



NOKIA

Data center
interconnection
for the cloud era

Enabling a scalable, dynamic cloud ecosystem with network automation

The demand for new distributed cloud-based applications and services changes the way we need to connect data centers in the cloud. AI, 5G, private wireless, IoT, Industry 4.0 and more all have varying bandwidth, latency and reliability needs. This increases the requirement for edge data centers and locations close to customers to run latency-sensitive applications and services while leaving others to run in core data centers.

Cloud applications and services dictate where each should ideally be processed and located. For example:

- Enhanced 5G mobile broadband applications requiring high bandwidth but best effort service can be processed in core or near edge data centers depending on requirements
- Applications that require ultra-reliable, ultra-low latency with redundant paths – such as robotics or autonomous vehicles – are best processed in far edge locations
- Dynamic applications that require massive connectivity and signalling but low bandwidth, such as IoT monitoring applications, are best processed in core data centers
- Some applications, such as AI, need additional compute and network resources, and elements may need to be processed in both edge and core data centers.

The data centers that make up the cloud form an ecosystem that enables digital transformation and the digital economy. This cloud ecosystem requires a highly interconnected data center infrastructure to deliver exceptional experiences for customers regardless of their location. It highlights the need for global and regional networks that connect and interconnect data centers in a scalable, secure, and reliable way. That's where Nokia comes in.

The big opportunity?

The cloud ecosystem lets organizations implement applications and services closer to their end users, customers and partners, which is why many are increasingly keen to use it.

For example:

- Enterprises undergoing digital transformation to support new applications such as IoT, AI, M2M and Industry 4.0, as well as disaster recovery and business continuity
- Cloud providers seeking to use interconnection to expand the footprint and reach of their applications and services into new markets
- Network operators and carrier providers that offer wholesale network connectivity services to connect customers to applications and services in cloud data centers
- Data center and interconnection providers implementing platforms and portals that provide their customers with dynamic access to the cloud ecosystem
- Mobile operators looking to extend 5G network roll outs more cost effectively by deploying cloud-based infrastructure.

Carrier neutral and colocation data center providers that have multi-tenant data center facilities and operate in key markets globally are ideally placed to offer computing, networking and interconnection services to support organizations as they implement edge and core cloud applications and services.

What are the challenges?

Players in the cloud ecosystem need to evolve their network architecture to support very large-scale data center interconnection.

They need to provide the bandwidth, connectivity and automation to support dynamic access to cloud applications and services whenever they are needed and wherever they are located – in core or edge data centers, or locations close to customers.

Today, connectivity to cloud data centers is enabled by complex, multi-layer networks with little or no integration between layers and outdated operations practices. Tomorrow's cloud infrastructure needs more integrated networks to provide data center interconnection that is more reliable, resilient and secure, and that reduces operating costs and improves efficiency through automation.



The solution is automated data center interconnection

Data center interconnection based on an agile, flexible and automated IP/optical infrastructure can support current cloud application and service requirements and anticipate future demands. As shown in Figure 1, it provides:

- **Connection** – Connect data centers using optical networking that maximizes fiber capacity for point-to-point, mesh and ring topologies while containing operations costs
- **Interconnection** – Interconnect data centers with IP routing that provides secure peering, gateway and IP edge functions with an optimized high-performance IP core
- **Automation** - Automate multi-layer network operations to reduce complexity, optimize resources and respond quickly to fast-changing demand.

