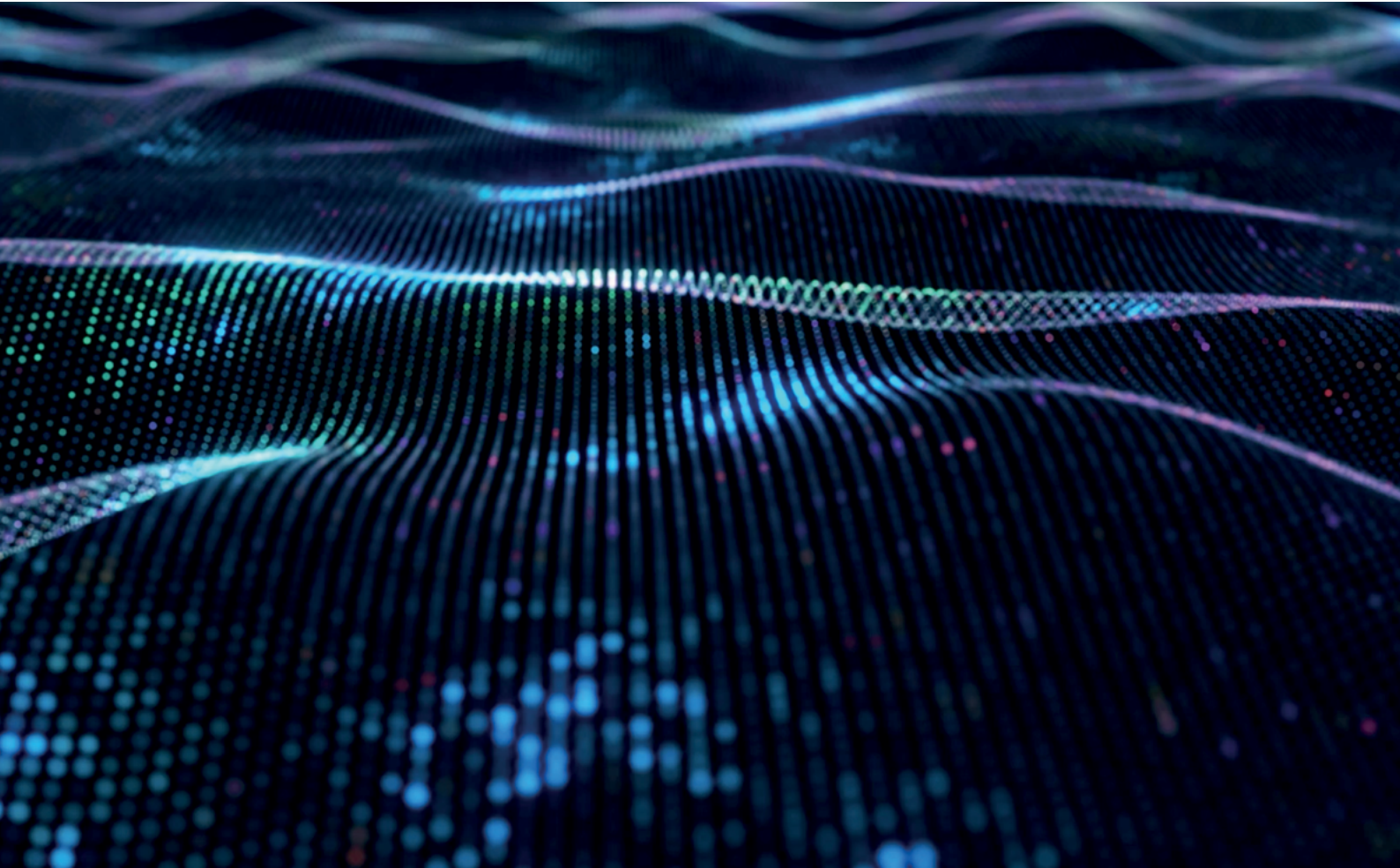


NOKIA



Nokia Data Center Fabric solution

Solution overview

Abstract

The demand for distributed cloud-based applications and services is growing rapidly and the ways that customers consume them are changing constantly. With data centers at the heart of the cloud delivery model, data center operators need networking solutions that scale easily and flexibly within buildings and across campuses and regions.

