

An aerial, long-exposure photograph of a complex highway interchange at night. The image is characterized by vibrant light trails from vehicles, appearing in shades of blue, red, and white. A large, bold white 'X' is superimposed over the center of the image, dividing it into four quadrants. The text 'NOKIA' is positioned in the top-left quadrant, and 'Adaptive Cloud Networking' is in the bottom-left quadrant.

NOKIA

Adaptive Cloud  
Networking

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# 5G changes the game

**5G technology is disrupting the service provider industry in unprecedented ways. Much more than an enhanced version of its predecessors, 5G is fundamentally changing the way we think of and consume mobile services.**

The characteristics of 5G offers the ability to deliver mission-critical enterprise applications that were not possible with previous generations of mobile technology.

For service providers, this presents significant challenges, as they need to rethink the way they operationalize 5G deployments in order to reap the business benefits it brings.

Despite these challenges, communication service providers are investing heavily into 5G as one of the differentiating technologies of their future.

## A few characteristics of 5G ...

### 10 Gbps

Maximum 5G  
connection speed.  
10x 4G

Source: <https://www.3gpp.org/>

### 1 ms

Lowest expected 5G  
latency connection.  
50x lower than 4G

Source: <https://www.3gpp.org/>

### 5.7 Billion

Unique mobile  
subscribers in the  
world by 2025

Source: GSMA, The Mobile Economy, 2021

### 1.8 Billion

5G mobile connections  
by 2025... 21% of  
total connections

Source: GSMA, The Mobile Economy, 2021

### 900 Billion

Total operator CAPEX  
between 2021 - 2025

Source: GSMA, The Mobile Economy, 2021

### 80%

Percentage of CAPEX  
spent on 5G

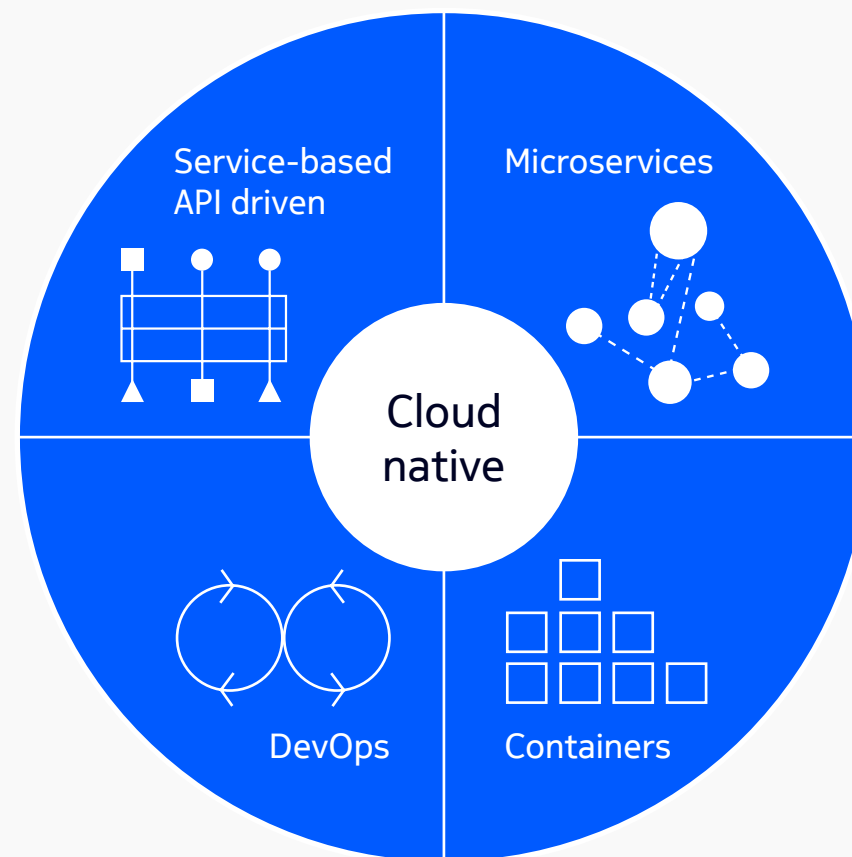
Source: GSMA, The Mobile Economy, 2021

# Cloud-native transforms networks

**Telco and cable cloud architectures are moving toward a cloud-native approach, which embraces a DevOps design methodology that allows for dynamic and agile application development techniques.**

Rather than relying on a monolithic application infrastructure, cloud-native takes a modular approach to building, running, and updating software through a suite of smaller cloud-based microservices.

