Data center networks for the AI era

Agile, high-performance and secure connectivity to, within and between data centers

Contents

The rise of AI and the role of data center networks

Artificial intelligence (AI) has radically changed what a data center is and how it is built and run. In parallel, rising global uncertainty has pushed nations to heighten security at their digital borders to safeguard privacy and assert data sovereignty.

Consequently, data centers are booming, from ~250 a decade ago to over 10,000 today. They are becoming larger and more complex, and are placed closer to the users they serve.

The critical role of the network

As the industry debates innovations in compute, energy, cooling and location to cope with AI and sovereignty requirements, let's not forget another essential component of the modern data center: the network.

The network is the connective tissue that enables the delivery of data, digital services and applications:

- Inside a data center, the network moves massive volumes of data between compute resources. It helps maximize efficiency and minimize job completion time.
- Between data centers, the network stitches multiple facilities together into a cohesive AI infrastructure that enables workload sharing and collaboration across sites.
- Between data centers and their users, the network ensures data can reach devices quickly and reliably, delivering the performance modern applications demand.

What data center teams expect from their networks

As data centers evolve, network design must respond to new requirements:

- Maximizing the usage of expensive graphics processing units (GPUs) requires extreme bandwidth, speed and reliability.
- Cascades of data requests and rapid traffic bursts require increased scale and adaptability.
- Quick model training iterations and real-time inference require responsiveness and low-latency transmission.
- Business- and mission-critical applications demand extreme availability and robust security.

Moreover, data center teams expect that everything will keep working even while they're upgrading hardware or software. They want data center networks that just work and are easy to operate.

It's time to transform data center network infrastructures

Nokia networking solutions for modern data centers feature a unique set of capabilities—high performance, quality-first design, operational efficiency and deep security—that help data center operators thrive in today's AI-driven environment.

1 "Worldwide Spending on Artificial Intelligence Forecast to Reach $632 Billion in 2028, According to a New IDC Spending Guide". IDC press release. 19 August 2024. Accessed 4 September 2024.

2. AI power: Expanding data center capacity to meet growing demand

IDC expects GenAI spending to reach

US$202 billion

by 2028, representing **32 percent of overall AI spending**.[1]

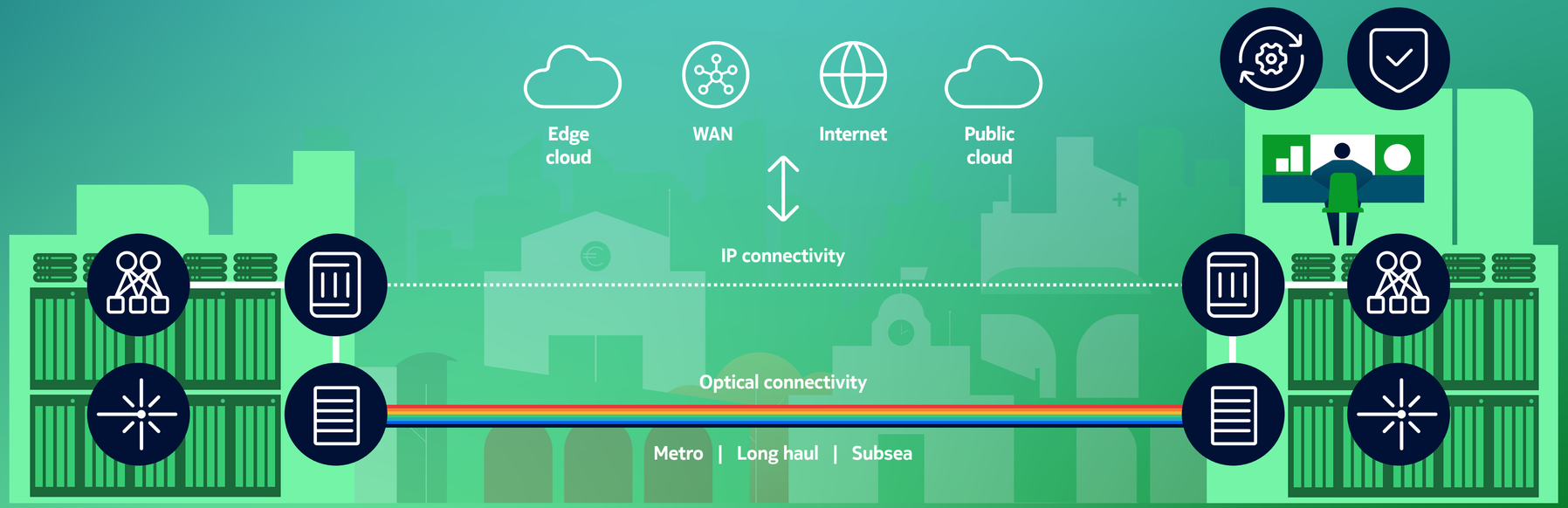
According to McKinsey,

70%

of the world's data center capacity will be used to **manage AI workloads by 2030**.[2]

Nokia data center networking solutions

Nokia addresses the demands of the AI era with a comprehensive data center networking solution. The solution includes high-performance data center switching and ultra-low-power optics that deliver reliable connectivity within the data center and IP/optical interconnectivity solutions that connect data centers, clouds, the wide area network (WAN) and the internet.