The key challenge facing data center network operators is to balance the need to constantly scale their networks and operations against the increasing costs of designing, building and operating them. This is driving the need to rethink how data center networks are designed and operated.

The Nokia Data Center Fabric solution enables data center operators to rapidly design and deploy, easily adapt and integrate, and confidently operate and automate data center network fabrics at scale. This document describes the Nokia Data Center Fabric solution and outlines its product components and key capabilities.

Contents

Abstract	2
Challenges for data centers	4
Introducing the Nokia Data Center Fabric solution	5
Nokia Service Router Linux	6
Nokia Fabric Services Platform	8
Fabric intent (as code)	9
Fabric operations	9
Fabric observability	9
Fabric integrations	9
Nokia Data Center routers	10
Benefits of the Nokia Data Center Fabric solution	10
Built for true openness	10
Routing at scale with resiliency	10
Automation and operations at scale	11
Summary	12
Learn more	12
Abbreviations	12

Challenges for data centers

Cloud providers, webscale companies, service providers and enterprises are all seeing increasing demands for the distributed, cloud-based applications and services they provide. Customers are accelerating their digital transformation to change the way they operate and do business, and consumers are changing their buying behaviors and attitudes to content consumption. Increasing demand for new services and applications such as 5G, the Internet of Things, artificial intelligence and Industry 4.0 is also driving the demand for edge computing and greater interconnection.

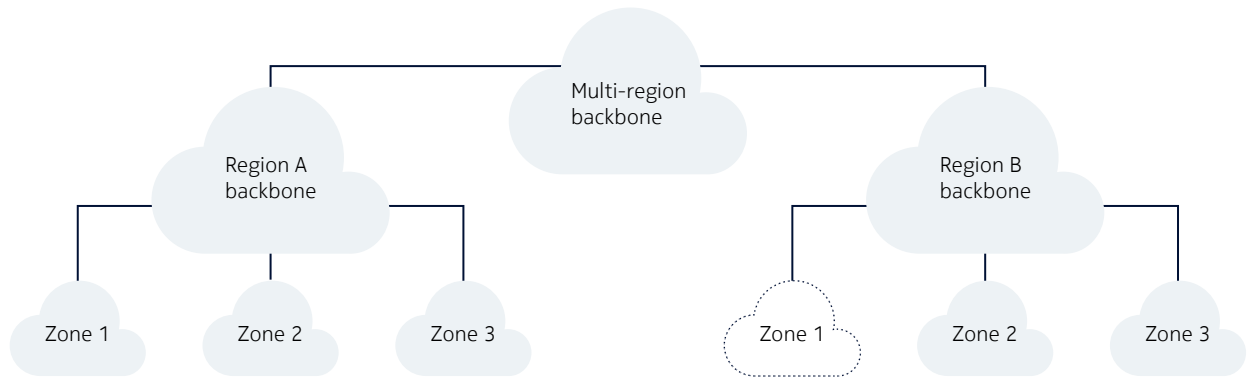
Data centers are at the heart of the cloud delivery model and the cloud experience. Growing demand translates into an increasing need for data centers that scale easily and flexibly within buildings and across campuses and regions. The data centers also need to be much more resilient and efficient.

Data centers have changed significantly in the last decade, including how they are designed, built and operated, and how data is processed, stored and accessed. Technical innovations have enabled much greater server density and processing capacity, higher storage capacity, greater energy efficiency, and more. New software methods such as containers, microservices and DevOps processes are now widely used to speed up application development and delivery.

