ADVANTECH

2nd Gen Intel Xeon Scalable Processors
Intel Select Solutions for NFVI Forwarding Platform

Solution Brief

Accelerating Forwarding Plane Performance

Solution Highlights

Advantech's SKY-8101D enables solutions that demand high scalability, throughput and reliability:

- 5G User Plane Function (UPF)
- Broadband use cases, such as virtual Broadband Network Gateway (vBNG)
- Network services such as virtual Evolved Packet Core (vEPC) and IPsec Gateways (IPSecGW)
- Cable use cases such as virtual Cable Modem Termination System (vCMTS)

The SKY-8101D is a verified Intel Select Solution for NFVI Forwarding Platform providing operators with faster access to optimized and stable configurations that accelerate 5G network transformation.

Executive Summary

In preparation for the widespread use of 5G and the broad array of functions that will be virtualized over the network, it is vital that newly deployed platforms take full advantage of verified pre-integrated solutions in order to provide predictable performance and offer the throughput headroom needed by new and future services. More specifically, the key to 5G network transformation success lies in the use of servers with NUMA-balanced I/O designs capable of accelerating data plane performance beyond that of traditional IT servers. With the right server architecture and configuration, further TCO and time to production savings can be achieved through optimized commercial off the shelf solutions destined for 5G uses cases.

This solution brief describes how Intel® Select Solutions for NFVI Forwarding Platform address the complexity that service providers face in choosing the right white-box infrastructure. It discusses Advantech SKY–8101D server configurations in detail and how it meets the Intel Select Solutions for NFVI Forwarding Platform criteria based on 2nd generation Intel® Xeon® Scalable processors. Ready to ship as pre-configured platforms, developers can now gain faster access to optimized and stable platforms to conduct testing and modeling of solutions that will help them define next-generation services.

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intel SELECT SOLUTIONS

Introduction

Advantech works closely with Intel on a number of network transformation initiatives including Intel Select Solutions, a program created by Intel to provide reference designs to accelerate time to market for key workloads. An Intel Select Solution reference design offers a checklist of required components including hardware, software and operating system. In addition, Advantech collaborates closely with independent software vendors, as active members of the Intel® Network Builders ecosystem, to ensure system level optimization of hardware, software and firmware, including the bios, and other settings.

> “The end result is faster time to deployment using verified off-the-shelf building blocks and improved Quality of Experience for customers.”

Intel Select Solutions provides workload optimized configurations across the data center, and for network specific workloads, has launched Intel Select Solutions for NFVI Forwarding Platform. Specifically targeted at vEPC, vUPF, vBNG & vCMTS, this solution helps developers by giving them an ultra-performant commercially viable and tested platform capable of sustained optimized data and control plane processing for workloads spanning 4G and 5G wireless functions as well as the wireline network gateway functions.

As communication service providers (CommSPs) gain more experience with NFV solutions based on Intel Select Solutions, they will gain from the flexibility enabled by a software-centric approach where a single edge NFVI platform can serve the evolving service needs of consumer, residential, and enterprise customer segments in both wireless and fixed networks.

Advantech verified Intel Select Solutions

Advantech’s SKY-8000 Server product range is designed with a NUMA balanced PCIe approach in mind. PCIe lanes are distributed equally between each CPU socket rather than connected to a single CPU or in the unbalanced manner found in many commercial servers. This avoids unnecessary latency and makes it ideal for networking applications as each socket can scale the application linearly.

Intel Select Solutions for NFVI defines the minimum NFVI hardware and software for specific application use cases and sets the baseline for performance.

For example, the SKY-8101D 1RU dual-socket server based on 2nd Gen Intel Xeon Scalable processors offers 200Gbps of PCIe bandwidth per socket, for up to 400Gbs per 1RU. This is ideal for

applications that are inline (for example BNG) where 100Gbps upstream and 100Gbps downstream capacity per socket maximizes the number of serviceable user sessions.

While testing the platform with the Intel Select Solutions for NFVI Forwarding Platform scripts, Advantech recorded 319 Gbps of vBNG throughput on the SKY-8101D server integrating Intel® Ethernet 800 Series Network Adapters, while overall server power consumption was less than 550W. When testing this configuration with simple Layer 3 forwarding, a platform throughput of 396 Gbps (99% line rate) was achieved with 256-byte packets.

Tests were also performed which make use of Enhanced Dynamic Device Personalization (DDP) on the Intel Ethernet 800 Series which allows reconfiguration of the network adapter's internal packet filtering and processing pipeline on-demand to meet specific use case needs. This is achieved by adding new configuration profiles to the Ethernet controllers at runtime without resetting or rebooting the server using the Data Plane Development Kit (DPDK).

This configuration profile provides the ability to classify packet types and protocols inline and distributes the packets to specific queues on the device host interface. These queues can be assigned to specific cores on the CPU. This enables application performance scale with the number of cores in the system improving overall performance and utilization. It also improves latency because the packets end up automatically on the right worker core. For example in a BNG application it is vital for performance that all the packet flows from the same CPE are handled by the same core to effectively enable technologies like billing & HQoS.