- Data center switching
- Intra-data center optics
- Data center gateways
- Optical data center interconnect
- AI-enabled automation
- Multilayer security

Key solution components

Component	How it supports networking for the AI era
Data center switching	• Supports our "Human Error Zero" mission by providing reliable data center switching with predictable and simplified operations for data center environments • Supporting products: Data center switches, network operating system (SR Linux, Nokia community SONiC) and Event-Driven Automation (EDA) platform
Data center gateway	• Provides high-performance data center to data center, internet, WAN and cloud interconnect, as well as security solutions for DDoS mitigation • Supporting products: 7750 Service Router portfolio
Optical DCI	• Provides highly compact, power-efficient optical networking for data center interconnect (DCI) to enable high-bandwidth, low-latency and highly secure data transmission from the edge to the core • Supporting products: 1830 Global Express (GX), 1830 Photonic Service Interconnect - Modular (PSI-M), 1830 PSS/PSI-L Optical Line Systems, ICE-X pluggables
Intra-data center optics	• Provides a highly integrated solution that combines multiple optical functions onto a single monolithic chip, resulting in low density, low latency and power efficiency • Supporting products: ICE-D intra-data center optics
Network automation	• Provides domain-specific and cross-domain network management, automation and orchestration powered by AI for network operations • Supporting products: EDA, Network Services Platform (NSP), WaveSuite
Network security	• Protects data integrity against the growing prevalence, volume and sophistication of global cybersecurity threats • Supporting solutions: Deepfield Defender, 7750 Defender Mitigation System (DMS), Quantum-Safe Networks solution

Reliable data center switching

Data center switching infrastructures are under massive strain because of the pervasive demand for all forms of content, evolution to cloud-native applications, growing dominance of AI/ML-based workloads, and increasing adoption of hybrid cloud, edge cloud and multi-cloud models.

Networking teams want their data centers to work reliably and consistently and be simple to operate. But human errors—from vendor product design and quality issues to mistakes by network operations staff—continue to cause major problems. Current solutions can't deliver the reliability, ease of use and flexibility required for modern data center switching infrastructures.

Our modern Data Center Fabric solution adopts a quality-first approach and provides new levels of reliability, simplicity and adaptability to help data center teams manage accelerating demand with all the freedom and control they need.

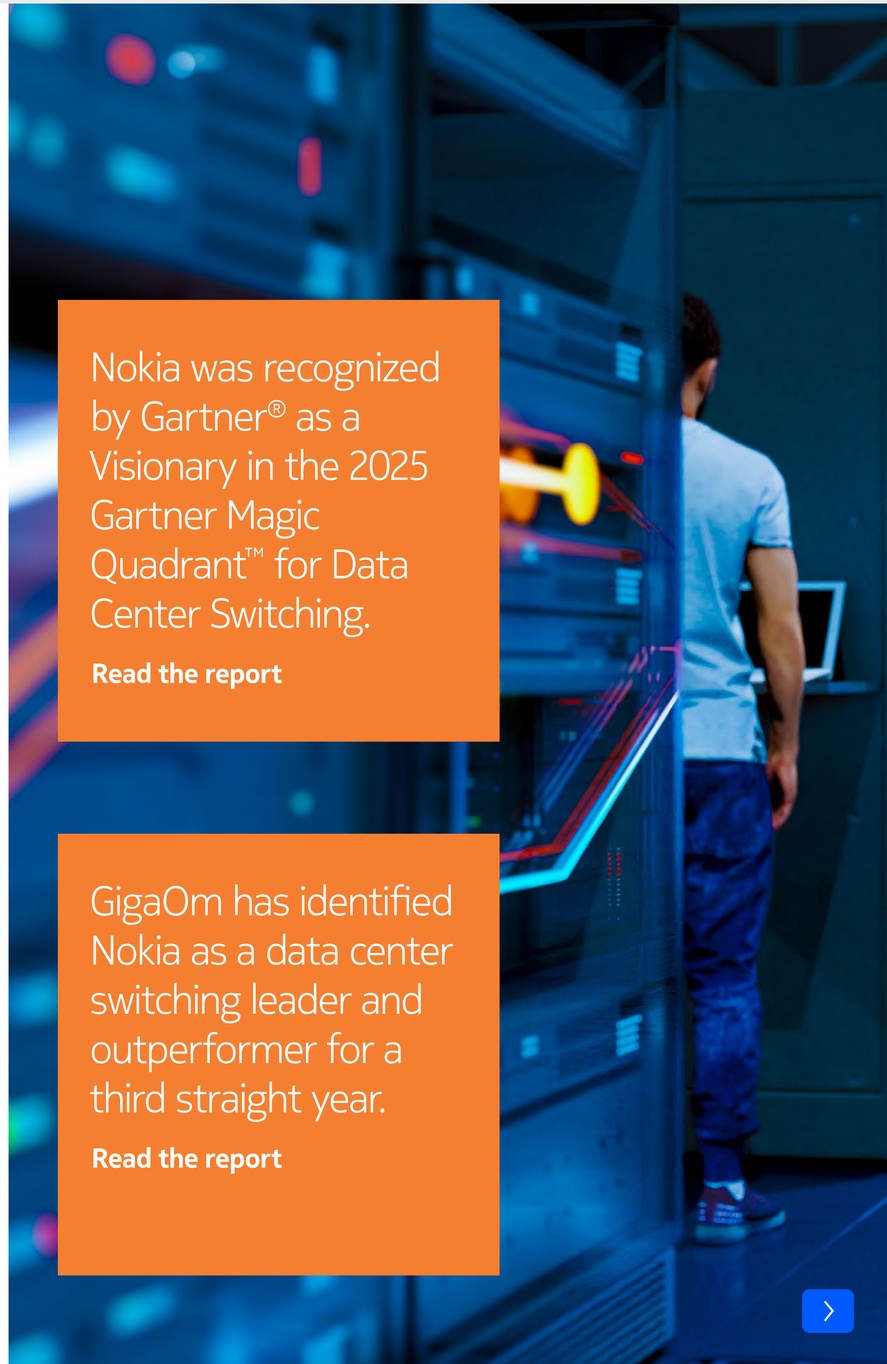
We offer a comprehensive portfolio of data center hardware platforms for implementing high-performance back- and front-end networks for AI workloads and traditional workloads. For more information on these network architectures, see our Networking for AI workloads application note.

