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vRAN: The Next Step in Network Transformation

Boost Capacity, Reduce Cost, and Enhance Customer Experience with Wind River, Altiostar, Amdocs, and Dell EMC

WHEN IT MATTERS, IT RUNS ON WIND RIVER

EXECUTIVE SUMMARY

Virtualized radio access network (vRAN) is the next step in the evolution of mobile networks, promising to intelligently boost capacity, dramatically reduce costs, and enhance customer experience. It will also provide the flexibility and dynamic scalability that will be necessary to support future services and applications. The vRAN architecture goes beyond the latest iterations of centralized RAN (C-RAN) by running virtualized baseband functions on commodity server hardware, based on the principles of Network Functions Virtualization (NFV).

As communications service providers (CSPs) are under pressure to keep up with capacity demands and launch differentiated offerings in a highly competitive mobile services market, the time is right to extend the benefits of NFV from the core network to the RAN.

Altiostar, Amdocs, Dell EMC, and Wind River® offer a complete, pre-integrated vRAN solution that cost-effectively delivers carrier grade performance, massive scalability, and rapid service instantiation for 4G networks today while laying the foundation for 5G networks in the future. The vRAN solution comprises the following key components:

- Altiostar vRAN solution is a pioneering software-intensive LTE eNodeB with Ethernet fronthaul that improves performance, reduces costs, and simplifies infrastructure expansion while improving the customer experience.
- Amdocs Network Cloud Service Orchestrator (NCSO) is an open, catalog-driven solution that continuously designs, fulfills, and assures network services from any virtual network function over all mainstream cloud management systems and SDN controllers. Amdocs also provides professional services for designing, deploying, operating, and optimizing mobile networks.
- Dell EMC PowerEdge R630, an ultra-dense, two-socket 1U rack server, is versatile and highly configurable for a variety of solutions, delivering the latest Intel® Xeon® processor E5-2600 v4 product family, 24 DIMMs of high-performance DDR4 memory, and a broad range of local storage options.
- Wind River Titanium Cloud™ is the industry's only fully integrated, ultra-reliable, and deployment-ready family of virtualization platforms that enable service providers to deploy virtualized services faster, at lower cost, and with guaranteed uptime.

This solution brief details the business and technical benefits of the combined vRAN solution, which will enable CSPs to cost-effectively scale capacity to meet rising traffic demands on 4G LTE networks today and gain the flexibility, agility, and scalability needed for 5G networks in the future.

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INTRODUCTION

The volume and variety of mobile traffic continues to grow at incredible rates, driven primarily by smartphone video consumption and new types of connected devices. Unpredictable traffic surges, short spikes known as microbursts, are becoming more common and are confounding capacity planning. Mobile networks soon will have to contend with even more bandwidth-intensive applications, such as 4K and 3-D video, augmented reality (AR), and virtual reality (VR); they will also need to connect many more millions of low-power Internet of Things (IoT) devices. Coping with such unabated growth and diverse traffic patterns is an unprecedented challenge for communication service providers (CSPs).

At the same time, CSPs are under pressure to add and retain customers, offer differentiated services, and maintain superior quality of experience (QoE) in a fiercely competitive mobile services market where average revenue per user (ARPU) is in decline. CSPs not only need to invest in the network to meet rising capacity demands but they also need to find operational cost savings and develop new sources of revenue to preserve profit margins.

> To overcome these challenges, the focus must be on the Radio Access Network (RAN), which is not only the most expensive part of the mobile network in terms of CAPEX and OPEX but also the source of 80% of performance problems that affect the customer experience.

4G LTE technology is more efficient than previous generations in handling high-bandwidth traffic, but the conventional RAN architecture widely deployed today is challenged to deliver the additional capacity, cost savings, service agility, and scalability that CSPs need to meet future demand.

RAN architectural changes are already underway, evolving in stages from the traditional distributed model to centralized to fully virtualized implementations. In a distributed RAN, each LTE base station—i.e., evolved Node B (eNodeB)—comprises a baseband unit (BBU) and remote radio units (RRUs), which are also referred to as remote radio heads (RRHs). The BBU and RRU are typically located at the base of the cell tower or in a nearby cabinet, and the RRU is connected to the antennas at the top of the tower via coaxial cable. In a split architecture, the RRU is located at the top of the cell tower with the antennas; it connects to the BBU via fiber using the Common Public Radio Interface (CPRI) protocol to transport the digitized radio frequency data. The distributed architecture is the classic deployment model for most mobile networks today.

