Solution Profile

January 2023

Nokia NSP

Automation Operations for IP and Optical

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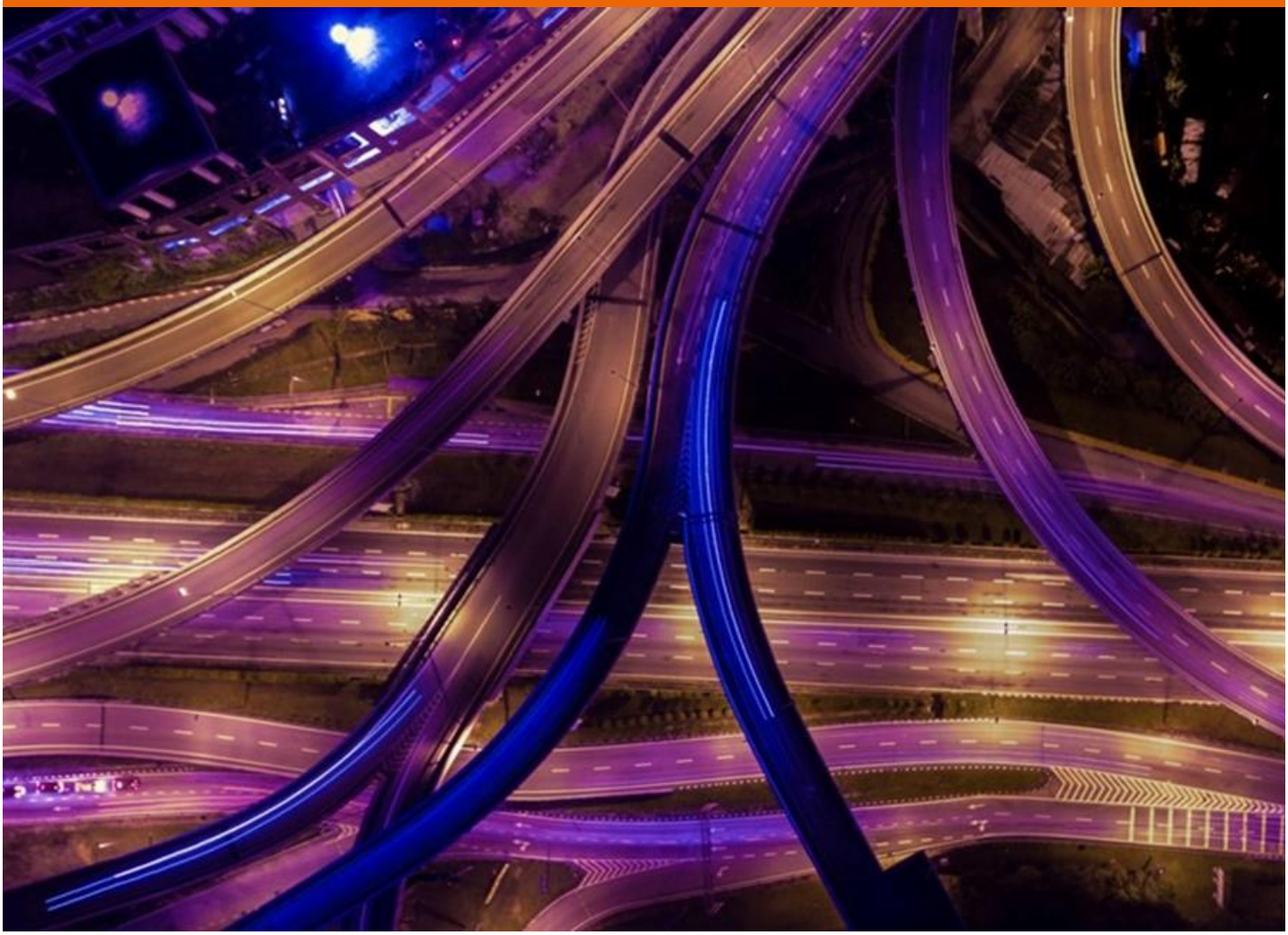

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INTRODUCTION

This solution profile is part of a series of profiles that accompanies our new market outlook report on automation in the transport domain. This research looks at the state of the art in automating transport networks and services. Our focus is on L2/L3 services, but with full observability of Layer 1. This profile focuses specifically on **Nokia's NSP**, one of the earliest entrants in this segment, with lineage back to Alcatel-Lucent's SAM.

Our research on transport is part of Appledore's focus on the software, technology and processes that will be necessary to transform networks and services from their static and labor-intensive current state to a dynamic, often cloudified, and highly automated future state. We believe that the objective of automation must be far broader and more strategic than mere cost reduction. Rather, automation must also enable an increase in agility and cost-effective innovation in the emerging digital economy. Appledore is conducting complementary research in the areas of end-to-end service innovation, the automation of data centers in telco cloud infrastructure, and Open RAN. Critical to, and supporting all of these, is our research stream in AIOps and the application of machine learning (ML) to all domains.