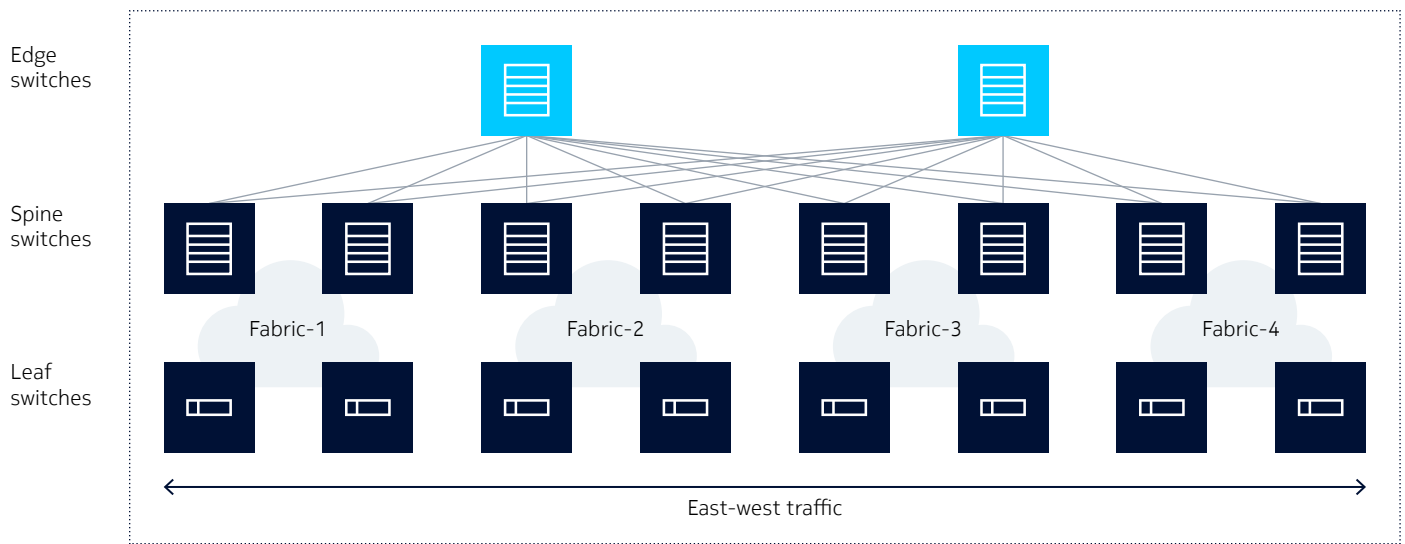
These changes have increased the demands on data center networks. The network is still the highway over which all data center traffic flows. East-west traffic or machine-to-machine traffic is the communication between microservices, application tiers or entire applications. This traffic has experienced tremendous growth and is driving important changes in data center network design to provide greater bandwidth within and between data centers.

Data centers are now predominantly designed using Clos principles and are increasingly adopting leaf-spine fabrics that are more scalable than previous designs, as shown in Figure 1.

Figure 1. Data center design using leaf-spine fabrics



Data Center, Region B, Zone 1



The number of network devices that require configuration and management has increased dramatically. Data center operators need networks that are more capable and intelligent without being too complex or too costly to build and operate. They also need solutions to build and operate on-premises, hybrid and multi-cloud data center networks.

The key challenge operators face is to balance the need to constantly scale their data center networks and operations against the increasing costs of designing, building and operating them.