Our uniquely open, extensible and resilient SR Linux network operating system (NOS) is built on the latest technological innovations, including containers, microservices, open-source projects, model-driven architectures, YANG data models, and streaming and "on change" telemetry. It also uses modern management protocols such as gNMI and REST APIs and provides capabilities for delivering lossless Ethernet networking for AI infrastructures.

The EDA platform provides automation capabilities that simplify data center network design, deployment and operations and ensure that the network delivers the expected reliability and predictability.

Why choose the Nokia Data Center Fabric solution?

- Boost reliability and quality with data center switching solutions that aim to eliminate human errors.
- Benefit from the highest levels of reliability, flexibility and openness with a NOS built from the ground up around model-driven management.
- Deploy a next-generation network automation platform designed to make network operations reliable and simple.
- Gain new levels of flexibility with a data center fabric solution that easily adapts to existing staffing, processes, ecosystems and environments.



Nokia was recognized by Gartner® as a Visionary in the 2025 Gartner Magic Quadrant™ for Data Center Switching.

Read the report

GigaOm has identified Nokia as a data center switching leader and outperformer for a third straight year.

Read the report

Open-source NOS for data center switching

For many data center teams, choice and flexibility hinge on having a vendor-agnostic software platform. Nokia community SONiC empowers customers to innovate on their own terms—providing freedom of choice and meeting them where they are, rather than dictating the path forward.

Data center teams that have already committed to the open-source SONiC NOS path now have the option to take on their networking challenges with our proven data center hardware and expertise. Teams exploring SONiC for the first time have the flexibility to deploy our hardware with SONiC or choose our SR Linux NOS-based Data Center Fabric solution—which offers industry-leading capabilities and performance—to determine the best fit for their environment.

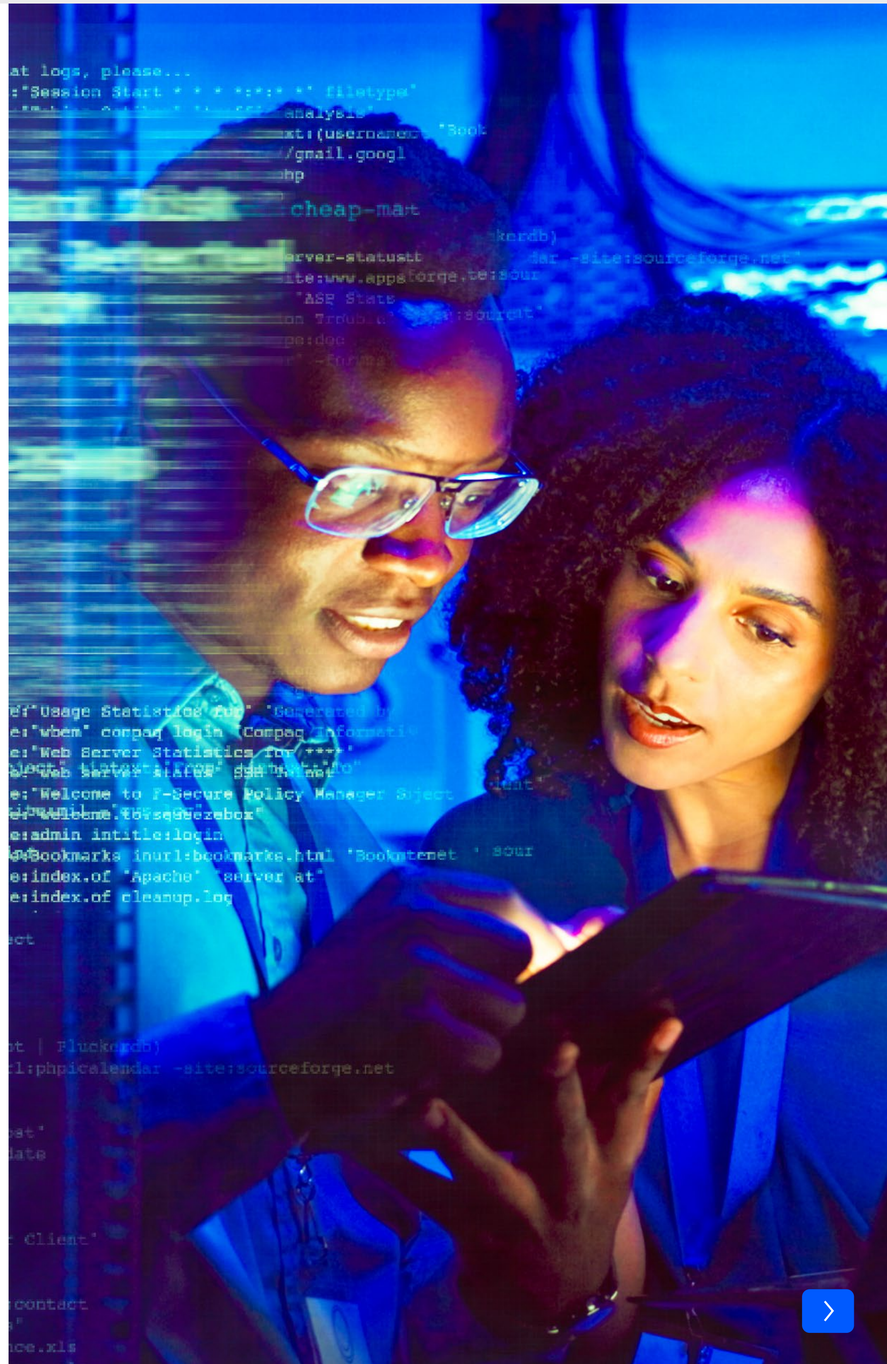
Nokia community SONiC combines open-source NOS software with advanced hardware, powerful automation and expert support to deliver robust, efficient solutions capable of handling the full range of modern workloads.

