Nokia Network Services Platform

A unified approach to the automation, control and assurance of IP/optical networks

Application note
Abstract

To thrive in the cloud era of networking, operators need to evolve to on-demand service delivery and automated network operations models. The Nokia Network Services Platform (NSP) unifies carrier SDN automation, network optimization and assurance over multi-vendor IP/optical networks so that service providers can deliver on-demand network services faster, more profitably and at greater scale than ever before. This application note summarizes the challenges network operators face as they enter the cloud and IoT era of networking and outlines how the NSP addresses them so operators can transform their existing networks to deliver the services they want, with the profitability they need.
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Introduction

To thrive in the cloud and the Internet of Things (IoT) era of networking, operators need to make their network services just as easy to consume as the cloud and IoT applications that are increasingly dominating network traffic. This means moving to an on-demand service delivery model so applications can consume only what they need, when and where they need it. It means being able to take new network services from concept to market in months, not years, and being able to provision them in minutes.

Realizing these aspirations will require removing significant roadblocks.

- Much bandwidth is currently kept in reserve — and effectively wasted — because network planning tools cannot adapt to changes in real time. Operators must gain greater and dynamic control of their network assets so networks can be run more efficiently and services can make the best use of available bandwidth.

- Network service development and provisioning is made unpredictable by the many complex APIs that must be absorbed by IT systems and Operations Support Systems (OSSs) in multi-vendor, multi-layer networks. Service providers need a faster, simpler way to define and provision network services.

Many vendors have attempted to address these needs with service or network control solutions based on carrier software-defined networking (SDN) concepts. However, their solutions lack the maturity for broad deployment. Some are based on a collection of acquisitions with limited co-ordination among components. Others address only a particular segment of the network or a limited set of services.

This is where the Nokia Network Services Platform (NSP) comes in. The NSP is purpose-built software that blends Nokia experience in service management and assurance, and in building and managing large-scale dynamic routing in IP/MPLS and optical networks, to deliver a unified approach to automation, control and assurance of a broad IP/optical infrastructure. The NSP can accomplish the following:

- Automatically provisions all network layers to speed up service delivery, and abstracts the service toward the IT/OSS layer to simplify integration

- Provides centralized path computation and network optimization capabilities at the optical, IP and flow layers so operators can run their networks more efficiently

- Bridges the gap between service provisioning and network engineering so that operators can satisfy dynamic service requests while making optimal use of available IP/optical assets
• Extends multi-vendor assurance capabilities to SDN and automates the assurance process so operators can dynamically and proactively ensure on-going network and service health

• Accomplishes the above with a highly modular and open architecture that encompasses multiple Layer 0-to-Layer 3 services, IP/optical/Ethernet technologies, physical and virtual network infrastructure and equipment from multiple network vendors.

The NSP also integrates the network systems management (NSM) capabilities of the Nokia 5620 Service Aware Manager (SAM) and the Nokia 1350 Optical Management System (OMS) platforms to provide customers with a seamless, self-paced evolution path to carrier SDN that enhances their investment in these platforms.

This application note summarizes the challenges service providers are facing as they enter the cloud and IoT era, and outlines how the NSP addresses those challenges so operators can transform their existing networks to deliver profitable on-demand services.

Network challenges in the cloud era

Today’s OSSs and IT systems communicate with the network through multiple complex and vendor-specific APIs. As a result, new service development can take years and service turn-up days or weeks, especially in multi-service, multi-vendor IP/optical networks where application development and service provisioning are complex and time-consuming tasks. Networks are operated with long-term connectivity in mind, and are typically engineered in cycles that are several months apart due to all the complex analysis and planning required. In an environment where network connections are essentially permanent and network traffic/demand patterns are fairly predictable, none of these limitations have any significant impact on an operator’s ability to meet customer needs profitably and to scale the network to meet demand. The advent of distributed cloud architectures and the adoption of cloud-based services have changed all this.

Enterprises now want their connectivity services to be provisioned in minutes, just like the cloud services at the core of their business processes. They want to consume network services on demand so they can get what they want, where and when they want it. They want service providers to innovate quickly so network services can keep up with the ever-evolving ways in which cloud services are being consumed.

