ConnectSuperior
Fiber Network Equipment and Services

Part A. Nokia Equipment Solution Description

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LightSpeed Confidential

1 Executive Summary

As Nokia's top VAR partner in 2022 and five of the last six years, LightSpeed Technologies is pleased to respond to ConnectSuperior's Fiber Network Equipment and Services RFI. In this document LightSpeed will describe the Nokia solutions that will allow ConnectSuperior to deploy a future-proof fiber access network utilizing XGS-PON technology.

Nokia creates technology that helps the world act together. As a B2B technology innovation leader, Nokia is pioneering networks that sense, think and act by leveraging its work across mobile, fixed and cloud networks. In addition, Nokia creates value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs. Service providers, enterprises and partners worldwide trust Nokia to deliver secure, reliable and sustainable networks today—and work to create the digital services and applications of the future.

Leadership in the research and development of fiber and copper access solutions, coupled with its deployment experience and professional services capabilities, enables Nokia to deliver reliable, operationally ready networks in an aggressive timeframe and to provide exceptional post-deployment and operational support critical to your success.

LightSpeed has been an exclusive Nokia Business Partner since 2001, specializing in the entire Nokia product line, including Fixed Networks and IP/MPLS. Our long-term relationship with Nokia uniquely positions us to get things done inside their organization due to LightSpeed's understanding of their processes, systems, and our long-standing executive relationships. LightSpeed is a full-service telecommunications system integrator, providing systems engineering, material management, installation and integration and ongoing maintenance services. LightSpeed has the highest level of Nokia Technical Certifications and a proven track record of success supporting its customers. By selecting to do business with LightSpeed, customers get **"The Best of Both Worlds"**:

> **Nokia** – "Best of Breed" Products, Bell Labs Technical Support, Comprehensive Portfolio and Global Resources

> **LightSpeed** – Responsive, Exclusive Nokia Focus, Systems Engineering Depth, Entrepreneurial, Flexible Organization and Creative Problem-Solving Experience

We believe that LightSpeed's expert-level technical assistance and responsive customer service will provide ConnectSuperior with the best overall value and solution.

Fiber Market Leadership

Nokia is a global leader in fiber access technology. Nokia's award-winning fiber access solutions have been deployed by more than 300 customers, powering some of the biggest and most advanced fiber networks in North America and across the globe. Supported by innovations and expertise from its Bell Labs researchers, Nokia was:

- **First** to demonstrate 10G symmetrical PON

- **First** with commercial deployments of TWDM-PON and XGS-PON

- **First** with commercial deployments 25G PON

- **First** to demonstrate 100G PON
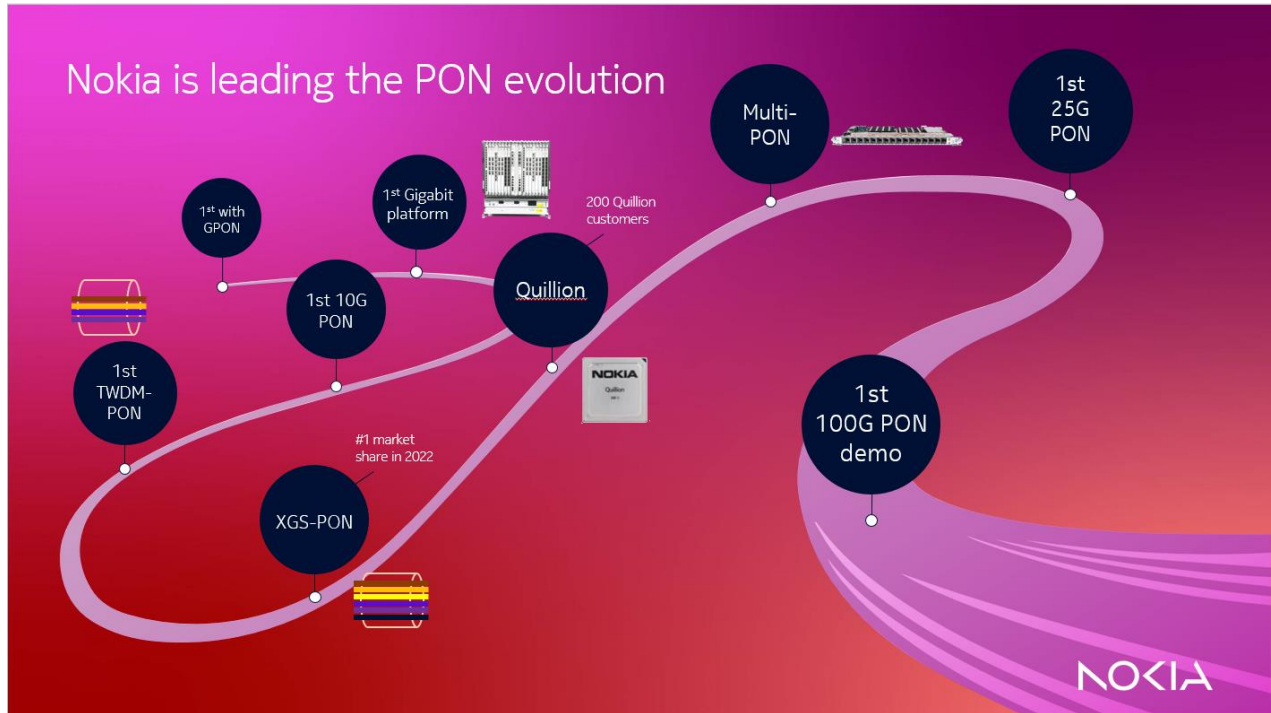
Nokia's continued innovation has helped solidify its market leadership in fiber access. In 2019, Nokia developed its own silicon that enables the support for multiple PON technologies, including GPON, XGS-PON and 25G-PON, from the same line card. With robust supply chain capabilities, Nokia has shipped over 140 million PON OLT and ONT/ONU lines. The figure below outlines additional information about Nokia's leadership in FTTH.
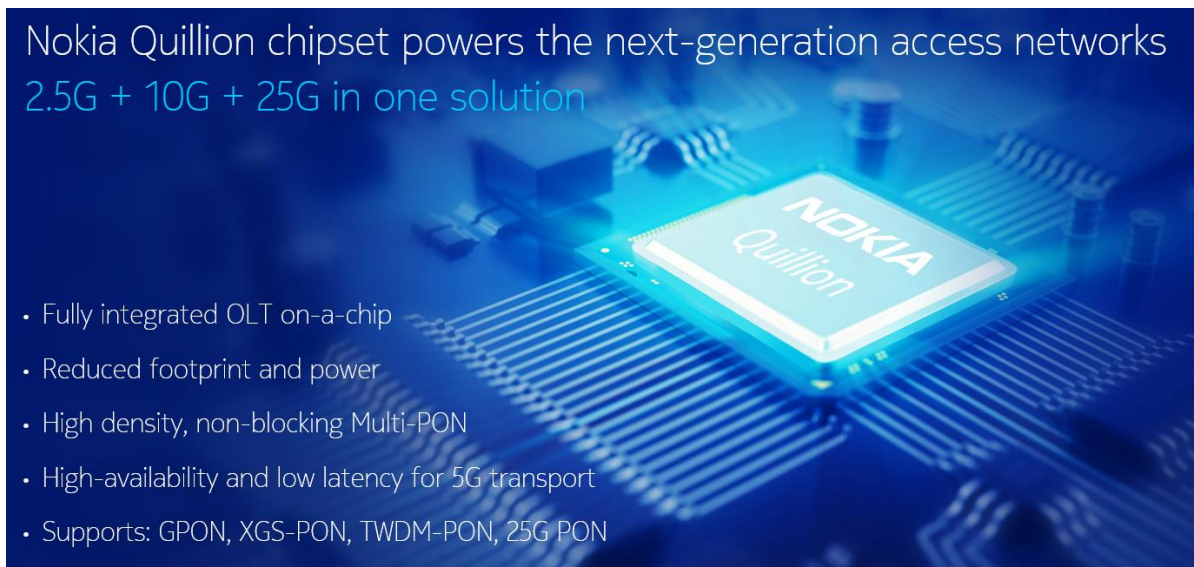
Solution Highlights

A key component of the Nokia Multi-PON solution is the FWLT-C, a new generation passive optical network (PON) line card, which supports multiple PON technologies and easy migration from current to next-generation technologies. The FWLT-C is based on the Nokia Quillion chipset. Designed to offer multi-PON capabilities with GPON, XGS-PON and 25G-PON all running on the same fiber, Quillion reduces energy consumption, with 50% less power needed in fiber installations than previous generations. With the use of Quillion, products offered are HW ready for 25G-PON.