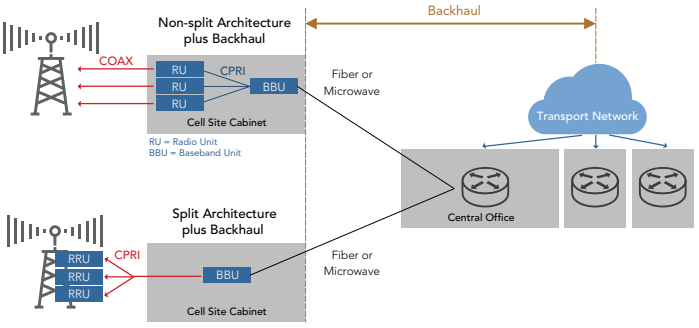

Figure 1. Traditional, distributed RAN

The next stage is centralized RAN (C-RAN), also known as baseband hoteling. The specialized BBU appliance is located in a central office (a baseband hotel), and it can control tens of cell sites. Multiple BBUs are located at the central office, which lowers operating costs by minimizing power requirements and real estate rental for each cell site and reducing the number of site visits required for network upgrades or troubleshooting. The centralized BBUs are connected to RRUs via CPRI-based fronthaul transport over fiber. The BBUs are colocated but the baseband processing is not shared, which limits scalability. That is, new cell site deployments require the physical installation of additional BBU appliances in the central office.

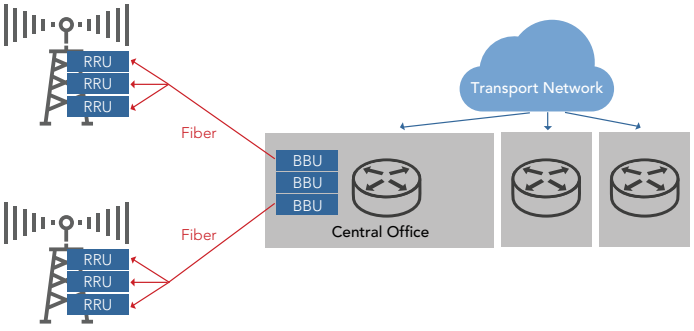

Figure 2. Centralized RAN

The C-RAN architecture can go a step further by enabling the pooling of baseband processing resources, which can be dynamically allocated to different cell sites and radio technologies. Sharing baseband resources uses available spectrum more efficiently and improves service reliability. It also enhances support for LTE-Advanced features and small cell deployments, which can boost capacity in densely populated areas and high-traffic hotspots.

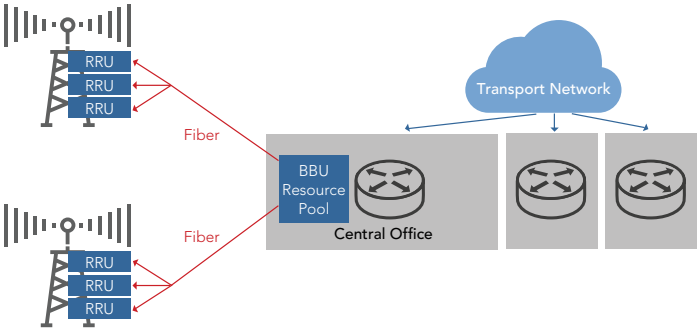

Figure 3. C-RAN baseband unit pooling

But centralized baseband pooling does not go far enough. To achieve the full potential of cost savings, dynamic capacity scaling, better QoE, and the rapid instantiation of new services, CSPs need to adopt a virtualized RAN (vRAN) architecture.

In the vRAN model, the BBUs are virtualized. The vBBUs are deployed on multiple NFV platforms on industry standard x86 hardware and consolidated in centralized data centers, while remote radio heads (RRHs) are left at the cell sites at the edge of the network. vRAN leverages standard server hardware that cost-effectively scales up or down processing, memory, and I/O resources with demand and infuses the RAN with capacity for application intelligence to significantly improve service quality and reliability. Depending on how the eNodeB functions are split, the architecture also allows for Ethernet and IP fronthaul transport, which gives services providers more cost-effective options for fronthaul transport.