The Nokia community SONiC solution includes:

- A broad portfolio of select merchant silicon-based platforms—including our 7215 IXS, 7220 IXR-H series and 7250 IXR-10e—designed to support data center switching architectures across leaf, spine, super-spine and management top-of-rack (ToR) roles.
- The SONiC open-source NOS, featuring a comprehensive suite of network functionality proven in some of the world's most demanding cloud and data center environments.
- EDA, a modern network automation platform that delivers speed, reliability and simplicity, complete with built-in safeguards to detect and prevent errors introduced by automation.
- Expert development and testing support from our NOS and automation engineering teams.

Why choose Nokia community SONiC for your data center fabric?

- Gain freedom of choice with vendor-agnostic, open and flexible.
- Benefit from the expertise of our experienced NOS and automation teams for validation, deployment and troubleshooting.
- Choose merchant silicon-based platforms that enable a range of deployment roles.
- Extend management and automation for SONiC to our EDA platform, which delivers speed and reliability.



AI data center networking

AI workloads fall into two main categories: training and inference. Training builds the initial AI model through stages such as data collection, model selection, training, evaluation, deployment and monitoring, all of which rely heavily on GPUs. Once the model is built, inference enables users or devices to interact with it in real time. To learn more, watch our Networking for AI video series.

For optimal AI performance, the network must be designed to meet the demanding requirements of training and inference, including high speed, capacity and reliability, low latency and lossless transmission. Efficient networking maximizes GPU utilization and minimizes job completion times (JCTs).

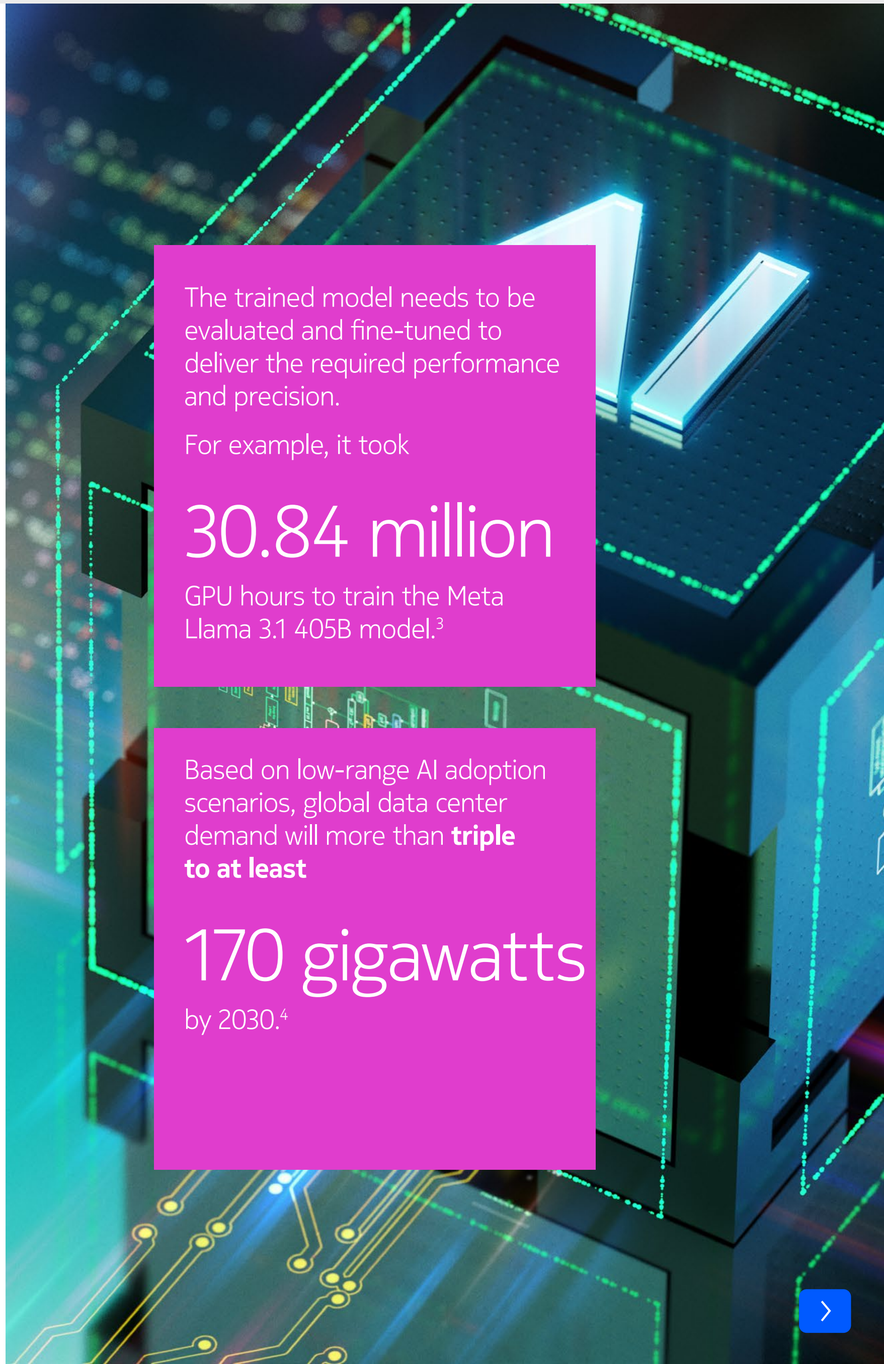
More and more organizations are choosing Ethernet technologies to build networks for AI workloads. The work of the Ultra Ethernet Consortium (UEC) is delivering enhancements that make Ethernet the best choice for AI network infrastructures.