Nokia Quillion chipset powers the next-generation access networks
2.5G + 10G + 25G in one solution

- Fully integrated OLT on-a-chip
- Reduced footprint and power
- High density, non-blocking Multi-PON
- High-availability and low latency for 5G transport
- Supports: GPON, XGS-PON, TWDM-PON, 25G PON

The heart of Nokia's solution is the Altiplano Access Controller. This is a network management application with a simple unified interface to visualize, optimize, and enhance the fixed access network, supporting SDN-native, legacy, and third-party access equipment.

Altiplano offers a single view to manage fixed services, leveraging zero-touch operations, powerful network life-cycle management and closed-loop automation. Leveraging intent-based policies and validated blueprints, this approach drives better outcomes with self-aware capabilities that continuously monitor and self-adjust to maintain the intended network state.

The cloud-native platform delivers powerful automation tools and flexible service programming via open interfaces. The open modular architecture allows the introduction of new network capabilities and integrates easily with OSS/BSS, IT, and cloud platforms.

2   Solution Overview

The diagram below shows the proposed Nokia solution for ConnectSuperior's access network. Three 7360 ISAM FX OLTs are in the ConnectSuperior datacenters, connecting to the ConnectSuperior core network infrastructure in both datacenters.

Nokia offers a wide range of CPE devices to support ConnectSuperior's XGS-PON deployment including:

- Residential Gateways: XS-2426G-A, XS-2426G-B, XS-2426X-A

- XGSPON ONT: XS-230X-A

- Nokia WiFi: Beacon 2, Beacon 6, Beacon G6, Beacon 10

Network Management is provided by the Altiplano Access Controller. The Corteca Home Controller provides advanced WiFi management with real-time, network-wide control for the Nokia WiFi devices. The Nokia WiFi Mobile App is the primary interface for the end user to install and manage their WiFi.
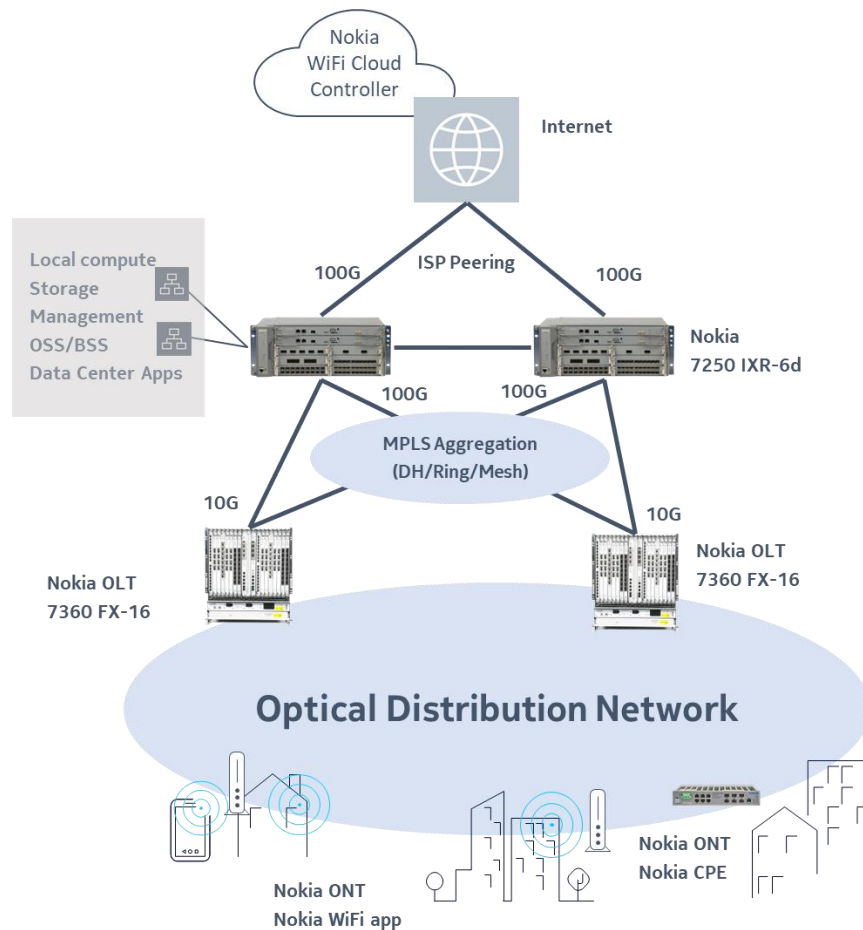
The following sections describe each of the solution components in more detail.

2.1   7360 FX

The Nokia 7360 FX platform is a high-capacity OLT addressing the need for mass-market, high-capacity fiber deployments. Nokia 7360 FX is ready to support any future fiber-based access application, with full

flexibility for mixing different access technologies on the same platform: Gigabit PON (GPON), Point-to-point Ethernet, XGS-PON, NGPON2/TWDM-PON, and 25G-PON.

ISAM FX has 3 different form factors: the FX-16 with 16 PON line cards, the FX-8 with 8 PON line cards and the FX-4 with 4 PON line cards. In addition to the line card slots, each FX has 2 Network Termination (NT) controller card slots and an NT-IO slot.

The FX is built as a modular multiplexer with a Network Termination board (NT), optionally 1+1 redundant, and a set of Line Termination (LT) boards. PON and P2P Ethernet line cards are supported simultaneously and may be installed in any line card slot.
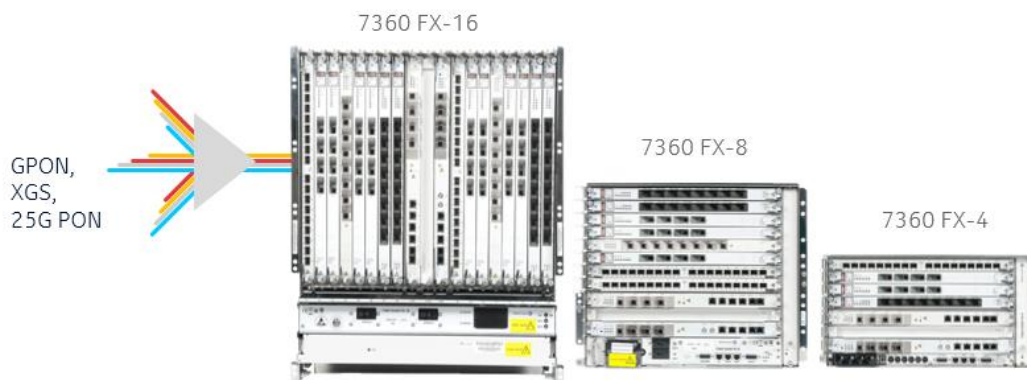
Advantages:

- FX-16, FX-8 & FX-4 are scalable chassis-based OLT solutions with a very high PON density

- Chassis based (add cards as your grow)

- Flexible selection of PON flavors: GPON, XGSPON, Multi-PON (GPON+XGS simultaneously on the same port), or 25G-PON

- A selection of uplink options

- Quillion based fiber platform

The key components of the ISAM FX solution are described below. Based on ConnectSuperior's subscriber requirements, Nokia is proposing the FX-16 shelf option, however detail on all three options is included.

2.1.1 FX-16 shelf (NFXS-D)

FX-16 is a 23" Subrack that can be deployed in a Central Office (CO) environment.