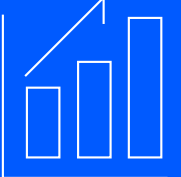
These microservices are often embedded into containers, which are standard units of software that package up code and all its dependencies, so the application runs quickly and reliably from one computing environment to another. In addition, this approach adopts API-driven service-based interfaces which eschews the rigidity of legacy pre-defined interfaces.



## Why networks need to transform

Due to massive increase in dynamicity of cloud-native applications, data center fabrics and edge cloud networks must transform to become more **responsive**, more **visible**, higher **performing**, more **scalable**, and operationally much more **productive**.

# CSP Challenges

|                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                   |                                                                                                                                                 |                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><b>Performance and scale</b>                                                                                                                                    | <br><b>Revenue and ARPU</b>                                                                                                                                      | <br><b>Operational productivity</b>                           | <br><b>Network complexity</b>                                                                                                                           | <br><b>Flexibility, visibility and control</b>                                                                                                    | <br><b>Far edge cloud growth</b>                                                                                                                                   |
| With 5G comes huge expectations for the performance and scale of enterprise services. In fact, these services are expected to have measurable SLAs attached to them, something that was not expected with previous generations of mobile technology. | CSPs are making massive investments in 5G technology with the expectation of being able to increase both revenue and ARPU. To succeed they need to evolve beyond the role of connectivity providers to become part of the 5G digital value chain. | As networks grow in complexity and scale, operational productivity must improve dramatically to satisfy the emerging operational demands of 5G. | CSP networks are becoming extremely complex. 5G is not replacing 3G/4G, but is being built separately with a cloud-native deployment model. In addition, service providers are distributing their network to various edge cloud locations. | CSP clouds have typically been built in vertical silos, and as a result they lack flexibility, visibility, and control. A horizontally integrated approach is needed to break down these silos and make the network more consumable. | CSP clouds are being distributed to the edges of the network. Although these “edge cloud” locations are very small and are both space- and cost-constrained, they still need to be managed. Automation of many tasks at these locations is essential. |

# Adaptive Cloud Networking

Addresses CSP challenges by providing the advanced tools and capabilities you need to transform your cloud network infrastructure to respond to the unpredictable demands of the 5G and cloud-native eras.

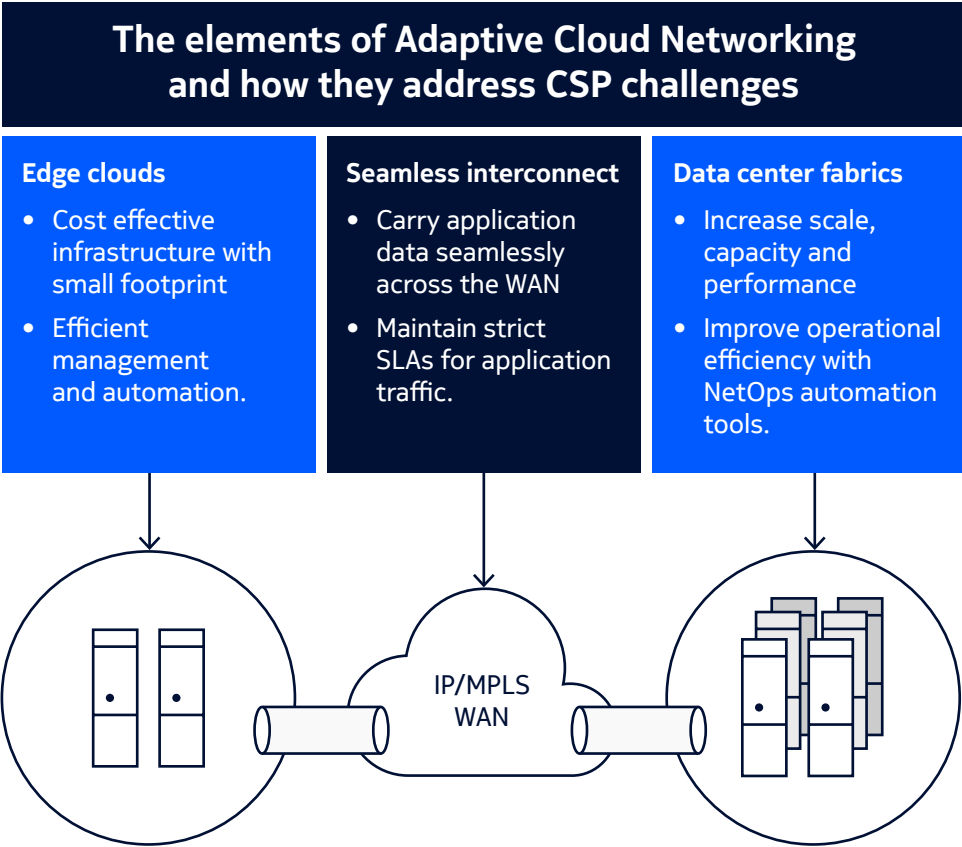
Adaptive Cloud Networking enables CSPs to address the challenges of implementing 5G and cloud-native networks by:

- Ensuring the performance and scale of enterprise services
- Enabling insertion into the 5G value chain to increase revenue and ARPU
- Improving operational productivity and efficiency as networks grow in scale
- Addressing increased network complexity as 5G is rolled out and the network is distributed to 1000s of edge cloud locations
- Increasing flexibility, visibility and control by making the network more consumable
- Automating management and operations at edge cloud locations.

Learn more about Adaptive Cloud Networking

A cloud-native IP solution, Adaptive Cloud Networking supercharges the data center fabric and seamlessly extends operations to the edge clouds. With it, your cloud network becomes a **consumable**, **agile**, and **automated** whole that gives you everything you need to capitalize on the 5G growth opportunity.

The solution provides these capabilities across the three areas of the network: the **data center fabric**, the rapidly emerging **cloud edge** of the network, and the **IP/MPLS WAN**.



# Adaptive Cloud Networking – products involved



## SR Linux NOS

An open, extensible model-driven NOS providing uncompromised visibility and control.



## Fabric Services System

A fabric management and automation platform that provides an advanced NetOps automation toolkit.



## Digital Sandbox

A digital twin of the production network that enables comprehensive network testing and validation.



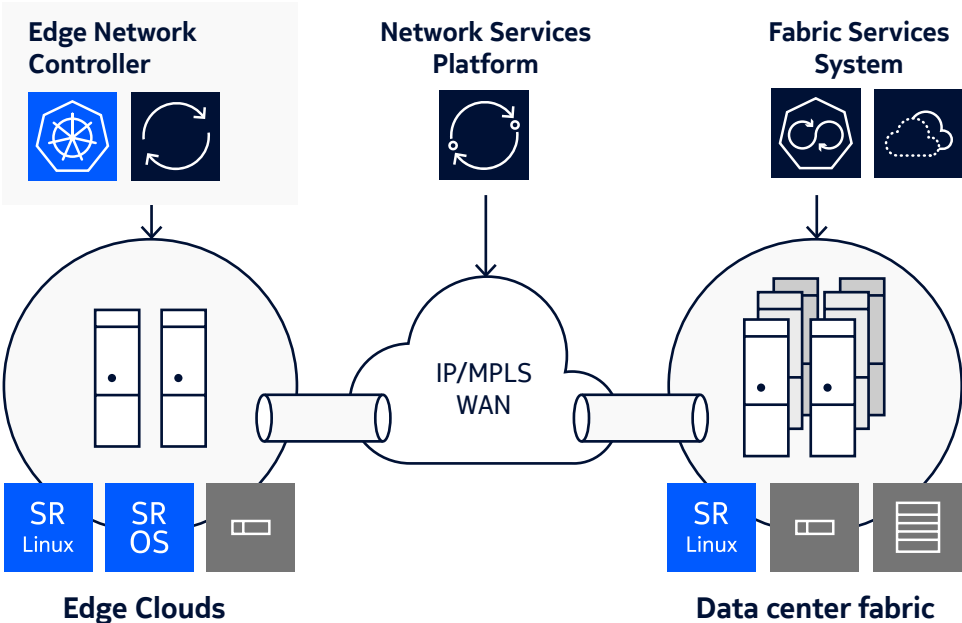
## Edge Network Controller

A lightweight, local automation platform for far edge deployments with a rich automation toolkit.



## Network Services Platform

A programmable platform providing automation to assure SLAs across any IP network.



## Nokia 7220 IXR/7250 IXR data center hardware platforms

High-performance, fixed-configuration and modular platforms to build open and automated data center fabrics.



## Nokia 7210 SAS/7750 SR IP router platforms

A range of industry-proven high-performance HW platforms, running SR OS.

