The ATCA® Advantage for NFV

Why the Best Network Functions Virtualization COTS Platform for Communications Service Providers Today is AdvancedTCA®

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Executive Summary

Looking to reduce costs, improve efficiency, and speed deployment of new services, communications service providers (CSPs) are exploring network functions virtualization (NFV). Suitable for many data plane packet processing and control plane functions in fixed and mobile network infrastructures, NFV implements network functions in software. These virtualized functions can then be instantiated wherever needed in the network without the cost of installing and maintaining new equipment.

Many large-scale cloud providers and data centers are already using virtualization and software-defined networking (SDN) to consolidate functions traditionally hosted on proprietary hardware appliances onto high volume commercial off-the-shelf (COTS) servers, switches and storage. However, this “white box” approach does not work for CSPs. Traditional COTS servers are not designed to handle the high demands of CSP network traffic, nor do COTS servers meet the industry’s high standards for reliability, regulatory and safety compliance, and business continuity.

Artesyn Embedded Technologies, a longtime global leader in Advanced Telecommunications Computing Architecture (AdvancedTCA® or ATCA®) and other open standards-based architectures, has more than 25,000 systems and a quarter million blades deployed in mobile and fixed networks globally. In this eBook, we look at why the best NFV COTS platform for CSPs currently is ATCA. We also look at ways to optimize ATCA solutions to provide the best performance for NFV.

1 A recent Artesyn eBook, “A Guide to OCP for Clever Carriers,” discusses the requirements for a “white box” approach for network equipment based on principles of the Open Compute Project.
Network Functions Virtualization

CSP networks include a large variety of proprietary hardware appliances. To launch a new network service often requires yet another type of appliance. For CSPs, this means having to balance the cost of the device against competing capital investment needs, as well as finding the space, power, and expertise to integrate, operate and maintain it. In addition, as the pace of innovation shortens, hardware lifecycles grow shorter, and the cost of replacing devices constrains investment in new revenue-generating services.

NFV addresses these issues by deploying software implementations of network node functions—virtualized network functions (VNFs)—on standard compute, networking and storage hardware. These resources make up what is known as network functions virtualization infrastructure (NFVI).

NFV is suitable for many data plane packet processing and control plane functions in fixed and mobile network infrastructures. For example, VNFs can be used for such applications as session border controllers (SBC), deep packet inspection (DPI), security appliances (firewalls, IDS/IPS, SSL VPNs, etc.), server load balancers, WAN acceleration, routers, gateways, and more.

A Simple Infrastructure

NFVI uses a virtualization layer that abstracts the hardware from the application software to support VNFs. This virtualization layer provides the execution environment (virtualized compute, storage and networking) required by the VNFs, allowing them to be dynamically instantiated on physical resources. A common solution is to implement the virtualization layer with a hypervisor and a guest operating system to support the VNFs. The VNFs can then perform as building blocks that may be connected, or chained, to create communication services.

CSPs can handle orchestration functions using a resource management tool such as OpenStack from the Open Stack Foundation. This cloud operating system provides a dashboard that gives administrators control while enabling authorized users to provision resources (compute, storage and networking) through a web interface.
Advantages of NFV Running on COTS Hardware

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<th>Lower CapEx Costs</th>
<th>Future Proofing</th>
<th>Multi-tenancy</th>
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<td>COTS hardware offers greater selection and more competitive pricing than single-purpose network appliances. For example, virtualized session border controller functions can be deployed for much less on a COTS server than the typical cost and complexity of obtaining and installing physical units. Combining multiple network functions onto a single COTS server results in even more savings.</td>
<td>Using COTS hardware reduces CapEx down the road. If a COTS server supplier goes out of business, a company using NFV can simply buy a similar server from a different supplier. Compare that to the cost of shopping for a new dedicated appliance, and then testing and implementing it.</td>
<td>NFVI can support multiple users on the same hardware platform using virtualization to enable secure separation of application execution environments. Through such multi-tenancy, a provider can support more customers with less equipment.</td>
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<th>OpEx Savings</th>
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<td>Instead of the unique support requirements of each network appliance, high volume COTS hardware delivers uniformity across physical network platforms and enables easier centralized configuration and management, and support by a homogeneous set of tools. IT staff with these skills are also much easier to find.</td>
<td>Exploiting COTS server power management features, as well as workload consolidation and location optimization, allows greater workload concentration on a smaller number of servers during off-peak hours. The remaining servers can come back online at the next demand cycle.</td>
<td>Using NFV frees companies from the lengthy procurement and deployment timeframes associated with proprietary hardware. With NFV, they can dynamically instantiate VNFs, quickly compose end-to-end services, and independently scale the network infrastructure capacity in minutes to support service demands. VNFs can be embedded into core, metro, edge, and even access networks as needed to meet demand and improve quality of experience (QoE).</td>
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Where Enterprise COTS Platforms Fall Short for CSPs

