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# Unified access management

## Bridge traditional and software-defined access systems with intent-based networking

White paper

As fixed network operators begin to transition to the cloud, their networks will spend a considerable period of time in a hybrid physical/virtual state. The operational efficiencies promised by SDN/NFV will not be realized without a management system able to master this hybrid environment. Unified access management provided by the Nokia Altiplano Access Controller unlocks the benefits of full network automation by enabling **intent-based networking**. Intent-based networking drives better business outcomes with self-aware, self-adjusting capabilities that continuously monitor network state against intent and execute changes as necessary across the entire network environment.

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# Introduction

Over the last decade, network providers have struggled to keep pace with increasing bandwidth demands. The explosive growth of the internet caused data traffic on fixed broadband connections such as xDSL, cable and fiber to grow much faster than revenues. A continuous build-out and incremental adoption of more nodes, more services and more technologies has been required for networks to keep up with demand, but not without its consequences.

The increased network complexity means it takes more time and effort to design, provision, monitor and troubleshoot access networks. The resulting increase in operational expenditure has put a premium on network programmability and network automation. Both are required to fulfill high volumes of service requests and drive operational efficiency.

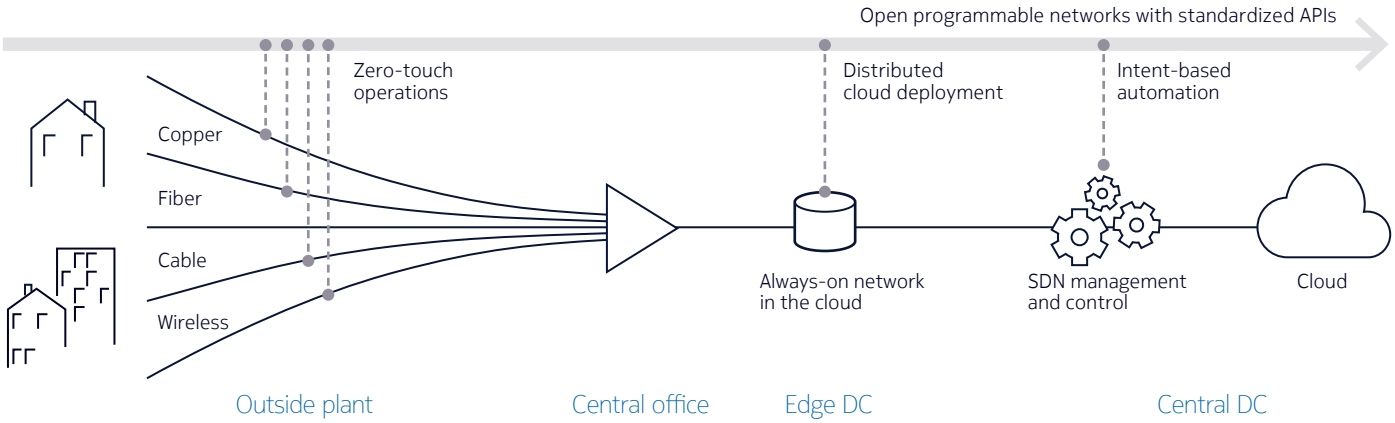
Fixed access networks have played an important role in creating the conditions for the internet revolution. Now it's vital for the telecommunications industry to advance to a whole new level of automation and facilitate the continued development of networks in the cloud era.

# The journey towards a software-defined future

In an increasingly fast-paced and digital world, first-time-right execution is important; without it, business opportunities, costs and brand reputation all suffer. Automation is a vital component for improving execution, but it's only successful when it blends seamlessly with the network operators' business environment and protects existing investments and the installed base.

Software-defined access networks (SDAN) are designed to deliver on the promise of automation and allow operators to take full advantage of widely used cloud technologies and IT practices. SDAN creates a programmable network fabric, which makes it easier to adapt, change and expand the network. With a programmable network, operators can dramatically reduce time-to-service (as well as time-to-market) and significantly streamline production costs through automation.