This new way of consuming network services also presents serious challenges for network planning and operations. Offline network engineering processes are unable to keep up with the rapidly changing demands and traffic patterns of the on-demand cloud and IoT world. Operators are forced to allocate increasing amounts of bandwidth to ensure their services do not run out of capacity or suffer serious quality degradation.
To ensure profitability, service providers must be able to adapt and optimize their networks in real time so they can make optimal use of network assets. They must be able to guide service automation with a real-time view and status of all available network resources so they can satisfy the bandwidth and latency requirements of on-demand service requests in the quickest, most cost-effective way possible. And just as service automation must become network-aware, network optimization processes must be guided by real-time link and tunnel key performance indicators (KPIs) so they can improve overall service health and network efficiency.

Assurance also plays a critical role in enabling broad commercialization of new on-demand services. To begin with, service providers must be able to extend their monitoring, service/network supervision and fault management applications — and the KPIs, analytics and correlations that drive them — to multi-vendor SDN environments. They must also be able to take assurance to the next level — by using KPIs/analytics to drive automated changes to the network so that ongoing network and service health can be ensured, without the need for constant manual intervention.

All these challenges were echoed in a recent primary research study conducted by Heavy Reading [1]. When service providers were asked to name the primary benefits they were looking for from carrier SDN, the top three responses were automation, assurance and optimization. When asked about the benefits of SDN network optimization, the top response felt it was more beneficial to optimize the IP and optical layers together instead of in isolation (see Figure 1).

**Figure 1. Heavy Reading primary research study on the expected benefits of carrier SDN**

*Global primary research study, sample size = 86, June 2016*
Satisfying all the above requirements necessitates a unified approach to carrier SDN. Vendors must provide open, highly independent modules that work closely together to deliver:

**Network-aware service automation:**
- Applies policy-based resource selection using real-time network visibility to meet service objectives in the most optimal way
- Provisions all network layers automatically to enable the service
- Abstracts the service toward IT systems/OSSs to simplify integration

**Service-aware network optimization:**
- Enables real-time network path computation and optimization
- Is centralized to leverage network-wide views, and KPI/analytics-driven to meet the changing needs of deployed services

**Integrated assurance:**
- Allows assurance applications to be tightly coupled with the SDN service and uses KPIs/analytics/correlations to drive automated changes to the network that ensure on-going network and service health.

**Multi-dimensional scope:**
- Applies all of the above across multiple Layer 0 to Layer 3 services, IP/optical/Ethernet technologies, physical/virtual network infrastructure, and equipment from multiple network vendors.

**Nokia Network Services Platform**

Nokia addresses these challenges and enables carrier SDN transformation with the Network Services Platform (NSP). The Nokia NSP unifies service automation, network optimization and assurance in one integrated software platform so that service providers can deliver on-demand network services quickly, cost effectively and at great scale (see Figure 2).

Figure 2. Nokia Network Services Platform
Nokia’s holistic approach to carrier SDN benefits from building some of the world’s largest service provider networks using all the key building blocks — service management, assurance, dynamic IP/optical control planes, SDN control/automation, and highly programmable IP/optical network elements. This experience has been rolled up into the three major modules of the NSP and their sub-modules: the Network Services Director (NSD) the Network Resource Controller (NRC) and the Network Functions Manager (NFM).

**Network Services Director**

The NSD uses network abstraction to simplify how the network — and network services it supports — appears to the IT/OSS layer so that network connectivity services can be developed and enhanced more quickly than ever before. This is accomplished by presenting only the subset of network services and endpoints that are relevant to a specific application, thereby greatly reducing the complexity the application is exposed to. Because NSD abstraction is inherently multi-tenant, operators can empower different business groups with their own network views and span of control.

The NSP translates device-specific models, used through its southbound interfaces, to vendor- and device-agnostic service models exposed on its northbound interfaces. As a result, IT/OSS applications can work transparently across network equipment from multiple layers and vendors. The NSD also provides abstraction through simple service creation GUIs that allow services to be defined and deployed in minutes.

