

IP networks built for AI, powered by AI

NOKIA

AI: Opportunities and challenges

Artificial Intelligence (AI) gives us powerful new tools to extract meaning and generate value from massive data in real time. Unlocking AI's full potential, though, has implications for IP networks.

IP networks play an essential role in connecting AI users to the data centers hosting their AI infrastructure and AI-assisted applications. They also interconnect data centers running AI training and inferencing workloads. For AI to meet user expectations, IP networks must deliver new levels of reliability, security and performance.

At the same time, AI holds tremendous promise to help simplify IP network operations and take your productivity to a whole new level.

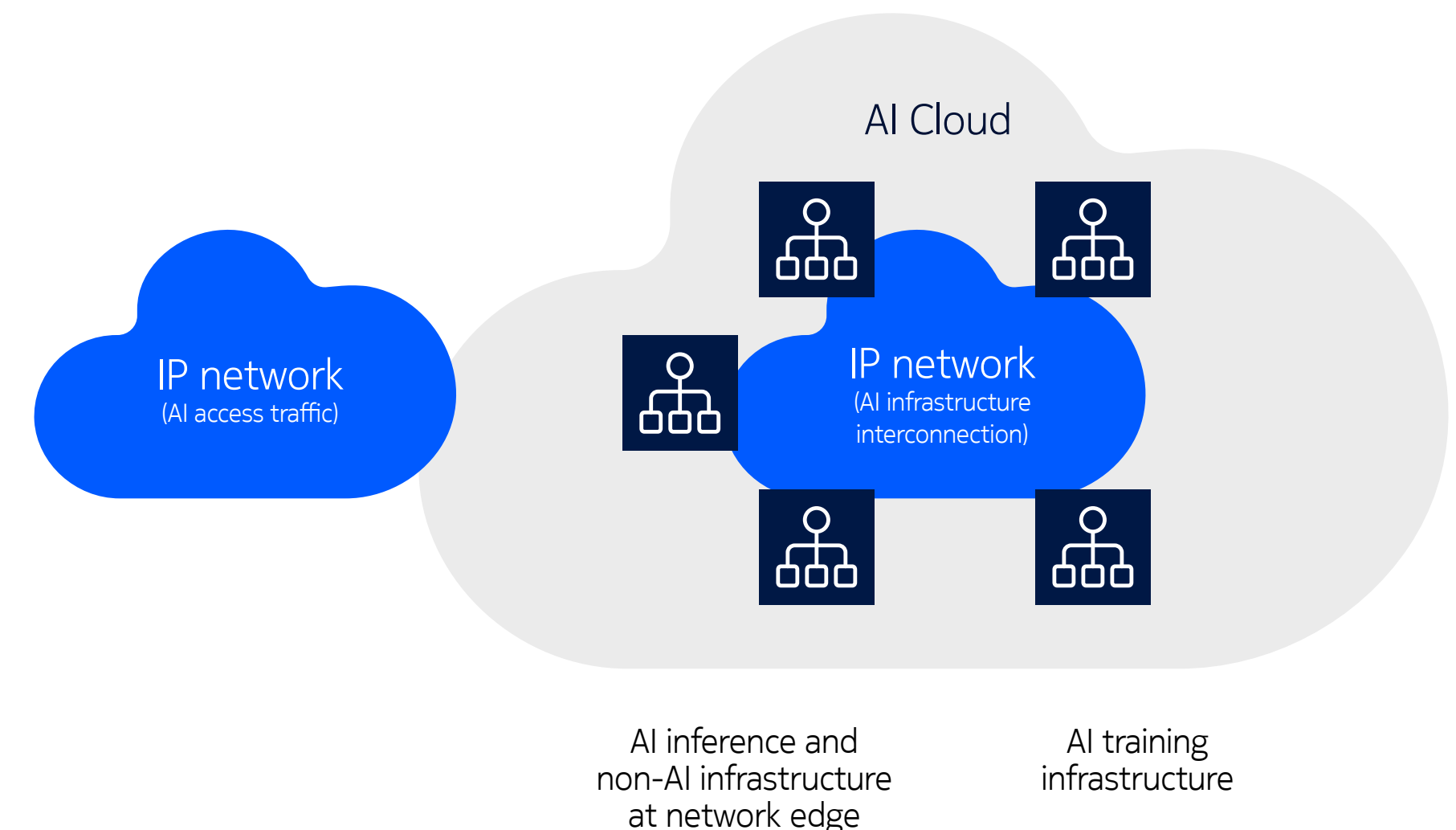
Nokia IP networks are ready for the challenges of AI. Our routers provide flexible bandwidth scaling, deterministic performance and security by design. We are also incorporating AI capabilities into our solutions to assist your operators with their tasks, predict and mitigate potential disruptions and help you run your network most effectively.