Our AI Data Center Fabric solution is designed to deliver the reliability and simplicity required to implement high-performance, lossless AI infrastructures. It supports the essential features required to deliver lossless ethernet networks for RDMA over Converged Ethernet (RoCE) deployments as well as deployments that align with the work of the UEC.

Organizations can choose to build private AI training infrastructure or use GPU-as-a-Service (GPUaaS) offerings from public cloud providers.

In addition to reliable connectivity within the data center, it is essential to support reliable, high-performance network interconnectivity (IP and/or optical) between data centers that implement AI and high-performance computing (HPC) workloads across multiple locations.

3 Meta Llama 3.1 405B model overview. Hugging Face website. Accessed 4 September 2024.
4 AI power: Expanding data center capacity to meet growing demand. McKinsey & Company website. 29 October 2024. Accessed 21 August 2025.



The trained model needs to be evaluated and fine-tuned to deliver the required performance and precision.

For example, it took

30.84 million

GPU hours to train the Meta Llama 3.1 405B model.[3]

Based on low-range AI adoption scenarios, global data center demand will more than **triple to at least**

170 gigawatts

by 2030.[4]

Why choose the Nokia AI Data Center Fabric solution?

- Meet the demanding requirements of AI training and inference workloads—high speed, low latency, high capacity, and lossless performance.
- Support high-performance RoCE deployments with features aligned with the work of the UEC.
- Deploy a robust and easy-to-operate fabric ideally suited for AI infrastructures that require consistent performance and availability.
- Ensure reliable, high-performance connectivity within and between AI and HPC data centers.

Data center fabric automation

Our goal with data center network operations is to reduce human error to zero. We're making it happen with EDA, a next-generation data center network automation platform that combines speed with reliability and simplicity. EDA makes network automation more trustable and easier to use, from small edge clouds to the largest data centers.

Existing solutions have not realized the promise of automation because they focus on the wrong things and miss out on adding more reliability and predictability to data center network operations. Automation is an amplifier that can make good things better and turn bad things into breakage at scale. Turning on automation at scale can uncover previously unknown weaknesses that expose the fragility of the network.

EDA makes network operations predictable. For example, operations teams can use tools such as pre- and post-automation checks to help identify conflicts before pushing a new configuration to a device. This makes it easy to verify whether the intended configuration has been applied on the device or rejected by it.

With EDA, operations teams can automate the entire data center network lifecycle from initial design to deployment and daily operations. They can specify what they want to achieve through high-level declarative intents and let EDA determine how best to implement the low-level detailed configurations.

EDA builds on the proven Kubernetes platform and leverages a vast open-source ecosystem. This reduces risk and lowers barriers to entry for adopting automation. EDA provides a built-in digital twin that creates a like-for-like virtual environment of the live production network. It provides a snapshot of the network and maintains its state to provide a true network emulation at any point in time.

AIOps, agentic AI and natural-language query capabilities turn EDA into a digital teammate that reasons across telemetry, alarms and configurations to simplify troubleshooting and data center fabric operations.. EDA integrates easily with cloud, workload management, event notification and collaboration systems without manual intervention.

Why choose Nokia EDA for data center automation?

- Work with the most automation-forward vendor in the data center space.
- Benefit from an automation platform that ensures that changes do what they are supposed to do, and that the network is operating as intended.
- De-risk operations with a digital twin that provides a simulated replica of the live data center network.
- Automate with confidence using a platform that delivers multivendor, intent-based management with a broad set of reliability-enhancing capabilities environments.

Businesses can realize up to **55 percent work effort savings** with the Nokia EDA digital twin.

Read the data center fabric business case analysis

Deep security

With the growing prevalence, volume and sophistication of global cybersecurity threats, protecting data from malicious actors is a critical concern. It falls to the network to provide policy enforcement and security in depth.