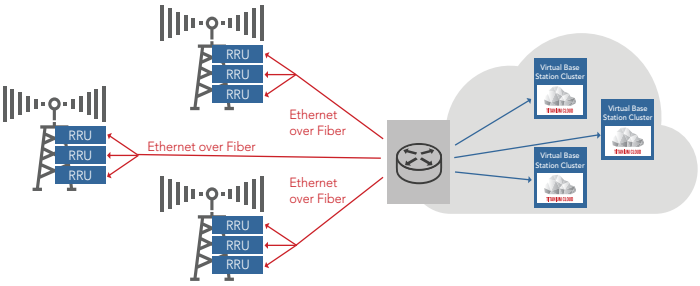

Figure 4. Virtual RAN

COMPLETE VRAN SOLUTION

Altiostar, Amdocs, Dell EMC, and Wind River have teamed to create a complete, pre-integrated vRAN solution that delivers unrivaled reliability and performance, best-in-class manageability and orchestration, massive scalability, and significant cost savings compared to conventional RAN architectures. The solution provides all the components CSPs need to migrate to vRAN today.

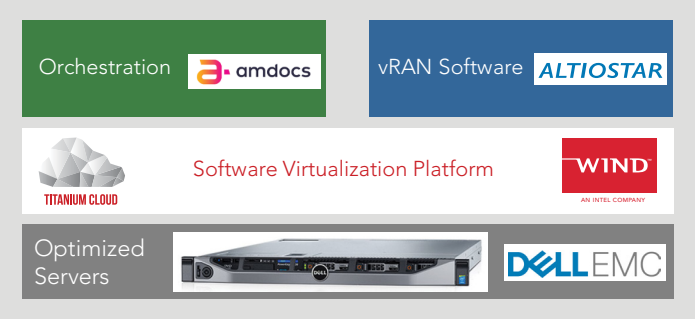

Figure 5. Introducing an end-to end solution for vRAN

- Altiostar vRAN solution is a pioneering software-intensive LTE eNodeB with Ethernet fronthaul that improves performance, reduces costs, and simplifies infrastructure expansion while improving the customer experience. Comprising intelligent remote radio heads (iRRHs) and virtualized BBU (vBBU), the solution supports LTE-Advanced features including inter-site uplink coordinated multipoint (UL-CoMP) and inter-site carrier aggregation and can leverage existing Ethernet or IP transport connectivity.
- Amdocs Network Cloud Service Orchestrator (NCSO) is an open, catalog-driven solution for service providers transitioning from physical networks to dynamic network clouds. The NCSO continuously designs, fulfills, and assures network services from any virtual network function over all mainstream cloud management systems and SDN controllers. In addition, Amdocs provides professional services for designing, deploying, operating, and optimizing mobile networks, including network service creation, network testing, and network service assurance.
- Dell EMC PowerEdge R630, an ultra-dense, two-socket 1U rack server, delivers an impressive solution for virtualization environments, large business applications, or transactional databases. The R630 server is versatile and highly configurable for a variety of solutions, delivering the latest Intel Xeon processor E5-2600 v4 product family, 24 DIMMs of high-performance DDR4 memory, and a broad range of local storage options.

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- Wind River Titanium Cloud is the industry's only fully integrated, ultra-reliable, and deployment-ready family of virtualization platforms that enable service providers to deploy virtualized services faster, at lower cost, and with guaranteed uptime. The portfolio comprises Wind River Titanium Core, which is designed for CSP data centers, central offices, and points of presence (PoPs); and Wind River Titanium Edge and Wind River Titanium Edge SX, which are designed for small footprint telco edge applications and support dual-server and single-server configurations respectively, making them ideal platforms for vRAN implementations.

CARRIER GRADE RELIABILITY

Since the RAN largely determines the level of service quality that customers experience, any vRAN implementation needs a carrier grade virtualization platform that is hardened and optimized to overcome the shortcomings of standard IT-grade equipment and open source software, which are not designed for stringent carrier network requirements.