While enterprise data centers are moving quickly to seize the advantages of NFV, CSP applications for NFV require many characteristics currently not found in enterprise COTS hardware. Enterprise COTS platforms fall short in the following areas:

- **CSP reliability standards**
  Few enterprise COTS platforms comply with the shock, temperature, vibration, electromagnetic compatibility (EMC), and other criteria of the Network Equipment-Building Standard (NEBS). This standard is the most common set of safety, spatial and environmental design guidelines applied to U.S. telecommunications equipment and is aligned with similar equipment standards or practices worldwide.

- **Five-nines availability standards**
  Such high availability is particularly important for physical layer applications such as transport.

- **Performance**
  Enterprise COTS platforms are not designed to meet the higher aggregate bandwidth capacity needs that CSPs face now and in the future.

- **Manageability**
  Many COTS platforms lack the necessary management granularity for finely controlling power and cooling at the blade, shelf and chassis level. CSPs need a defined management interface providing sophisticated controls for monitoring system health and maintaining five nines or better availability.
The Advantages of ATCA for NFV

One of the best currently available COTS platform for carrier NFV implementation is one that CSPs know and embrace: ATCA (AdvancedTCA or Advanced Telecommunications Computing Architecture)

Developed to support carrier-grade communications equipment, ATCA is the leading telecom core network platform. It is designed from the ground up to incorporate the latest high speed interconnect technologies and processors, as well as advanced reliability, manageability and serviceability features.

ATCA products are available from a large ecosystem of vendors, providing products such as chassis, shelf managers, hub switch blades, payload blades and full systems. As a true multi-vendor, multi-customer technology, no single large company dominates the landscape so all the players innovate and compete in an open market to the advantage of users. The ATCA standard itself is managed by an independent consortium, the PCI Industrial Computers Manufacturing Group or PICMG, which has been involved in technical specification development since 1984.

Using the latest Intel® Xeon® processors and other technologies, ATCA gives CSPs the features and reliability they need in a NFV platform. As a commodity item available from multiple manufacturers, ATCA also delivers on cost.

Let’s look at all the ways ATCA delivers a solid platform for CSP NFV.
The Advantages of ATCA for NFV

Cost

ATCA platforms are high-availability, NEBS-compliant, and offer redundancy at the hardware level. Consequently, one cost comparison is to the proprietary single-purpose network equipment they replace through NFV. What’s more, through virtualization, ATCA blades can handle multiple workloads, doing the work of several single-purpose network appliances for a fraction of the cost of buying several appliances.

ATCA blades also deliver long-term value through all the OpEx savings that come from deploying NFV throughout a carrier network. Service providers can enjoy the advantages of both worlds, relying on tried-and-true carrier-grade, high-availability equipment that can be managed with a single management solution, while gaining NFV’s benefits in rapid service introduction, scalability, and flexibility.

When comparing solutions based on ATCA technology against those based on generic COTS rack mount servers, it is important to consider all the aspects you will need to create an actual application platform. An ATCA platform uses a backplane inside the chassis to connect server blades rather than cables and I/O modules.

Artesyn’s research has revealed that the cost of cabling and modules to achieve equivalent connectivity, and build a genuine application platform, can run into the tens of thousands of dollars per rack.