Without transport domain automation, network slicing is impractical; service providers will forego significant new revenues in the enterprise WAN segment, and new innovative services will languish either because they are too difficult to design, too slow to introduce, or too costly to introduce and deliver.

Appledore's network automation reference taxonomy specifically advocates autonomic and independent domains – linked together by capabilities such as componentized catalogs and E2E Service Orchestration. Each of these domains implements its own automation and typically orchestration – delivered by specialists in that particular domain (IP, optical, Radio/RAN, etc.). In this case, NOKIA offers a modular solution (NSP's various components) that automates the entire L0-L3 transport stack, across the entire life-cycle from resource day zero operations through retirement or re-configuration and with healing and scaling along the way.

We encourage readers to first read our Market Outlook on Transport Domain Automation.

NOKIA CORPORATION

Background

Nokia has arguably the broadest portfolio in telecom, with depth in Radio, Optical, IP, SDWAN, Fixed Access, Network Automation Software and significant parts of BSS – especially monetization.

While Nokia is first and foremost a NEP, unlike many NEPs they operate their software organization quasi-independently with a focus on multi-vendor and delivering complete solutions – at least in what Appledore now calls "Network Automation Software". NSP however, is part of the IP & Optical business unit, and therefore closer to the equipment types it manages. While few of Nokia's products came from acquisitions, several were intrapreneurial – essentially corporately funded

start-ups (particularly under ALU). This focus distinguishes Nokia from **Ericsson, Huawei, Fujitsu, Cisco** and **Juniper** – all of whom are more closely associated with their own equipment (although some are trying to change this).

Facts & Figures

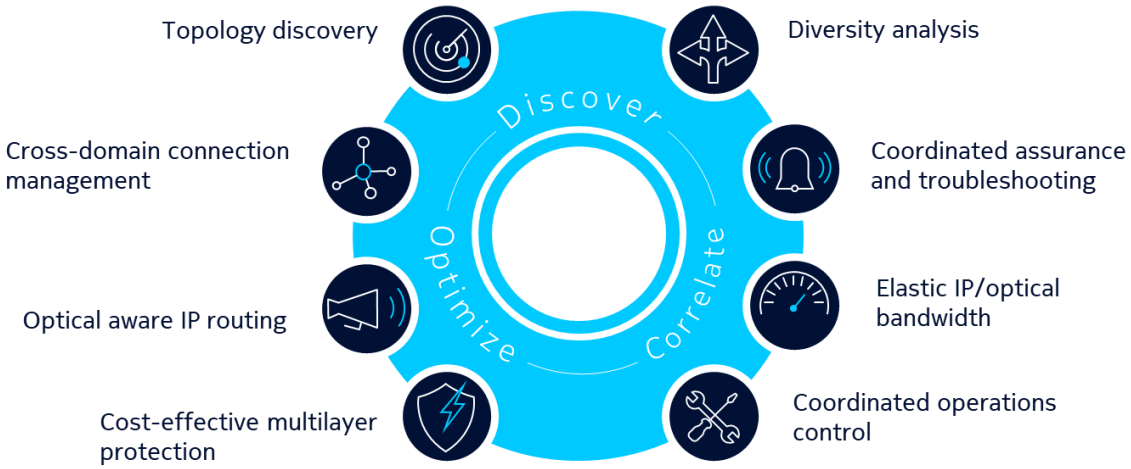
Nokia no longer breaks out its software revenues, and never broke out its IP & Optical software revenues. Appledore has performed independent estimation, which is best consumed in our NAS Market Share/leaders forecast (2020). While NSP no doubt has many (most) deployments closely associated with Nokia hardware, they also have a large number of multi-vendor deployments. More on that below.

Strategy

Nokia's NSP strategy has several pillars. Note that these pillars include both stated goals from Nokia and Appledore's observations.

1. ***Intent driven, closed-loop automation***: For the several years that I have covered this segment, NSP has been marching down the rules-based, intent-driven, automation path. At Nokia's recent IP & Optical SReXperts gathering, "intent" seemed to be every other word – across products. Clearly, Nokia's IP & Optical division have religion on this topic. NSP also has built-in assurance/observability functions, and can input data from external AIops sources, and feed that into the intent-based engine. More on closed loops below.
2. ***Multi-Vendor capability***: yes, Nokia is a transport/IP NEP. Yes, they no doubt combine NSP with "kit" extensively to create complete solutions. Yet, NSP has legitimate cred in multi-vendor, supporting both direct (standards based, documented interface based) methods and the alternative (sometimes preferred for more extensive proprietary functionality, or simplicity) of working with multiple vendors' abstracted and normalized management systems. Nokia claims an extensive library of fully characterized third-party vendors. On the flipside, it is expected that competitors are less thrilled with providing documentation to a competitor (Nokia) than to an independent ISV. The complex life of a full-portfolio player is full of challenges.
3. ***Multi (cross)-layer***: Nokia has always emphasized that NSP operates not only across vendors, but critically, across Layers 0→3 with full correlation and automation. NSP is, in fact, made up of an IP module, an Optical module and a cross-layer module. The advantage is to be able to both optimize the entire stack, and to automatically find paths that adhere to path diversity restrictions, jurisdictional restrictions, and simply to spread traffic such that risk is reduced – portfolio theory for service paths. Nokia is not new to either multi-vendor nor multi-layer, and interested readers can see in our profiles and a white paper dating back several years. Below is a graphic, courtesy Nokia, illustrating NSP's cross-layer capabilities and uses/benefits.