After a service request has been communicated through simple RESTful APIs or through the NSD GUI, the NSD uses operator-defined policies to guide dynamic network resource selection and automated provisioning. These policies use a real-time view of the network (including link and tunnel status/utilization) to map service connection requests to the best available tunnels/paths (Layer 0 to Layer 3) that meet the customer’s Service Level Agreement (SLA) requirements and the operator’s network efficiency goals (i.e. optimize service path selection on latency vs bandwidth utilization vs cost).

For example, the NSD can track bookings and use real-time network KPIs to assess whether existing tunnels/paths are congested. If so, the NSD uses operator-defined policies to bind incoming service requests to less utilized paths that provide approximately the same connection attributes. It can revert the services to the optimal paths when demand subsides. If no path that meets the requested attributes is available, the NSD asks the NRC to compute a new path (see Figure 3).

Network elements are then provisioned using standard protocols and object models such as NETCONF/YANG and OpenFlow. Customers can also use traditional network management interfaces available through the NFM modules to act as a mediation layer for either Nokia or third-party network elements.
Network Resource Controller

The Network Resource Controller (NRC) leverages centralized, intelligent network control capabilities so that operators can quickly adapt to changing demand and traffic patterns and run their networks more efficiently. The NRC accepts path connection requests from the NSD, from OSS and orchestration systems, and from physical/virtual network elements. The NRC modules are able to calculate optimal paths through the network for a given set of business and technical constraints by leveraging centralized views of all available assets/topologies and their current state.

The NRC modules are based on a Path Computation Element (PCE) architecture that integrates standard protocols such as the Path Computation Element Communication Protocol (PCEP) to open up path computation to external centralized control. This allows PCEs to be enhanced with various path optimization algorithms that ensure optimal path placement across the multi-domain, multi-layer network. The NRC leverages these algorithms to free up fragmented bandwidth, to intelligently distribute paths across the network so that operators can make more money from the existing network, and to eliminate the need for manual stitching of inter-area and IP/optical paths.

The NRC uses real-time network KPIs to drive the network optimization process. The data serves as triggers for operator-defined policies that can adapt the network to optimize services in real time by re-routing existing paths or by adding more Layer 0 to Layer 3 service bandwidth to paths that reach a specified utilization threshold. The NRC provides 3D visualization of the network paths/tunnels across all layers. By reducing complexity, enabling more efficient use of network assets and lowering overall congestion, the NRC modules allow operators to lower overall CAPEX and OPEX and increase revenue from existing assets.

There are four NRC sub modules: the NRC-T, the NRC-P, the NRC-F and the NRC-X.
NRC-T: Intelligent resource control for optical transport networks

The Network Resource Controller – Transport (NRC-T) manages the creation of transport path connections and services for Layer 1 optical transport networks (OTNs), Layer 0 dense wavelength division multiplexing (DWDM) and multi-layer transport services. It is based on proven control plane software from the industry-leading Nokia 1830 Photonic Service Switch (PSS) and complements intelligent optical switches by providing optimized dynamic path computation using centralized network views. The NRC-T has up-to-date topology and state information and takes physical layer knowledge into consideration to ensure that optimal paths are computed. The NRC-T is able to interface with optical network elements in one of two modes — with the NFM-T network management module (see below), or by using standards-based protocols for topology discovery and management as they become available.

NRC-P: Intelligent resource control for IP/MPLS networks

The Network Resource Controller – Packet (NRC-P) augments the IP/MPLS network with centralized PCE software derived from the highly scalable and widely deployed Nokia Service Router routing code base to dynamically create and manage Label Switched Paths (LSPs) across IP network elements. The NRC-P supports both segment routing traffic engineering (SR-TE) and traditional Resource Reservation Protocol (RSVP)-TE LSPs. The NRC-P adds bi-directional, non-divergent path computation and bandwidth booking SR-TE so it can serve as a highly-scalable alternative to RSVP-TE.

The NRC-P is open and standards-based. It communicates with network elements such as IP routers using PCEP and leverages multiple techniques for topology discovery, including Border Gateway Protocol - Link State (BGP-LS), Open Shortest Path First (OSPF) and Intermediate System-to-Intermediate System (IS-IS). The NRC-P can also use the NFM-P network management module for legacy-based mediation to Nokia or third-party network elements.