Figure 1. Nokia Software-Defined Access Network



With Nokia Altiplano, Nokia has built an open software framework that helps operators transition at their own pace from traditional access networks to an open telco environment. Altiplano helps to capture the full benefit of automation. Service fulfilment and assurance are simplified and customization to individual needs is achievable through programmable interfaces. A fundamental principle is the decoupling of device and service layers, which inherently reduces the risk of introducing new technologies and allows investment in new systems and services to be incremental. It equips providers with the means to enforce business rules through best-in-class policy capabilities independent from the underlying implementations.

Altiplano augments FCAPS (Fault, Configuration, Accounting, Performance and Security) processes and enables unified management across different systems, technologies and deployment models. It achieves this through validated blueprints, field-proven workflows and the assurance of pre-integration with commonly deployed IT and cloud platforms. Nokia SDAN brings a common set of tool chains, which makes networking no longer the exclusive realm of telco experts and blurs the boundaries between network operations and IT operations. The interdisciplinarity is one of the forces driving network transformation. This cross-fertilization will allow operators to tap into global resource pools of skilled IT professionals, reduce learning curves and enhance employees' career opportunities by building in-demand and transferable software skills.

## Helping operators overcome the barriers to SDN/NFV adoption

Despite the promise, fixed network operators have been hesitant to embrace SDN/NFV for 3 primary reasons. Nokia has addressed these concerns in its SDAN solution.

- **Being restricted to certain software silos**
  Having succumbed to hardware lock-in in the past, operators are concerned that SDAN will simply create software lock-in instead. Nokia SDAN uses an open software framework which can be combined with different SDN controllers, orchestration systems and automation platforms. The cloud-native modular architecture, the service and device abstraction and open interface strategy will enable multi-vendor innovation at all layers.
- **Deploy carrier-grade cloud solutions**
  Operators feel that SDN/NFV's carrier-grade pedigree is unproven. It takes craft to determine what to virtualize and take it beyond the lab and into production. Nokia combines validated best-practices and real-world use cases to deliver operational and performance benefits with carrier-grade network functions optimized for the cloud.
- **Interoperate physical and virtual in existing networks**
  Bridging legacy and software-defined networks is essential to keep complexity under control. No matter where an operator stands in adopting SDN principles, SDAN addresses the entire life cycle of the access network, with automated tools that help you to plan and grow efficiently.

## Unified management drives better business outcomes

This last point – interoperability of physical and virtual worlds – is critical. Fixed network operators have significant investments tied up in the existing installed base and want to maximize their returns on this investment. At the same time, there is an absolute necessity to maintain continuity of services for customers.