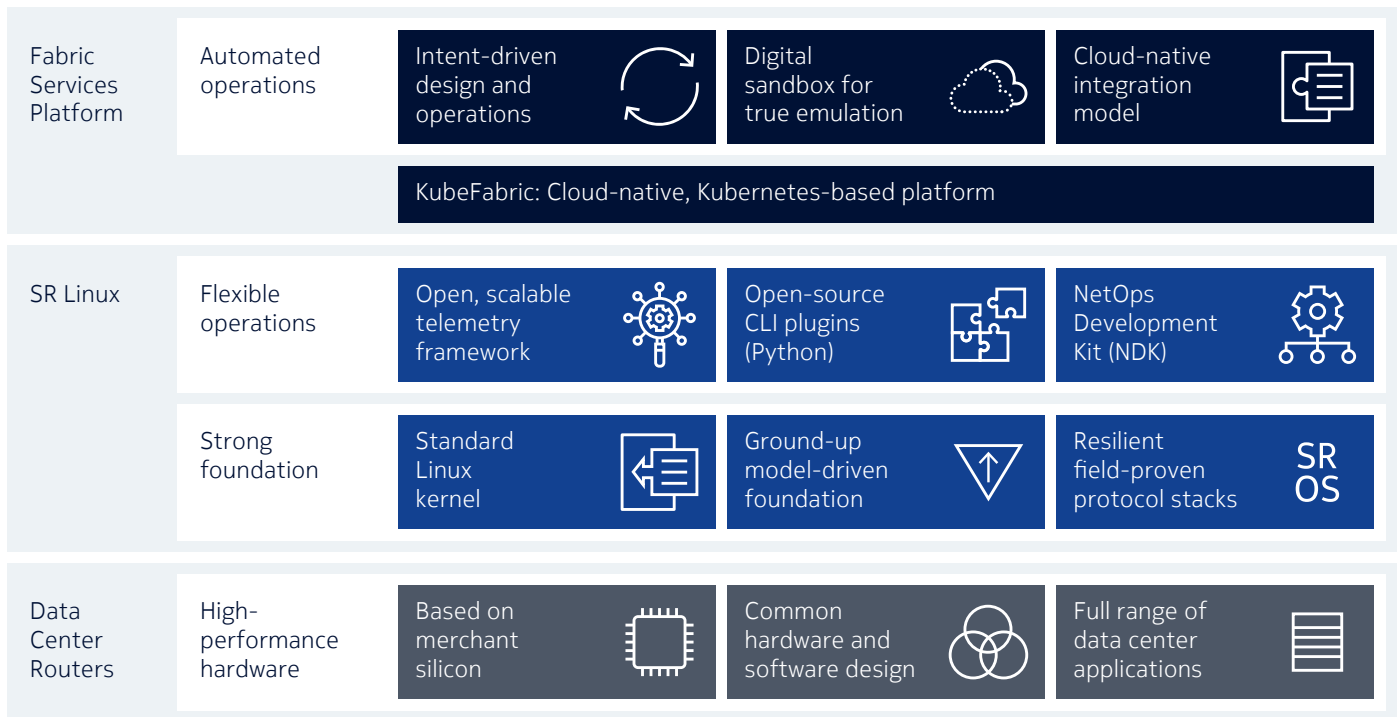
Introducing the Nokia Data Center Fabric solution

The Nokia Data Center Fabric solution is a next-generation data center networking solution that enables data center operators to rapidly design and deploy, easily adapt and integrate, and confidently operate and automate data center network fabrics at scale.

The Nokia Data Center Fabric solution shown in Figure 2 comprises the following products:

- Nokia Service Router Linux (SR Linux): An open, extensible and resilient network operating system (NOS) based on standard Linux® that enables scalability, flexibility and efficiency in data center and cloud environments.
- Nokia Fabric Services Platform: A declarative, intent-based automation and operations toolkit that delivers agile and scalable network operations for data center and cloud environments.
- Nokia Data Center routers: A portfolio of routers that deliver massive scalability, openness, aggregation and interconnection for data center and cloud environments.

Figure 2. The Nokia Data Center Fabric solution



The Nokia Data Center Fabric solution leverages Nokia’s expertise in IP routing and network operations, our Service Router Operating System (SR OS), our IP network automation solutions, and our proven track record of building business-critical Ethernet and IP/MPLS networks for service providers, webscale companies and enterprises globally.