The Subrack has 2 NT slots, 1 NTIO slot and 16 LT slots.
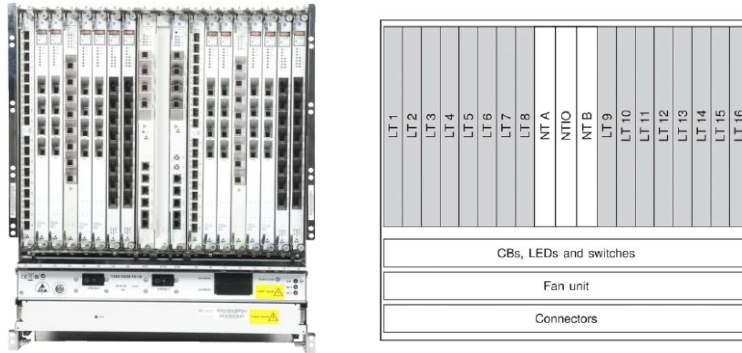
The dimensions of the FX-16 (or NFXS-D) subrack are:

- Width: 497.3 mm (~14 RU)

- Height: 622.5 mm

- Depth: 280 mm

The FX-16 shelf mounts vertically in a 23 in. rack.

Main characteristics:

- Designed to support large sized OLT configurations.

- Is equipped with a 100G backplane capacity per line card slot.

- The Shelf has 16 LT Slots, 2 NT Slots and 1 NTIO Slot.

- When fully equipped with two NT cards supports an aggregate uplink of 400Gbps+.

- The shelf is a stand-alone unit. No Top Rack Unit is required.

- Allows for flexible LT board mounting, meaning that several types of boards can be housed in the LT slots.

- Supports 1+1 NT redundancy.

- It is HW-ready to support LT redundancy between adjacent LT slots.

- Contains a field-replaceable hot swappable fan unit with dust filter (BFAN-H).

- Contains a general function & control (GFC) unit to interface to external power supply and external alarm inputs.

- Has no Connector area for Subscriber interfaces. External cabling is applied directly to Front Access Connectors on the Line Termination Cards.

- Because of the Front Cabling concept, the shelf can house cards of any port density.

- Is fed by 2 fully redundant power branches (BATA & BATB) with a nominal voltage of -48V or –60V.

- Each power input branch is protected by a circuit breaker of 40A.

- All cabling, both electrical and optical, has to be routed away from the FAN unit.

- Pre-cabling is supported via dummy face plates with cable lockers.

- The Shelf is made of stainless steel and complies to RoHS standards.

- EMC compliant at subrack level according to EN 55022 Class B

- Safety compliant at subrack level according to IEC 950 (EN 60950-1)
- Protection of the power interface according K.20 (up to 4kV)

Port density:

- Per FX-16 chassis: 16 FWLT-C linecards containing each 16 XGSPON ports results in a maximum of 256 XGSPON ports
- Per RU: An FX-16 chassis is 14 RU in height, so the density per RU is 16 XGSPON ports

Power per port for a fully loaded chassis:

Configuration FX-16: 256 XGS-PON (-> 16x FWLT-C) + 2 x 100 GigE (1x FANT-H BB)

Typical Ta=25C full load, Max Ta=65C full load

- Typical: 1545W full configuration
- Typical: 6.25W per PON
- Maximum: 1897W full configuration
- Maximum: 7.41W per PON

2.1.2   FANT-H (BB) Network Termination Card (NT)

The FANT-H network controller card (NT) is designed for high capacity GPON, XGS-PON and 25G-PON deployments. The FX-16 shelf can accommodate two NT cards. The protection scheme for NT redundancy is 1+1 (active/active) in the data plane and 1:1 (active/standby) in the control plane and the management plane.
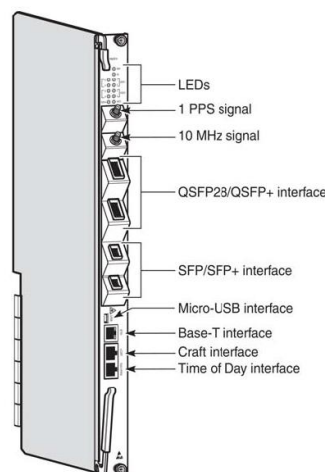
Main characteristics:

- 2.6 Tbps Ethernet switch
- 1 x fixed 10/100/1000Base-T port. This port operates in 10 Mb/s, 100 Mb/s, or 1 GE mode.

- 2 x 100 GE QSFP28 port. This port operates in 100 GE mode, 40 GE mode, 25 GE, and 10 GE mode.

- 2 x SFP/SFP+ port. The SFP+ interfaces support 10 GE and 1 GE data rates.

- LCMI interface (RJ-45 connector)

- ToD/1 PPS interface (RJ-45 connector)

- 10 MHz GPS interface (SMA connector)

- 1 PPS interface (SMA connector)

- Debug interface (Mini-USB connector)

- Can be used in the following operational conditions:

    - 5C to 40C (41F to 104F) for normal operating range, or

    - -5C to 50C (23F to 122F) in a Central Office (CO) environment

2.1.3   FANT-H (BC) Network Termination Card (NT)

The FANT-H network controller card (NT) is designed for high capacity GPON, XGS-PON and 25G-PON deployments. The FX-16 shelf can accommodate two NT cards. The protection scheme for NT redundancy is 1+1 (active/active) in the data plane and 1:1 (active/standby) in the control plane and the management plane.

Main characteristics:

- 1.8 Tbps Ethernet switch

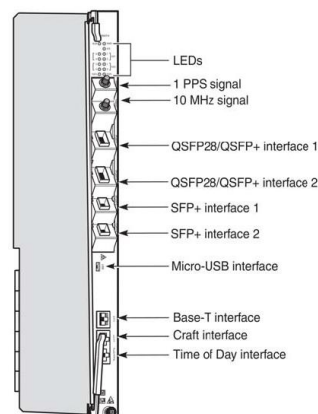- 1 x fixed 10/100/1000Base-T port. This port operates in 10 Mb/s, 100 Mb/s, or 1 GE mode.

- 2 x 100 GE QSFP28 port. This port operates in 100 GE mode, 40 GE mode, 25 GE, and 10 GE mode.

- 2 x SFP/SFP+ port. The SFP+ interfaces support 10 GE and 1 GE data rates.

- LCMI interface (RJ-45 connector)

- ToD/1 PPS interface (RJ-45 connector)

- 10 MHz GPS interface (SMA connector)

- 1 PPS interface (SMA connector)

- Debug interface (Mini-USB connector)

- Can be used in the following operational conditions:

  - -20°C to 40°C (-4°F to 104°F) normal operating range *or*

  - -5°C to 50°C (23°F to 122°F) in a Central Office (CO) environment *or*

  - -40°C to 65°C (-40°F to 149°F) in a Class 2 outside plant (OSP) environment

2.1.4   FWLT-C Line Termination Card (LT)

FWLT-C is the next-generation fiber line termination (LT) card based on the Nokia Quillion chipset, supporting GPON, 10G symmetrical and asymmetrical PON (XGS-PON dual rate), Time and Wavelength Division Multiplexing Passive Optical Network (TWDM-PON) technology as well as multi-PON via MPM optical modules. The card is also HW ready for 25G-PON.