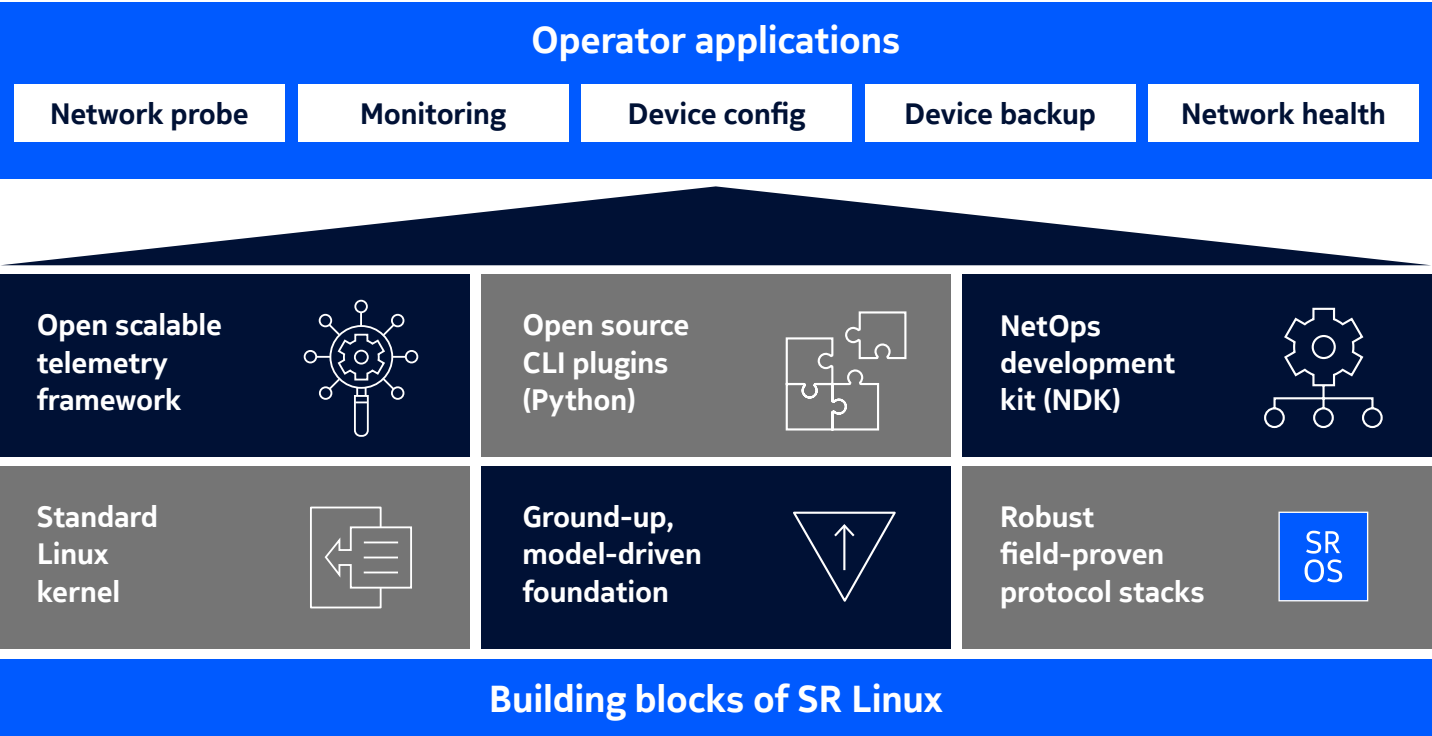
# Making data center networks more consumable

Today’s networks often lack the ability to easily extract the data needed to perform operational tasks at the velocity needed. Often, network data is extracted from various interfaces and then consolidated to create the insight needed. This process is slow, inefficient, and prone to errors.

In addition, network operating systems (NOS) are not architected to keep pace with the network data requirements demanded from them, which can result in a slow and inefficient process that can impact service.

Making data center fabrics consumable requires a sea change in how network operating systems are built. Adaptive Cloud Networking address this requirement by building a new NOS from the ground up. Nokia’s SR Linux NOS features an open, extensible, and model-driven approach that takes network consume-ability to the next level.