Figure 1: Nokia NSP Cross-Layer Capabilities Overview

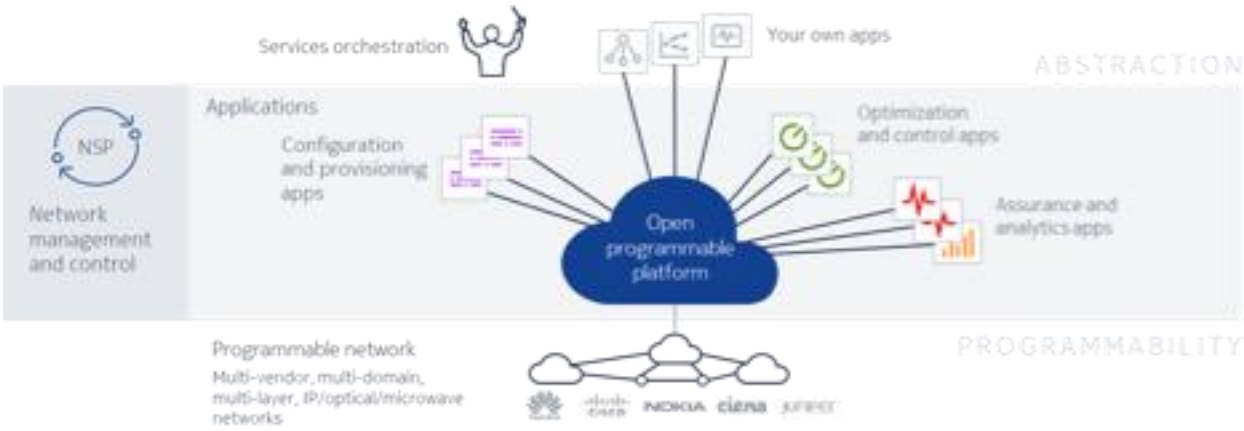


Source: Nokia

4. ***Modular:*** Nokia can deliver NSP as an IP controller, an Optical controller and then add cross domain capabilities. It also has several functional packages, allowing a scalable purchase. Some components do double duty with slightly different names in the optical portfolio.

The diagram below shows a conceptual view of NSP, illustrating such diverse concepts as orders via APIs "northbound", multi-vendor abstraction and adaptation "southbound" and various capabilities called out within.

Figure 2: Nokia NSP High Level Concept view and "strategy" overview



Courtesy: Nokia

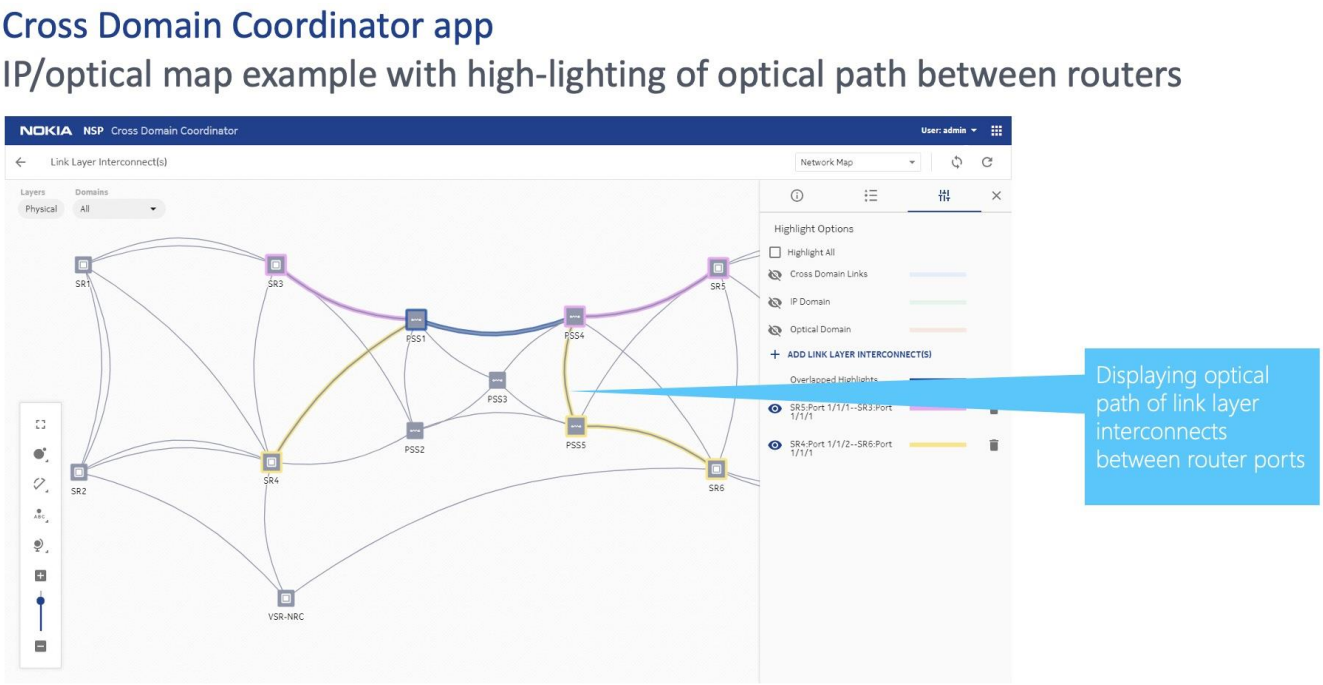
Nokia clearly has the strategic goal of delivering complete, hardware-software solutions that implement automation. "One broadband automation, please"; yet being able to deliver an independent, class-leading, multi-vendor software solution when desired (typically necessary for the larger players). This is always a difficult line to walk – subject to criticism from both sides, yet from what we saw, right down to live demos, it appears to do its job.