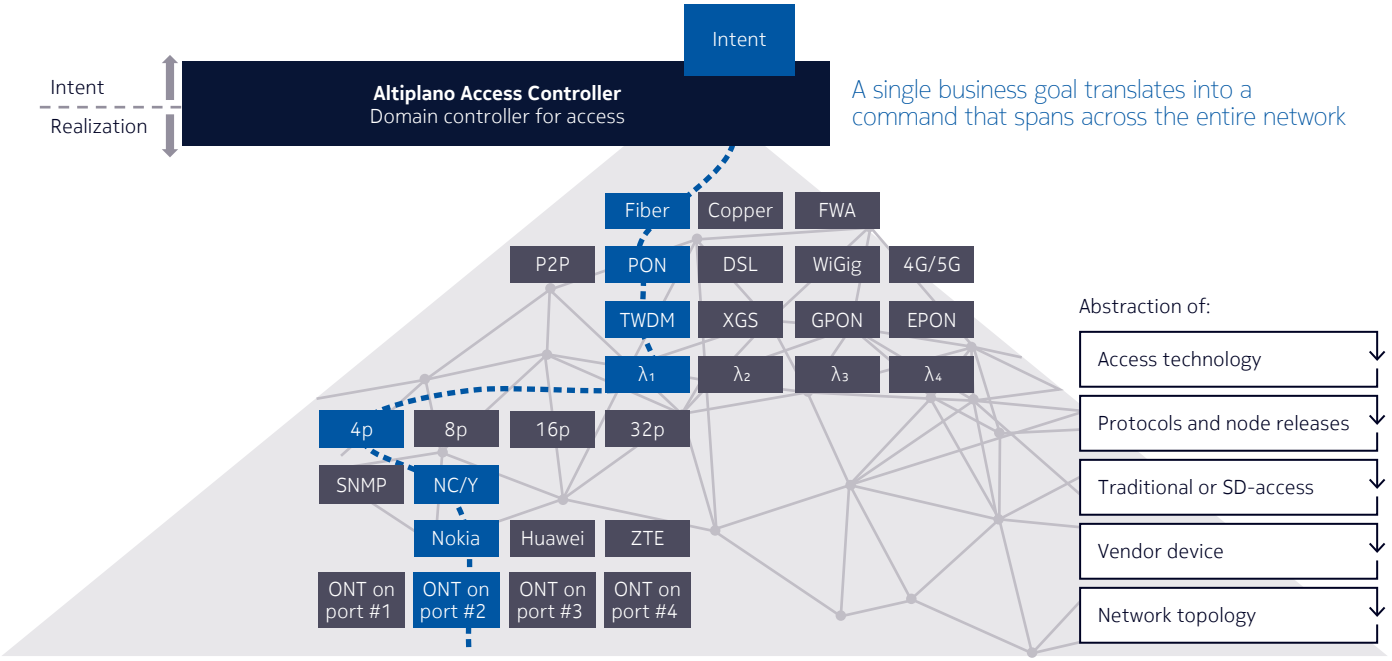
It is for these reasons that a binary switch from a cloudless to a full cloud environment is an impossibility. Operators must be able to roll out SDN automation in phases to ensure a smooth transition from their existing delivery models. This allows providers to stay in control as they evolve their networks.

Understanding that a hybrid physical/virtual network will be a mid- to long-term requirement, it is necessary to have a single management system for both environments; otherwise the operator's life in the cloud becomes more rather than less complex.

Nokia Altiplano provides such unified management of the access network. It offers options to gradually introduce new deployment models reusing existing management interfaces. It lowers the integration costs for SDN/NFV by serving as the single management interface for the operator's OSS/BSS system. The workflows and tools visualize, automate and optimize the network across different operational deployment models, vendor device implementations and even traditional and SDN-enabled environments. This unified management is vital for automating the network.

Multivendor networks can be easily managed as blueprints can be created for different access device implementations and vendor-specific APIs. The network operations are not restricted by the ability of the network infrastructure to support SDN capabilities; the software can manage different protocol implementations (NETCONF or SNMP) and bridge legacy and software-defined networks. This is essential for keeping network complexity under control.

Figure 2. Unified access management across the entire network




Adding a new technology variant to an existing network typically requires a lot of integration effort, with testing and validation for every vendor, solution, and release. Unified access management decouples the operator systems from different underlying implementations and means the service layer can be scaled and developed separately from the device layer. A service for a fiber-to-the-home subscriber can be configured without needing to know the OLT and ONU hardware designs, or even the specific PON

technology deployed. The Nokia Altiplano Access Controller software automatically translates the high-level goal to the correct device configuration and reduces the time to service by reusing the same set of service tools and service workflows. The abstracted model avoids exposing all details of the network complexity to the OSS/BSS systems.

Integrated network automation drives better business outcomes. The service fulfilment and service assurance dashboards enable you to view, analyze, and manage service availability from a business perspective rather than from an infrastructure perspective and hence gain better insight into the customer experience.

# The intent-based networking model

A unified management solution abstracts the implementation aspects of the network and empowers operators to safely apply software-defined networking for network automation. Much automation today is based on a clunky imperative model – if x, do y – and often operates in a single physical or virtual environment. With SDN/NFV, powerful **intent-based automation** can be established by incorporating network awareness and service assurance tasks, saving multiple steps of configuring devices for the subscribers. This makes it ideal to automate repetitive and dynamic processes that are a drain on operators' resources.