Are you ready to step up to the challenges and seize the opportunities of the AI era? Does your IP network have what it takes to position you for efficient business growth?

This e-book will help you answer these important questions and prepare for the AI era.

We also provide networking solutions inside AI data centers. For more information, please go to the [Nokia data center networks web page](#).

AI uses and
applications



IP networks built for AI

An expanding universe of applications

AI users and their application needs are diverse.

Most people are familiar with AI as a tool to recommend social media content, search the internet, write text or generate images.

Other AI applications can assist us with complex tasks and critical decision-making in such varied areas as medicine, research, manufacturing, finance, transportation or public safety. These real-time tasks require lower latency and higher reliability than chatbot-type tasks, particularly when safety is at risk.

A fast-growing AI user segment is IoT devices and autonomous machines such as factory robots or drones that are being enhanced with AI for greater precision and more versatility. Autonomous devices and AI-driven real-time control processes require ultra-low latency and high performance.

AI vision is another area with many applications where AI is used to analyze images and streaming video to detect specific objects or situations.

For optimal accuracy and responsiveness, the AI vision workloads must ingest large volumes of high-resolution images from potentially many video sources with minimal delay and packet loss.

It is essential for IP networks to support a wide range of requirements from an expanding universe of AI-based applications.

INTELLIGENT CHATBOTS



AI-ASSISTED OPERATIONS



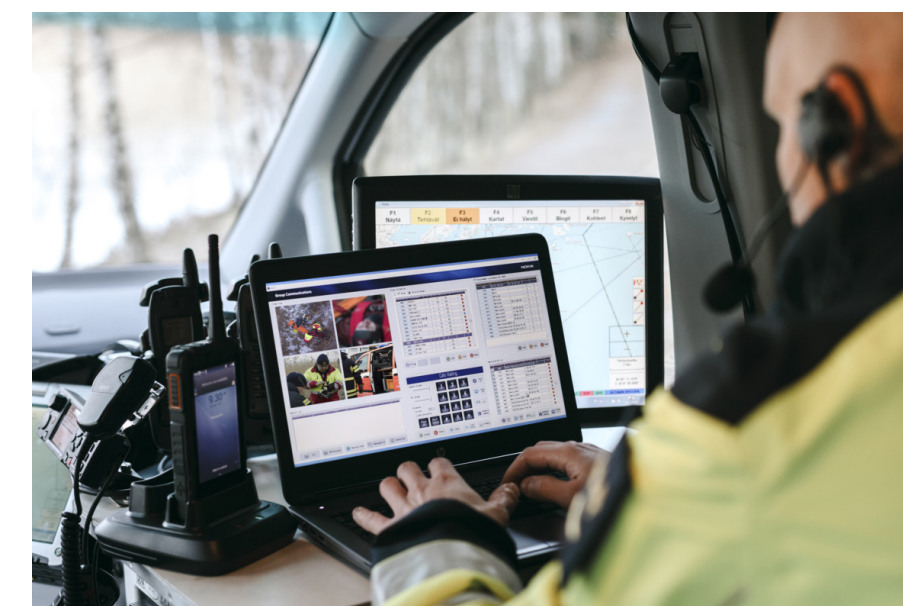
AUTOMATION CONTROL



CONTENT CREATION



REAL-TIME AI VISION



AUTONOMOUS VEHICLES



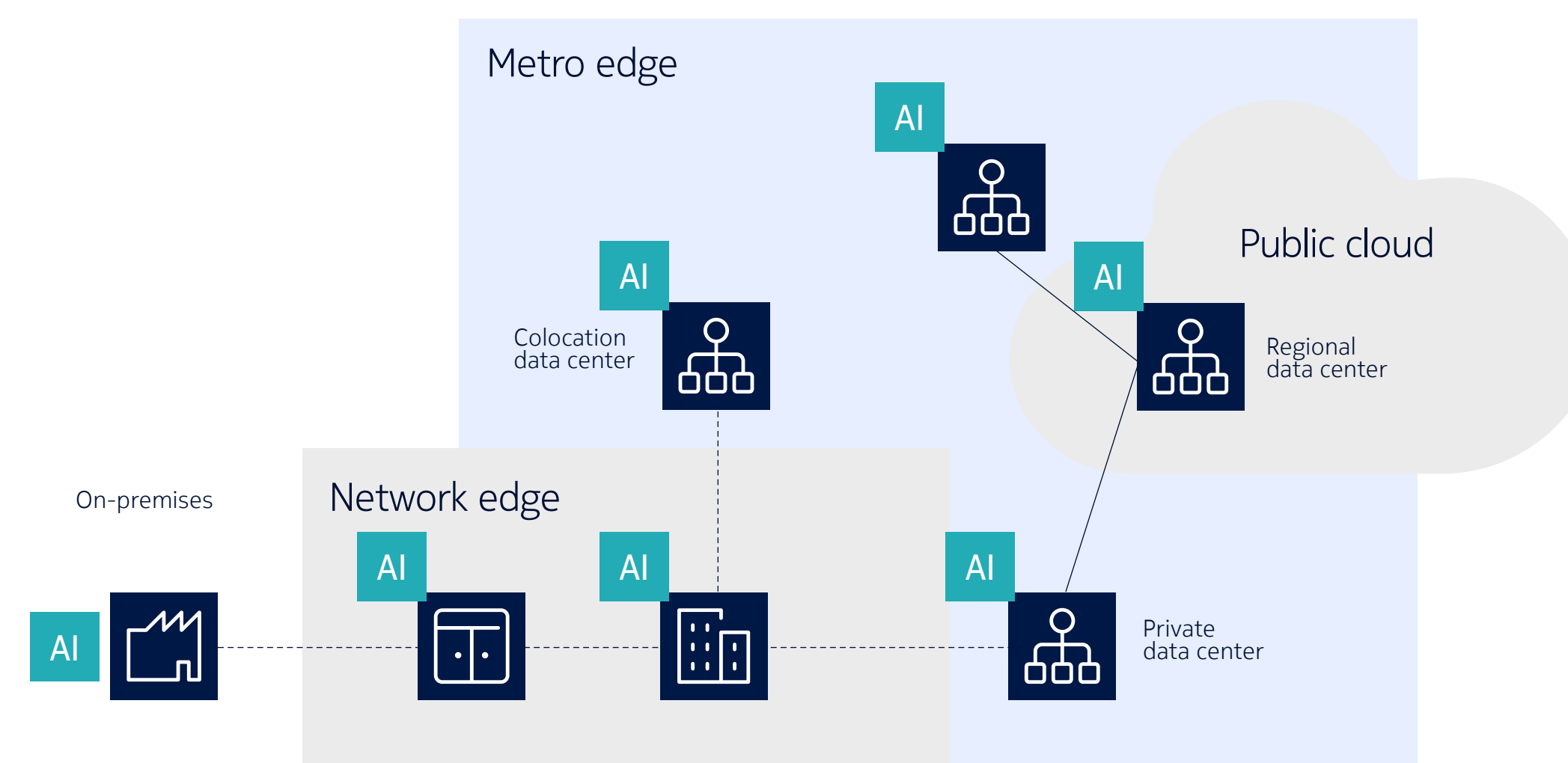
Interconnecting AI users and distributed workloads

There are many options for locating AI infrastructure. Embedded on user devices like smart phones and self-driving cars. Or residing on servers at the user premises, in network equipment cabinets or local central offices, or farther away in private or public data centers in the cloud. The network must have the flexibility to allow AI workloads to be easily placed and moved anywhere.

The optimal AI infrastructure location depends on several factors:

- On-device AI gives instant response but is limited by the processing and power available on the device. Your private, critical data is at risk if your device is lost or stolen.

- Enterprises and industry may choose to locate mission-critical AI workloads on-premises for ultra-low latency and privacy, or in private or colocation edge data centers for multi-site use and redundancy.
- Applications such as AI vision, gaming, and virtual/extended reality are best placed at the network edge to minimize latency and data transport costs.
- AI workloads for non-real-time applications can be centralized in metro or regional data centers.
- Hybrid models are common, where an application may use AI workloads located in a combination of on-premises, private, edge and public centralized clouds.