## How SR Linux makes data center networks more consumable



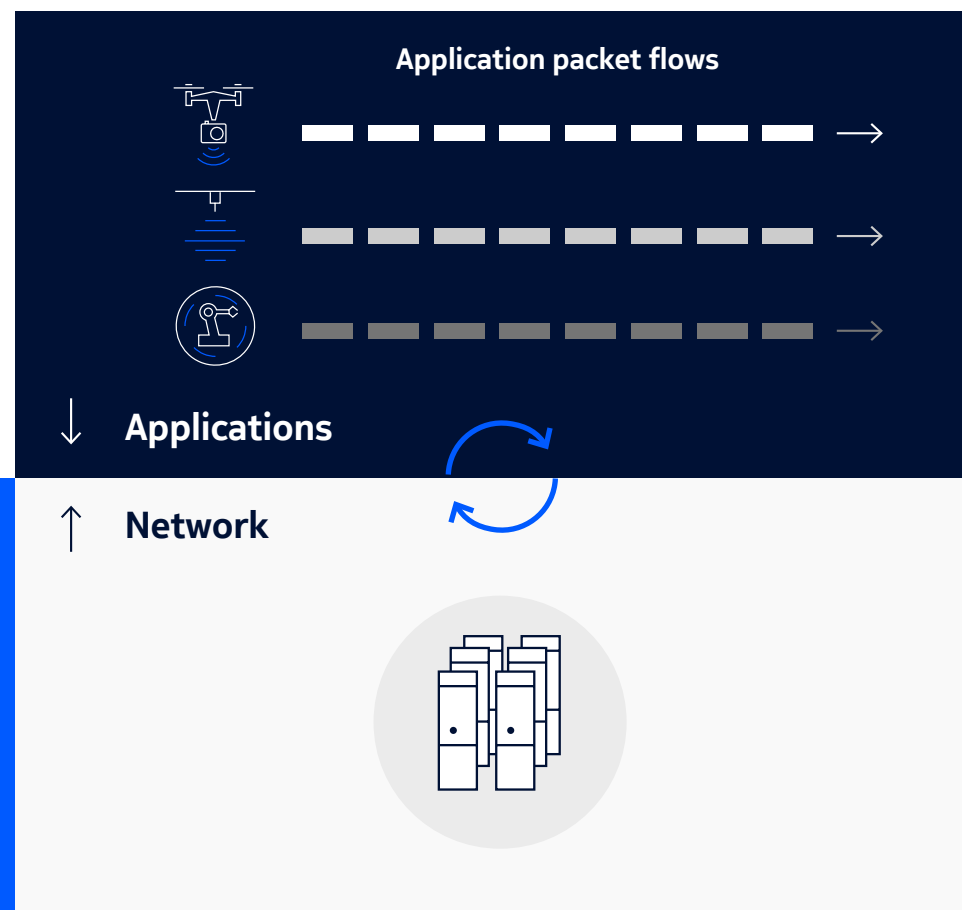
# Making data center networks **more agile** for 5G and cloud-native

The ephemeral native of cloud-native applications is putting much more strain on existing data center fabrics and edge clouds. Networks need to be much more responsive and need to react immediately to provide the constantly changing performance and scale needed. Networks need to be in “lock-step” with the applications.

Adaptive Cloud Networking empowers your network with the ability to adapt quickly to the constantly changing scale and performance requirements of the application layer.

## Fabric Services System

The Fabric Services System provides seamless integration into the major cloud management platforms, ensuring that the data center fabric stays in “lock-step” with the applications. This enables the data center fabric to react with agility to changes in the applications and provides the performance and elastic scalability as dictated by the applications.



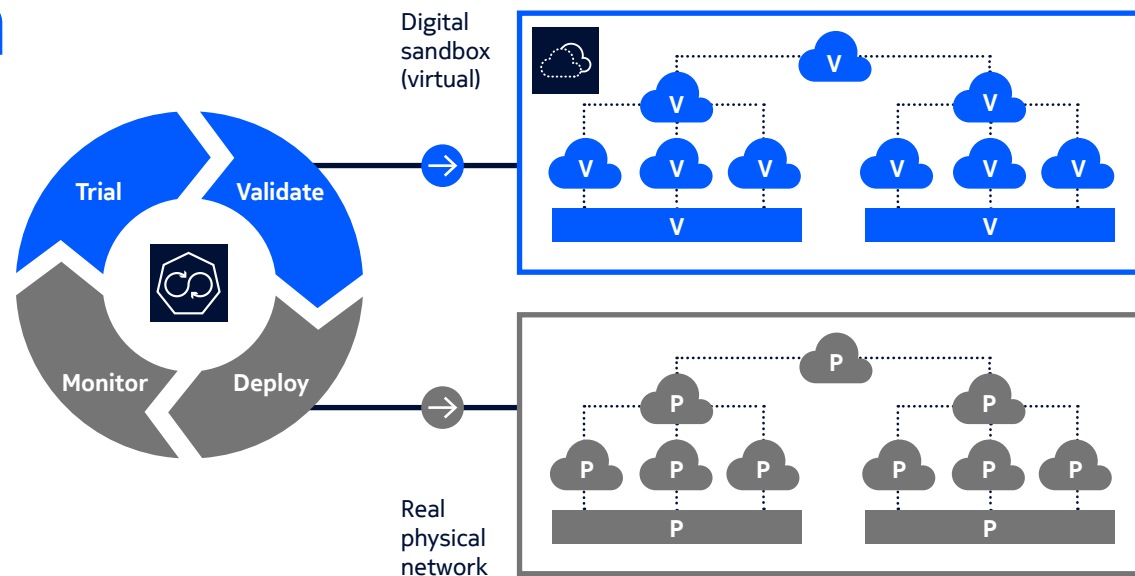
# Automating data center networks with DevOps/NetOps

As networks become more and more complex and cloud native application development processes are widely adopted, service providers need to re-invent their approach to operations.