The base PCE capability can be augmented with value-added algorithms such as Nokia Bell-Labs Self-Tuned Adaptive Routing (STAR) [2] so that operators can get more out of their existing networks. STAR leverages real-time views of link congestion across the entire network and combines this functionality with Constrained Shortest Path First (CSPF) to intelligently distribute paths across the network. The result is better “packing” of paths into the network and therefore more revenue from existing network resources.

NRC-F: Intelligent flow steering

The NRC-F is used to manage the steering of flows in the network from a central, policy-driven point in the NSP. It is primarily used to steer flows from congested network paths/links to secondary paths/links so service providers can make better use of their network assets while providing higher quality network and cloud services.
Flows can be mapped to existing paths to avoid routing table changes, or NRC-F can be combined with NRC-P to dynamically create new paths on which to steer flows. Service providers can create and trigger flow mappings manually, or they can use KPIs/analytics to trigger policies that enforce flow redirection as part of a dynamic network/service assurance process. The NRC-F uses OpenFlow to communicate flow steering decisions to Nokia and third-party IP routers, and will add other interfaces as they become available.

**NRC-X: Intelligent resource control for multi-domain IP/optical networks**

The NRC-X dynamically creates optimal paths across multiple domains that are separated by IP/optical or vendor boundaries. This is especially critical for hybrid IP/optical networks where multi-layer path stitching and provisioning is often a long and complex process. When combined with NSD, the NRC-X allows operators to Instantiate hybrid IP/optical services in seconds, and with the knowledge that the best path was selected using available network resources. Multi-layer optimization ensures more efficient use of network assets than techniques that optimize the IP and optical layers independently.

**NFM (-T and -P)**

The NFM component of the NSP integrates the network systems management (NSM) capabilities of the 5620 SAM (NFM-P) and 1350 OMS (NFM-T) platforms to provide Nokia customers with a seamless evolution path to carrier SDN. All capabilities, including network configuration, traditional service provisioning, fault management, network/service supervision, will be supported by the respective NFM modules. Integration provides SAM/OMS customers with a self-paced evolution to carrier SDN that allows them to:

- Manage both traditional and new dynamic SDN services using one integrated and highly modular software platform, the NSP
- Extend all the assurance applications, KPIs/analytics/correlations they have used with SAM/OMS to all Nokia and multi-vendor elements under SDN control
- Implement SDN automation/optimization/assurance with new SDN protocols, or through traditional interfaces they used with SAM/OMS (i.e. now referred to as NFM-P/T) as a transitional step.

**Integrated assurance:**

As dynamic consumption of new on-demand network services makes network demand and traffic patterns less predictable, the need for integrated network/service assurance becomes more important than ever. The NSP accomplishes this by extending all the comprehensive OAM tests, monitoring, service/network supervision and fault management capabilities found in SAM and OMS to the new, multi-vendor SDN infrastructure controlled by NSD and all the NRC modules. NSP also allows service providers to begin automating the assurance process so they can ensure ongoing network and service health without
the need for constant manual intervention. For instance, KPIs/analytics that indicate latency or congestion problems in a service can be used to drive SDN control policies that automatically place bandwidth where and when it is needed, or to steer flows away from congested links (see Figure 4).

**Figure 4. NSP integrated IP/optical assurance**

Auto add bandwidth, change path, spin up a new VM

Collect

Act

Automate!

Correlate

NSP

Create SDN/NFV assurance policies using data triggers

Give the operator visibility and control of the process

The NSP dynamic assurance capability is a key component of Nokia’s domain-specific closed-loop automation architecture that takes action at the lowest possible level to drive greater network agility and optimization. The example in Figure 5 shows how the NSP can be used as part of an end-to-end assurance strategy that includes mobile radio access network (RAN) and the mobile backhaul/core. In this scenario, latency/performance issues in the RAN force the local closed-loop assurance platform (e.g. Nokia Eden-NET) to re-adjust cell boundaries. Because this will change the traffic patterns across limited-capacity mobile backhaul microwave links, this change is communicated to the NSP, which re-routes paths or redirects flows to ensure latency and performance requirements are met, and optimal use is made of microwave links.