In addition, SKY-8101D server configuration integrating the Intel® Ethernet Network Adapter E810-CQDA2 also provides unique Application Device Queues (ADQ) capabilities. ADQ technology improves performance scalability and predictability by dedicating queues to key workloads, delivering predictable high performance with dramatically reduced jitter.

Server Hardware Requirements

The Intel Select Solutions for NFVI Forwarding Platform defines a hyperconverged infrastructure in a 1U or 2U rack-mounted form factor, with solution components and configurations selected to ensure maximum I/O throughput. The hardware topology incorporates 2nd generation Intel Xeon Scalable processors, Intel Ethernet Server Adapters for DPDK accelerated networking, and Intel Solid State Drives (Intel SSDs).

PLUS NODE

Tailored for the highest performance for maximum networking density and packet throughput per NUMA node

BASE NODE

Value/performance-optimized configuration suited to deployments further from the network core

CONTROLLER NODE

Performant CPU and NICs able to manage and communicate with all cloud nodes

This platform addresses general use cases for NFVI, focusing resources on I/O to provide the widest data path possible into each NUMA node. Optional components can be added to meet the requirements of specific use cases. Intel Optane DC persistent memory can be added to the configurations to provide massive memory resources that enlarge the pool of warm data that can be held in close proximity to the processor. User plane nodes are available in two primary configurations, with configurability to fine-tune the stack for specific solution needs: Base Node and Plus Node.

In addition, the reference architecture specifies system configuration parameters for the Intel Select Solutions for NFVI Forwarding Platform Controller Node.

The Advantech SKY-8101D is a verified Intel Select Solutions for NFVI Forwarding Platform and is designed for high throughput and reliability across the CommSP Network Infrastructure. It is built around the architectural and deterministic performance features of 2nd Generation Intel® Xeon Gold processors.

The system is made up of the following key components and technologies:

- Balanced non-uniform memory access (NUMA) connectivity: I/O is evenly distributed across both CPU sockets. Workloads running on both sockets can benefit from direct access to network, storage (Non-Volatile Memory Express or NVMe drives), and Intel® QuickAssist Technology (Intel® QAT) acceleration.
- High throughput network adapters: The SKY-8101D offers four NUMA balanced PCIe x16 Gen3 slots. For Plus node validation, four dual-port (QSFP28) 100Gb Intel Ethernet Network Adapters E810-CQDA2 were installed in the system.

Standards-based networking performance across NFVI workloads is provided by the adaptors through a combination of sophisticated packet processing, intelligent offloads and accelerators, and high-quality open-source drivers. In addition to optimizing throughput, the adapters are designed to enable broad interoperability and agility. Key features and capabilities associated with the adapters include the following:

- Data Plane Development Kit (DPDK) to accelerate packet processing in the data path. It also facilitates building packet forwarders designed to operate on general-purpose, standards based servers.
- Dynamic Device Personalization (DDP) is a programmable packet-processing pipeline provided by the Intel Ethernet 700 and 800 Series that supports on-demand reconfiguration of network

controllers at runtime, enabling workload-specific optimizations to increase throughput and decrease latency.

- Application Device Queues (ADQ) is a capability first implemented in the Intel Ethernet 800 Series that provides dedicated queues to key workloads, enabling application-specific data steering, signaling, and rate limiting using an optimized application thread-to-device data path. The ADQ innovation increases application response time predictability, reduces latency, and improves throughput.

The adapters deliver excellent small-packet performance that is well suited to the requirements of NFVI, together with advanced I/O virtualization that helps increase throughput on virtualized servers. In addition, they offer network virtualization optimizations including VXLAN, GENEVE, NVGRE, MPLS, and VXLAN GPE with Network Service Headers (NSH).

- Storage: 2 x 480 GB Intel® SATA Solid State Drives are configured as boot drives.

Figure 1. Advantech SKY-8101D server front and rear views

Advantech SKY-8101D - Intel Select Solution for NFVI Forwarding Platform Plus Node Configuration

The Intel Select Solution for NFVI Forwarding Platform plus node is based on the Intel® Xeon® Gold 6252 CPU @ 2.1 GHz, This hardware configuration is tailored for the highest performance and maximum networking density and packet throughput per NUMA node.

The SKY-8101D is a high-end server optimized for computing power, accelerated workloads and high speed, high density I/O with optimum energy efficiency.

Two 2nd Gen Intel Xeon Scalable processors provide the latest architectural enhancements, including rebalanced cache hierarchy, and Intel® Ultra Path Interconnect (Intel® UPI) for increased bandwidth and transfer rates between sockets at up to 10.4GT/s.

In addition, the new Intel® Advanced Vector Extensions 512 (Intel® AVX- 512) Vector Neural Network Instruction (VNNI) extension increases the throughput of tight inner convolutional loop operations, reduces the memory bandwidth required to perform deep learning operations and will improve the performance of image matching algorithms on Advantech white box servers.