SOLUTION DESCRIPTION

Nokia's NSP is very widely deployed, and at the same time very complete – with proven and in-production multi-vendor, cross-layer, and closed-loop automation/optimization/healing. As noted above, its multi-vendor capabilities may be implemented via either standardized interfaces or adaptation to proprietary NMSs per vendor, often useful in optical where standards are at most optimistic, "emerging". Appledore believe that cross-layer automation will be increasingly critical – either built into a transport domain solution or added as a resource. Without cross-layer observability HA circuit assignment will be partially manual, and fully auto healing as well. Furthermore, optimization of capacity utilization becomes highly manual.

Nokia NSP automates all phases of a network and services. First, it configures base network functions, creating a functional underlay for services. Second it automates the path selection, assignment, configuration and user configuration from service order through turn up, with full observability of the optical underlay (and vulnerabilities) that a L2/L3 service takes. Next, it implements an automated control loop across a service's or network resource's life cycle. Finally, it can handle bulk changes to achieve capacity optimization – e.g.: the re-arrangement to free 'stranded" capacity for example.

Figure 3: One of several cross-layers views provided by NSP

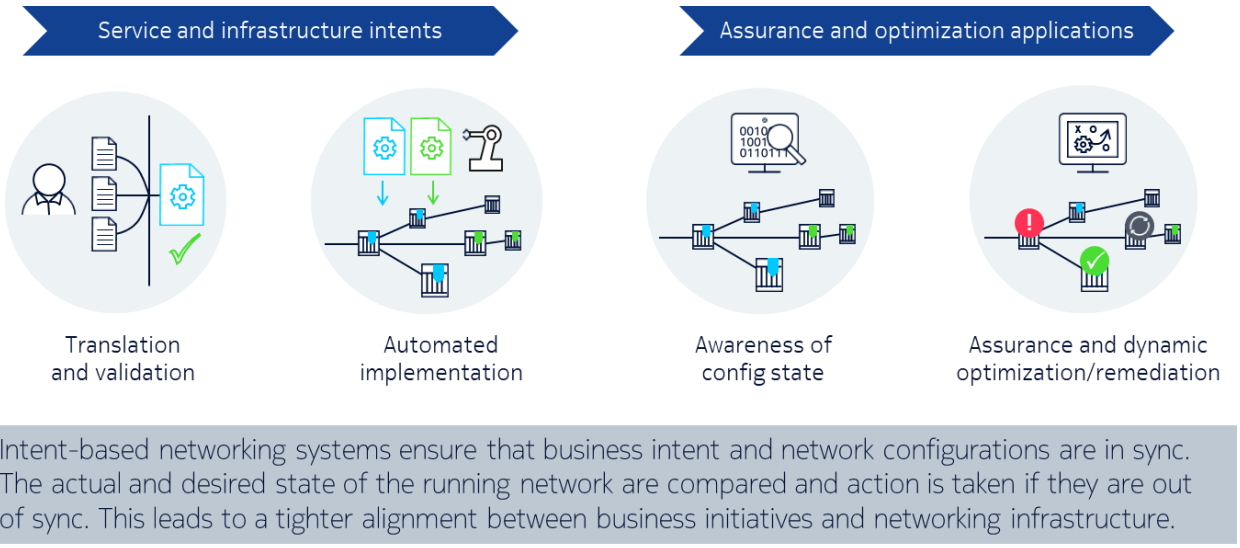


Source: Nokia

Elegant implementation of automation – at any phase in the network and service's lifecycle, really demands intent-driven operation and abstracted, declarative definitions and models. OK, that's a mouthful, but intent is essential to both simplification and to the flexibility to allow algorithms to meet SLAs within realistic constraints. Nokia emphasizes intent across many of its solutions (see