**Figure 5. Multi-domain closed-loop assurance**

1. Cell congestion
2. Adjust cell boundaries
3. Communicates new traffic patterns, latency requirements
4. Re-optimizes network around changes
5. Multi-domain and mobile assurance
6. NSP assurance
7. Mobile backhaul and core
8. Content partner
9. KPIs/analytics
10. Policies
Nokia’s broader SDN solution

The benefits of carrier SDN automation optimization can only be fully realized when combined with an open and flexible network infrastructure, such as Nokia 7750/7950 Service/Core Routers and virtual network functions (VNFs), the Nokia 1830 Photonic Service Switch (PSS), and similar offerings from third-party vendors. Programmable IP/optical network elements that provide flexible, fine-grain network control — through flexible ODU sizes, configurable flow steering, segment and wave routing, and other mechanisms — are necessary for the NSP to make optimal use of network assets. Communications with the NSP are possible through new, standards-based SDN technologies such as OpenFlow, BGP-LS, PCEP and NETCONF/YANG, and backward compatibility is achieved through NFM modules that support traditional network interfaces.

In addition to the NSP, Nokia’s broader solution for SDN automation, optimization and assurance includes the Nuage Networks Virtualized Services Platform (VSP), the CloudBand Network Director (CB ND), and standards-based SDN controllers provided by other vendors and open consortiums such as the Open Source Network Operation System (ONOS) and OpenDaylight.

The Nuage Networks VSP software includes a centralized policy engine and an SDN controller that automatically establishes overlay tunnels to interconnect virtual machines and applications in one or more data centers. By harnessing programmable business logic and a powerful policy engine, the VSP abstracts networking details, automates service creation and simplifies the overall solution. Service providers can combine the NSP in the network with the VSP in the data center to enable automated provisioning of enterprise cloud services, such as value-added application service chains, across both data center and IP/optical network boundaries. Orchestration between the VSP and NSP is provided by the CloudBand Network Director. The NSP provides assurance of the IP/optical portion of the network while the Nuage Networks Virtualized Services Assurance Platform (VSAP) correlates overlay and underlay in the data center to provide service providers with end-to-end network/service assurance (see Figure 6)

Figure 6. Nokia SDN solution for dynamic enterprise network services
The Nuage Networks VSP can also be used to dynamically extend overlay tunnels all the way to enterprise branch/small office/home office (SOHO) sites outside the provider’s own network. Referred to as SD-WANs, these tunnels also serve as conduits to extend value-added application service chains to remote customer sites. In this configuration, the Nokia NSP can be used to establish the peering point connections to the internet, and to dynamically redirect SD-WAN tunnels over the peering connection that makes optimal use of peering bandwidth and provides the highest service quality. When an SD-WAN service is established over the service provider’s own IP/MPLS network infrastructure, the NSP can be used to create a series of underlay tunnels with varying degrees of quality of service (QoS). It would then dynamically map each SD-WAN overlay tunnel to the appropriate underlay based on the stated QoS requirements. Orchestration between the Nuage Networks VSP and the Nokia NSP is again provided by CloudBand ND, or a third-party orchestration system (see Figure 7).

Figure 7. Nokia SD-WAN solution with NSP

Use cases

The following customer-derived uses cases illustrate how service providers are using the Nokia NSP to optimize their networks and eliminate roadblocks to dynamic operation and on-demand service adoption.

On-demand IP/optical enterprise network service with dynamic service assurance

Problem: Customers want their network and bandwidth services to dynamically follow data center virtual machine movements. They want to support changes in traffic patterns such as nightly backups and bursts of customer activity while adhering to existing network and security policies.
Solution: Provide customers with an on-demand IP/optical network service and empower them to dynamically manage connectivity between data centers. Allow customers to specify particular needs, such as bandwidth, time of day and the length of time the connection is required.