A critical element of the platform for many NFV applications is the ability to manage and balance the flow of data packets to optimize the throughput and performance of each processor core.

Artesyn’s ATCA switch blades can run the company’s FlowPilot™ load balancing software eliminating the need for a load balancing appliance in the rack, which can cost many hundreds of thousands of dollars.

From a ‘wire-in to wire-out’ perspective, rather than comparing individual components, ATCA comes out a much more cost effective approach from a CapEx perspective. And that doesn’t even begin to cover the potential OpEx savings from less power wastage, high reliability and easier serviceability.

Artesyn has worked with a major communications carrier to develop a set of criteria and capabilities for their next-generation DPI application in an NFV deployment. We found an order of magnitude in CapEx cost difference between a bladed server based on ATCA technology and a rack mount server system once all the requirements had been considered.
The Advantages of ATCA for NFV

CSP-level Reliability
A highly regulated environment, such as 911 emergency calls, cannot afford connection drops due to electromagnetic interference, shock, vibration, heat, or cold. Designed to meet telecom building practices, ATCA meets the challenge, complying with NEBS to provide a proven reliable solution for metropolitan to nationwide networks.

ATCA systems avoid problems with radio interference by controlling radio emissions at the server and rack level, instead of just the facility level. They also withstand shock and vibration, as well as wider ranges in temperature.

Five-Nines Availability
The world depends on reliable connections for routine and critical communications. A hiccup in the ability to make a connection is so unusual it can alarm a telecom customer. ATCA platforms are high-availability systems designed to deliver five nines network uptime. The specification includes hardware backplane redundancy and proven middleware that provides fault detection, fault isolation, failover, and system recovery to ensure redundancy.

The ATCA shelf manager controls the modules and blades in the platform, supporting automatic switchover from active to backup switch blades, power supplies, cooling trays, and shelf managers as necessary. If, in the rare event an ATCA server blade fails, it can be hot-swapped while the rest of the blades, including its backup, are running.
The Advantages of ATCA for NFV

Making Bandwidth a Non-Issue
Recent ATCA developments ensure that its network connections will be able to keep up with the exponential bandwidth growth from mobile network and other traffic — as well as feed the growing core counts of Intel processors on each blade. The most recent of these is Artesyn’s 3+1 QuadStar™ configuration. This configuration has three active switch blades to support three times the bandwidth of a standard Dual Star system.

The fourth switch blade is ready on standby in case one of the three active blades fails. The 3+1 QuadStar Fabric configuration with 40GBaseKR4 switching supports 120Gbps per blade or 160Gbps with four active switch blades and no redundancy, equating to 1.6Tbps aggregate bandwidth. This configuration can be implemented using current technology backplanes, switch devices, and payload blades with support for four fabric interfaces.

ATCA Star configuration fabric interfaces.
As an example, the ATCA-7480 features a QuadStar™ interface consisting of four 40GbE channels that connect to the shelf’s backplane. By integrating multiple ATCA-7480 blades with up to four 40G hub blades into a single shelf, applications can benefit from high data rates flowing through the available hub blades. In addition external network connectivity can be further increased by a wide range of I/O network options. Selectable bandwidths from 1GbE, 10GbE to 40GbE support the integration of the ATCA-7480 into different network environments.

On the horizon are 100Gbps backplane links with ATCA. Working with other industry leaders, Artesyn is pioneering this technology. In the near future, CSPs will see chassis and backplane supporting 300Gbps interfaces with redundancy to each payload blade. In a 14-slot system, this equates to a theoretical aggregate data bandwidth of 3Tbps — or 4Tbps with no redundancy.
The Advantages of ATCA for NFV

Flexibility within the Box
ATCA chassis enable multiple technologies to coexist within the same box, each one designed to provide the compute density, I/O bandwidth, and carrier-grade hardness required by particular CSP applications. Since CSPs operate many central offices — locating them near customers to provide better service — space and costs constraints are key CSP challenges.

Compare this to enterprises that run massive, highly centralized data centers with tens to hundreds of servers running a single application. Flexibility, space, and placement matter less to such operations.