This involves adapting DevOps processes and tools for the network and adopting NetOps technologies.

Adaptive Cloud Networking addresses these requirements by providing “built-in” NetOps automation capabilities including:

- Intent-based automation across entire lifecycle of the fabric’s lifecycle from Day 0 design, Day 1 deployment, and Day 2+ operations
- An approach for Continuous Integration and Continuous Deployment (CI/CD).



## CI/CD with Fabric Services System

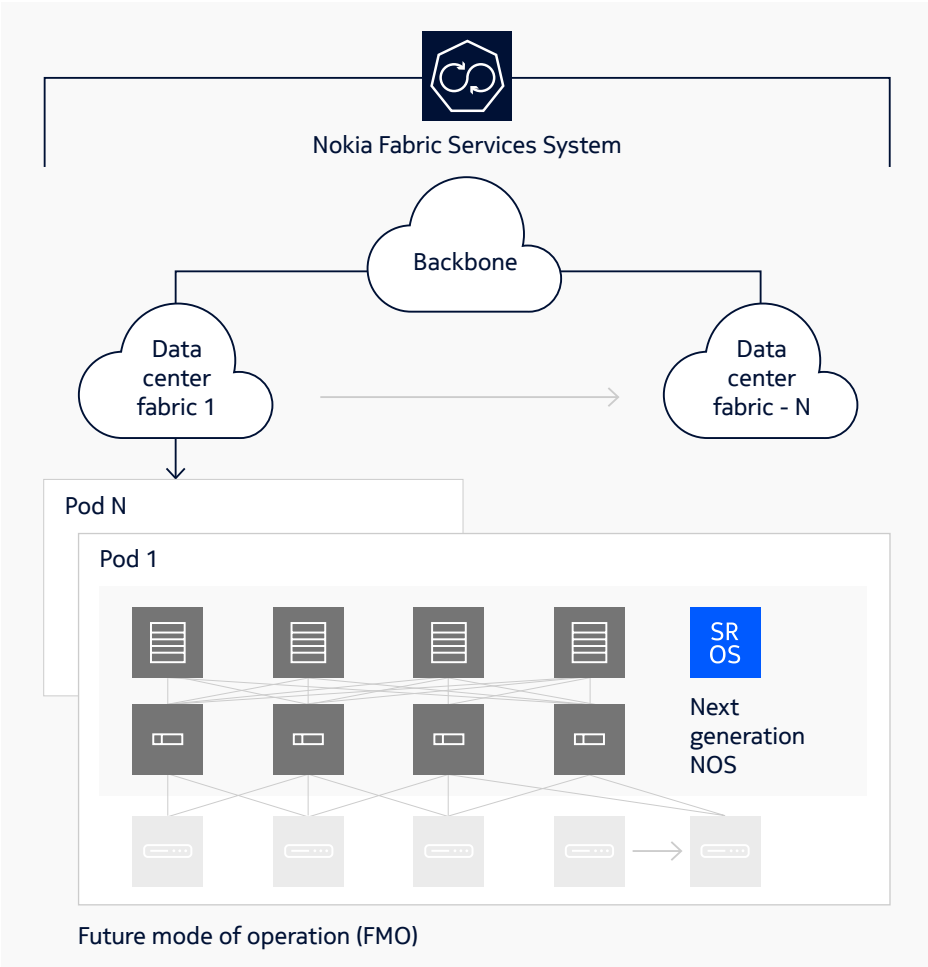
1. Digital Sandbox provides digital twin or exact replica of the fabric digital
2. Any network change is trialed and validated in the Digital Sandbox before being scheduled for deployment in fabric
3. Fabric is monitored and receives “on change” telemetry to ascertain any anomalies (configs, SW, faults, etc.) that deviate outside of desired intent
4. Candidate network changes are then trailed and validated in the Digital Sandbox.

# Reduce operational effort with Nokia Data Center Fabric solution

The Nokia Bell Labs Consulting business case analysis (BCA) models a migration scenario from a present mode of operation (PMO) to a future mode of operation (FMO). The PMO is a data center fabric based on a 10GE/40GE or 25GE/100GE leaf-spine architecture.