Main characteristics:

- 16-port universal PON line termination card

- Supported in all FX shelf variants (4/8/16)

- Universal PON linecard, which provides flexibility to choose a variety of optic interfaces:

  - GPON 2.5G/1.25G

  - XGS-PON: dual rate, 10G/10G and 10G/2.5G capable

  - MPM (GPON+XGS PON) using dedicated MPM optical module

  - TWDM-PON: either 10G/10G or 10G/2.5G capable

  - HW-ready for 25G-PON: 25G/25G deployable in odd ports (license)

- Per-subscriber per-service bandwidth control

- Support features for lean operations and remote troubleshooting: Received Signal Strength Indication (RSSI) and rogue optical network unit (ONU) detection

- Synchronization features for mobile backhaul application (IEEE 1588v2, SyncE)

2.2   Nokia CPE Devices

2.2.1   XGS-PON CPE

2.2.1.1   XS-230X-A – Data/Voice ONT

The Nokia Optical Network Terminal (ONT) XS-230X-A with one 1/10 Gigabit Ethernet (GigE), two GigE, and two plain old telephone service (POTS) ports is part of the industry-leading Nokia ONT product family and is compatible with the Nokia fiber to the x (FTTx) product line. It is designed to deliver triple play services in a fiber to the home (FTTH) environment to single family units (SFUs) where multiple Ethernet and voice ports are required. The Nokia ONT terminates the 10G symmetrical Passive Optical Network (XGS-PON) fiber interface that is compliant with a Full Service Access Network (FSAN).

Key Features:

- Integrated XGS PON ONT
- Two RJ-11 Voice ports
- One RJ-45 100M/1G/2.5G/5G/10G auto negotiating interface
- Two autosensing 10/100/1000Base-T Gigabit Ethernet LAN
- Deployable in outdoor rated enclosures
- Temperature Hardened (inside the outdoor enclosure) -40c to +65c
- Battery backup capable
- Wall Mount Bracket available

2.2.1.2   XS-2426G-A – Residential Gateway ONT

The Nokia ONT XS-2426G-A is the solution for home networking that is delivered by 10 Gigabit symmetrical Passive Optical Network (XGS-PON). The device has built-in concurrent dual-band Wi-Fi® 802.11 b/g/n/ax and 802.11a/n/ac/ax networking with triple play capabilities that include voice, video and data. The XS-2426G-A supports Wi-Fi EasyMesh™, to create a whole home mesh network. This coverage can be expanded at any time by installing additional Wi-Fi EasyMesh-capable beacons to ensure seamless roaming throughout the home. The XS-2426G-A includes the Nokia WiFi Mesh Middleware which ensures the best possible Wi-Fi performance. The end-user experience is enhanced by the service provider's Wi-Fi management capabilities in the cloud and intuitive home user support using the Nokia WiFi mobile app.

Key Features:

- Integrated XGS-PON ONT

- Dual band WiFi6 AX1800 (2+2)

- 2x2 802.11b/g/n/ax @ 2.4GHz

- 2x2 802.11a/n/ac/ax @ 5GHz (1W EIRP)

- Two RJ-11 Voice ports

- Four autosensing 10/100/1000Base-T Gigabit Ethernet LAN

- One USB 3 interface

- EasyMesh support enhanced by Nokia value added features

- Hybrid Backhaul with Ethernet/Wi-Fi backhaul auto-sensing

- Nokia WiFi Real-Time Analytics integrated

- Multicast over mesh optimized video streaming

- TR-069 Remote Management support

2.2.1.3   XS-2426X-A and XS-2426G-B – Residential Gateway ONTs

The Nokia ONT XS-2426X-A and XS-2426G-B are solutions for home networking that is delivered by 10 Gigabit symmetrical Passive Optical Network (XGS-PON). The devices have built-in concurrent dual-band Wi-Fi® 802.11 b/g/n/ax and 802.11a/n/ac/ax networking with triple play capabilities that include voice, video and data. The XS-2426X-A and XS-2426G-B both support Wi-Fi EasyMesh™, to create a whole home mesh network. This coverage can be expanded at any time by installing additional Wi-Fi EasyMesh-capable beacons to ensure seamless roaming throughout the home. The XS-2426X-A and XS-2426G-B include the Nokia WiFi Mesh Middleware which ensures the best possible Wi-Fi performance. The end-user experience is enhanced by the service provider's Wi-Fi management capabilities in the cloud and intuitive home user support using the Nokia WiFi mobile app. The XS-2426X-A and XS-2426G-B also support application containers, which allow introducing new services, from cybersecurity to entertainment to productivity.

Key Features:

- Integrated XGS-PON ONT
- Dual band WiFi6 AX6000 (4+4)
  - 4x4 802.11b/g/n/ax @ 2.4GHz
  - 4x4 802.11a/n/ac/ax @ 5GHz (1W EIRP)
- Two RJ-11 Voice ports
- Three autosensing 10/100/1000Base-T Gigabit Ethernet LAN
- One autosensing 100/1000/2.5G/5G/10GBase-T Ethernet LAN (XS-2426G-B up to 2.5G)
- One USB 3 interface
- EasyMesh support enhanced by Nokia value added features
- Hybrid Backhaul with Ethernet/Wi-Fi backhaul auto-sensing
- Nokia WiFi Real-Time Analytics integrated
- Multicast over mesh optimized video streaming
- TR-069 Remote Management support

2.2.2   Nokia WiFi

2.2.2.1   Nokia WiFi Beacon 2

The Nokia WiFi Beacon 2 extends the whole home Wi-Fi experience for broadband subscribers. This premium class Beacon supports Wi-Fi 6 and Wi-Fi EasyMesh™, to create a whole home coverage mesh network backhauled by wired Ethernet or Wi-Fi. This coverage can be expanded at any time by installing additional Wi-Fi EasyMesh-capable beacons to ensure flawless roaming throughout the home. The Beacon 2 includes the Nokia WiFi Mesh Middleware which ensures the best possible Wi-Fi performance. The end-user experience with the intelligent self-organizing mesh system is enhanced by the service provider's Wi-Fi management capabilities in the cloud and intuitive home user support using the Nokia mobile app.

Key Features:

- Dual band WiFi6 AX1800 (2+2)

    o 2x2 802.11b/g/n/ax @ 2.4GHz

    o 2x2 802.11a/n/ac/ax @ 5GHz (1W EIRP)

    o Support MU-MIMO and MU-OFDMA

    o Maximum EIRP up to 500mW on 2.4GHz and up to 1000mW 5GHz

- One autosensing 10/100/1000Base-T Gigabit Ethernet WAN (can work as LAN when device is used as wireless extender)

- One 10/100/1000Base-T Gigabit Ethernet LAN interface

- EasyMesh support enhanced by Nokia value added features

- Hybrid Backhaul with Ethernet/Wi-Fi backhaul auto-sensing

- Nokia WiFi Real-Time Analytics integrated

- Multicast over mesh optimized video streaming

- Nokia WiFi management by mobile app and Corteca Home Controller

- TR-069 Remote Management support

2.2.2.2 Nokia WiFi Beacon 6

The Nokia WiFi tri-band Beacon 6 extends the whole home Wi-Fi experience for broadband subscribers. This premium class Beacon supports Wi-Fi 6 and Wi-Fi EasyMesh™, to create a whole home coverage mesh network backhauled by wired Ethernet or Wi-Fi. This coverage can be expanded at any time by installing additional Wi-Fi EasyMesh-capable beacons to ensure flawless roaming throughout the home. The Beacon 6 includes the Nokia WiFi Mesh Middleware which ensures the best possible Wi-Fi performance. The end-user experience with the intelligent self-organizing mesh system is enhanced by the service provider's Wi-Fi management capabilities in the cloud and intuitive home user support using the Nokia mobile app.