Titanium Cloud delivers 99.9999% (six nines) guaranteed uptime, which results in less than 30 seconds of downtime per year. This is achieved through many features in the software stack, including automatic failure detection and recovery and fast, live virtual machine (VM) migration. For example, Titanium Cloud can detect when a VM fails within 500 milliseconds, while an enterprise-grade platform takes more than a minute to detect VM failures. Likewise, Titanium Cloud detects the failure of a compute node in 1 second, compared to more than a minute for enterprise platforms. Not only does Titanium Cloud detect the failure but it automatically relaunches impacted VNFs and begins controlled recovery of the failed node, all without any manual effort or delay.

Unlike conventional, distributed RAN solutions, the Altiostar vRAN solution is inherently designed with network redundancy, which minimizes service downtime. A recent analysis compared distributed RAN and vRAN on cell area downtime, which measures the average minutes per year that base station failures cause all users in a cell to lose service. Since vRAN incorporates redundancy, it had significantly better results.

> The vRAN had 5.8 minutes of downtime per year, whereas the distributed RAN had 18.8 minutes per year.

The high availability of vRAN is due to vBBUs that can automatically recover from hardware and software failures with no impact on mobile services.

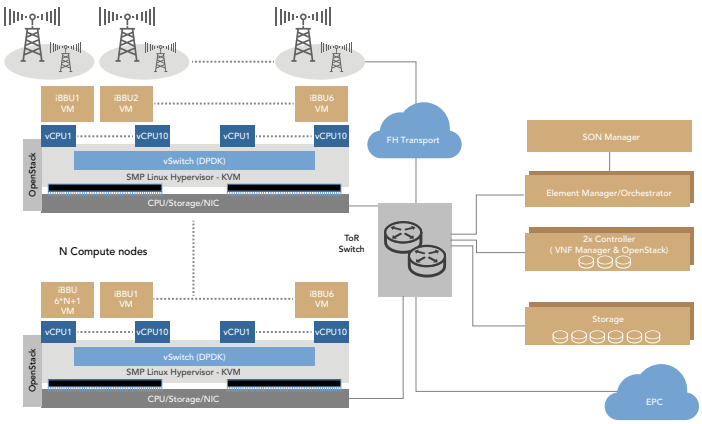

Figure 6. NFV architecture on commercial off-the-shelf hardware

The combined vRAN solution delivers the consistently high availability and predictably that CSPs require.

ULTRA-LOW LATENCY

The solution is optimized to ensure ultra-low latency in vRAN deployments, which is critical for supporting real-time applications such as voice over LTE (VoLTE) and enabling future 5G services. The fronthaul transport between vBBUs and RRHs cannot become bottlenecks in the vRAN, as that would defeat the service quality and cost efficiency gains of the new network model.

In Altiostar's vRAN solution, the eNodeB functional splits are designed to ensure low latency. In the higher layer split, real-time functions are integrated in the iRRH, including the PHY, media access control (MAC) scheduler, and radio link control (RLC). Non-real-time functions are run on the centralized vBBUs, including packet data convergence protocol (PDCP), radio resource control and management, mobility management, IPSec, deep packet inspection, application intelligence, content caching and streaming, and analytics. In this way, the real-time functions are not hindered by latency conditions and bandwidth constraints in the fronthaul transport and CSPs have more options for transport infrastructure than just dark fiber, as is typically required in C-RAN deployments.

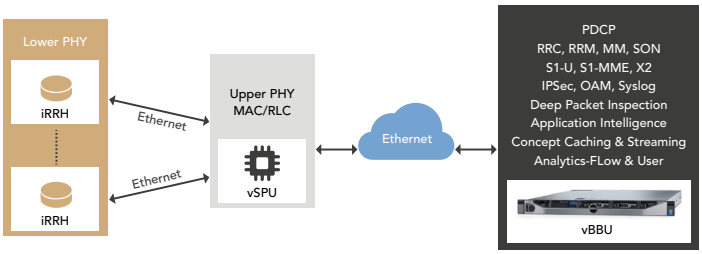

Figure 7. Altiostar vRAN architecture: Functional split options

In the lower layer split, many of the real-time functions (except layer 1 PHY) run on virtualized signal processing units (vSPUs) at local aggregation sites, while the non-real-time functions remain on the vBBUs.

The latency requirement between the iRRH and vSPU is around 200 microseconds, while the requirement between the centralized vSPUs and vBBUs is tens of milliseconds.