Nokia Service Router Linux

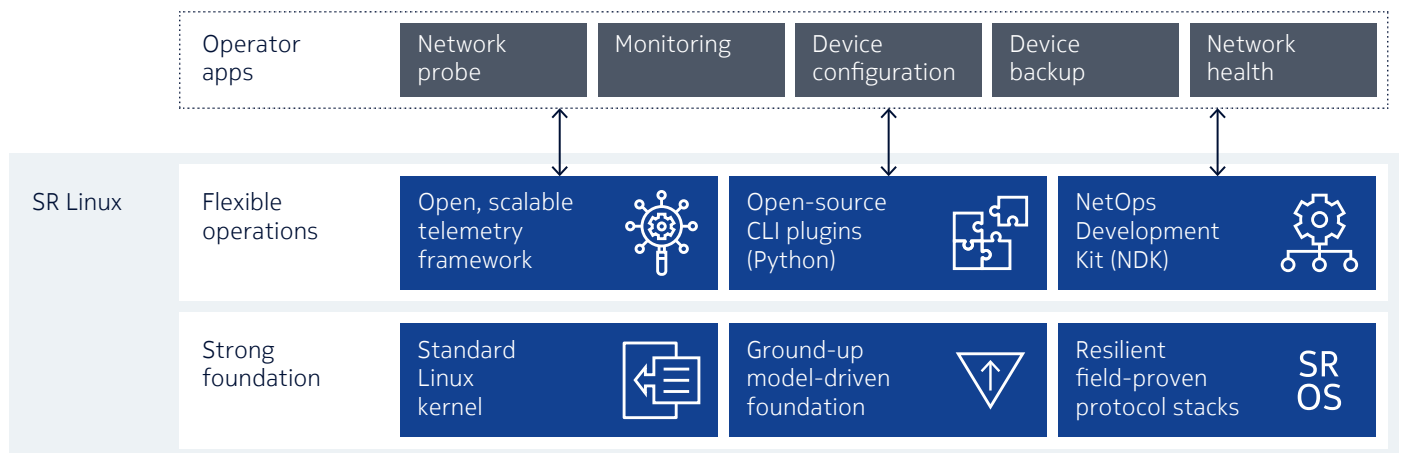
Nokia SR Linux was designed and developed to solve real-world challenges in on-premises, hybrid and multi-cloud data center networks, where the primary challenges are scalability, ease of operations, or both. A common approach to this problem is to simplify the data center network design, components and protocols. While this allows additional scalability, it reduces flexibility in a world of constantly evolving network requirements.

The overall network must still provide high levels of openness, programmability, reliability and extensibility to meet growing NetOps and agility requirements. These diverging requirements cannot be met by current industry solutions, and they were the genesis for the development of SR Linux and the Nokia Data Center Fabric solution to make data center and cloud environments easier to scale, adapt and operate.

Nokia SR Linux, shown in Figure 3, is a truly open and extensible Linux-based NOS that provides a set of modular applications that are isolated into their own failure domains. SR Linux uses an unmodified Linux kernel as the foundation on which to build a suite of network applications. This provides many benefits, including reliability, portability and ease of application development.

A central application manager is responsible for the life cycle of each application and provides full control of the protocols running on the system. This means only the applications required for a given environment need to be run, which simplifies administration and improves security. Using an unmodified kernel also speeds the availability of non-Nokia applications (for example, OpenSSH) and security patches for operating system components.

Figure 3. Nokia SR Linux



SR Linux implements a modular, state-sharing architecture and ground-up, model-driven management combined with field-proven protocol stacks from the Nokia SR OS. Together, these create a unique foundation that delivers superior openness, extensibility and resilience.

This strong foundation supports an open, scalable telemetry framework, plug-and-play integration via open-source command line interface (CLI) plugins, and a NetOps Development Kit (NDK) that enables operators to easily integrate third-party network applications and develop their own applications.

SR Linux provides high levels of openness, programmability, reliability and extensibility with the operational features that data center operators need for modern data center networking and operational agility. In summary, SR Linux delivers:

- A truly open and extensible Linux-based NOS that is fully programmable and massively scalable
- A complete, model-driven management architecture that enables simplified operations and greater automation
- Proven and mature IP routing protocol stacks that provide scalability and resilience

- Scalable streaming telemetry that provides unprecedented granularity and volume for ultimate network visibility
- A customizable, open-source CLI and on-demand, customized CLI commands that leverage the flexibility of Python
- An NDK that provides unrivaled support for integrating operator and third-party applications into the system.

For more information, see the [Nokia SR Linux data sheet](#) and the [Nokia SR Linux product description](#).

