Infinite Capacity Engine – Extensible (ICE-X) Network Demarcation Unit

Universal Network Edge Demarcation of XR Optics Networks

XR Optics Overview

Since the inception of optical networking, there has been a significant misalignment between actual network traffic patterns and the technology used to transport that traffic. Network traffic patterns, particularly in metro networks, are overwhelmingly hub and spoke, with numerous endpoints consuming traffic that is aggregated by a small number of hub locations. In contrast, optical connectivity solutions have been implemented using strictly point-to-point technology, where each end of the connection is required to operate at the same speed (1G, 10G, 25G, 100G, etc.). The result is an extremely inefficient transport architecture that requires large numbers of bookended transceivers, as well as numerous intermediate aggregation devices to "up-speed" traffic flows.

XR optics is the next major inflection point in optical transceiver technologies. XR optics utilizes digital signal processing to subdivide the transmission and reception of a given wavelength spectrum into a series of smaller-frequency channels called digital subcarriers. These digital subcarriers can be independently managed and assigned to different destinations, enabling the industry's first scalable point-to-point and point-to-multipoint, direct low-speed to high-speed optical transceiver connectivity. A single 400G XR optics hub transceiver generates 16 x 25 Gb/s digital subcarriers. One or multiple digital subcarriers can be combined and assigned to a specific destination to provide the required point-to-point or point-to-multipoint bandwidth.

Smooth Migration to XR Optics

XR optics pluggable transceivers are designed for a wide range of networking equipment. Many networking product categories can therefore make use of the technology, e.g., access and aggregation equipment, routers, Carrier Ethernet switches, wireless baseband processing systems, cable/MSO aggregation platforms, passive optical network (PON) headend aggregation systems, multi-access edge compute (MEC) servers, and leaf/spine carrier switches. In many cases, these systems are expected to be upgraded from 10G to 25G in the access to 100G and 400G link speeds in the aggregation layer. While many of the new systems that are being introduced into the market are designed to host coherent optics and will natively support XR optics, systems already operating in access and aggregation networks were designed for grey client optics handoff and cannot support coherent optical technologies.

Leveraging innovative XR optics technology, Nokia's suite of vertically integrated ICE-X pluggable DCOs offers network operators the performance, scale, and efficiency critical to delivering differentiated 5G, enhanced broadband, and next-generation cloud and business services. ICE-X pluggable DCOs support a range of transport rates, including 100G, 200G, 400G, and future 800G, and utilize industry-standard QSFP-DD and CFP2 form factors.

Key Benefits of ICE-X Network Demarcation Unit

- Maximizes return on investment by leveraging the enhanced economics of XR optics and Nokia's ICE-X pluggable DCOs for existing access and aggregation equipment that lacks native support

- Enables a physical demarcation function and standardized handoff between the ICE-X-based transport network and IP routing layer

- Enables any XR optics deployment model: point-to-point, point-to-multipoint (16 x 25G), and breakout (4 x 100G) operating modes over both single- and dual-fiber infrastructure

- Supports flexible bandwidth allocation through XR Virtual Traffic Interfaces

- Enables easy "plug-and-go" commissioning with default port mapping and media conversion settings

- Zero-touch provisioning (ZTP) for centralized capacity and service provisioning via a centralized management system

- Compact footprint and low power consumption

- Temperature hardened and ETSI 300 compliant

ICE-X Network Demarcation Unit

The Infinite Capacity Engine – Extensible (ICE-X) Network Demarcation Unit is designed to provide an effortless translation of ICE-X pluggable line optics into standardized client QSFP28 optics at 100G. These client optics also support 25G through a 4:1 breakout cable over distances of up to 2 km. This enables XR optics deployment in locations requiring 100G/25G grey optics handoff.

ICE-X Network Demarcation Unit

The ICE-X NDU enables the simple and cost-effective deployment of ICE-X pluggable DCOs in scenarios that do not support direct deployment in third-party devices. The ICE-X NDU also creates a demarcation point between 100G/200G ICE-X line optics and two QSFP28 100G client optical ports. Through the embedded Virtual Transport Interface of ICE-X pluggable DCOs, bandwidth can be sliced in steps of 25G up to the full bandwidth of the client interfaces. ICE-X pluggable DCOs support encryption functionality, and therefore the ICE-X NDU offers encrypted line-side communication between the remote ICE-X NDU location and the hub node.