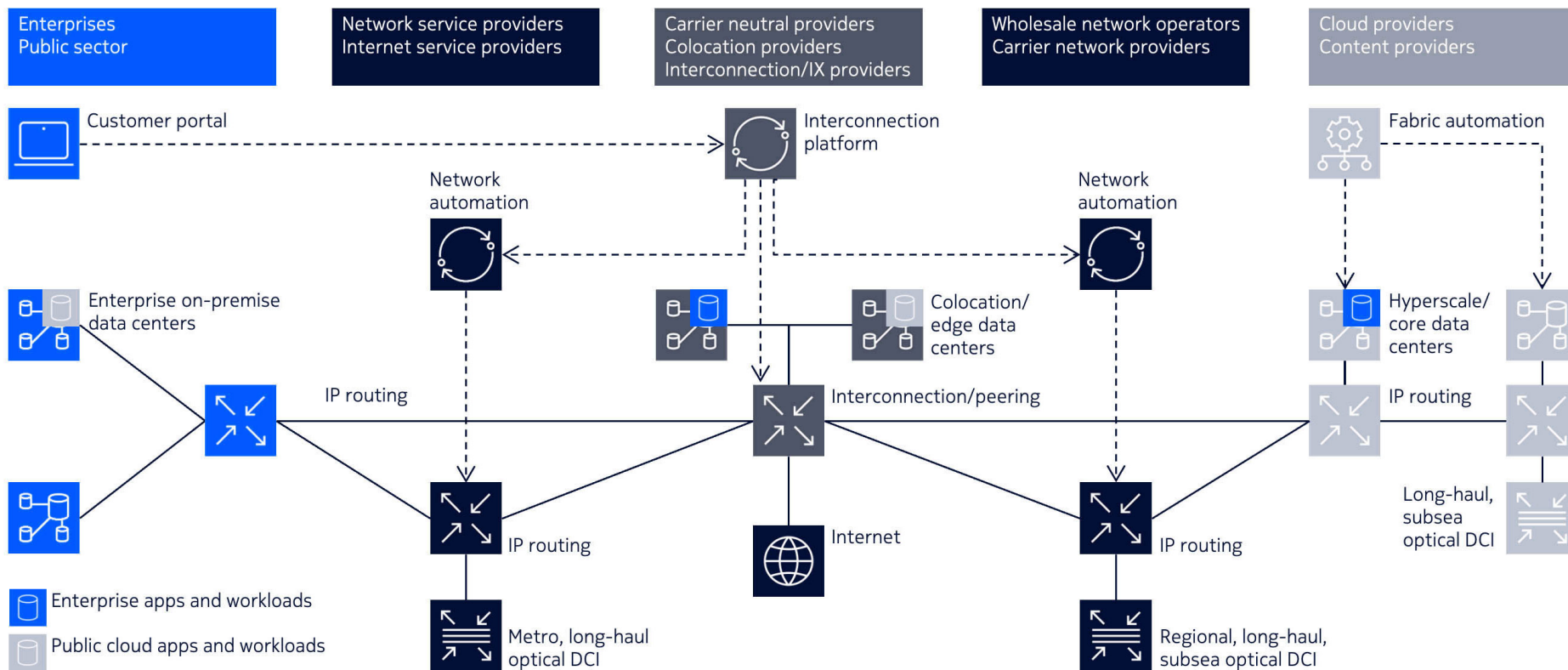


Figure 1: Automated data center interconnection

The customer benefits

Using cloud data centers with rich interconnection ecosystems provides attractive business benefits to enterprise customers, including:

- **Improved security** - Applications and services can be accessed via private direct connections to the ecosystem of cloud providers collocated in the same facility without traversing the internet
- **Reduced transport costs** - Collocated service providers, alternative network providers and carrier-neutral network operators offer a wide choice of connections to remote destinations
- **Higher performance and lower latency** - As connections are direct, they reduce latency and are more reliable as they bypass multiple hops across the public internet
- **More control** - Through network automation and via customer portals, enterprises can gain more control of their cloud connectivity
- **Greater flexibility** - With a wider range of connectivity options, enterprises can distribute workloads and access cloud applications and services globally to meet business demands and to gain access to new markets.



The power of automated multi-layer networks

Automation of multi-layer networks allows the underlying IP and optical network infrastructure to be abstracted, automated and optimized dynamically. It enables the convergence of optical and IP networks by optimizing routing and transport across multiple network layers, while being aware of the SLA requirements of cloud application and service traffic.

Multi-layer, cross domain control provides coordinates between IP routing and optical transport, managing cross-domain services and optimizing resources for data center interconnection as shown in Figure 2.

The cross domain controller provides intelligent resource control for multi-domain IP/optical networks. It dynamically creates optimal paths across multiple domains that are separated by IP/optical or vendor boundaries and provisions hybrid IP/optical services by selecting the best path for the application or service based on available network resources.

The cross domain controller is critical for hybrid IP/optical networks

where multi-layer path provisioning is often a long, complex and manual process. Multi-layer optimization also ensures more efficient use of network resources than techniques that optimize the IP and optical layers independently.

AI and machine learning allow the cross-domain controller to improve network efficiency by automating complex and repetitive tasks. Open, model-driven interfaces allow customized and automated workflows that translate operational intent into proactive and corrective actions. Model-driven programmability optimizes network traffic in real time and programs the network to meet operational goals based on an organization's business needs.

The open APIs also enables integration with providers interconnection platforms and customer portals, enabling their customers to self-provisioning access to cloud applications and services wherever they are located.