our Research Note on SReXperts 2022). The graphic below illustrates the degree to which intent is baked in and widely employed in NSP. We use this rather than closed-loop lifecycle charts since this shows the LCM closed loop, but also much more.

Figure 4: NSP Automation areas, all based on intent driven methods



Courtesy: Nokia

Self -Contained and Modular

Unlike some systems, NSP is a self-contained product, focussed exclusively on the 4-layer transport domain. It can take an intent-based service order (for transport), parse it, find an SLA compliant route, "assign" it, configure it, and continually monitor its state. If the state crosses some threshold or a fault event is detected, NSP can take immediately and automated corrective action.

To achieve all this, NSP is made up of many modules which may be sold/purchased independently. Below we show a categorization of these from Nokia. Fundamentally, on one axis we have the IP, Optical and cross-layer ("X") modules. On another axis we have various software packages, such as analytics, multi-layer, or the NSP assurance capabilities. Note that closed-loop assurance/healing can take input either form NSP's feeds, or from external AIops – including analytics or external fault and performance data feeds, or external ML/AIops. Nokia recognizes that its customer base is heterogeneous; small to large, IP-only to multi-layer, complex multi-vendor to simplified Nokia shops. The modularity allows them to customize the delivery to various customers' or solutions' needs, trading cost vs. capability.

Figure 5: NSP Modularity and Features

Table 1: Structure of NSP software suites, base packages and feature packages

	NSP software suites		
	Network operations	**Resource control**	**Network programming**
Base packages	Platform	Platform	Platform
	High availability	High availability	High availability
Feature packages	Classic management	Control and visualization starter	Intent-based networking framework
	Pluggable network adaptation	Path control and optimization	Workflow automation engine
	Network infrastructure management	Enhanced optimization	
	Service activation and configuration	Simulation	
	Service assurance	Multilayer discovery and visualization	
	Network operations analytics	Multilayer control coordination	
	Transport slice operation		

Courtesy: Nokia

Use Cases and Focus

NSP is targeted to both telcos and major enterprises, both of whom operate extensive, complex networks. Nokia has pre-built solutions for a variety of use cases. These pre-built solutions focus on specific use cases (or business outcomes) and include NSP packages complemented with software artefacts (such as workflows, intents, device adapters), as well as some professional services to help deploy the solution into specific customer environment.

The list of supported used cases Includes, but is certainly not limited to, the following:

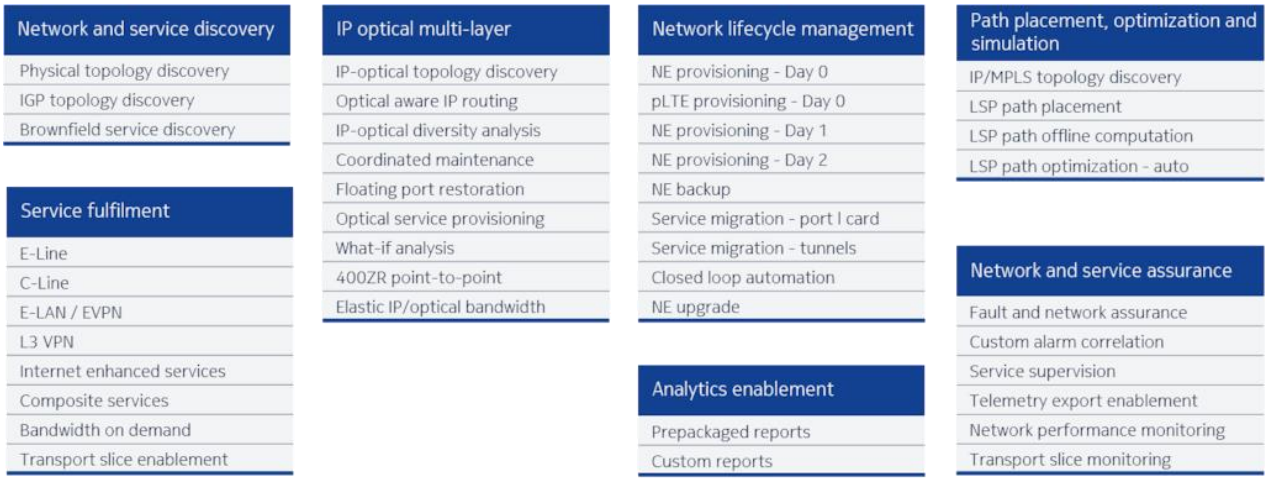
- Network slicing (transport segments)
- SDWAN Underlay *(SDWAN is handled by the Nuage controller and broader service by Nokia's Digital Operations Center)*
- Metro Ethernet / MEF Use Cases
- MPLS
- IP-VPNs
- Bandwidth On Demand
- Automated Path Computation
- Mobile x-haul

Note that many more use cases could be supported with the proper reference data and workflows.