Our multilayered approach lets organizations build secure data center networks that can help mitigate attacks before they impact business continuity.

Our data center switches strengthen management, control and data plane security with capabilities that implement secure access controls, traffic rate limits and strict filtering policies.

The solution supports micro-segmentation, a security technique that divides the data center network into isolated zones to enable fine-grained policy enforcement between connected servers or appliances. Micro-segmentation aligns with zero-trust networking models, where no entity is inherently trusted and verification is continuous.

The availability of cryptographically relevant quantum computers (CRQC) within the next 5-10 years threatens the security of sensitive data transiting between data centers. Bad actors can store encrypted data now and decrypt it later.

Operators of mission-critical networks must act now to deploy a security solution that can counter the CRQC threat.

Our Quantum-Safe Networks solution provides quantum-safe encryption, secure symmetric key management and distribution, and intrusion detection to protect data and networks from quantum threats now and in the future.

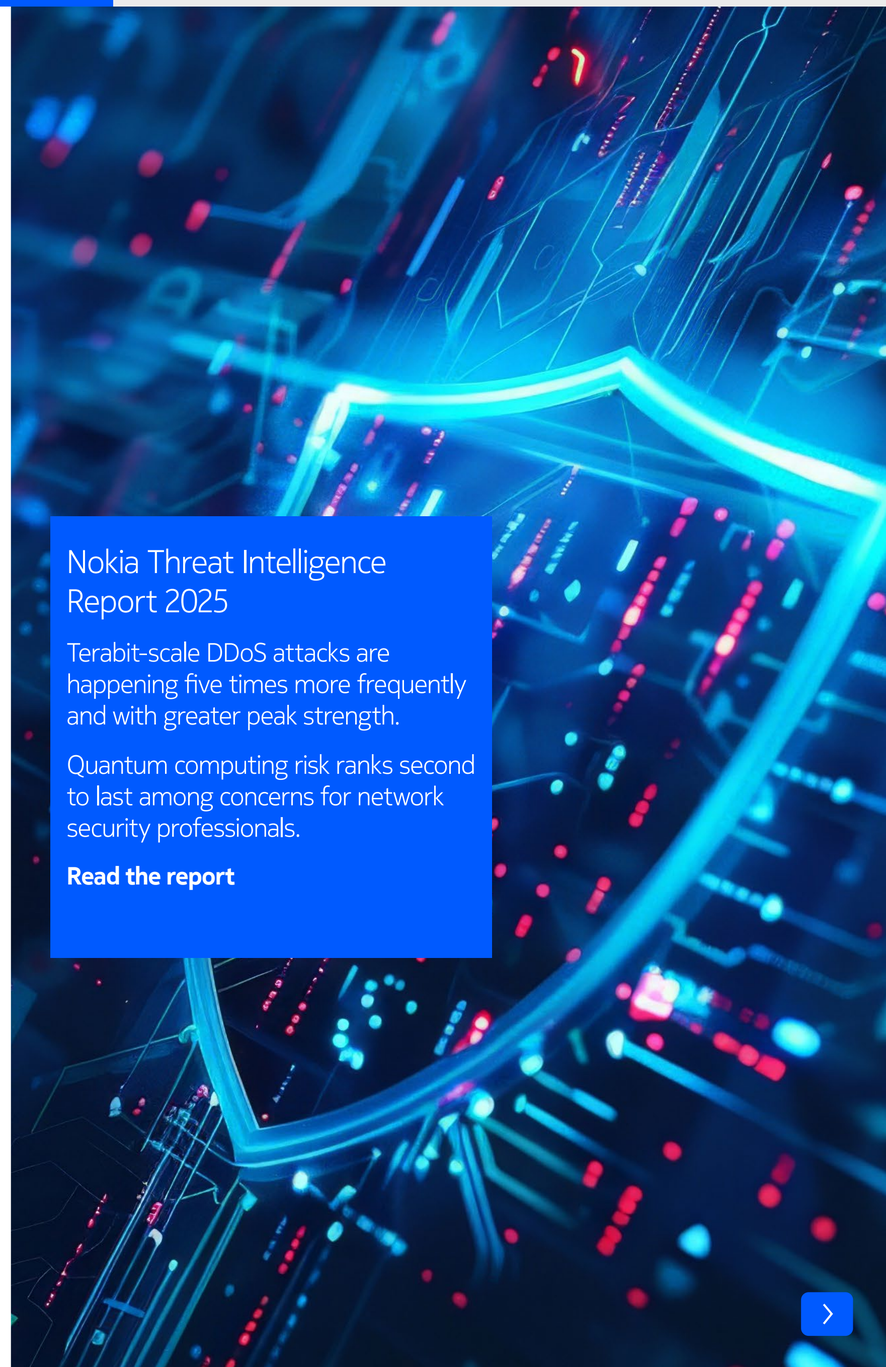
Daily terabit-scale DDoS attacks increase the risk of bandwidth overload, latency spikes, connectivity loss between sites and bad customer experiences.

Deepfield Defender combines big data IP analytics with the advanced capabilities of Nokia routers to neutralize DDoS attacks at the IP network edge or at peering points.

Deepfield Defender is integrated into the 7750 DMS, a dedicated security enforcement platform with advanced DDoS protection and automation capabilities.

Why choose Nokia for data center network security?