Each socket supports 6 memory channels and up to 12 DDR4 RDIMMs at 2666 MHz for up to 1536GB of ECC memory using the latest technology. Advanced RAS modes such as mirroring and sparing increase platform reliability.

The SKY-8101D's thermal system design enables support for processors with up to 165W TDP. This allows the appliance to scale from 8 core CPUs to the highest performance 28 core processors available today.

With an abundance of PCI Express lanes, the SKY-8101D can support up to four full height 3/4 length (10.5") PCIe x16 adapters for modular, configurable networking I/O and acceleration. PCIe Gen3 technology on all slots provides sufficient bandwidth to support multiple 40GbE 25GbE and 10GbE network adapters as well as the latest Intel Ethernet Network Adapters offering 100GbE connectivity. With integrated security and compression acceleration based on Intel QuickAssist Technology and two 10GbE ports with SR-IOV and RDMA support, the system offers best-in-class integration in a 1RU form factor.

Advanced Lights Out Management based on Advantech code base BMC and IPMI suite improves system manageability and reliability, providing platform thermal management, H/W monitoring and supervision. Remote firmware upgrade capability and hardware-based BIOS redundancy make the SKY-8101D an ideal platform for mission-critical and highly available networks.

Redundant power supplies, the ability to withstand single fan failures, redundant firmware images with failsafe upgrades and hot swappable FRUs make the SKY-8101D the platform of choice for applications requiring zero downtime.

The SKY-8101D is CE, FCC, UL, CB, CCC, and RoHS compliant.

Table 1 shows the exact configuration of the SKY-8101D and compares it to the reference specifications.

Table 1: SKY-8101D – Intel Select Solution for NFVI Forwarding Platform Plus Configuration – Hardware	
Processors	2x Intel® Xeon® Gold 6252N processor @ 2.3 GHz 24C/48T
Memory	384 GB DDR4-2666
Discrete Network Adapters	4x 100Gb Intel® Ethernet Network Adapter E810-CQDA2
Local Storage	2x Intel® SSD @ 480 GB
LAN on Motherboard	2x 10Gb Intel® Ethernet Network Adapter X722
	2x 1Gb Intel® Ethernet Controller I210-AT

Verified Performance Throughput Benchmark Testing

The SKY-8101D has been verified by Intel to meet a specified minimum level of workload-optimized performance capability. The verified Plus Configuration exceeded vBNG design and testing standards as shown in Table 2.

Table 2: SKY-8101D – Intel Select Solution for NFVI Forwarding Platform Plus Configuration – vBNG Performance		
Benchmark	**Target for Plus Configuration**	**SKY-8101D**
Overall Throughput	310 Gbps	319 Gbps
Latency	50 µ at 256 B packets	Pass
Overall Server Power	<600 W if using Intel®(R) Ethernet 800 Series	540 W
Per CPU Power	<160 W per socket	128 W

Software and Firmware Stack

The Intel Select Solutions for NFVI Forwarding Platform includes comprehensive, workload optimized software and firmware stack based on RHEL8.2. As part of the SKY-8101D verification for Intel Select Solutions program, the server has been certified with Red Hat Enterprise Linux 8 and Red Hat OpenStack Platform 16.

Enhanced Features

Advantech's SKY servers come with an enhanced feature set to improve availability, serviceability and usability:

- Remote Intelligent Platform Monitoring & Control
  - Integrated IPMI Based Management Controller
  - Development, Customization, Validation and Life Cycle Management
  - Standard and Advanced IPMI Features
- Redundant BIOS & Fail-Safe Remote BMC/BIOS Upgrade
  - Physical Redundant Flashes for Current/Backup BIOS
  - x86 BIOS Upgradable by BMC and ABU (Advantech BIOS Utility)
  - Industry Standard HPM.1 Protocol
  - Watchdog Mechanism to Detect Failing / Corrupted BIOS
  - Rollback Mechanism for System Recovery if BIOS Upgrade Fails
  - Dedicated Update Utility (ABU)

Remote Evaluation Service

Advantech's unique Remote Evaluation Service (RES) offers developers easy and secure access to an entire range of platforms upon which they can rapidly evaluate Advantech value-add and test new services. In concert with other Intel Network Builders ecosystem members, Advantech enables developers with early access to the latest technology, which accelerates their next generation product designs. As a result, they can apply innovative new technology sooner to reduce operating expense and grow new revenue faster. RES offers an evaluation framework that brings together members of the Intel Network Builders community who share similar philosophies about telecom and edge cloud architecture and where they can openly collaborate together on a range of platforms from two Intel Atom processor cores to a large number of Intel Xeon processor cores.

With RES, developers can get ahead of the curve and begin to test different NFV infrastructures on platforms destined for deployment closer to the subscriber in the access network, mobile edge and in customer premises (uCPE) as well as the network core and telecom data center.

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