A highly dense platform like ATCA, which fits in less than a 20-inch depth, provides a heterogeneous environment that maximizes limited real estate. ATCA platforms offer up to 16 slots for any mix of CPU, NPU, DSP, storage and I/O payload blades, together with up to four switch blades. Each blade can also have a smaller rear transition module (RTM) to support additional storage or I/O capacity.

This isolates the major I/O from the compute blades, easing cabling and maintenance. The most common ATCA platform configuration is a 14- to 18-unit shelf with 14 slots for mounting in a 19-inch rack.

Targeting carriers specifically, the ATCA ecosystem uses its experience and market penetration to meet cost and space constraints and evolve the form factor to continually address current and future telecom infrastructure needs.
Higher Aggregate Bandwidth Performance
Today’s smart devices and cloud services continue to drive demand for network bandwidth, particularly in mobile networks. Supporting this growth requires network infrastructure that can support both SDN and NFV, as well as deliver line rate deep packet inspection (DPI), packet classification and load balancing.

This is no job for enterprise COTS hardware. While white box servers generally offer no more than two 10GbE Ethernet ports at the front of a server, ATCA platforms have a passive backplane that supports Base and Fabric Interfaces, supporting multiple 10Gbps, 40Gbps and even 100Gbps interfaces. The systems that support this network infrastructure need to be scalable and upgradable so service providers can quickly respond to demand and deliver profitable services to satisfied customers.

In ATCA, the Base Interface consists of a pair of 1GbE channels connected from each payload blade to a pair of centralized switch/hub slots. This Dual Star configuration supports active and standby switch blades and is used for control plane functions in carrier systems. The Fabric Interface is the high speed interconnect and is typically used for data plane functions. Most current ATCA platforms support a Dual Star Fabric Interface configuration as well. In a 14-slot shelf this configuration can support 12 payload slots and 1+1 redundancy with one active and one standby switch blade. Each port can support 40Gbps per blade for a total of 480Gbps bandwidth. Ingress/egress ports are usually connected directly into the active switch.

A 2+2 Dual-Dual Star doubles the system switching and ingress/egress bandwidth with two active switch blades and two standby switch blades. The number of payload blades in this configuration is reduced by two to 10 to accommodate the additional switch blades. The configuration can support 80Gbps per blade for a total of 800Gbps.

Defined Management Interfaces
The ATCA standard includes PICMG’s Intelligent Platform Management Interface (IPMI). This interface enables remote shelf managers to monitor and control individual ATCA blades. For instance, using IPMI, shelf managers can shut down a dead blade and switch its function and processing load to another blade. Through IPMI, shelf managers can perform in-line diagnostic tests and monitor physical health parameters such as blade voltages, airflow, fan speed, temperature, and insertion and power supply status. With a documented programming interface for all managed entities within an ATCA system, a management tool written for one vendor’s ATCA system will work with other vendors’ ATCA systems as well. The IPMI specification provides automatic alerts with remote system shutdown, restart and logging, making it easier for system administrators to respond to alert conditions.

At a higher level, ATCA also provides for redundant Ethernet management. Through ATCA’s high bandwidth interface, managers can perform code updates, upgrade system features, diagnose hardware defects, and even modify the hardware function if it is reprogrammable logic.

The Advantages of ATCA for NFV

The ATCA® Advantage for NFV
ATCA Innovations and Optimizations for NFV

Innovations and optimizations from Intel and ATCA manufacturers like Artesyn are further increasing the advantage of using ATCA solutions for NFV. Through these improvements CSPs can achieve even greater performance, bandwidth and flexibility in their NFV implementations.

Faster, Scalable Performance for Virtualized Workloads
The latest Intel® Xeon® processor E5-2600 v3 product family provides excellent, scalable performance for virtualized workloads such as packet processing, deep packet inspection, network optimization, and security operations. These powerful processors, combined with ATCA high speed data path, reduce response times for database accesses, accelerate pattern matching, and optimize routing decisions in NFV environments. Equally important, the latest Intel designs for communications chipsets and Ethernet network controllers offload packet processing to preserve more cores for CSP applications.