Key Features:

- Functions in either routed mode or bridged mode
- Tri-band concurrent Wi-Fi 6 (AX4200), compatible with all earlier generations of Wi-Fi
  - 2x2 802.11b/g/n/ax 2.4GHz WLAN interface
  - 2x2 802.11a/n/ac/ax 5.2GHz WLAN interface
  - 4x4 802.11a/n/ac/ax 5.8GHz WLAN interface
  - PHY Rate up to 600Mbps for 2.4GHz and 1200Mbps for 5.2GHz with 1024QAM capable clients, and dedicated 2400 Mbps 5.8GHz for Mesh backhaul
  - Support MU-MIMO and MU-OFDMA
  - Maximum EIRP up to 1000mW on 2.4GHz and 5.2GHz and up to 2000mW on 5.8GHz
- One 10/100/1000Base-T Gigabit Ethernet WAN interface
- Two 10/100/1000Base-T Gigabit Ethernet LAN interface
- EasyMesh support enhanced by Nokia value added features
- Hybrid Backhaul with Ethernet/Wi-Fi backhaul auto-sensing
- Nokia WiFi Real-Time Analytics integrated
- Multicast over mesh optimized video streaming
- Nokia WiFi management by mobile app and Corteca Home Controller
- TR-069 Remote Management support
- One USB 3 interface

2.2.2.3   Nokia WiFi Beacon G6

The Nokia WiFi Beacon G6 extends the whole home Wi-Fi experience for broadband subscribers. It supports one 2.5Gbps and two 1Gbps LAN interfaces with a 2.5Gbps uplink. This premium class Beacon supports Wi-Fi 6 and Wi-Fi EasyMesh™, to create a whole home coverage mesh network backhauled by wired Ethernet or Wi-Fi. This coverage can be expanded at any time by installing additional Nokia WiFi Beacon 2 units to ensure flawless roaming throughout the home. The Beacon G6 includes the Nokia WiFi Mesh Middleware which ensures the best possible Wi-Fi performance. The end-user FWLT experience with the intelligent self-organizing mesh system is enhanced by the service provider's Wi-Fi management capabilities in the cloud and intuitive home user support using the Nokia mobile app.

Key Features:

- Dual band WiFi6 AX6000 (4+4)
  - 4x4 802.11b/g/n/ax @ 2.4GHz

- o 4x4 802.11a/n/ac/ax @ 5GHz (1W EIRP)

- o Support MU-MIMO and MU-OFDMA

- 1x 2.5Gbps Ethernet WAN uplink

- 1x 2.5Gbps Ethernet LAN port

- 2x 1Gbps Ethernet LAN ports

- Nokia Mesh Middleware including Easymesh support

- Nokia WiFi management by mobile app and Corteca Home Controller

- Nokia WiFi Real-Time Analytics

- TR-069 Remote Management support

2.2.2.4   Nokia WiFi Beacon 10

The Nokia WiFi Beacon 10 is the ultimate WiFi 6E tri-band gateway. The Nokia WiFi mesh creates a seamless WiFi 6E network throughout the home. The Nokia WiFi Beacon 10 is based on EasyMesh™ enriched with Nokia value added features and functionality.

This new unit is targeted to release in the second half of 2023.

Key Features:

- Tri-Band WiFi6E AX10200 (2+4+4)

  - o 2x2 802.11b/g/n/ax @ 2.4GHz

  - o 4x4 802.11a/n/ac/ax @ 5GHz

  - o 4x4 802.11a/n/ac/ax @ 6GHz

  - o 30dBm EIRP for indoor per FCC guidance (HW designed to support standard power up to 36dBm via firmware update and availability of an AFC)

  - o Support MU-MIMO and MU-OFDMA

  - o Support 128 clients per radio or 128 client for the mesh

- 1x 10Gbps Ethernet WAN uplink

- 1x 2.5Gbps Ethernet LAN port

- 2x 1Gbps Ethernet LAN ports

- Nokia Mesh Middleware including Easymesh support

- Nokia WiFi management by mobile app and Corteca Home Controller

- Nokia WiFi Real-Time Analytics

- Support for containers (LXC) and TR-157

- TR-069 or TR-369 Remote Management support

2.2.3 Nokia 7250 Interconnect Router R6d (7250 IXR-R6d)

The 7250 IXR-R6d routers provide extensive routing flexibility. The deep functionality of the 7250 IXR-R6d includes scalable layer-2 edge services such as EVPN VPWS and EVPN VPLS and layer-3 edge services such as VPRN. Nokia prides itself on the flexible mix of Segment Routing, RSVP-TE and LDP based MPLS tunnels, and the overall proven stability of the 7250 IXR's SR OS software. Also demonstrated is the strength of the 7250 IXR's MPLS and segment routing capabilities. Using the 7250 IXR-R6d allows the solution to utilize IP/MPLS or Segment Routing to provide a network built on the same technology that has been adopted as the most reliable and capable architecture by Service Providers worldwide.

The 7250 IXR-R6d offers high-density 10GE, 100GE, and 400GE port counts in a compact form factor. The 7250 IXR-R6d delivers low latency for Internet of Things (IoT), and mission-critical applications while providing plenty of buffer memory for less delay- sensitive applications.

The router's per-service queuing features support differentiated quality of service (QoS). These features also help network operators merge their operational and business services traffic.

Network longevity

The 7250 IXR-R6d's modular architecture supports a variety of deployment options. High-density 1GE/10GE/100GE/400GE interface cards accommodate future growth.

Figure: 7250 IXR-R6d chassis and linecards.

Card name	Details		
2-port 400GE	• 1 x CFP2-DCO 400GE + 1 x CFP2-DCO 100GE • 2 x CFP2-DCO 200GE/100GE		
5-port 100GE	• 5 x QSFP28 100GE		
1-port 400GE + 1-port 100GE	• 1 x QSFP-DD + 1 x QSFP28 100GE		
10-port 50GE	• 10 x SFP56/SFP28/SFP+ 50GE/25GE/10GE		
15-port 25GE + 3-port 10GE	• 15 x SFP28/SFP+ 25GE/10GE + 3 x SFP+ 10GE		
20-port 10GE/1GE	• 20 x SFP+/SFP 10GE/1GE		

High Performance

The 7250 IXR-R6d offers industry-leading control-plane performance combined with symmetrical multiprocessing. Service providers benefit from faster convergence times and powerful OAM and security features. The router's unique active/active system architecture uses load sharing to unleash the forwarding and buffering capabilities of both CPIOM control modules while maintaining redundancy.

Reliable service delivery

Granular, in-depth, and highly scalable per-service monitoring offers visibility into packet flows. The 7250 IXR-R6d provides comprehensive reporting on key performance indicators such as packet discard and forward counters. These capabilities improve reliability and help service providers fulfil service-level guarantees.

The 7250 IXR-R6d provides excellent protection against link or equipment failures through control and Datapath redundancy options. It quickly reroutes traffic and re-converges networks using a robust set of dynamic routing and recovery capabilities. Superior network resiliency reduces network downtime and improves the overall productivity of network operations. With a highly resilient network, service providers can reduce operating costs, improve end-user satisfaction, and offer higher-value service-level agreements (SLAs).

Software features

The 7250 IXR-R6d supports, but is not limited to, the following features. Please note that some of these features require specific RTUs to activate.

Services

- Point-to-point Ethernet pseudowires/virtual leased line (VLL)
- Ethernet Virtual Private Network (EVPN): EVPN-VPWS, EVPN-VPLS, Multihoming with single active or active/active modes
- Multipoint Ethernet VPN services with VPLS based on T-LDP and BGP
- Routed VPLS with Internet Enhanced Services (IES)/IP-VPN
- Ingress and egress VLAN manipulation for L2 services
- IP VPN Virtual Private Routed Network (VPRN)

Network protocols

- Segment routing: SR-ISIS and SR-OSPF, SR-TE
- MPLS LER and LSR functions: LDP, RSVP-TE
- IP routing: Dual-stack IGP, Multi-topology and multi-instance IS-IS, Multi-instance OSPF, Multiprotocol BGP (MP-BGP), IGP and BGP shortcuts
- Layer 3 Multicast – base routing: IGMP, PIM-SM, PIM-SSM, MLD
- Layer 3 Multicast – VPRN: NG-MVPN, MLDPv4, IGMP/MLD
- Layer 2 Multicast: IGMP/MLD snooping

Quality of service and traffic management

- Hierarchical QoS (HQoS)
    - Hierarchical egress schedulers and shapers
    - Port sub-rate
    - 4 GB of buffer memory
- Intelligent packet classification
- Hierarchical policing
- Strict priority, weighted fair queuing schedulers
- Congestion management via WRED
- Egress marking or re-marking

Operations, administration, and maintenance

- IEEE 802.1ag, ITU-T Y.1731: Ethernet CFM for both fault detection and performance monitoring, including delay, jitter, and loss tests
- IEEE 802.3ah: EFM
- BFD
- Mirroring
- Loopback capabilities
- Management by CLI, SNMP MIBs, with comprehensive support through the Network Services Platform (NSP). Please note the NSP is not included in the pricing.
- The 7250 IXR-R6d is **not** managed by the Altiplano Access Controller

Resiliency
- Non-stop routing
- RSVP-TE Fast Reroute (FRR)
- VRRP
- IEEE 802.3.ad Link Aggregation Group (LAG)
- Pseudowire and LSP redundancy
- IP and MPLS load balancing by ECMP

Security
- RADIUS, TACACS+, and comprehensive control-plane protection capabilities
- Access control lists (ACLs): IPv4, IPV6, and MAC access lists
- SNMPv3
- Secure Shell (SSH)

2.3   Altiplano Access Controller

Nokia will provide and install the Nokia Altiplano Access Controller on ConnectSuperior provided server resources as the Management System for monitoring and provisioning of the network. Please refer to the attached datasheet for more details.