Supplementing Altiostar's unique functional splits, other elements of the combined vRAN solution are designed to speed packets through the platform as quickly as possible. Within the Wind River software virtualization platform, the time it takes to deliver packets to guest VMs is a critical factor in app performance. All Titanium Cloud platforms feature a low-latency compute profile and comprehensive enhancements to the integrated Kernel-based Virtual Machine (KVM) hypervisor, which deliver an average interrupt latency of just three microseconds to guest VMs.

Furthermore, the underlying server hardware from Dell EMC is powered by the latest Intel Xeon processors, up to 24 DIMMs of high-capacity DDR4 memory and up to three PCI Express 3.0 expansion slots, making it well suited to running low-latency applications.

BEST-IN-CLASS MANAGEABILITY AND ORCHESTRATION

Through constant monitoring of service availability, fault management, and user experience conditions, Amdocs' Network Cloud Service Orchestrator (NCSO) dynamically allocates resources across the vRAN. If a cell site becomes overloaded with heavy traffic during peak usage times or experiences an unexpected microburst, processing capacity can be dynamically scaled up to relieve the pressure on the network and improve services for customers. If a cell site is not in use for many hours during the night, that site can be consolidated with other low-traffic cell sites on a few compute servers through the use of VM live migration, and the unused compute servers can be powered down to save energy, which substantially reduces operating costs.

The NCSO automates the design, fulfillment, and assurance processes for network services in the vRAN solution, which enables CSPs to rapidly create new services and implement them instantly. It essentially performs a continuous fulfillment process. The NCSO features a catalog of virtual and physical network resources as well as service parameter models. Leveraging Amdocs' Sensei real-time service design technology, the NCSO dynamically designs services by combining the service models from the catalog with a variety of other parameters, such as service policies, data center status, network status, customer orders, and service level agreement (SLA) stipulations. The orchestrator continuously gathers real-time data on network service and customer key performance indicators (KPIs) and then redesigns services to be in line with current network conditions and customer requirements.

This closed loop of design–fulfillment–assurance minimizes the time it takes to resolve service issues and reduces the amount of manual processes, which are often error prone. The NCSO also integrates with operational support systems (OSSes) and business support systems (BSSes).

Other important capabilities of the NCSO are network slicing and service chaining, which enable a wealth of service differentiation possibilities and network optimization for CSPs. Network slicing splits vRAN traffic into multiple streams that can be allocated to applications or customers according to QoS requirements. There are many use cases for network slicing. For example, the NCSO can support a bandwidth-on-demand service for a specific customer by creating a service chain on that network slice that adds bandwidth when the user requests more capacity.

Titanium Cloud network virtualization platform also features industry-leading service manageability:

- A comprehensive fault detection and alarming system instantly notifies operators of issues that could impact service, with a highly visible on-board notification and off-board reporting system. This system feeds directly into existing OSS/BSS systems.
- A powerful patch delivery and orchestration engine independently manages the rollout and activation of product updates across all nodes.

- Upgrades from one major product release to the next are managed in place, with no systems outages or service downtime.
- System debugging and problem investigation are accelerated through powerful log analytic tools and clear graphical visualization facilities.

Dell EMC further enhances the solution's manageability with its OpenManage solutions, which simplify and automate server lifecycle management tasks. By streamlining server deployment, configuration, and updates, the OpenManage portfolio makes the Dell EMC R630 more productive, reliable, and cost-effective.

MAXIMUM RESOURCE UTILIZATION AND PERFORMANCE

vRAN requires the best possible system resources to operate efficiently and with high performance. When running on the Titanium Cloud family of virtualization platforms, Altiostar's vBBUs and vSPUs have more cores available to them per processor than on any other competing virtualization platform. In addition, the network throughput for Altiostar's vBBU and vSPU functions is greater on Titanium Cloud as well.

Titanium Cloud includes an accelerated virtual switch (AVS) built from the ground up for NFV deployment. Based on the Data Plane Development Kit (DPDK), AVS achieves line rate virtual switching performance using fewer CPU cores than any other virtual switch. This frees up more cores per CPU than competing solutions, enabling a greater density of VNFs and ultimately ensuring that service providers are deriving the greatest number of services possible out of their platform investment.

A further advantage of the AVS architecture is that Altiostar VNFs achieve a much higher network throughput than on standard, open vSwitch (OVS)-based systems. Depending on the application, AVS throughput is between 15 and 40 times higher than OVS. The Altiostar vRAN solution takes full advantage of multi-socket and multi-core processors and DPDK support for maximum use of underlying hardware resources, resulting in excellent performance and throughput.