The FMO is a higher scale and capacity data center fabric based on a 10GE/25GE/100GE, 100GE/100GE or 100GE/400GE leaf-spine architecture. The FMO is powered by the Nokia SR Linux NOS running on Nokia’s high performance data center switching platforms (7220 IXR / 7250 IXR) and the Nokia Fabric Services System.

Learn more



Up to 40% cumulative effort savings

Over 4 years for all data center operations phases and associated tasks

Up to 43% effort savings

With Nokia SR Linux for specific operations tasks

Up to 60% effort savings

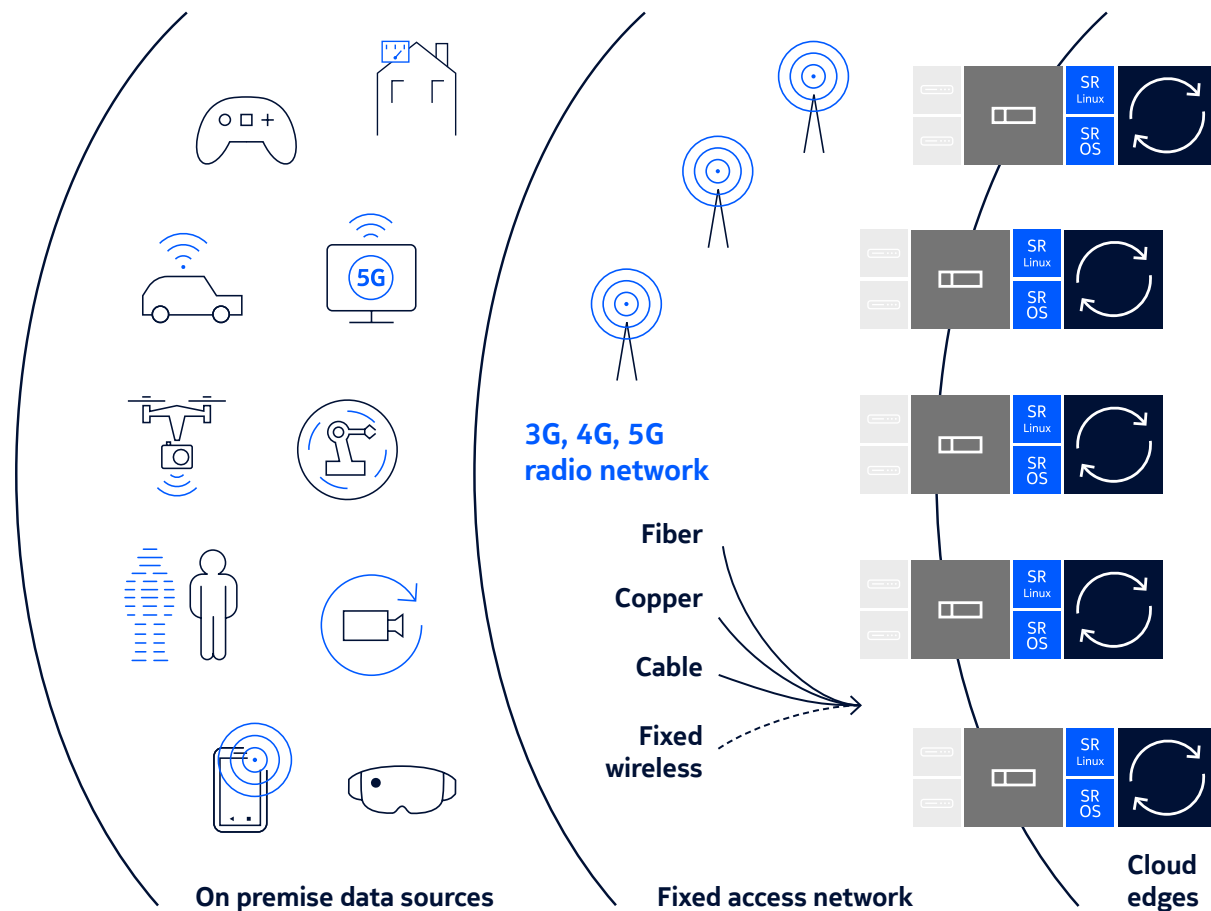
With Nokia SR Linux + Fabric Services System for specific operations tasks

# The edge cloud

Edge clouds are small sites located in baseband hotels, tower and rooftop sites, cable hubs, enterprise premises, office buildings, stadiums, airports, etc.

Edge clouds are both space and cost constrained yet still need to be managed and automated. Edge clouds need to maintain local autonomy with limited reliance on centralized control in order to scale efficiently.