The Nokia Altiplano Access Controller as the SDN Domain Controller for Fixed Access, is a cloud-native modular software architecture solution for global management capable of controlling all access technologies (Cable, PON, DSL, fixed wireless access, Access Aggregation, BNG, Active Ethernet). It is designed to support the right levels of abstraction to enable programmability and automation.

The Altiplano Access Controller architecture is composed of microservices that run inside lightweight containers. Operators can install, upgrade, and elastically scale each microservice independently. Containers offer the highest possible adaptability for deployment on a virtual machine (VM) or bare-metal (BM), at a private or public cloud.
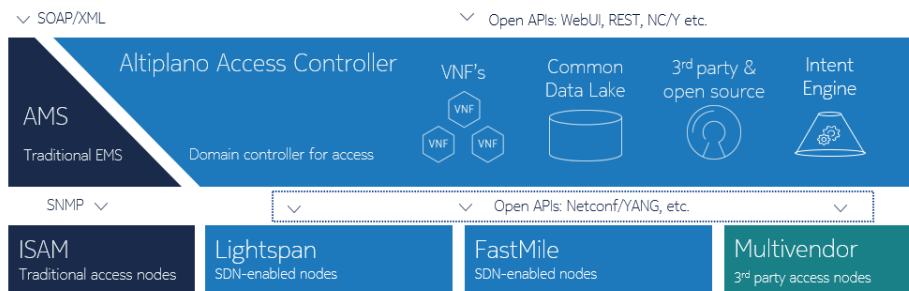
Altiplano Access Controller supports unified management of both SDN-enabled and traditional access networks. As fixed network operators begin to transition to the cloud, networks will be required to spend a considerable period of time in a hybrid physical/virtual state. The Nokia Altiplano solution will allow operators to evolve traditional Nokia fiber nodes to Lightspan SDAN programmable access nodes. With this, service providers can continue to manage their existing networks today and migrate to SDAN in the future when they want, without the need for replacing technology. Through a controlled software migration, operators can turn an existing ISAM FX shelf installed in the network into a SDAN Lightspan FX node. Once SDAN is applied to the network, operators will be able to easily manage a physical/virtual hybrid environment.

The Access Controller is made of two distinct but complementary functional blocks: Abstraction & Automation (A&A) running over Network Virtualizer (NV) to manage NC/Y devices. Abstraction & Automation also runs over other EMS equivalents to manage non-NC/Y devices, such as the Nokia 5520 AMS to manage Nokia SNMP access devices.
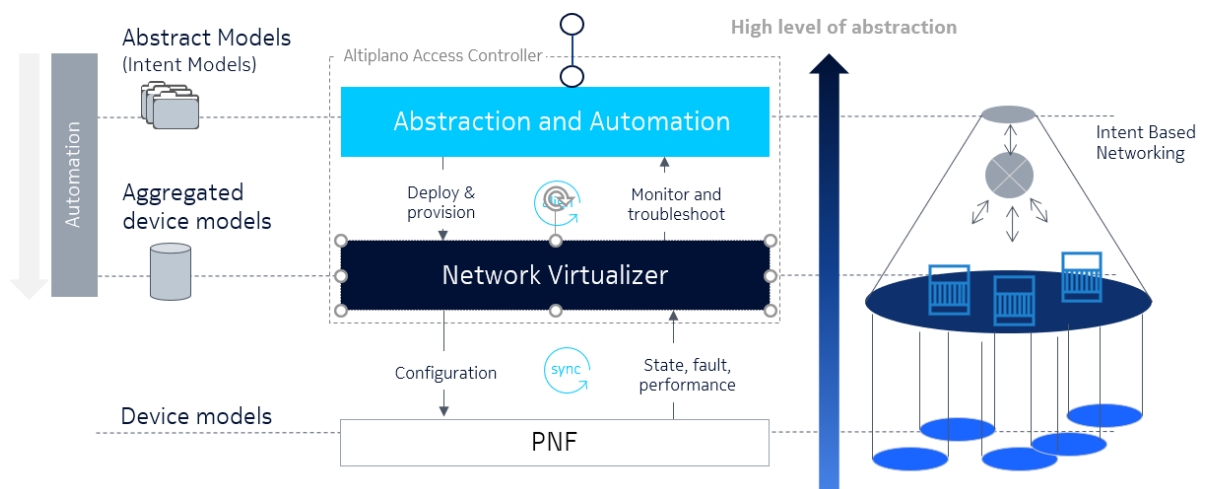
The Network Virtualizer is a next generation management virtualization software for managing access network devices using the NETCONF protocol and the YANG language.

Abstraction & Automation eases management of different types of access networks at a higher level of abstraction than Network Virtualizer and provides extended control capabilities including some capabilities that were typically provided in an OSS.

The features supported by the Altiplano Access Controller are organized into different applications presented in the landing page of AC. These applications are accessible at same time through the Web UI and through the NBI of AC. They are also accessible from an application switcher which is always accessible from any Web UI.

Some of the key features that Abstraction and Automation provides and will provide are: intent based provisioning, intent health, network visualization, ZTP (Zero Touch Provisioning) for device turn up, software campaign management, troubleshooting, alarms analysis, network utilization visualization, NGPON2 mobility management, network slicing, third party device management, etc.

Some of the key features that Network Virtualizer provides and will provide are:TR-301 standard PMA (Persistent Management Agent) based on BBF OB-BAA components, PMAA (PMA Aggregator), device software management, alarm management, logging, enhanced programmable interface (NBI) for device management as well as NV management, auto-device turn-up, multivendor support (standard devices), performance monitoring with different kinds of collectors (bulk, live), online configuration datastore versioning (online device backup in the Cloud), data persistency (including TCA, raw and derived metrics), virtualized alarm handling, network slicing and Type-B PON protection support

The Access Controller has a modular software architecture that operates in an open and disaggregated way. It is made of microservices, running inside containers orchestrated by Kubernetes. These microservices can be independently installed, upgraded and elastically scaled. The customer can customize the solution by selecting, mixing and matching these microservices with compatible services already running in its private or public cloud.

Functionally Altiplano comes with open development tools that will enable operators to customize provisioning abstract modules aka intents, PM models and topology which will result in a faster time-to-market.