### The power of abstraction

> **Intent** / ɪn'tɛnt/ noun
>
> A mental state that represents a commitment to carry out an action or actions in the future.

The key take-away from this definition is that intent (the "what") and realization (the"how") are decoupled and do not necessarily happen at the same time.

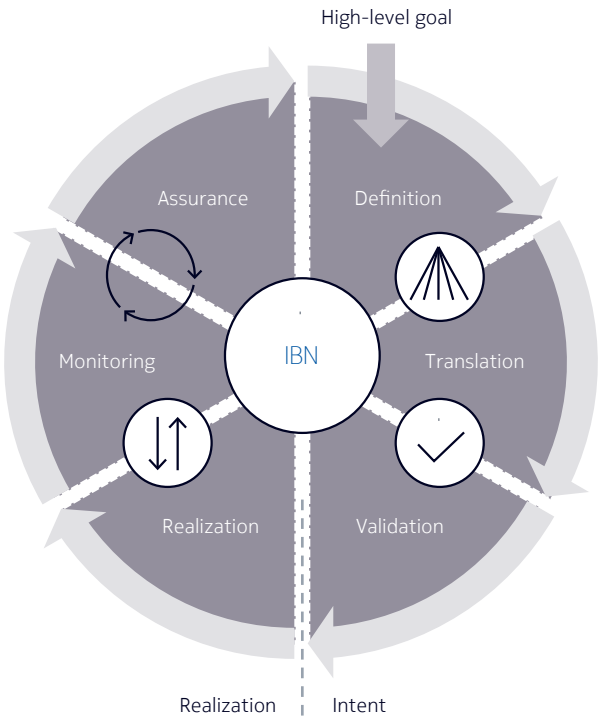
Intent is effectively a new abstraction layer within the network management hierarchy. An intent represents a business goal such as provisioning network infrastructure or the IPTV service for a specific end user. The definition of the goal can largely be set independently from the underlying specific network implementations.

The abstracted intent model is agnostic in many respects. It doesn't expose all details of the network complexity to the OSS, such as protocols, media types, node releases, technology flavors or node form factors. The abstraction between service and device levels reduces application development, testing and deployment when evolving the network infrastructure. This allows the network operator to run a single command that spans the entire network (whether it is SNMP or NETCONF/YANG). Just as importantly, abstraction doesn't care which technology or even which vendor's equipment is involved. Multi-technology and multi-vendor environments are managed seamlessly.

## How it works

Intent-based networking (IBN) abstracts the intricacies of network configurations. These configurations are automatically translated to the network, putting it in the desired state along with policy enforcement. IBN works through the following steps.

Figure 3. Intent-based networking in six steps




- **Definition**
  The network operator declares an intent to achieve a high-level goal, e.g. activate a service for an end user.
- **Translation**
  The abstract intent definition is translated into network configuration policies.
- **Validation**
  Software verifies the syntax of the intents and that the policies can be executed.
- **Realization**
  The policies in the cloud get enforced and network resources are configured once the network is available.
- **Monitoring**
  The state of the network is constantly monitored and reported to ensure it aligns with the intent definitions.
- **Assurance**
  The desired state of the network is audited and maintained. When needed, automated corrective actions are taken to maintain that state.