Figure 1: ICE-X Network Demarcation Unit

Simple and Quick Commissioning

To accelerate turn-up, the ICE-X NDU has built-in automation and pre-staging functionality. The software can automatically map XR subcarrier bandwidth to client ports, providing "plug-and-go" operation that makes it easy to install and commission the ICE-X NDU into an operational state without any local manual configuration. This capability is further enhanced by zero-touch provisioning (ZTP) operation, which further eases the complexity that can be found in large-scale deployments. Based on an industry-leading secure IoT onboarding technique, the ICE-X NDU will automatically connect to a centralized management system that supports advanced features such as auto-discovery, automatic ICE-X subcarrier mapping, bandwidth upgrades, error propagation options, telemetry settings, and software upgrades.

Pluggable Amplifiers and Variable Optical Attenuator

ICE-X NDU supports two QSFP28 ports for pluggable optical layer amplifiers or variable optical attenuators (VOA). The pluggable amplifiers can be used as pre-amp or booster functions when the device is installed in remote locations that require additional optical amplification. Automatic power leveling is performed to avoid the need for manual optical settings. The pluggable VOA modules can be used when power levels require attention. The XR optics power control loop helps automate optical power settings during installation and ongoing operations.

Harsh and Limited-space or Low-noise Environments

The compact footprint, temperature hardening, and low-noise design of the ICE-X NDU make it ideal to install in various environments, including harsh environments such as street cabinets with extended temperature requirements (-20 to +65°C) and rack or desk mounts in office locations.

Thanks to a compact design, a pair of ICE-X NDU devices can be deployed in a single-rack-unit chassis in a 300-mm ETSI cabinet. This makes the ICE-X NDU ideal to support equipment and path redundancy when required.

Applications

ICE-X pluggable DCOs can be used for traditional point-to-point optical transport but also for point-to-multipoint transport. In point-to-point applications, the ICE-X NDU offers a cost-efficient alternative to transponder-based solutions for up to 200G coherent bandwidth in both dual- or single-fiber configurations. In point-to-multipoint applications, traffic aggregation at the optical layer enables cost-efficient low-speed to high-speed hub-and-spoke architectures.

The images shown are for illustration purposes only and may not be an exact representation of the product.

This optical innovation enabled by XR optics is applicable in most aggregation networks, such as metro access and aggregation, cable DAA, wireless xHaul, DSL/PON backhaul, and high-capacity PON overlay for business, mobile, and other services. For example, XR optics can be deployed to connect aggregation routers in an operator's central offices to hub routers at the operator's core sites. This is a generic application that can be applied to any operator's network and backhaul traffic, be it residential backhaul (OLT aggregation), mobile backhaul, or connectivity for business services.