From an OSS integration perspective, Altiplano supports integration with both Traditional and Cloud Native OSS Interfaces
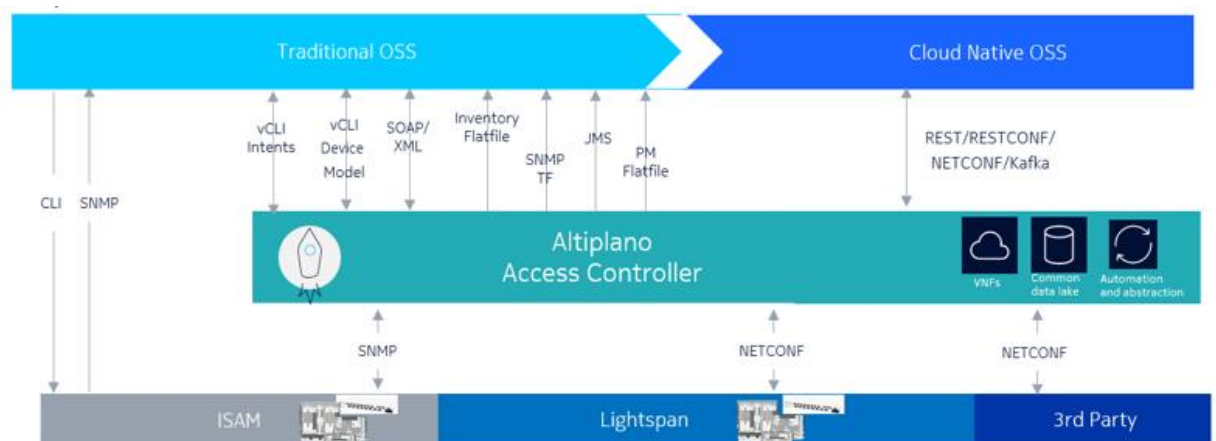
Overall, Nokia's SDN solution is a specialized access domain controller providing unified management of a physical, virtual, multi-vendor, multi-technology broadband access environment. All functions of Altiplano leverage a common data lake, it uses one shared message bus (KAFKA) to offer a coherent implementation of the SDN Services (Virtual Network functions, Telemetry functions, Close Loop Automation, provisioning, alarms management, ...).

Nokia's SDAN Solution is developed from its rich leadership in providing solutions for and supporting the world's largest access networks. Nokia's SDAN solution eliminates regrettable spend, provides a software upgrade path to 25G, offers the ability to create new services that increase ARPU and customer satisfaction, and reduces OpEx through automation and new operational tools that simplify backup and break/fix scenarios. An independent analysis performed by a service provider in Europe concluded that Nokia's SDAN Solution achieves significant, measurable improvements in time and cost associated with daily operational tasks as well as with ARPU. The figure below summarizes their findings and summarizes the benefits of Nokia's SDAN Solution.

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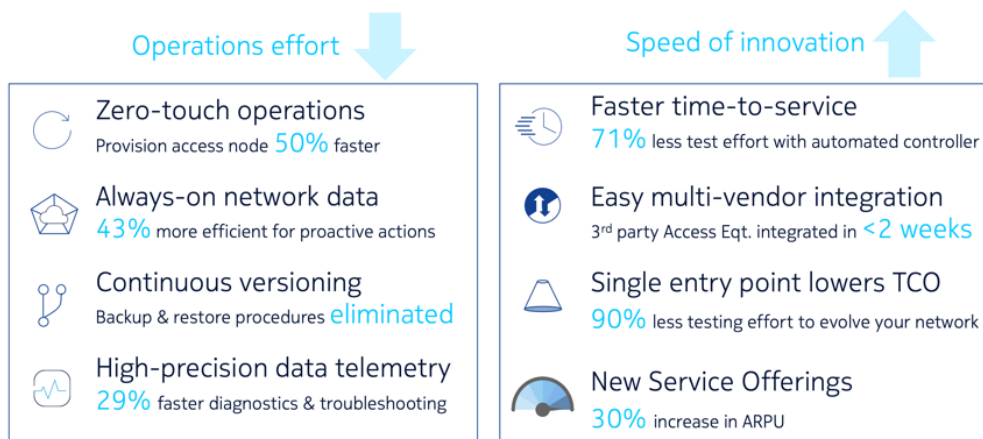
2.4 Corteca Home Controller

2.4.1 Overview

The Corteca Home Controller is a cloud-based solution that provides Wi-Fi management, radio resource management (RRM) optimization, and Wi-Fi insight visualization capabilities.

The cloud-based approach for Corteca Home Controller enables the RRM algorithms to have a holistic view of the network, and to combine information from multiple APs in a neighborhood to assemble a complete, cohesive view of APs, channels, clients and system performance—both real-time and historically. In cases where the Corteca Home Controller is unable to obtain certain metrics from a specific AP, the algorithms piece them together from other managed APs in the neighborhood. This enables the Corteca Home Controller to work with already deployed, potentially less feature-rich APs, as well as next generation APs.

The Corteca Home Controller can be implemented as a Nokia hosted solution (multi-tenancy or dedicated instance)/ or a CSP hosted solution (public or private cloud). For ConnectSuperior Nokia recommends a Nokia shared hosted instance.

Corteca Home Controller provides a Northbound Restful API to integrate its features with service providers OSS/BSS including device management, device provisioning, and statistics such as WAN and device usage.

2.4.2 Features

Features provided by the Corteca Home Controller are based on two licensing tiers.

The Corteca Home Controller L1 tier is mainly focused on real time support for the home network for customer care agents and basic cloud services. It provides:

- Real time management
- OSS/BSS integration
- Multi-vendor support (3rd party CPEs)
- Remote Mobile App access
- Individual configuration changes
- OTA service
- Performance and Ranking reports
- Reactive customer care case handling
- Real time home network analytics, topology, events, diagnostics, recommendations, etc.
- Speed test & latency tests
- Generate reports (e.g. firmware version, model, reachability status, etc.)

The Corteca Home Controller L2 tier complements Corteca Home Controller L1 tier by adding tools in the scope of WiFi monitoring optimization for network administrators. It provides:

- Radio resource management (RRM)
- Configuration, grouping & profiles
- Visibility & Analytics
- Network-wide view
- External analytics platform support

For an additional licensing fee the Nokia Home Device Manager (HDM) can be included with Corteca Home Controller as a microservice. HDM is the Nokia TR-069 server supporting traditional ACS device management functions. Functions provided by HDM include:

- Grouping & bulk device management operations
- Individual FW updates and backup and restore

The Corteca Home Controller L1 + HDM is recommended for ConnectSuperior. Please see attached presentation "Corteca Home Controller" for details.
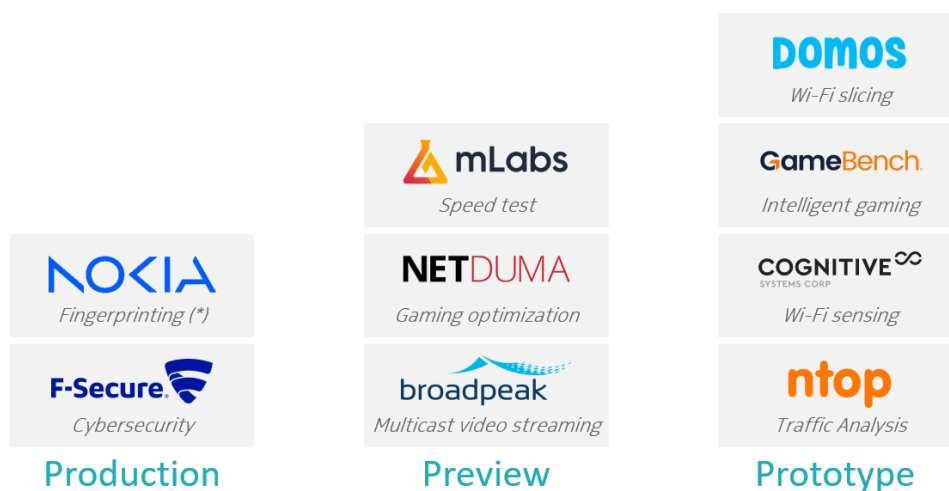
2.5   Nokia WiFi Mobile App

The Nokia WiFi Mobile app provides end users with an intuitive and simplified interface for self-install trouble-free management of their home network and WiFi. It also provides advanced functions such as guest Wi-Fi management and parental controls. Please see attached presentation "Nokia WiFi Mobile App" for details.