- Achieve the comprehensive security protection by embedding security at the IP and optical layers.
- Harness the power of big data analytics and AI with a cutting-edge solution that detects and neutralizes all DDoS attacks in seconds.
- Work with the only network vendor to offer a quantum-safe solution. Deploy it today for robust IP cryptography (MACsec, **ANYsec**, **IPsec**) powered by quantum-safe key entropy, strength, and distribution, all secured with AES-256 network encryption for unmatched protection.



Nokia Threat Intelligence Report 2025

Terabit-scale DDoS attacks are happening five times more frequently and with greater peak strength.

Quantum computing risk ranks second to last among concerns for network security professionals.

Read the report

Interconnectivity with the data center gateway

Businesses now implement multiple data centers or clouds as part of their digital transformation journey. For example, they may use a mix of their own privately run central, regional, metro or edge data centers. They may also use resources from public cloud or colocation facilities to form their own hybrid clouds. The use of distributed edge clouds is gaining momentum as a means to offer better performance by locating data centers and clouds closer to the end user.

In addition to managing these complex and varied networks, businesses need to connect data centers to each other, to the internet, to the WAN and to edge clouds. Our Data Center Gateway (DCGW) addresses this challenge by enabling high-performance interconnectivity between these entities.

As AI-related workloads become a more dominant part of business transformation initiatives, the role of data center interconnectivity will become even more important, especially in scenarios where it needs to deliver:

- Connectivity to public AI-based cloud frameworks (also known as GPUaaS) to provide the data needed to build the AI models.
- Low-latency connectivity for AI inferencing interactions with end users or things, which often means running use cases in private AI infrastructures at enterprise edge locations.
- Connectivity across AI infrastructures where workloads are distributed and offered across multiple GPUaaS provider locations to keep power consumption within specific limits.

The DCGW provides an industry-leading Border Gateway Protocol (BGP) and Ethernet VPN (EVPN) protocol stack in a wide range of fixed and modular routing platforms based on Nokia or merchant silicon. Our flagship 7750 SR portfolio supports all gateway applications without compromising on performance. Our 7250 IXR for data center fabrics platforms support interconnectivity between data centers and across the WAN.

Why choose the Nokia Data Center Gateway?

- Support DCI over IP-only, MPLS (LDP, RSVP, SR-MPLS) or SRv6 tunnels in the WAN.
- Optimize traffic performance with internet connectivity that uses multiple BGP peering agreements.
- Connect public cloud providers to on-prem data centers to support a hybrid approach that combines the strengths of both.
- Combine DDoS mitigation with traffic encryption to secure the data center fabric and ensure maximum availability.

Scalable, resilient optical data center interconnect

AI is fueling demand for scalable, high-performance inter-data center connectivity for linking distributed compute, storage and workloads across cities, regions, countries and continents. Innovation in next-generation embedded and pluggable coherent optical engines, optical line systems and intelligent automation is meeting this demand by delivering a reliable foundation for future-ready data center interconnect (DCI).

Widely deployed across the world's largest and most demanding networks, our optical DCI solutions empower leading CSPs, hyperscalers, cloud providers and enterprises to deliver massive interconnect capacity with exceptional performance, security and spectral efficiency—from the network edge and campus environments to metro, regional, long-haul and subsea applications. Our business-critical DCI solutions also support a wide range of use cases, including real-time business continuity, disaster recovery, synchronous data replication and cloud backup.

Powered by a commitment to deep vertical integration and in-house expertise in digital signal processing, photonic integration and fabrication, our optical DCI portfolio enables network operators to:

- Deliver scalable, high-performance, low-latency connectivity with greater resiliency, lower cost, reduced power consumption and simplified operations.
- Streamline deployment through zero-touch provisioning, network auto-discovery, unique Instant Bandwidth capabilities and intuitive GUIs for easier network design and management.
- Safeguard mission-critical data with quantum-safe networking capabilities and secure hardware and software architectures.
- Reduce OPEX and improve IT efficiency through data center consolidation and virtualization.
- Enhance data control and security to meet sovereignty and compliance requirements.

Our optical DCI solutions portfolio includes the 1830 Global Express (GX) compact modular transport platform, 1830 Photonic Service Switch (PSS-M/L), ICE-X multi-haul pluggable coherent transceivers and a suite of network automation and management tools. Our flexible, application-optimized solutions meet a wide range of data center connectivity needs, delivering the scale, security, and resiliency required to support today's rapidly evolving AI-driven workloads.

Why choose Nokia for optical DCI?

- Work with an industry leader in optical DCI, quantum-safe networking, and coherent optical transport systems and subsystems.
- Leverage cutting-edge optical line system technology with transmission capabilities that span the Super C- and Super L-bands. These solutions deliver over 25% more capacity per fiber than traditional extended C-band solutions, without compromising performance.
- Achieve continuous cost and power per bit savings and increase network capacity with a pay-as-you-grow model that supports seamless integration of multiple generations of coherent optical engines.

High-performance intra-data center optics

As AI workloads surge, the volume of data that must move between the racks of servers and storage elements inside the data center is growing exponentially. This demand is driven by incremental gains in processing power and the rapid rise in parallel processing inherent to AI. At the same time, the power consumption, of compute elements is growing at an unprecedented rate, creating an extraordinary challenge: Scale intra-data center bandwidth without exceeding power budgets. Increasingly, data center operators are seeking intra-data center optical interconnect solutions to address these challenges.