On a more granular level, NSP also has a large catalog of more than 40 predefined use-cases (see below) that Nokia will adapt to customer environment and can be leveraged as templates for new use cases, or in combination. Nokia notes that its use-cases are proven, and may be used to speed and risk reduce the introduction of automation functions into networks. Appledore has regularly advocated industry collaboration and cooperation to move the huge automation ball forward. By

choosing a use case from the catalog, service providers can take advantage of the experience of others to reduce risk and speed up implementation.

Figure 6: Nokia catalog of automation use cases



Courtesy: Nokia

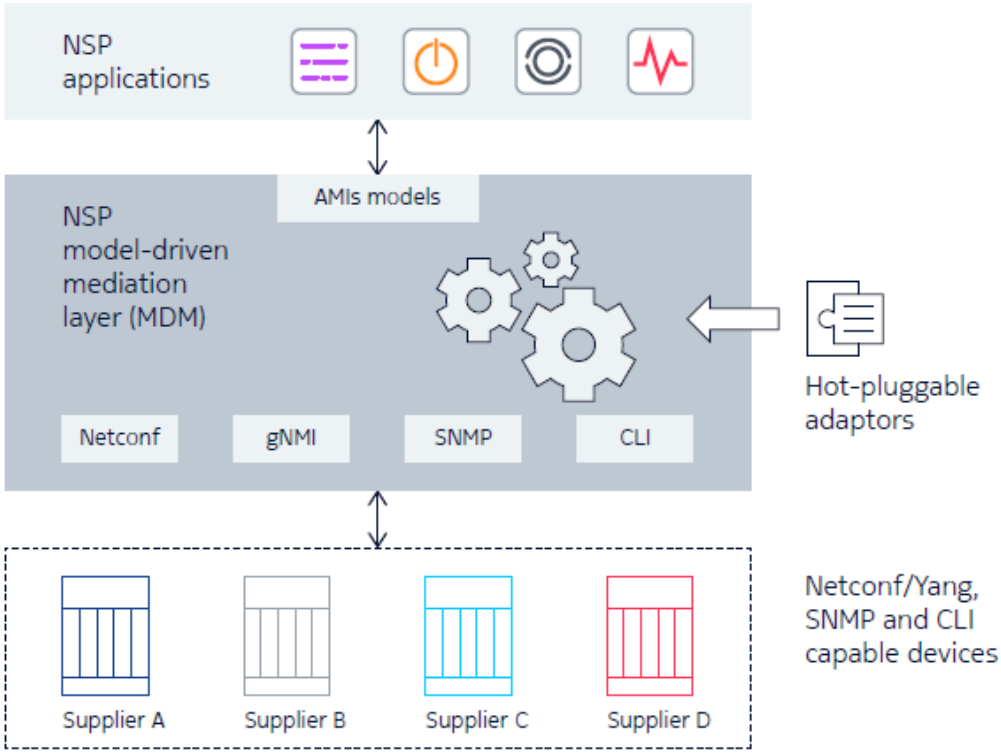
NSP itself is evolving to cloud native and can be delivered as licensed software to be run locally, in a local (private) cloud or in public clouds.

Standards and APIs

NSP's support for standards and open APIs is beyond the scope of this profile, but in general they document support for a long list of TMF, MEF, and IETC RFCs/standards. These include modelling formats such as YANG, southbound flow control interfaces such as OpenFlow, discovery and configuration standards (BGP, NetConf, YANG) and almost all the usual suspects. Nokia also claim proven models/adaptations/support for a wide range of network elements from third parties including Juniper, Cisco, and others. NSPs supports multi-vendor L1 optics via TAPI, and claim that it is finally becoming a reality as SPs increasingly deploy "alien wavelengths". For now, most optical line equipment remains relatively closed and vendors are not mixed within systems.

Nokia are particularly proud of their ability to facilitate the simple creation of new adaptations to network functions, based on what they call their Model Driven Mediation layer. This guides a user through the creation of new network element support, and/or support for new functionality. A high level view is below:

Figure 7: Nokia Multi-Vendor Adaptation via Model Driven Mediation (MDM)



Courtesy: Nokia

MARKET IMPACT

Nokia's NSP, as noted, has a lineage back to Alcatel's 5620 SAM. Our take is that this lineage is good, not bad – today's code is predominantly new, and the lineage has lent experience to Nokia and backward compatibility to NSP. In fact, when NSP was introduced quite a few years ago, we went out on a limb to defend the integration of SAM interfaces saying, "what use is an automation/SDN controller platform that does work with the large installed base of routers?"