2.6   Nokia Application Containers

The Nokia Managed Wi-Fi solution is based on Nokia Home Networking OS which allows the support of containerized applications. The benefits are:

- Introduce standalone applications on residential gateways, with a potential for monetization

- Isolated from the gateway's firmware, portable, secure; includes full lifecycle management

- Eco-system of established app developers

- Ease of use for the end user: no need to install on every device, no need to update

Containerized applications in various stages of production

		DOMOS *Wi-Fi slicing*
	mLabs *Speed test*	GameBench. *Intelligent gaming*
NOKIA *Fingerprinting (*)*	NETDUMA *Gaming optimization*	COGNITIVE ∞ SYSTEMS CORP *Wi-Fi sensing*
F-Secure. *Cybersecurity*	broadpeak *Multicast video streaming*	ntop *Traffic Analysis*
Production	**Preview**	**Prototype**

Please see attached presentation "BBD Applications Overview" for details.

2.7   ONT Easy Start (Optional)

The Nokia ONT Easy Start is an optional automated xPON service activation solution that speeds time to market while at the same time dramatically improving OPEX and QoS.

The ONT Easy Start is a simple three step PON broadband service activation process that can be performed by the end-user by:

- Subscribing to the broadband access service

- Connecting the ONT and logging in on the Easy Start self-service Web portal

- The PON broadband service is automatically tested and activated on the ONT

By automating a multi-step and complex process, the Nokia ONT Easy Start solution speeds up, simplifies, and transforms FTTH service activation into a radically simplified virtually error-free process.

The ONT Easy Start solution is a pre-integrated solution for automation of ONT and RGW service activation for new subscriptions and ONT replacements and can be used by a field technician or by the end customer enabling a self-activation capability.

This solution has been designed to complement the operation of Nokia XGS-PON/GPON portfolio. It is integrated with Altiplano, which means it supports both traditional ISAM SNMP as well as Lightspan NC/Y OLTs/ONTs.

With Nokia ONT Easy Start, operators can speed up installation and accelerate time to market. By remotely automating FTTH subscriber connections, operators get improved quality of service, fewer truck rolls and, more importantly, increased end user satisfaction.

Benefits of the ONT Easy Start solution include:

- Accelerated time to market
    - ONT can be shipped to end user or picked up from store
    - ONT is automatically configured
    - Appointments for on-site installer no longer needed
    - Subscribers are connected more quickly
- Reduced Costs
    - If fiber is already installed, no truck rolls are needed for new service activation
    - Truck rolls for ONT replacement are avoided
    - Lower cost of customer care due to automated and simpler self-provisioning
    - In case of field technician installation and activation of an ONT will be fast and simple, thereby limiting time on-site, redo's and need for training
- Improved Quality of service
    - First time right activation—automation reduces the number of errors
    - End user self-provisioning—subscribers can do it on their own time without need to schedule an appointment

Please see attached presentation "ONT Easy Start Service Description" for details.

3   Rack Elevations

The following is a picture of the rack elevations for the PON and IP equipment:

7250 IXR-R6d
Interconnect Router

7360 FX-16
Optical Line Terminal
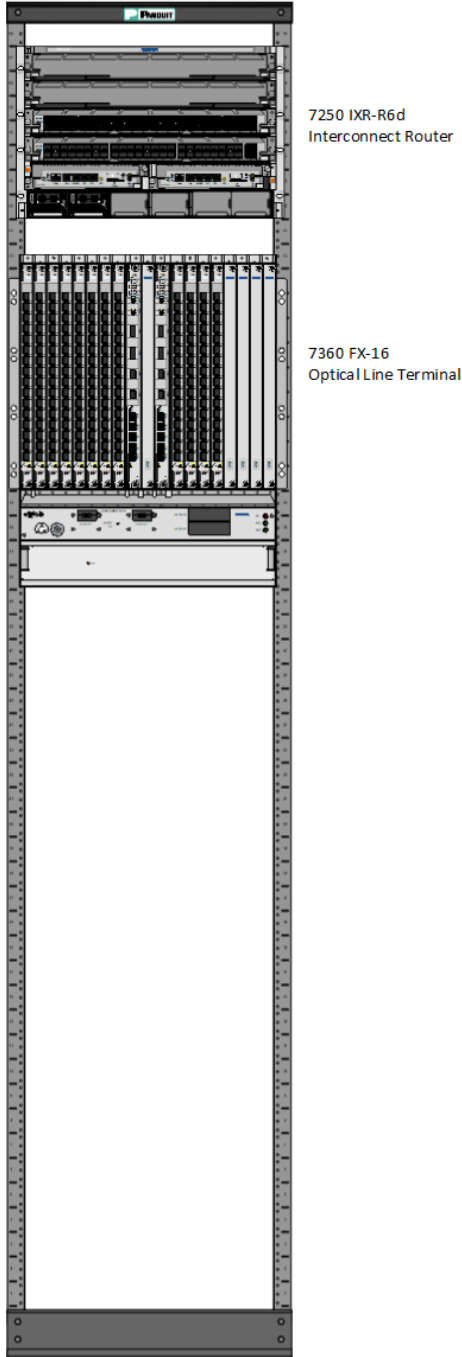
4 Customer References

4.1 Nokia Open Access Customer References

SiFi Networks

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Chelan County Public Utility District

Chelan, WA

Justin Cornea, Sr. Telecommunications Network Administrator

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Shentel

Edinburg, VA

Roland Silva, Manager of Network Engineering

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roland.silva@emp.shentel.com

American Tower

https://www.youtube.com/watch?v=6riYImVQ-3c

https://www.nokia.com/about-us/news/releases/2022/12/02/nokia-deploys-next-generation-fiber-technology-for-a-smarter-faster-and-greener-australian-national-broadband-network/

American Tower and Nokia deploy next-gen neutral host infrastructure for FTTH in Argentina - YouTube

American Tower's video testimonial about the deployment of an open access infrastructure for FTTH in Argentina. Learn more: https://www.nokia.com/networks/fix...

4.2   LightSpeed FTTP Customer References

Fort Dodge Fiber

Fort Dodge, IA

Jeremy Pearson, Director

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Knoxville Utilities Board

Knoxville, TN

Tim Corum, Manager of Fiber Network Operations & Engineering

Work: (865) 558-2063

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Greenlight Community Broadband

Wilson, NC

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City of Albany, GA

Albany, GA

David Walton, Inside Plant Project Manager

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5 Nokia Services

5.1 CARE Services

Nokia provides warranty, technical support and repairs/replacements through our CARE services. Standard warranty includes hardware defect repair/replacement for 12 months from the date of delivery. Technical Support Gold is available which provides 24x7x365 call receipt and remote diagnostic support. Please see the attached "FN Care Services Overview" attachment for detailed information on these services.

Nokia provides a standard 12-month warranty within the equipment price for each item. This 12-month period starts on the delivery date of the item to ConnectSuperior. When the 12-month warranty period for a particular item expires, annual Repair & Exchanges Services charges apply. Nokia has provided the pricing for Technical Support, Repair/Replacement, and SW Release Subscription.

5.2 Professional Services

The attached quote includes Professional Services for the Network Management System (NMS) solution install and configuration, along with the Lightspan OLT configuration and network integration. Nokia's Professional Services team will work with the ConnectSuperior engineers on requirements, create the detailed design and acceptance test plan (ATP) and then perform the engineering work to stand up and integrate the Fixed Network elements. We will do the initial testing to verify traffic flow and then work with the larger team on ATP to validate the end-to-end network. Nokia is also providing informal training which allows for ConnectSuperior to observe and ask questions on such topics such as design implementations, provisioning services, commissioning a new OLT and viewing PM metrics. ConnectSuperior will have access to all customer documentation, which includes equipment manuals and installation guides.

Nokia has also provided pricing for the equipment engineering, which would include the pre-installation planning and site survey for both the PON and IP equipment. The equipment installation quote provided assumes the equipment is being installed into an existing cabinet with power already available. Any installation-related materials (IRM) are not included and would be provided after the site survey.

End of document