Titanium Cloud has been uniquely optimized for use on Intel Architecture CPUs, resulting in consistent and predictable application performance. Enhanced Platform Awareness (EPA) features are deeply embedded into Titanium Cloud, which ensures that operators can tune Altiostar VNFs to deliver exactly the degree of performance they require.

At the hardware level, Dell EMC's R630 delivers the compute capability of 2U servers in a two-socket 1U rack server. Versatile and highly configurable, the R630 is packed with the latest Intel Xeon processor product family, 24 DIMMs of high-performance DDR4 memory, and a wide range of local storage options.

Only vRAN implementations with Altiostar running on Titanium Cloud and Dell EMC R630 servers can deliver these advanced resource utilization and performance benefits.

FLEXIBLE DEPLOYMENT OPTIONS

The combined vRAN solution supports a variety of deployment scenarios, including urban environments, rural areas, campuses or residential apartment buildings, and stadiums. Altiostar iRRHs can be deployed as micro cells, pico cells, macro cells, and massive MIMO active antenna systems in any spectrum band to create heterogeneous networks (HetNets) that densify the RAN and increase capacity. This deployment flexibility is largely due to Altiostar's Ethernet fronthaul capability, which allows operators to utilize the most efficient or readily available transport to suit the rollout, such as metro fiber rings, point-to-point microwave, non–line of sight wireless systems, GPON, vDSL, DOCSIS, and dark fiber. In contrast, C-RAN is limited by the fact that the architecture requires dark fiber for CPRI-based fronthaul, which adds huge cost to deployments if it is not already in the ground.

With flexible fronthaul transport options, CSPs have more freedom to choose the location of the vSPUs, which aggregate up to 100 iRRHs, and the vBBUs, each of which supports between 10 and 100 vSPU aggregation sites.

Wind River Titanium Cloud family of virtualization platforms also provides flexibility to support any vRAN deployment scenario. For clusters of centralized vBBUs in data centers, central offices, or PoPs, Titanium Core can scale seamlessly from four to 100 servers in geographically dispersed locations. For smaller footprint deployments or vSPU aggregation sites, Titanium Edge has all the features of Titanium Core and runs on two servers.

OPEN STANDARDS AND OPEN APIS

In the transition from deploying physical network appliances to implementing virtual network functions, CSPs want to break free from vendor lock-in and adopt standardized solutions across the network. Altiostar, Amdocs, Dell EMC, and Wind River are each committed to supporting openness and choice. The combined vRAN solution offers standard interfaces and open APIs.

Altiostar vRAN and Titanium Cloud are software solutions, each fully independent of any underlying infrastructure or hardware device. While the vRAN solution runs on Dell EMC hardware, Altiostar, Amdocs, and Wind River support a wide range of physical servers from the industry's largest suppliers, including major telecom equipment manufacturers and enterprise IT leaders. Titanium Cloud also supports a broad catalog of pre-integrated applications so that CSPs can add functions to the vRAN solution as needed. In addition, Altiostar's open vRAN development platform allows third-party radio equipment vendors to leverage the vRAN solution software.

Open interfaces and APIs are supported at every solution level, including standard management and orchestration APIs offered over REST, SNMP interfaces for OSS/BSS systems, and standard logging interfaces for problem investigation and troubleshooting. Furthermore, the solution also benefits from Amdocs' expertise and pioneering work on Enhanced Control, Orchestration, Management, and Policy (ECOMP), which the company created with AT&T. ECOMP is now part of the Open Network Automation Platform (ONAP) open source group hosted by the Linux Foundation. ONAP creates a framework for real-time, policy-driven orchestration and automation of VNFs and enables the rapid creation of new services.

PRE-INTEGRATED SOLUTION VERSUS BUILD YOUR OWN

Some companies may prefer to develop and build their own vRAN solutions rather than adopting a pre-integrated solution. This may seem attractive in the short term, but the costs can be significant in terms of direct expenditure as well as lost market opportunity.

Together, Altiostar, Amdocs, Dell EMC, and Wind River have dedicated teams of architects, software engineers, and validation specialists with experience designing, building, and maintaining carrier-class virtualization platforms, software-based eNodeBs, orchestration systems, and physical servers. These individuals are involved in standards groups and open source projects and are helping advance the state of the art in their respective fields.

