and software, test scripts, and a set of benchmark performance test results.
The foundation of the Intel ONP Server RA is a SHVS based on Intel® Architecture (IA) with a software stack composed of open source, open standard software building blocks (Figure 1). This RA is designed to deliver high-performance processing and acceleration, plus wide applicability across open source projects using the x86 instruction set. The open source software ingredients consist of OpenStack,* OpenDaylight,* Open vSwitch,* DPDK,* and KVM.* Thus, the Intel ONP Server provides a reference server node solution for SDN and NFV application development, for testing, and for Proof of Concept (POC) demonstrations.

The Intel ONP Server software has been tested within a SDN-like environment to deliver foundational functionality and to meet benchmark performance results expected in the industry. Figure 2 illustrates a typical RA test environment, which includes Intel ONP Server nodes, OpenDaylight controller, and OpenStack functionality.

Figure 2. Intel® Open Network Platform Server Reference Architecture environment enables innovative 3rd party solution development.
Example Intel® ONP Server Node Hardware and Software Building Blocks in ONP Server Rel. 1.2

Each Intel ONP Server node specifies the following components:

### Hardware
- Intel® Xeon® processor E5-2697 v3, 2.60 GHz, Dual 14 cores
- Intel® 82599 10 GbE Controller (2X)
- Memory: 8x8 GB DDR4 RDIMM Crucial CT8G4RFS4213
- Intel® Communications Chipset 8950 with Intel® Quick Assist Technology

### Software
- BIOS: GRNDSDP1.86B.0038.R01.1409040644
- DPDK: v1.7.1
- OVS: multiple OVS versions used in different nodes: OVS v2.3.0 (Controller node), v2.1.2 (OVDK compute node), v.2.3.90 (Accelerated OVS compute node)
- OVDK: v1.2-0
- OpenStack: Juno
- OpenDaylight: Helium
- KVM: v1.6.2-10.fc20.x86_64
- Linux* OS with KVM* hypervisor
- Intel® QuickAssist Drivers for function acceleration

The Intel ONP Server was designed to support the performance needs of network services in a virtualized environment. It integrates two processor sockets, a large number of cores, and 10-gigabit Ethernet, all running on Linux.* By integrating Intel libraries, drivers, APIs, and other 3rd-party software components, Intel exposes the performance and reliability features of the Intel ONP Server silicon and underlying hardware to higher level software, such as OpenStack and OpenDaylight. With these tools, developers can quickly take advantage of the unique server capabilities for networking.

**Orchestration with OpenStack**
OpenStack is the cloud operating environment used to automate deployment of software solutions on virtual machines. OpenStack itself has several components. Together, they provide automation intelligence and drive deployment of the needed business and network applications. For example, when a customer requests a new data analysis service that requires only specific packet types, OpenStack could orchestrate the construction and deployment of VMs that deliver the analytics application and any required NFV-based packet filtering services.

Enhanced Platform Awareness in OpenStack enables deployment of NFV virtual machines onto server platforms with the specific hardware and silicon capabilities that are optimal for the particular needs of the VM. This helps ensure the application is provided the best combination of features available across the spectrum of available systems in the data center.

**Abstracting Network Control with OpenDaylight**
Network control is rich and complex. OpenDaylight provides a framework through which the network application can direct control decisions. OpenDaylight is a combination of many components, including a fully pluggable controller, APIs, protocol plug-ins, and applications, all designed to enable the SDN application abstractions to manifest. The Northbound (programmatic) and Southbound (implementation) interfaces are clearly defined and documented APIs through which the application developer can interface with the controller to take advantage of the rich set of protocols and services within OpenDaylight.

**VM Traffic Forwarding with Open vSwitch**
In a virtual environment, the hypervisor needs a method of forwarding traffic across independent virtual machines and to the external network. Open vSwitch provides these services. Open vSwitch delivers a production-quality, manageable virtual switch targeted at multi-server virtualization deployments.

