The term “carrier grade” has been an often used—and misused—term. To some it refers to high-availability network elements, or “five 9s” availability, or network links that fail over in 50 milliseconds. But carrier grade has a much wider scope. It is not limited to telco requirements for equipment quality, reliability, availability, and maintainability. Carrier grade encompasses a much broader range of carrier requirements, such as for equipment management, billing, security, traffic performance, packaging, and powering, as well as for practices used for development, product support, and operations.

The carrier network continues to undergo significant transformation that requires the modernization of what we mean by carrier grade. The carrier network is no longer constructed using purpose-built equipment running proprietary software. Network equipment providers (NEPs) no longer design their systems in-house. They build products by developing network applications on commercially available software systems that run on standardized multi-core hardware platforms. This enables NEPs to focus their resources on designing higher-value applications to better differentiate their products from those of the competition.

Another significant change is underway: Network Functions Virtualization (NFV) is transforming how networks are built, provisioned, and managed. Virtualization enables network functions to run on multiple virtual machines (VMs), enabling them to share a pool of hardware and software resources. Virtualized network functions (VNFs) are chained together to create services, and can be located anywhere in the network where they are most cost-effective. NFV promises to improve the total cost of ownership, but its success depends upon its ability to comply with carrier grade requirements. NFV infrastructure (NFVI) is the transformed virtualized platform that incorporates carrier grade capabilities. NFVI is the foundation for affordable carrier grade compliance, enabling NEPs to deliver new NFV equipment quickly to market without compromising compliance to carrier grade requirements.

Wind River® Titanium Server is the industry’s leading carrier grade NFVI product. Its carrier grade features reduce outage, maintenance, and power costs and provide efficient, predictable performance. The following checklist highlights the key carrier grade NFVI capabilities that shaped the development of Titanium Server, and represent an excellent guideline for companies with NFV ambitions.
NFV CARRIER GRADE CHECKLIST

☑️ Does the NFVI support a wide range of fault-tolerant options to achieve “six 9s” (99.9999%) availability?

Because the public network provides both business-critical and life-critical services, it is vital that NFV systems are resilient to failure. Stringent service level agreements (SLAs) require network solutions to achieve high availability at low operational and capital costs. To do this the NFVI must support a wide range of fault-tolerant options so that the system’s fault tolerance can be optimized for different VNF types and quantities. Wind River Titanium Server supports a wide range of redundancy models, including N-way load-shared, N:1, and N:M. It supports VM protection groups, VM health check monitoring, and server heartbeat checking with multi-millisecond regularity. Together with its advanced fault detection and recovery features, Titanium Server achieves high fault coverage and hitless failover. Its redundancy options are available for both the data and management planes, and achieve better than six 9s availability for both service and management availability metrics.

☑️ Is the NFVI capable of in-service upgrades?

The high availability requirements for the public network must be met 24/7, because end customers depend on the network for life- and business-critical services. Therefore communications service providers (CSPs) require systems that can be updated without having to power them down or remove them from service. Titanium Server supports automated software upgrades in which each server is upgraded and verified, then returned to service without requiring any service downtime. Any problems with the new software load or update results in an auto-failback to the previous version.

☑️ Does the NFVI support the necessary operations, administration, maintenance, and provisioning (OAM&P) features required to maximize operational efficiency?

Effective provisioning, monitoring, and maintenance, both remote and local, of equipment and failures is required to reduce operational costs and ensure optimum compliance to carrier grade requirements. Automation of OAM&P features reduces provisioning and maintenance costs and reduces procedural errors, thus reducing outage costs. Titanium Server provides a comprehensive set of standards-compliant network management software and tools that support seamless and reliable integration into CSP operations support systems (OSS). One example is the augmented Ceilometer subsystem, which collects enhanced performance statistics, flexible VM definition and creation, SNMPv2C OSS/BSS interfaces, a dynamic alarm dashboard for faults, continuous alarm streaming, and fault diagnostics for fast and accurate fault isolation.
Does the NVFI implement advanced security features?
Cyberattacks are becoming more sophisticated. This means that the NFVI system’s security features that detect unauthorized access attempts and prevent or mitigate their impact on the system must be effective and continually improving. Titanium Server provides a coordinated set of fully embedded security features such as guest network isolation; program store and hypervisor protection; authentication, authorization, and accounting (AAA) access control; rate limiting; infrastructure database privacy; stateless firewall; OpenStack spoofing protection; tenant data access privacy and encryption; and secure password management.

Does the NFVI provide predictable, robust performance for all types of applications?
NFVI traffic capacity, throughput, and latency requirements are driven by high bandwidth, multimedia video applications and enabled by high-capacity access technologies such as fiber and 4G wireless. Systems must be able to meet the performance demands as efficiently as possible. Because of the diverse range of real-time requirements and priority levels for applications, NFVI systems must implement standards-compliant quality-of-service (QoS) features to ensure that end-users’ quality-of-experience (QoE) expectations are met. Titanium Server implements a set of performance features to achieve predictable performance. It provides low latency interrupt and timer services to VMs, restricted resource assignment to VMs, and high performance VM-to-VM communications. Its kernel supports preemption actions so that real-time functions are given the required computing resources to minimize interruptions. The scheduler distributes the computing resources fairly and in relative isolation from other functions, minimizing latency. The system is hardened by policy-based overload controls and resource monitoring features such as memory monitoring, which reports low memory conditions to the applications, together with invalid and out-of-bounds request protection.

Is the NFVI highly scalable?
As capacity requirements grow, the NFVI system must be capable of adding VMs and processing power efficiently and at sufficient granularity to maintain a high capacity-to-cost value. This capability requires modular hardware and software architectures that do not have design-based resource limits. Titanium Server is a modular system with clearly defined interfaces to facilitate system growth and interoperability. It supports the incremental addition of VMs to support cost-efficient growth to hundreds of VNFs and beyond.
Does the NFV platform minimize the impact on the environment?

Environmental requirements are being legislated globally to control the impact on the environment of network equipment. The legislation bans toxic substances used in the product and its manufacturing, and requires high energy efficiency, lower power consumption, less packaging, extended life, and designs that are easily disassembled to promote reuse and recycling. Wind River hardware partners are compliant to the current Restriction of Hazardous Substances directive. Titanium Server supports low power and low footprint solutions.

Does the NVFI supplier use mature practices and tools to develop and support the NFV platform?

Achieving carrier grade depends on how the NFVI is designed, implemented, deployed, and supported—and the degree of NVF equipment compliance to carrier grade requirements depends on the type and quality of the NVFI carrier grade features. There can be a wide range of actual carrier grade levels depending on the NFVI suppliers’ development and support practices and tools. To design Titanium Server, the Wind River engineering team analyzed and modeled the system to ensure that the fundamental design—which sets the inherent carrier grade capability of the NFV equipment—was optimized to meet carrier grade requirements. For example, a Markov modeling analysis of Titanium Server’s fault-tolerant features was done to ensure that the design is capable of meeting six 9s availability. To ensure this capability is realized and maintained, the Titanium Server engineering team uses rigorous analysis and testing practices that are compliant to TL9000 and CMMI Level 3, such as design reviews, code inspections, failure mode analysis, robustness and fault insertion testing, and field tracking. The Wind River software partner management program and its integrated development environment (Wind River Workbench and Wind River Simics®) provide quality platforms. Wind River Professional Services provides world-class 24/7 support services.