Choosing a pre-integrated solution offers a 12- to 24-month advantage over in-house development, even when the in-house team has the necessary expertise in Linux, KVM, DPDK, OpenStack virtual switching, security, and myriad other networking stacks and protocols.

Customers who select the pre-integrated vRAN solution go to market faster because they can focus their own resources on accelerating trials and deploying new services.

COMPLETE VRAN SOLUTION DELIVERS BUSINESS BENEFITS

The technical advantages of the vRAN solution translate into business value that includes reduced CAPEX and OPEX, new service revenue, and faster time-to-market:

- Compared to conventional, distributed RAN, Altiostar's state-of-the-art vRAN software solution, which runs on industry standard x86 hardware and supports Ethernet fronthaul, reduces CAPEX by 40% to 60% and lowers OPEX by 30% to 40%. Compared to distributed RAN, vRAN reduces the total cost of ownership (TCO) over a seven-year period by up to 50%.
- With virtual switching performance that is up to 40 times faster than OVS, VM density is maximized to allow service providers to serve more customers from the same server, which reduces operating costs. Titanium Cloud is optimized so that its accelerated vSwitch uses fewer cores for switching traffic, while Altiostar's vRAN solution has more cores to use per processor than any competing platform.
- The solution's carrier grade reliability enables service providers to maintain service uptime and guarantee SLAs for customers, which protects service revenue. The combined solution delivers 99.9999% availability (less than 30 seconds of downtime per year), which is facilitated by Titanium Cloud's ability to perform hitless upgrades and patches, automatic fault detection and recovery, accelerated VM migration, and telecom-grade security.
- Orchestration and automation utilize network resources more efficiently and minimize manual processes, which also contributes to lower OPEX. Amdocs' orchestrator enables CSPs to quickly launch new services, while network slicing capabilities allow CSPs to create new revenue-generating services and monetize quality of service (QoS) by charging for different levels of service quality.
- The Dell EMC PowerEdge R630 server maximizes central office and data center efficiency. It packs powerful processing into a compact, space-saving form factor and automates server lifecycle management tasks.
- With the fully integrated solution comprising the virtualization platform, vRAN radio and vBBU elements, orchestrator, and server hardware, CSPs can increase time-to-market by shortening development time frames and focusing on services.

AMDOCS PROFESSIONAL SERVICES

Amdocs provides a broad portfolio of services for NFV that assist service providers along the planning, implementation, and operations journey of network virtualization, including the introduction of new services. These services for NFV help service providers build an NFV platform, test it, integrate it back into their networks, develop new customer services, and operate those services in production.

Amdocs' long-standing reputation and delivery experience, along with the work done deploying the Open Network Automation Platform (ONAP) with early adopters, have uniquely positioned the company to guide service providers through the complexities of NFV and ONAP implementation, deployment, and operation.

The Amdocs services for NFV portfolio includes an infrastructure delivery service, which enables service providers to accelerate and de-risk the design and deployment of NFV and telco cloud infrastructure, and specifically Wind River Titanium Cloud. The service includes addressing large-scale design and deployment; high performance; VNF compatibility; compute, networking, and storage; and production go-live management.

In each stage of vRAN deployment, from design to optimization, Amdocs professional services provide the expertise that will reduce NFV deployment risks and shorten development cycles so that CSPs can accelerate time-to-market and confidently launch reliable services after thorough testing and validation. Services include network service creation, network testing, and network service assurance.

SUMMARY

The widely deployed distributed RAN was designed nearly 20 years ago in the pre-smartphone 3G era, when few would have foreseen the incredible volume and variety of traffic, devices, and applications that mobile networks carry today. While this outdated architecture has evolved to more centralized models, current solutions do not go far enough to address CSP challenges. CSPs are under pressure to keep up with surging traffic demand and the influx of new devices and applications, while at the same time finding additional service revenue to stabilize ARPU and cut costs to protect profit margins.

By extending the benefits of NFV from the core network to the RAN, virtualized RAN is the optimal solution for cost-efficiently increasing capacity, reducing costs, and creating new services. Altiostar, Amdocs, Dell EMC, and Wind River have joined forces to create a pre-integrated solution that CSPs can deploy today to start reaping the benefits. The solution delivers carrier grade reliability and predictable performance, low-latency, unrivaled manageability and orchestration, massive scalability, optimized resource utilization, and flexible deployment options as well as the ability to quickly launch new services through network slicing and service chaining. The pre-integrated vRAN solution and comprehensive professional services mitigate deployment risk and accelerate time-to-market.