The new processor family achieves these gains through these advancements:

- **More Cores**
  Using the Intel Xeon processor E-2600 v3 family, an ATCA configuration can offer up to 28 cores per dual-socket blade — four more than the previous generation’s top processor. The additional cores enable an increase in virtualization density of up to 1.6x over the previous generation. This density increase helps reduce CapEx cost by allowing more workloads to run on a single server.

- **Support for DDR4 memory and the PCIe Gen 3 protocol**
  These advances enable highly optimized data paths to main memory and I/O. Support for DDR4 alone delivers up to 3x greater memory bandwidth for faster access while consuming as little as half the power of DDR3 memory.

- **Advanced communications chipset**
  Many ATCA blades include the Intel® Communications Chipset 89xx Series with Intel® QuickAssist Technology. When paired with the Intel Xeon processor E5-2600 v3 family, this chipset offers hardware-assisted acceleration for workload optimization. Applications that use Intel QuickAssist Technology increase workload efficiency by offloading compute-intensive security, compression, and packet operations, allowing more cores to be used for applications.

- **Intel® Virtual Machine Control Structure (Intel® VMCS) Shadowing**
  For CSPs with legacy applications left behind by advanced technology, this advancement can extend application life and postpone rewrite costs. Intel VMCS Shadowing extends root virtual machine monitor (VMM)-like privileges to a guest VMM, enabling legacy OS, applications, security software, and other code not supported on the platform root VMM to be run on the system.

- **Large Intel® Smart Cache (L3)**
  To meet the demands of high performance packet processing applications, up to 30 MB L3 cache accelerates processing by bringing and keeping more data closer to the cores and reducing memory reads. A new cache monitoring technology allows an operating system or virtual machine manager (VMM) to determine usage of L3 cache on a per-application or per-thread basis, allowing more accurate scheduling decisions to be made. Applications can be restricted from consuming an unfair volume of resources, resulting in greater performance from other, I/O hungry applications.
**ATCA Innovations and Optimizations for NFV**

**Faster Input/Output**
Additional I/O gains can be achieved through use of the Intel® Ethernet Controller XL-710 product family. These 10 and 40GbE controllers extend Intel® Virtualization Technology (Intel® VT) hardware assistance for the first time to network virtualization. These controllers reduce I/O bottlenecks by intelligently offloading networking traffic per VM, enabling near-native performance and VM scalability. An innovative offload feature, Intel® Ethernet Flow Director, reduces latency by directing packets to the core and application that requires them by observing outgoing flows and creating a connection between sources and destinations.

**Optimizations for NFV**
To help CSPs make the most of NFV, ATCA manufacturers offer optimized solutions for NFV. A good example is the Artesyn Centellis® Virtualization Platform, a carrier-grade, NEBS-certifiable application virtualization platform based on open hardware and software architectures. This platform is architected for next generation networks based on OpenFlow for SDN and OpenStack for NFV. The platform facilitates running multiple virtualized applications such as firewall, DPI, security, or session border controller on a single hardware platform. Load-balanced switching provides additional efficiencies to virtual application deployment.
ATCA Innovations and Optimizations for NFV

Further optimizations come with the blades themselves. Using an Artesyn example again, the Artesyn ATCA-7480 blade includes enabling software that enhances its performance in the Centellis® Virtualization Platform. The blade also supports Wind River Titanium Server, a fully integrated, virtualized software platform that enables an ultra-reliable, high-performance NFVI.

To maximize performance, the ATCA-7480 supports Intel® Data Plane Development Kit (Intel® DPDK)-accelerated Open vSwitch, OpenFlow and OpenStack plug-ins for managing virtualization services on the computing platform. Intel DPDK is a collection of community-driven, open source packet-processing libraries designed to boost the packet processing throughput on Intel® processors by assisting in managing memory, buffers, queues, and flow classifications.