One implication is that NSP – at least modules of NSP – is very widely deployed. This is good in that it gives a huge customer and revenue base to support continued development and enhancement. This is bad for those of us that need to weed through the multitude of deployments to ascertain those that are relevant to most of our users – public network operators with extensive, complex, multi-vendor and multi-tenanted networks. Fortunately, Nokia helped us filter these down, and the resulting data (abstracted for confidentiality) is presented below.

All in, NSP claims > 1,000 customers as of 2022. As Nokia clarifies, "CSPs, enterprises and webscale operators use NSP for equipment configuration, network lifecycle management, network and service provisioning, assurance and optimization". They also give another measure – their (presumably) largest deployment supporting 45,000 nodes and 4.1 million IP services in a single instance in a live network – handling 300,000 API calls daily. That's huge – and a good example where automation is

necessary not just for volume, but for the implied complexity – a network too large to have "in one's head".

Nokia also helped Appledore understand how many of those 1000 deployments really meet the "spirit" of this profile and our Market Outlook Report on transport automation, the larger project of this profile is a related asset. Few deployments currently feature every advanced feature. This is hardly unique to Nokia NSP and tells the story of where we are in the maturity of the transport automation market: "early". Of those 1000 deployments Nokia indicates that ~ 24 are with service providers and feature some combination of intent (with "aaS" API), multi-vendor, automated path computation, multi-layer, and operating a closed loop across the service' life cycle. Only a very few meet all of those criteria. Again, this ought to be taken in a positive light since few others have this many. It's just that NSP, overall, has a LOT of deployments, and yes, most are older and simpler.

Some of NSP's customers that are public are included, by region, in the market impact table below.

Table 1: Deployment and Customer Data - NSP

Operator	NSP Deployment(s) / Use Case
Public (announced) SP references:	Claro, Bell, Elektro, Equinix, SDN Communications, A1, BT, BWI, DT, du, Etisalat, Mobily, Telia, Telefonica, Vodafone (Europe, Asia), Bharti Airtel, BSNL, Globe Telecom, LG U+, M1, SPTel, Starhub, Taiwan Mobile, TPGT, True
Customer / Use Case #1 Example:	Multi-vendor, automated provisioning & Configuration for IP (L2/l3) services simplifies process, speeds process, supports new service types (E-LAN/Line) and reduces errors.
Customer / Use Case #2 (Du):	Automation of full lifecycle including provisioning, assurance (healing) and capacity management (scaling) plus re-assignment over time. Results in (documented) 60-85% reductions in cost and time, plus fewer errors.
Customer / Use Case #3: North American Tier 1: ZTP for Wireless backhaul	NSP utilized to handle all configuration and readiness for SR-series routers to provide back-haul. At completion NSP manages the service LCM for those back-haul services. Unquantified benefits, but the usual benefits of lower error rates, faster time to service, and the associated OPEX/cost savings.
Customer Use Case #4 Example: MEA Tier 2	LAG migration for all customer and enterprise services (triple play, plus mobile) rom older series routers to newer series routers. NSP automates process, ensures consistency and accuracy, faster TTM, lower cost and lower error rate. Also allows job to be done within maintenance windows.
SDN Communications: Multi-Layer Automation Ip/Optical	SDN communications replaced its previous IP and Optical processes with a unified NSP solution to fully automate IP configuration and path/service provisioning with optical underlay observability, including use of SRLG (shared risk link group) and latency information from the optical domain to improve resilience and QoS when computing IP paths. Cross-layer correlation to isolate faults and dependencies.
All deployments:	>1000 globally, of all sizes, across SPs, enterprise and government/public

Operator	NSP Deployment(s) / Use Case
Deployments that meet all or moist of the criteria in this document (most relevant):	~ 24 deployments that have some combination of true multi-vendor (Optical layer multi-vendor via TAPI is very early days for all vendors); automatic path computation, PCE with L12 observability, intent-based operation and closed loop life cycle. In reality, Nokia acknowledge that many have one or tow of those characteristics, but very few have all. It's a journey.
Public SPs; Americas:	Claro, Bell, Elektro, Equinix, SDN Communications
Public SPs; EMEA:	A1, BT, BWI, DT, du, Etisalat, Mobily, Telia, Telefonica, Vodafone
Public SPs; APAC:	Bharti Airtel, BSNL, Globe Telecom, LG U+, M1, SPTel, Starhub, Taiwan Mobile, TPGT, True, Vodafone