Adaptive Cloud Networking provides a local light weight (up to 1 vCPU) automation platform ideally suited for the space and CPU requirements of far edge sites called the Edge Network Controller.



## Edge Network Controller

- Built within Kubernetes (K8s) the network is always available or consumable to the applications
- Provides declarative event driven network automation increasing network agility
- Enjoys runtime integration within K8s making both being able to operate autonomously
- Leverages the rich and complete K8s ecosystem and automation tools

# Enabling seamless interconnect across the WAN

**Often connections across the WAN are provisioned statically but this approach is rigid, costly, and does not scale. Interconnection across the WAN must be automated.**

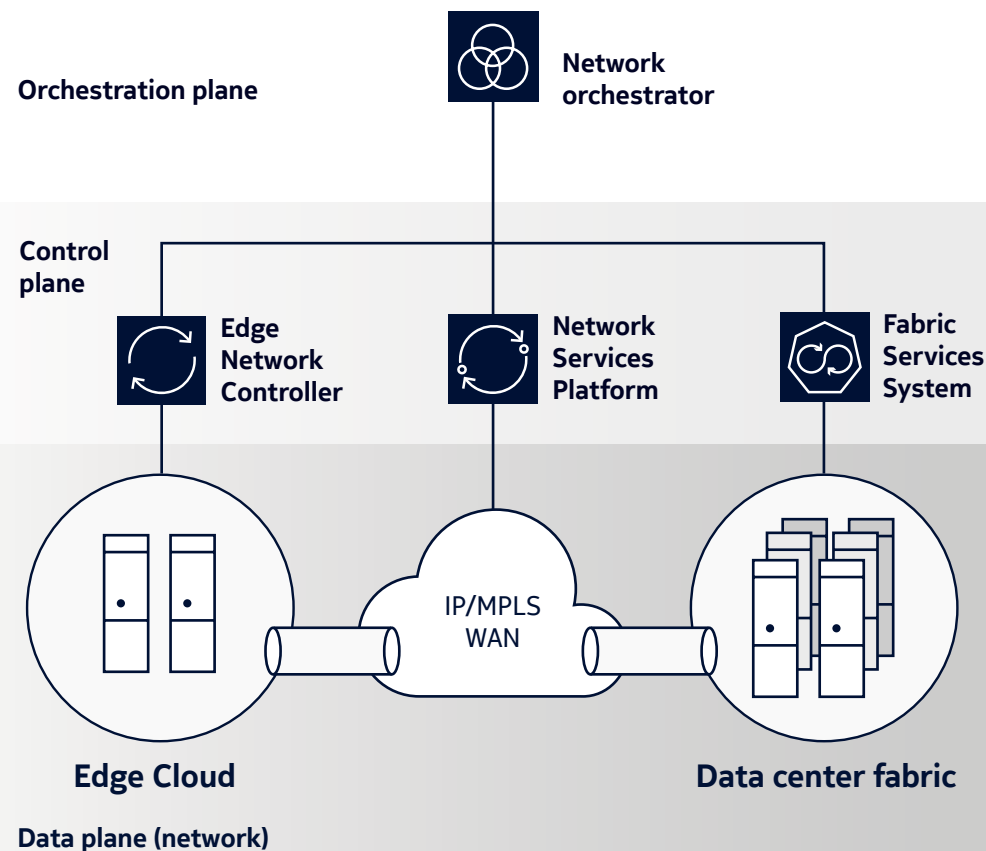
Adaptive Cloud Networking leverages intent-based orchestration across the network from the edge cloud to the data center fabric to provide:

- Automation of end-to-end connectivity
- Application and SLA-aware WAN automation
- Local automation at each location
- Co-ordination with all parts working together.

Adaptive Cloud Networking leverages domain controllers in each part of the network:

- Edge Network Controller for the edge cloud
- Network Services Platform for the WAN
- Fabric Services System for the data center fabric
- Network Services Platform for connectivity across the WAN.

The end result is seamless, per-application end-to-end connectivity that maintains SLAs.



## How seamless interconnect works

1. Network orchestration understands end-to-end network requirements and parses info as separate intent for each domain controller: Edge Network Controller, Network Services Platform, and Fabric Services System
2. Each domain controller then sets up its portion of the end-to-end connection and leverages its own intent approach to instruct the portion of the network it is controlling.

# Resources

**Adaptive Cloud Networking**

**Edge Network Controller Page**

**Read the White paper**

**Watch the video**





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### **About Nokia**

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

As a B2B technology innovation leader, we are pioneering the future where networks meet cloud to realize the full potential of digital in every industry.

Through networks that sense, think and act, we work with our customers and partners to create the digital services and applications of the future.

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