Another example is 5G xHaul, where XR optics can be used to backhaul and aggregate traffic across any of the xHaul domains – fronthaul, midhaul, or backhaul. Cable MSO examples include Distributed Access Architecture (DAA), where many Remote PHY devices (RPDs) connect to a virtual Converged Cable Access Platform (vCCAP) or many Remote MAC-PHY devices connect to a router. ICE-X pluggable DCOs' ability to be deployed over single fibers (i.e., single-fiber working) make it a very compelling solution for backhaul, next-generation passive optical technologies such as XGS-PON and NG-PON2, and high-speed business services. Within PON networks, XR optics can be used to provide network operators with both a high-capacity coherent overlay for services that exceed the capabilities of the underlying PON network and backhaul for remote optical line terminal (OLT) nodes deployed deeper into the single-fiber PON fiber plant.
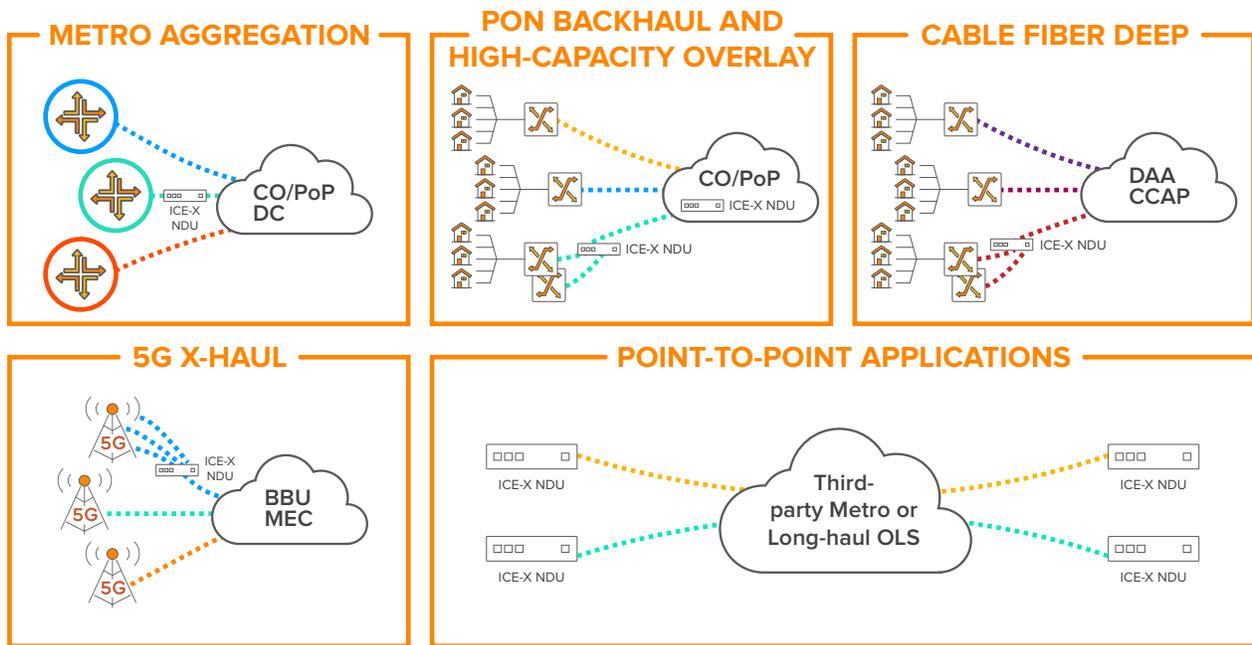

Figure 2: ICE-X network access and aggregation applications

Key Specifications

Applications
- XR 200G optics to 2 x QSFP28 and 100G/25G breakout

Pluggable Optical Layer
- Pre-amp and/or booster add/drop
- VOA

Network Demarcation
- Port handoff with client PM data
- Remote optical power control

XR Optics Modulation
- XR subcarriers with 16QAM, QPSK

Clients
- 100 GbE: 2 x QSFP28
- Breakout option: 25 GbE: 2 x QSFP28 to 2 x 4 x SFP28

XR Mode of Operation
- Port mode point-to-point and break-out mode

Virtual Transport Interface mode
- Shared downlink bandwidth

Management
- IPM Intelligent Pluggables Manager
- DCN
- Optical ZTP

Telemetry
- Subscription-based streaming telemetry via IPM

NOKIA

Dimensions
- 1RU, half slot, mountable ETSI 300 mm

Power
- Redundant DC or Single AC
- Power dissipation (max)
  - +25°C: 40 W (DC), 47 W (AC)
  - +55°C: 68 W (DC), 73 W (AC)
  - +65°C: 100 W

Environmental
- C-temp: NEBS Level 3
- Hardened: GR3108 Class 2
- -40°C (boot) -20°C to +65°C (operational) ambient

About Nokia

At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering networks that sense, think and act by leveraging our work across mobile, fixed and cloud networks. In addition, we create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

With truly open architectures that seamlessly integrate into any ecosystem, our high-performance networks create new opportunities for monetization and scale. Service providers, enterprises and partners worldwide trust Nokia to deliver secure, reliable and sustainable networks today – and work with us to create the digital services and applications of the future.