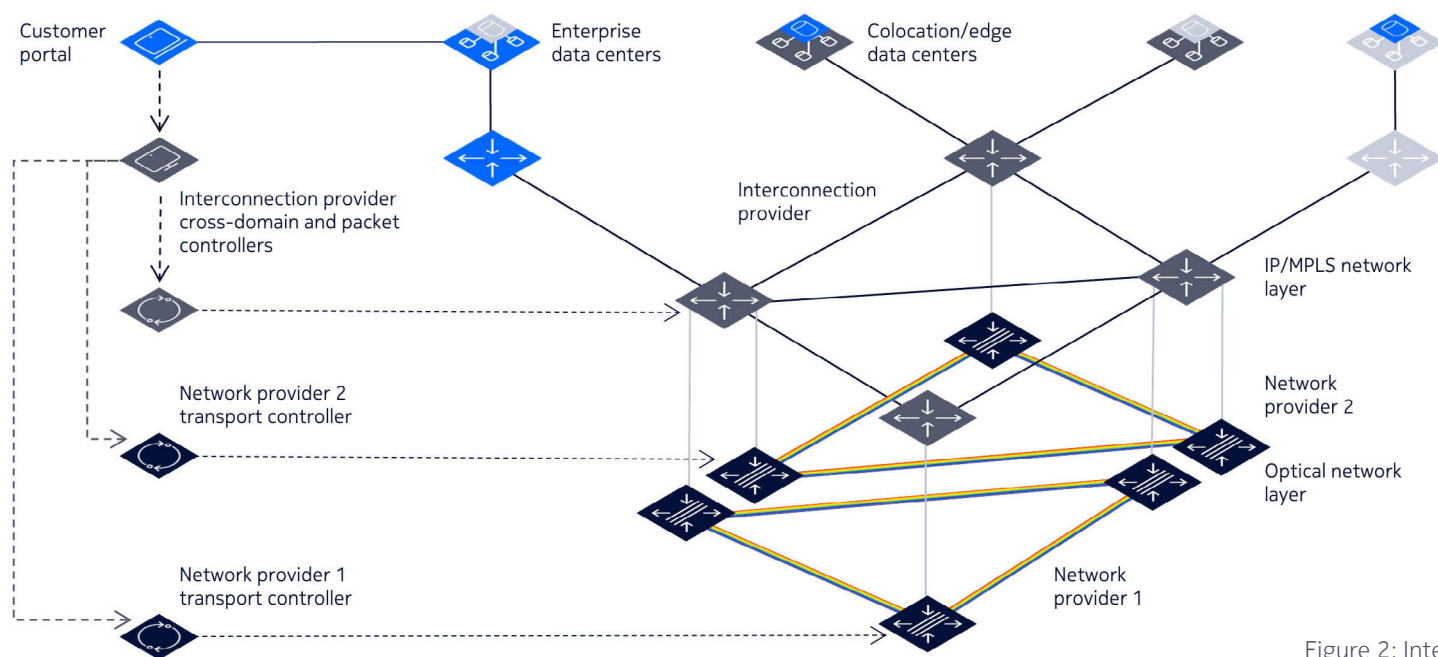


Figure 2: Interconnection across multi-layer, multi-domain networks

The benefits are impressive

Deploying data center interconnection comprising an integrated IP/optical network and multi-layer network automation and control brings multiple benefits. For providers and their operations teams, these include:

- **Scale simply with operational efficiency** – Maximize fiber capacity and reach to provide scalable efficient, lowest cost optical transport
- **Performance without compromise** – implementing secure peering, data center gateway and comprehensive IP features such as traffic engineering and DDoS mitigation at the edge while providing a high performance, optimized core
- **Low latency** – Ensure the performance of real-time interactive applications such as gaming by automatically selecting optimum network paths with the lowest latency
- **Simplified architecture** – Only edge routers need to maintain network state information, removing this burden from core routers. The network can scale while optimizing cost by choosing using routers with the right capability, performance and cost profiles
- **Common network operating system** – Ensure feature compatibility and interoperability across a choice of routing platforms based on merchant or custom silicon depending on requirements
- **Cost reduction** – Enjoy a 65% reduction in overall operations costs, as shown in a study by Analysys Mason of operators using Nokia's Network Services Platform (NSP).



What's the conclusion?

Cloud and colocation data center providers are ideally placed to take advantage of the opportunities now opening up.

By implementing very large-scale data center interconnection with the required bandwidth and latency characteristics, they are able to help their customers support new cloud applications and services such as AI, 5G, private wireless, IoT, Industry 4.0 and more whatever their bandwidth and latency requirement and wherever they are located – at the edge or in the core.

The secret is automated data center interconnection, which enables providers to implement a scalable, flexible and programmable network that seamlessly connects edge and core data centers. Providers can support highly scalable, reliable and secure data center interconnection and edge cloud infrastructure with ultra-low latency and bandwidth on demand: perfect for supporting these new emerging applications and services.





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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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