These optimizations make the ATCA-7480 blade the ideal work load unit for meeting the performance and network requirements of NFV. Optimized for best-in-class computational performance and packet throughput combined with high bandwidth network connectivity, the ATCA-7480 enables a wide range of applications including packet processing, security functions, NFV environments, and control tasks on a single platform. This can help simplifying development and integration of the target application and shortening time to market.
ATCA Demonstration Platform for SDN/NFV

Artesyn is currently running a demonstration for SDN/NFV applications that features our ATCA-7480 blade based on the Intel Xeon processor E-2600 v3 product family. The demonstration setup use the Intel® Open Network Platform Server Reference Design and includes the following components:

- Intel® Communications Chipset 89xx series
- Intel® Ethernet Controller XL-710
- DPDK-accelerated Open vSwitch (for high-throughput packet switching)
- Kernel-based Virtual Machine (KVM) hypervisor for SDN and NFV environments

Located at Artesyn’s Munich lab, the system is accessible to remote users. You can run a specific set of predefined demonstrations or upload your own VNFs to try the environment and test performance.

The capabilities of this platform were first demonstrated at Mobile World Congress 2015 in Barcelona. In the demo, the system simultaneously ran three separate VNFs from three independent vendors. The demo showed how the applications could be scaled up and down via a dashboard in Artesyn’s meeting room. Attendees watched the actual unit via a webcam.

To demo the unit, please contact Jim.Darroch@Artesyn.com
New, More Flexible Payload Options

A key benefit to moving to NFV is enabling CSPs to run network functions on carrier-grade COTS hardware like ATCA. However, some applications, especially in the network core, can require higher levels of performance and power than the ATCA specification for 400 watts per slot.

To accommodate these needs, Artesyn’s Centellis 8000 ATCA series system is the first to provide a power boost and cooling boost in a select number of slots for blades drawing up to 600 watts. By enabling high power capacity slots, this chassis family gives CSPs the ability to meet each location’s needs with a mix of powerful and less powerful blades that better maximize total available power. This ability to accommodate higher performance blades also provides future proofing. CSPs can choose to add more powerful blades later if needed.

Using these higher power capacity slots, a CSP can mix dual-socket blades with 28 cores with other blades using less. For instance, a CSP could install power-hungry specialized blades like Artesyn’s high-density voice transcoding engine for communications traffic within session border controllers or Artesyn’s media processing solutions for high-density voice and video processing for multimedia and over-the-top application support. The same CSP could also install one or two blades that include application-specific network processor units (NPUs) or digital signal processors (DSPs) that draw lots of power.

Seizing NFV Advantages with ATCA

An excellent platform for CSPs looking to incorporate NFV in their operations is one they are already familiar with: ATCA. By bringing the advantages of a COTS platform to the carrier world, ATCA enables CSPs to use NFV to reduce CapEx costs, improve operational efficiency, and speed deployment of new services.

The communications industry is introducing new ATCA chassis, blades, and hardware and software optimizations that improve NFV’s implementation in carrier networks. Processor manufacturers like Intel are providing valuable contributions through more powerful processors and advanced technologies designed to offload packet processing and preserve more cores for CSP applications. As a result, what used to require several single-purpose network appliances can now be achieved with a single system running multiple applications. These applications can be deployed with the hardware necessary for the current peak traffic load and easily scaled by adding more blades or more systems as traffic load increases.

As one of the top contributors to the ATCA specification, Artesyn is continuing its leadership by providing advanced ATCA solutions for NFV. These solutions include the Artesyn Centellis Virtualization Platform and NFV-optimized ATCA blades that offer a wide range of performance.
About Artesyn Embedded Technologies

Artesyn Embedded Technologies is a global leader in the design and manufacture of highly reliable embedded computing solutions for a wide range of industries including communications, military, aerospace and industrial automation.

Building on the acquired heritage of industry leaders such as Motorola Computer Group and Force Computers, Artesyn is a recognized leading provider of advanced network computing solutions ranging from application-ready platforms, single board computers, enclosures, blades and modules to enabling software and professional services.

For more than 40 years, customers have trusted Artesyn to help them accelerate time-to-market, reduce risk and shift development efforts to the deployment of new, value-add features and services that build market share.

Artesyn has over 20,000 employees worldwide across nine engineering centers of excellence, four world-class manufacturing facilities, and global sales and support offices.