We leverage our deep vertical integration capabilities, including our semiconductor fabrication facility in Silicon Valley, to address the dual challenge of delivering terabit-plus capacity per wave and continuous power per bit reductions. At the heart of this innovation is our monolithic photonic integrated circuit (PIC), built on highly efficient indium phosphide (InP). This PIC integrates multiple optical functions into a single compact chip, delivering high-speed, short-reach optical connectivity with minimal power consumption.

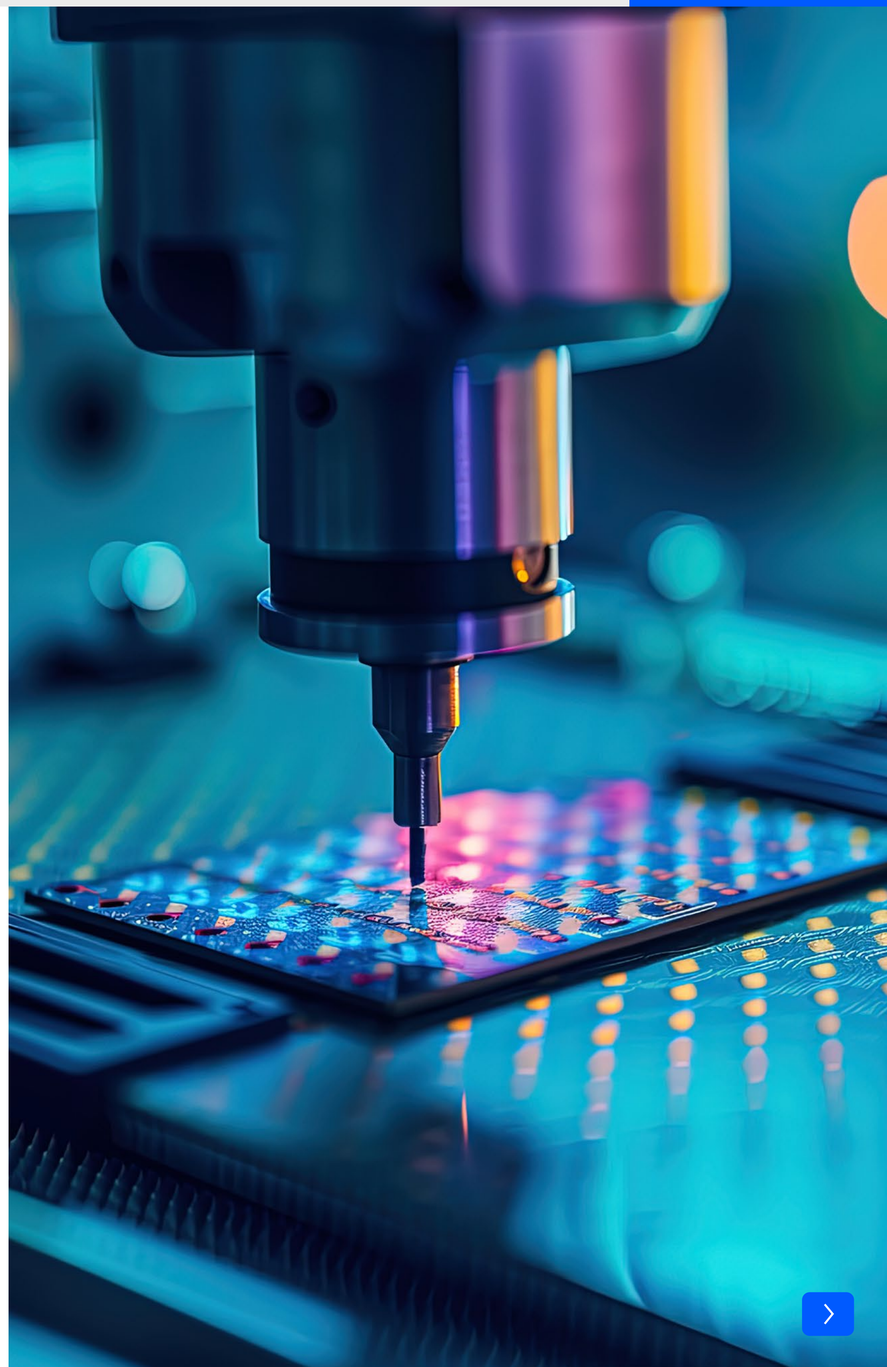
Our innovative design supports a range of deployment models, including fully retimed solutions for maximum flexibility, linear pluggable optical solutions that integrate seamlessly into switches, routers and network interface cards for ultra-low power consumption, and packaged optical solutions designed for direct integration onto a server blade.

Our ICE-D line of intra-data center connectivity optics enables data center operators to continue to scale compute capacity while minimizing the power consumption of optical connectivity.

Additionally, by operating our own production facilities—including an in-house photonic semiconductor fab—we have the capability and capacity to support the substantial data volumes demanded by intra-data center optics.

Why choose Nokia for intra-data center optical connectivity?

- Partner with a highly vertically integrated supplier capable of scaling to meet the demanding capacity requirements of intra-data center connectivity.
- Leverage highly flexible technology that supports diverse deployment models that align with any business objective.
- Continue to scale data center capacity while dramatically reducing the power consumed per bit for intra-data center connectivity.



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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 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, which is celebrating 100 years of innovation.

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.