Nokia Fabric Services Platform

Companies building data center networks are faced with competing requirements: keep the design of the fabric simple and uniform to fully leverage predictable automation at scale, but also deliver flexibility for a highly dynamic operational environment. Modern data center fabric management solutions must:

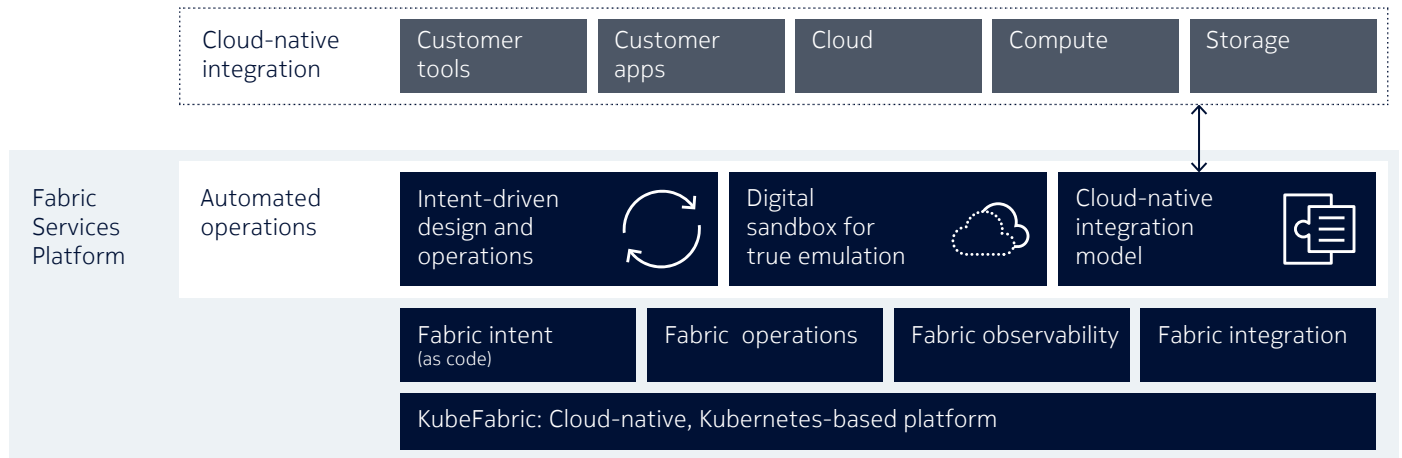
- Provide intent-driven automation
- Scale within and across data center and cloud environments
- Offer extensive telemetry analytics
- Leverage opensource platforms to support flexible deployment options
- Integrate seamlessly with existing platforms for all workloads.

The Nokia Fabric Services Platform provides openness, flexibility, resiliency and automation to make data center and cloud environments easier to scale, adapt and automate by providing the next-generation tools that achieve all these goals.

The Fabric Services Platform leverages Kubernetes and its open components combined with our specific innovations to deliver a unique platform foundation called "KubeFabric" (see Figure 4). All fabric services use a distributed microservices approach, delivering a truly cloud-native automation and operations platform for data center and cloud environments. Operators can also take advantage of the KubeFabric foundation with the option to include customized or third-party apps within the solution.

Nokia chose to use Kubernetes because it offers stability and scalability. Data center operators can deploy the Fabric Services Platform on their existing Kubernetes infrastructure or they can use packaged Kubernetes infrastructure and platform components provided by Nokia.

Figure 4. Nokia Fabric Services Platform



With a Kubernetes-based extensible platform providing a solid foundation, the Fabric Services Platform provides four key capabilities.

Fabric intent (as code)

The Fabric Services Platform is designed from the ground up to represent fabric as code. We represent all the intent and configuration state of the data center fabric in a declarative way in YAML format; this lays a strong foundation for continuous integration/continuous deployment (CI/CD) of network infrastructure, thereby fitting into the bigger movement toward infrastructure as code.

Fabric operations

The Fabric Services Platform is designed to improve fabric operations through faster deployment and low-risk fabric operations. Certified fabric designs simplify and decrease fabric design times. A digital sandbox enables low-risk Day 0, Day 1 and Day 2+ operations such as fabric design planning, change management and troubleshooting by emulating and running SR Linux instances virtually, creating a digital twin of the live production network.