NSP enablers: The NSP allows the bandwidth-on-demand or calendaring service to be delivered cost effectively and with scalability (see Figure 8). It enables automated provisioning of IP and optical elements and of IP/optical paths so that a service can be provisioned and consumed on demand. KPIs/analytics, monitoring utilization on the service path, are used to trigger policies that place bandwidth where it is needed, re-routing paths if necessary to ensure service health.

Figure 8. On-demand IP/optical enterprise network service with dynamic service assurance

- New IP/MPLS services delivered on-demand across IP/optical fabric
- Bandwidth dynamically matched to customer requirement

Optimizing for the new cloud interconnect ecosystem

Problem: With the advent of a new ecosystem for interconnecting enterprises with IT providers and webscale companies, operators need a more flexible and efficient way of sharing a network among different groups, one that adapts to changing network conditions and empowers each group to quickly create services and manage the assets assigned to them.

Solution: With the NSP, operators can provide both the dynamic IP/MPLS and wavelength/OTN services required. The NSP can rapidly segment the network into “slices” that correspond to different internal business groups, partners and customers.

NSP enablers: The NSP accomplishes this through multi-tenant abstraction that provides owners of each slice with their own GUI-based network views and span of control. It then dynamically optimizes each slice and the network as a whole to match changing demand and traffic patterns. Each business unit, partner or customer is empowered with the ability to rapidly define and instantiate services and with full views and control of their own assets and services.
Data center WAN link optimization

Problem: Web access through residential/mobile networks is often compromised by the network’s inability to keep up with rapid changes to demand and traffic patterns. Customers want the ability to make optimal use of all IP/optical links to ensure high quality of service (QoS), and to provide preferential treatment for key web/content partners if necessary.

Solution: Provide service providers with the ability to dynamically remap flows to secondary links or data centers based on latency, congestion or content partner preference.

NSP enablers: The NSP allows the bandwidth-on-demand or calendaring service to be delivered cost-effectively and with scalability (see Figure 10). It enables automated provisioning of IP and optical elements and of IP/optical paths so that a service can be provisioned and consumed on demand. KPIs/analytics, monitoring utilization on the service path, are used to trigger policies that place bandwidth where it is needed, re-routing paths if necessary to ensure service health.
Conclusion

The Nokia Network Services Platform (NSP) enables carrier SDN by unifying service automation, network optimization and assurance so that service providers can deliver on-demand network services quickly, cost effectively and at great scale. It does this by providing service providers with a more efficient way to define, provision and activate network services across networks that can span multiple layers (Layer 0 to Layer 3), multi-technology services and physical/virtual infrastructure as well as equipment from multiple vendors. The NSP allows service providers to keep service quality and network efficiency high by using automated assurance and KPIs/analytics to intelligently adapt networks to real-time changes in demand and traffic patterns.

For more information about the Nokia Network Services Platform, go to the Nokia NSP web site (networks.nokia.com/NSP).

Acronyms

API   application programming interface
BGP-LS  Border Gateway Protocol Link State
CAPEX   capital expenditures
CSPF   Constrained Shortest Path First
IP VPN   IP virtual private network
IS-IS   Intermediate System-to-Intermediate System
KPI   key performance indicator
LSP   Label Switched Path
MPLS   Multiprotocol Label Switching
NFV   network functions virtualization
NRC   Network Resource Controller
NRC-P   Network Resource Controller - Packet
NRC-T   Network Resource Controller - Transport
NRC-X   Network Resource Controller - Any
NSD   Network Services Director
NSP   Network Services Platform
OPEX   operating expenditures
OSPF | Open Shortest Path First
OSS | Operations Support System
OTN | Optical Transport Network
PCE | Path Computation Element
PCEP | PCE Communication Protocol
REST | Representational State Transfer
RSVP | Resource Reservation Protocol
SDN | software-defined networking
STAR | Self-Tuned Adaptive Routing
TE | traffic engineering
XaaS | anything as a service
YANG | Yet Another Next Generation

References

Related materials
- [Network Services Platform web page](#) – includes related NSP business cases, white papers, data sheets and more.
- [Video channel for Network Services Platform](#) – includes NSP demo videos and product tours