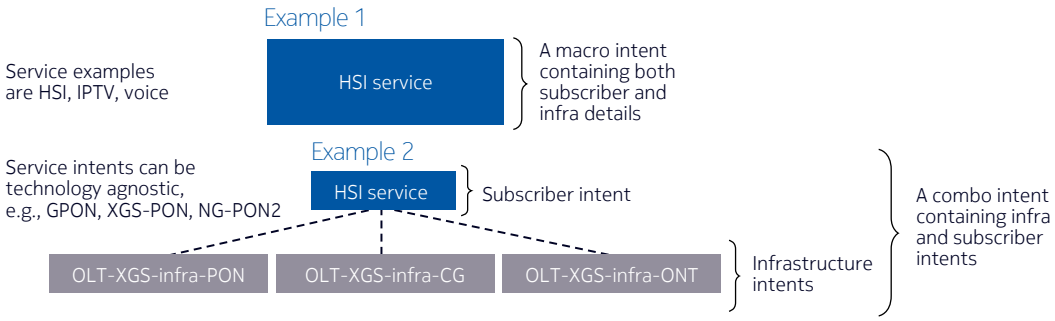
A powerful concept in IBN is the consistency of executing a recurrent set of decoupled activities, which can individually be repeated when necessary. The IBN software sets up audit facilities for comparing the desired intention against the actual state and is able to automatically find misconfigurations and fix them via synchronization processes and policy management.

### Programmable modular design

The Altiplano Access Controller runs a flexible service-to-device mapping engine which holds the logic for the optimal realization in the network. Operators have the flexibility to break down network element configuration into multiple micro-intents, split into infrastructure and service intents or use a single macro-level intent.

As shown in Figure 4, for each macro intent, such as provisioning a high-speed internet service, how the network needs to be configured can be split into distinct steps. Built in to Altiplano is a catalogue of infrastructure and service intents, which allows plug-and-play provisioning. The pre-loaded and integrated intent blueprints align with Nokia playbooks for best-in-class network design and leverage Nokia's global experience in access networks. New blueprints can be created, or the preset blueprints customized to an operator's deployment model and preferred reference configuration.

Figure 4. Defining intent-based policies




The definition of an intent (based on YANG models) is customizable and hot-deployable via the graphical user interface in the Altiplano software. The designer has the flexibility to define what information gets exposed to the OSS and what gets assigned automatically by the business logic of the IBN software.

As not all situations can be foreseen and pre-programmed, system engineers must incorporate the principles of human-machine interaction in their designs to achieve maximum system performance. The full potential of intent-based automation (efficiency, consistency and reliability) cannot be fully realized if the interaction with the human operator is just an afterthought. Altiplano proactively provides feedback about the system's intentions or actions to allow the human operator to remain in control of the network.

# Operator benefits

Unified management with IBN help apply consistent operations and create a more adaptive network: with it, fixed network operators can:

- **Increase business agility**
  Ease the introduction of new services and apply changes rapidly and consistently.
- **Optimize operational expenditure**
  Automate network operations and reduce time-consuming manual interventions.
- **Improve service assurance**
  Help human operators to view, analyze and manage service availability.
- **Increase programmability**
  Break down complex network configurations with a modular and customizable approach.