Fabric observability

The Fabric Services Platform receives granular and comprehensive telemetry data from SR Linux and stores the data collected in a scalable purpose-designed lightweight database. This data is available for any application to use by leveraging the Kubernetes-based infrastructure. The operator receives visual intent-driven alerts when the network configuration or state does not reflect the design defined by the intent. Closed-loop resolution provides a continuous audit process.

Fabric integrations

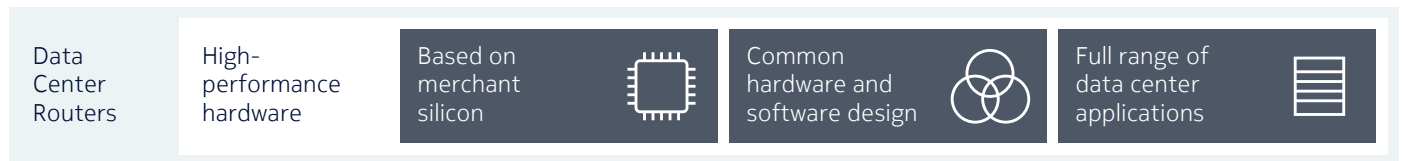
The Fabric Services Platform supports extensible northbound application programming interfaces (APIs) to enable a flexible cloud-native approach to integration into an operator's environment with minimum development effort; for example, integration with fault, performance management, trouble ticketing, provisioning and security systems. The platform also allows cloud-native integration in a loosely coupled fashion with customized or public cloud environments within a standard Kubernetes framework. The Kubernetes infrastructure also enables operators to add their own applications to the management stack and leverage network state and telemetry.

For more information, read the [Nokia Fabric Services Platform product description](#).

Nokia Data Center routers

The Nokia portfolio of Data Center routers, shown in Figure 5, addresses the needs of modern data centers. The portfolio includes the Nokia 7250 IXR-10/IXR-6 Interconnect Routers for data center fabrics and the Nokia 7220 IXR routers for data center fabrics. The portfolio offers a broad range of high-performance platforms for data center leaf-spine deployments. Both modular and fixed-form-factor platforms are available, enabling data center network teams to choose the appropriate hardware while maintaining the same SR Linux NOS and its benefits.

Figure 5. Nokia Data Center routers



For additional information, see the [Nokia Data Center routers portfolio web page](#).

Benefits of the Nokia Data Center Fabric solution

The Nokia Data Center Fabric solution based on SR Linux and the Fabric Services Platform has several key benefits that are outlined in the following sections.

Built for true openness

Nokia SR Linux is a truly open, modular and extensible NOS. It implements a ground-up, model-driven architecture that delivers superior openness and extensibility. It supports scalable streaming telemetry and a customizable, open-source CLI as well as unrivaled operator and third-party application support via the NDK for plug-and-play integration. These are all critical features for modern data center networking.

Using an unmodified Linux kernel as the foundation on which to build a suite of network applications provides openness as well as reliability, portability and ease of application development. Model-driven management with modern interfaces that require no translation layers opens up the NOS infrastructure, giving applications the ability to simplify their own internal schemas around data modeling languages and expose these schemas directly for consumption.

Routing at scale with resiliency

Data centers are now predominantly designed using Clos principles. Increasingly, they are adopting leaf-spine fabrics that are more scalable and use higher-speed connections to provide more bandwidth. These fabrics use Layer 3 routing protocols such as Border Gateway Protocol (BGP), Multiprotocol Extensions for BGP (MP-BGP), Ethernet VPN (EVPN) and Virtual Extensible LAN (VXLAN) to provide massive scale while avoiding single points of failure.

SR Linux was designed using field-proven protocol stacks from the Nokia SR OS, which has a strong pedigree with more than a million routers deployed in over 1,300 networks, including the internet backbone and some of the largest service provider, webscale and enterprise networks worldwide. By using these field-proven protocol stacks, data center operators can immediately benefit from the scalability, resiliency, stability and interoperability of a proven OS.