**Accelerating Packet Processing with Data Plane Development Kit (DPDK)**
The DPDK is a set of libraries and drivers that take advantage of Intel® instruction set architecture features to accelerate packet processing on x86 platforms. The libraries include:
- A multicore framework
- Huge page memory
- Ring buffers
- Poll-mode drivers

The libraries can be used to:
- Receive and send packets within the minimum number of CPU cycles (usually less than 80 cycles)
- Develop fast packet capture algorithms
- Run third-party fast path stacks

**A Complete SDN and NFV Development Environment**
The Intel ONP Server Reference Architecture is a complete environment that helps accelerate SDN and NFV deployments, plus applications development and deployment for cloud data centers. The architecture abstracts the development from the hardware and exposes the enhancements and features of the Intel® platform for networking applications.

An application developed by Intel engineers and implemented on the Intel ONP Server Reference Architecture are described below.
**SDN & NFV Use Case Examples**

Enterprises typically deploy a number of network functions as dedicated hardware infrastructure. These are often expensive and proprietary appliances or systems with little flexibility to adapt to changing needs. With increasing innovative development of virtual functions, a service provider might deliver these to an enterprise in the future on a Virtual Network Functions as a Service (VNFaaS) basis. Here are some possible examples:

- Enterprise Access Router as Enterprise Customer Premise Equipment
- Provider Edge Router
- Enterprise Firewall
- Enterprise WAN Optimization Controller
- Deep Packet Inspection
- Intrusion Prevention System (IPS) and other security appliances
- Network Performance Monitoring

**Virtualizing the Enterprise CPE (Access Router) into the Operator’s Network**

Traditional IP routers are based on custom hardware and software. They are among the most capital-intensive portions of service provider infrastructure. Yet, Provider Edge (PE) routers often run out of control plane resources before they run out of data plane resources. Virtualization of the control plane functions can improve scalability while making use of the existing data plane infrastructure. This can be a revenue opportunity for the service provider.

Rather than the enterprise invest capital in deployment of networking infrastructure, the service provider can provide advanced networking features as a measured service on an expense basis. With the service provider implementing the enterprise CPE, it can also offer additional VNF instances on demand and as needed for the control plane of the PE router, improving its scalability and increasing revenue opportunities. Making the VNF functionality available to the enterprise as a service is comparable to the cloud computing notion of Software as a Service. Figure 3 illustrates a possible implementation.

As shown in the figure, enterprise local traffic is handled by a local L2 or L3 switch, providing physical connectivity (and possibly further functionality) to the wider network. The LAN is extended to the operator’s network through a virtual enterprise CPE (vE-CPE). In addition to providing access to router services, the vE-CPE might also virtualize next-generation firewall (NG-FW), WAN optimization controller (WOC), deep packet inspection (DPI), and VPN termination services. As the enterprise required additional services, perhaps unique to the business, the operator could likely respond more quickly than an equipment manufacturer, offering added services to the enterprise.

![Figure 3. Enterprise vCPE Router provided as part of a virtual service can create revenue opportunities to service providers.](image-url)
Enabling Additional Functionality

SDN and NFV target applications may require functions, such as High-Precision Event Timer (HPET). These functions would need to be enabled in BIOS as required, and the appropriate modules added to the Linux kernel. Other functionality to consider, and described in the Getting Started Guide, include the following:

- Power management and power saving
- Reducing context switches with Linux core isolation
- Loading the DPDK Kernel NIC Interface (KNI) module for keeping compatibility with standard Linux network interfaces and also for running the KNI sample application
- Running DPDK with Intel® Virtualization technology (Intel® VT-d)
- High performance of small packets on 40 Gbps NICs
- Running applications without root privileges

Summary

The Intel ONP Server Reference Architecture provides an environment for network application developers and cloud architects to quickly create and showcase innovative SDN and NFV solutions that can enable flexible, responsive, less costly networks. The Reference Architecture leverages standards-based, open source software projects and Intel drivers, libraries, and APIs. The Intel ONP Server Reference Architecture Guide provides the instructions and information to build out a validated development and test environment, including sample applications to help new developers to get started innovating solutions for their customers.

Across that spectrum of options, software vendors, system integrators, developers, and cloud architects can benefit from the use of Intel ONP Server as a vehicle to evaluate and jumpstart development of systems or software for use in SDN and NFV environments.
For more information on Intel Open Network Platforms, visit
https://01.org/packet-processing/intel%C2%AE-onp-servers

For more information about the open source projects and to download source files, see their respective web sites:

- www.openstack.org
- www.opendaylight.org
- www.openvswitch.org
- www.dpdk.org

For more information about Intel® QuickAssist technology, visit