# Automation use cases

## ONU wavelength mobility

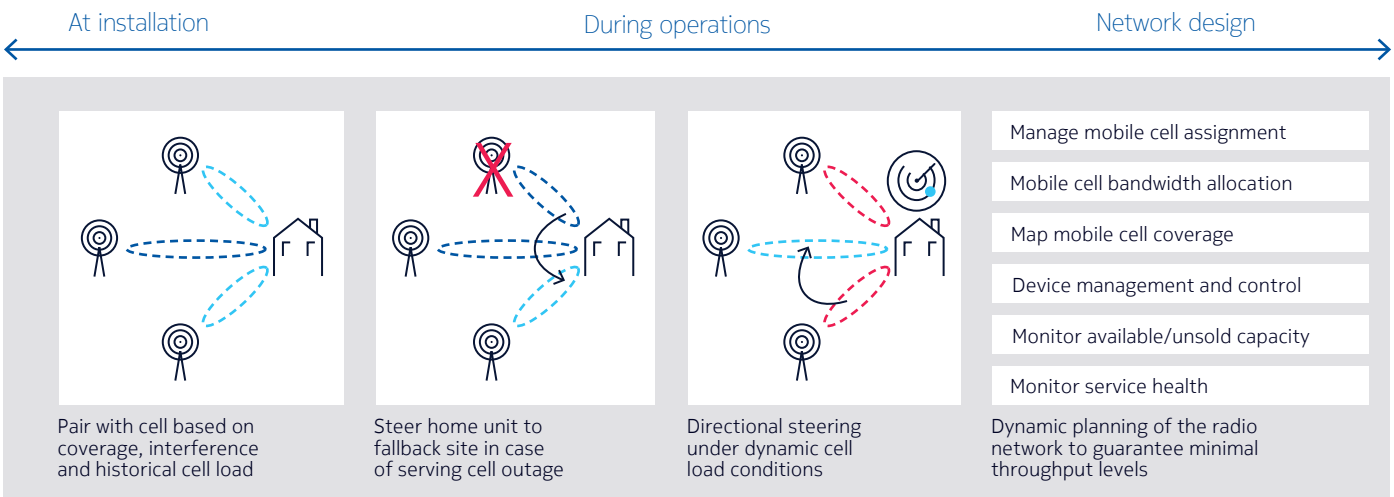
NG-PON2 technology expands the capacity of a single fiber by exploiting multiple wavelengths with dense wavelength division multiplexing and with tunable transceivers in the subscriber terminals (ONUs). In many cases the wavelength allocation is done manually by the network operator while the wavelength selection can be done more efficiently by using intent-based policies.

Automated wavelength mobility can be used for dynamic bandwidth rebalancing and can be used to reassign users to less congested wavelengths. During maintenance or off-peak hours, subscribers can be switched and grouped on a reduced set of wavelengths for operational efficiency. In multi-operator unbundling scenarios, IBN also helps streamline the provisioning process. The network operator can simply change the end-user's service provider connection and the network will automatically pair with the most appropriate operator wavelength. IBN prevents unauthorized switching of wavelengths and ensures consistency when (re)configuring the network.

## LTE cell selection for fixed wireless access

Another application of intent-based networks is the design, installation and operations of fixed wireless access (FWA) solutions. Operators need to manage, provision and monitor the service health and perform device management to ensure minimum guaranteed wireless throughputs. The FWA software controllers manage the mobile cell assignment, mobile bandwidth allocation and cell coverage. This capability allows operators to plan additional capacity into the radio network but also steer the home outdoor units (HOU) under dynamically changing network conditions. At installation, IBN helps to auto-pair HOUs with the preferred cell based on coverage, interference level and historical cell load without manual intervention. During operations, home units can automatically be paired to a fallback site in case of an outage or steer traffic to less loaded cells under new cell load conditions. This helps operators ensure minimum service levels for customers are met.

Figure 5. Intent-based policies for fixed-wireless access automation



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# Conclusion

The workforce of the future will spend less time on predictable, repetitive activities – where machines already outperform humans – and more time on advanced cognitive activities where machines cannot compete, such as applying human reasoning and expert evaluation. In order to increase machine-assisted decisions in all FCAPS aspects of a network, a single, unified management system is an absolute necessity. The Nokia Altiplano Access Controller is capable of managing network environments which are multi-vendor, multi-technology and hybrid SDN, and helps to automate service fulfilment and service assurance flows across the entire access network.

With solutions like Altiplano, Nokia is helping operators harness the power of software-defined networking while staying in command of their network's performance.

# Acronyms

| | |
|---|---|
| BSS | Business support system |
| DPU | Data processing unit |
| DSL | Digital subscriber line |
| FWA | Fixed wireless access |
| HIS | High-speed internet |
| HOU | Home outdoor unit |
| IBN | Intent-based networking |
| NETCONF | Network Configuration Protocol |
| NFV | Network function virtualization |
| NOC | Network operations center |
| OLT | Optical line terminal |
| OSS | Operations support system |
| PNF | Physical network functions |
| SDAN | Software-defined access network |
| SDN | Software-defined networking |
| SNMP | Simple Network Management Protocol |
| VNF | Virtual network functions |
| ZTO | Zero-touch operations |

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