BGP is the main routing protocol used by the internet and is often the routing protocol of choice for large data center fabrics. The SR Linux BGP protocol stack from the SR OS enables highly scalable data center fabrics with the benefit of almost 20 years of development, testing and proven deployment in live networks.

SR Linux enables data center operators to build large BGP-based fabrics, especially when using EVPN to extend Layer 2 networks. BGP provides automated neighbor discovery and EVPN supports network isolation and network slicing by traffic type, application or security need.

By leveraging the Link Layer Discovery Protocol (LLDP) to assist in BGP configuration, SR Linux overcomes the complex manual configuration normally associated with BGP. Combined with the Fabric Services Platform, SR Linux provides a complete solution for configuring and managing BGP and EVPN services in large data center fabrics.

Nokia field-proven protocol stacks and support for high-performance hardware when combined with the true open approach and foundation of SR Linux provides unmatched flexibility, extensibility and resiliency.

Automation and operations at scale

Nokia designed SR Linux and the Fabric Services Platform to enable confident automation and operations at scale.

The SR Linux NDK is powered by generalized Remote Procedure Call (gRPC) and Google protocol buffers (protobufs). Operators can develop their own applications in their choice of supported languages and have full access to the entire system. All third-party applications are driven by YANG models, which provide integration into northbound APIs, CLI and telemetry. Even the SR Linux CLI can be customized via plugins to enable customized, efficient operations.

The Fabric Services Platform provides a time-series database that collects telemetry data at scale and uses open tools such as Grafana and Kibana to render and display this data. The platform also has customized screens to display a combination of configuration and telemetry data that makes it useful for network operators. The combination of telemetry and state with correlation and visualization is the key to the platform enabling data center operations at scale.

The Fabric Services Platform digital sandbox emulates and runs SR Linux instances to create a digital twin of the live production network. The platform treats emulated network elements in exactly the same way as production elements. The digital sandbox can therefore provide confidence when testing network designs, changes, upgrades or failure scenarios without impacting the live network. The platform and the digital sandbox are critical tools that help data center network operators to mitigate operational risks.

The Fabric Services Platform achieves automation at scale via intent, and the Nokia solution takes this a step further by expressing intent as code (fabric as code). The platform takes intent as a declarative input and then generates appropriate configuration files for each network element. These inputs or configurations can be stored in a revision control system such as Git and become a key component of broader initiatives to manage infrastructure as code.

The Fabric Services Platform can also be used to automate network changes based on events or conditions detected via streaming telemetry to provide a complete automation life cycle.

Summary

SR Linux provides a solid foundation with a truly open and extensible Linux-based NOS, a model-driven management architecture and field-proven IP routing protocol stacks. With scalable streaming telemetry, a customizable open source CLI and an NDK, for integrating applications into the system, SR Linux also provides unrivaled operations support.

Combined with intent-driven automation, the digital sandbox for fabric emulation and a cloud-native integration model provided by the Fabric Services Platform, the Nokia Data Center Fabric solution enables operators to meet the challenges of building truly open, high-performance and reliable data center fabrics and operating them at scale.

Learn more

To learn more about the Nokia Data Center Fabric solution:

- Visit the [Nokia Data Center Fabric solution web page](#)
- See the [Nokia Data Center Fabric solution eBook](#)
- Read the [Nokia Service Router Linux product description](#)
- Read the [Nokia Fabric Services Platform product description](#)

Read the data sheets:

- [Nokia Service Router Linux](#)
- [Nokia 7250 IXR-10/IXR-6 Interconnect routers for SR Linux](#)
- [Nokia 7220 IXR-D series Interconnect routers for SR Linux](#)

Abbreviations

API	application programming interface	NOS	network operating system
AWS	Amazon Web Services	SR OS	Nokia Service Router Operating System
CLI	command line interface	SSH	Secure Shell
DevOps	development and operations	SR Linux	Nokia Service Router Linux
IP	Internet Protocol	YAML	YAML Ain't Markup Language (data serialization language)
MPLS	multiprotocol label switching	YANG	Yet Another Next Generation (data modeling language)
NDK	NetOps Development Kit		
NetOps	network operations		



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