APPLEDORE ANALYSIS

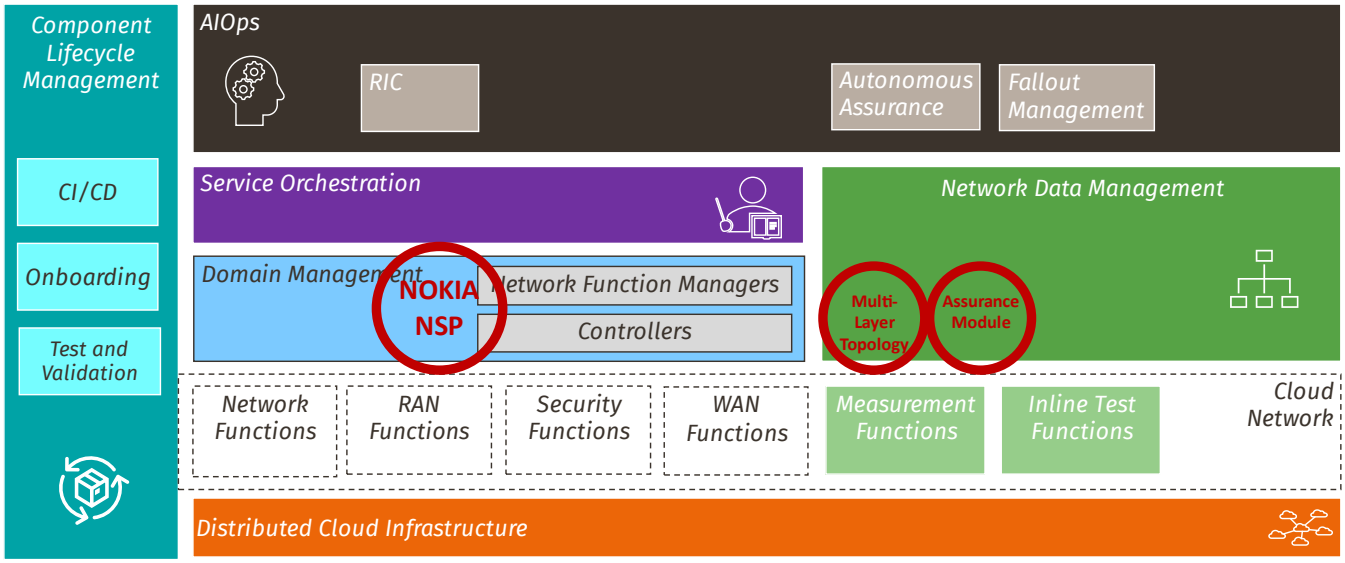
Network Automation Software Taxonomy position

Appledore Research's network automation taxonomy defines a forward-looking set of market segments for automation software. These segments replace traditional "OSS" segments, which are obsolete, and in our opinion do not represent going forward market buying behaviors. Besides being highly modular, our taxonomy emphasizes the existence of many technology domains -- each of which should be self-managing including self-automating. Generally referred to as "domain driven design" this approach simplifies the addition of new vendors and technologies, and greatly simplified upgrades with minimal reintegration -- if any at all.

Nokia's NSP forms one of these self-managing domains. It is shown below, as one of many domains linked together by end-to-end service automation. We also note that some of the optional modules also fit within other areas of our taxonomy but are very transport-specific. Unlike some competitors/peers that employ a single orchestration solution in various different applications / domains, each domain defined by unique models, rules and other data, Nokia has very specific products for the L0→3 domain vs its more general end-to-end orchestration, or, for that matter, its Nuage SDWAN orchestration. We see no inherent benefit to either approach. In fact, in many cases unique orchestrators share the same underlying software platform, and differ only in models, APIs, rules etc. We support this approach.

Nokia sells an entirely different solution for E2E service automation: our profile on Digital Operations Center in E2ESO is here.

Figure 8: Nokia NSP on Appledore NAS taxonomy diagram



Source: Appledore Research

NSP ticks nearly all of our "best practices" boxes. It provides automation across all lifecycle phases, and also manages automation across layers. It supports multiple vendors both natively and through proprietary NMS adaptation. It supports a wide range of both open in standards-based interfaces and APIs. Finally, NSP is a very complete and feature rich product, but also modular so that it may be consumed as required.

We see few downsides to NSP, except that it is delivered by a major IP/Optical NEP, whom other such NEPs may not wish to collaborate with. This is not Nokia's fault, but it can be their problem. We also note that the large majority of their huge installed base is made up of smaller networks, one vendor and limited use cases.

SUMMARY

In summary, NSP is a purpose-built solution with a goal of providing intent-driven automation of deployment, configuration, service path selection, service activation and lifecycle service management, across all four transport layers and supporting any vendor. No doubt it is imperfect, but all the words and documents point to a serious effort with years of development.

We are entering (we hope) a golden age of automation, where decades of hopes are finally being fulfilled – not just by Nokia but by other serious players. We strongly encourage service providers to become invested in a journey toward more and smarter automation of every domain, and across them.

Insight and analysis for telecom transformation.

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