APPENDIX 1: TITANIUM CLOUD ECOSYSTEM FOR VRAN

In addition to developing solutions that are ready for deployment, Wind River works with a variety of suppliers through the Titanium Cloud Ecosystem partner program. Solutions in the partner program have been validated and pre-integrated with Titanium Cloud, providing more choice for service providers when evaluating OSS/BSS systems, NFV orchestration solutions, VNF providers, and standard server platforms.

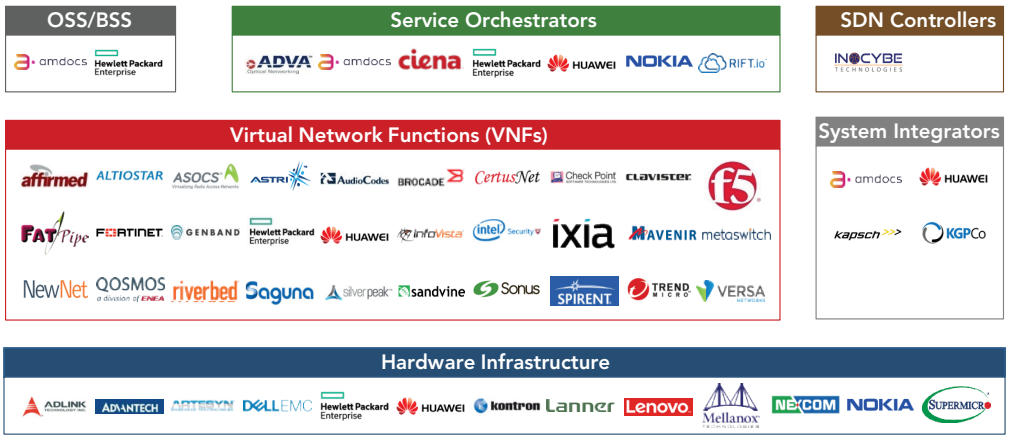

Figure 8. Titanium Cloud Ecosystem

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APPENDIX 2: TITANIUM CLOUD FEATURES

The Titanium Cloud portfolio includes the industry's only fully integrated, ultra-reliable, and deployment-ready virtualization platforms that enable service providers to deploy virtualized services faster, at lower cost, and with guaranteed uptime. When service uptime is critical for profitability, Titanium Cloud products ensure that virtualized services run when, where, and how they need to by providing:

- The flexibility to rapidly and efficiently scale services up, down, in, and out, deploying new services dynamically when and where they are needed
- Performance to maximize the number of subscribers supported on each server and minimize operating costs
- The carrier grade reliability needed to keep services up—always

Key features of Titanium Cloud include:

- **99.9999% reliability.** Titanium Cloud ensures uptime SLAs can be met as required by telecom applications. This is achieved with carrier grade availability and reliability optimized throughout the software stack, such as fast VM failure detection that's up to 50 times faster than standard IT grade systems.
- **Packet performance.** 20 Gbps line-rate performance achieved using only two cores, which is the industry's best vSwitch performance. Live VM migration is achieved in less than 150 milliseconds.
- **Fully integrated, open, and interoperable.** Titanium Cloud is built from OpenStack using carrier grade plugins. It includes industry standard Linux, KVM, and Ceph, and it is compliant with industry-recognized telco open standards.
- **Scalable.** Titanium Cloud is a complete, turnkey product, pre-integrated and ready for deployment, supporting deployments as small as two nodes up to hundreds of nodes across geographies. It supports open APIs for provisioning and management to enable thousands of VMs.
- **Supported by the Titanium Cloud Ecosystem.** A rich ecosystem of NFV hardware, management software, and VNFs has been validated with Titanium Cloud. The ecosystem creates an open and flexible environment to enable third-party software.

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Wind River is a global leader in delivering software for the Internet of Things. The company's technology is found in more than 2 billion devices, backed by world-class professional services and customer support. Wind River delivers the software and expertise that enable the innovation and deployment of safe, secure, and reliable intelligent systems.