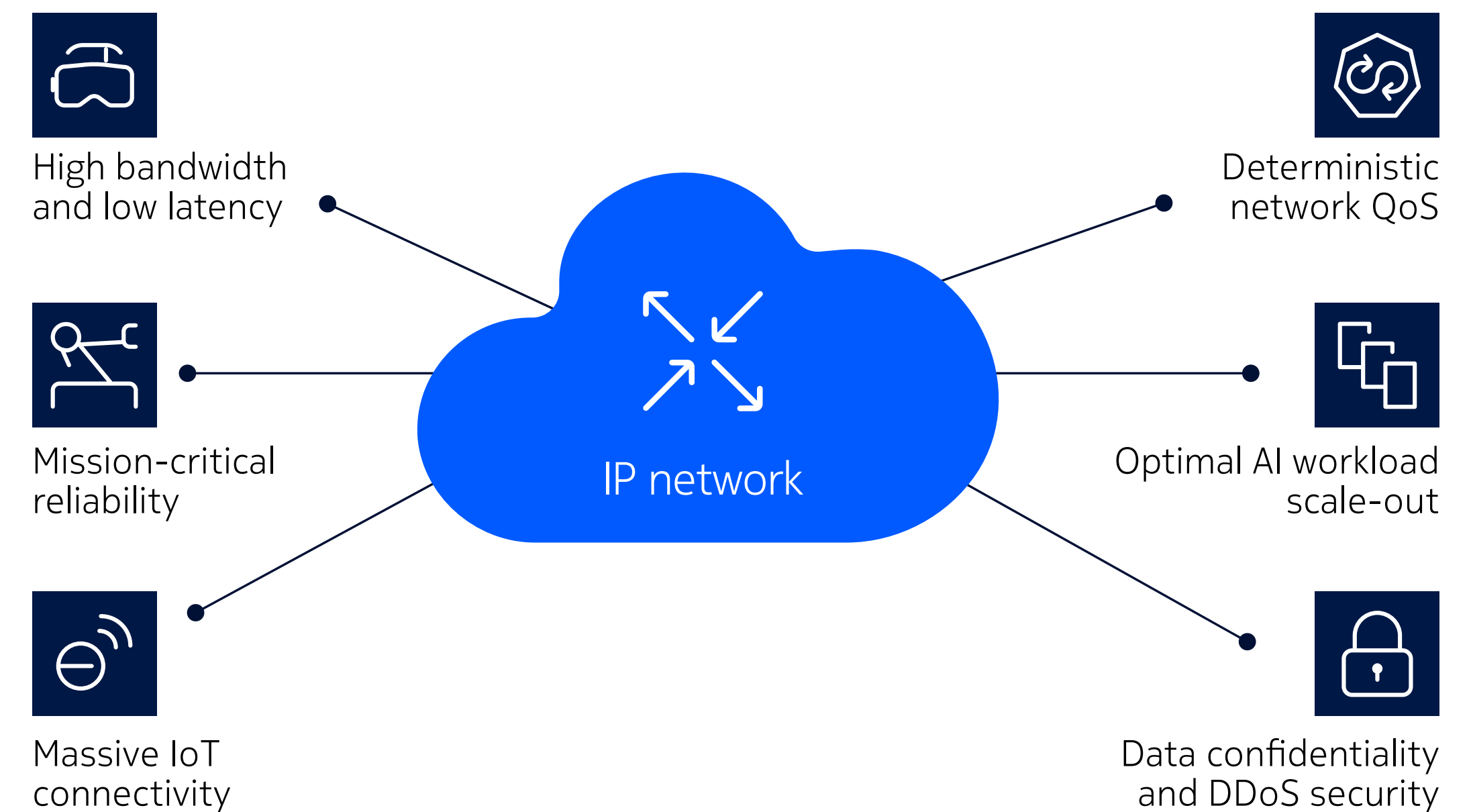
IP network requirements

Which features are required in an IP network to support AI applications and workloads, wherever they are located?

High capacity with low latency and low packet loss, along with deterministic performance for real-time applications such as automation, AI vision, and virtual and extended reality.

High flexibility to quickly interconnect newly spun-up AI workloads – for business models such as GPU-as-a-Service or AI-as-a-Service – anywhere.

Ultra-reliability and security, to support mission-critical AI applications for business and industry, including finance, healthcare, government and public safety.



High bandwidth, low latency and deterministic quality of service

Real-time AI applications need strict guarantees on packet throughput, latency and loss. For example, AI vision relies on ingesting high-resolution images to accurately detect specific objects or situations, while augmented and virtual reality applications require low latency to avoid motion sickness.

The IP network must be factored into round-trip delays of application traffic. While physically locating workloads close to end users reduces fiber propagation delays, queuing delays caused by network congestion and buffering of data packets in intermediate routers can easily undo these gains.

As data traffic grows over time, your network will need to grow to avoid congestion. Nokia IP networks provide flexible bandwidth scaling with interface speeds of up to 800GE along with software and automation tools to distribute the traffic load.

Segment routing provides explicit path control and traffic engineering, ensuring that AI data takes the most efficient routes through the network. Network slicing prevents interference and cannibalization of resources by other applications.

Hierarchical quality of service scheduling, priority queuing and explicit congestion notification will help to manage queuing delays in routers due to transient congestion situations.

The Nokia [7750 SR](#) product family is designed from the ground up to deliver superior network performance with our in-house developed [FP](#) routing silicon and [SR OS](#) network operating system software. Our [7730 SXR](#) product family, with its [FPCx](#) routing silicon and [SR Linux](#) software, extends these performance qualities to routers designed for network edge and on-premises deployments.



Security

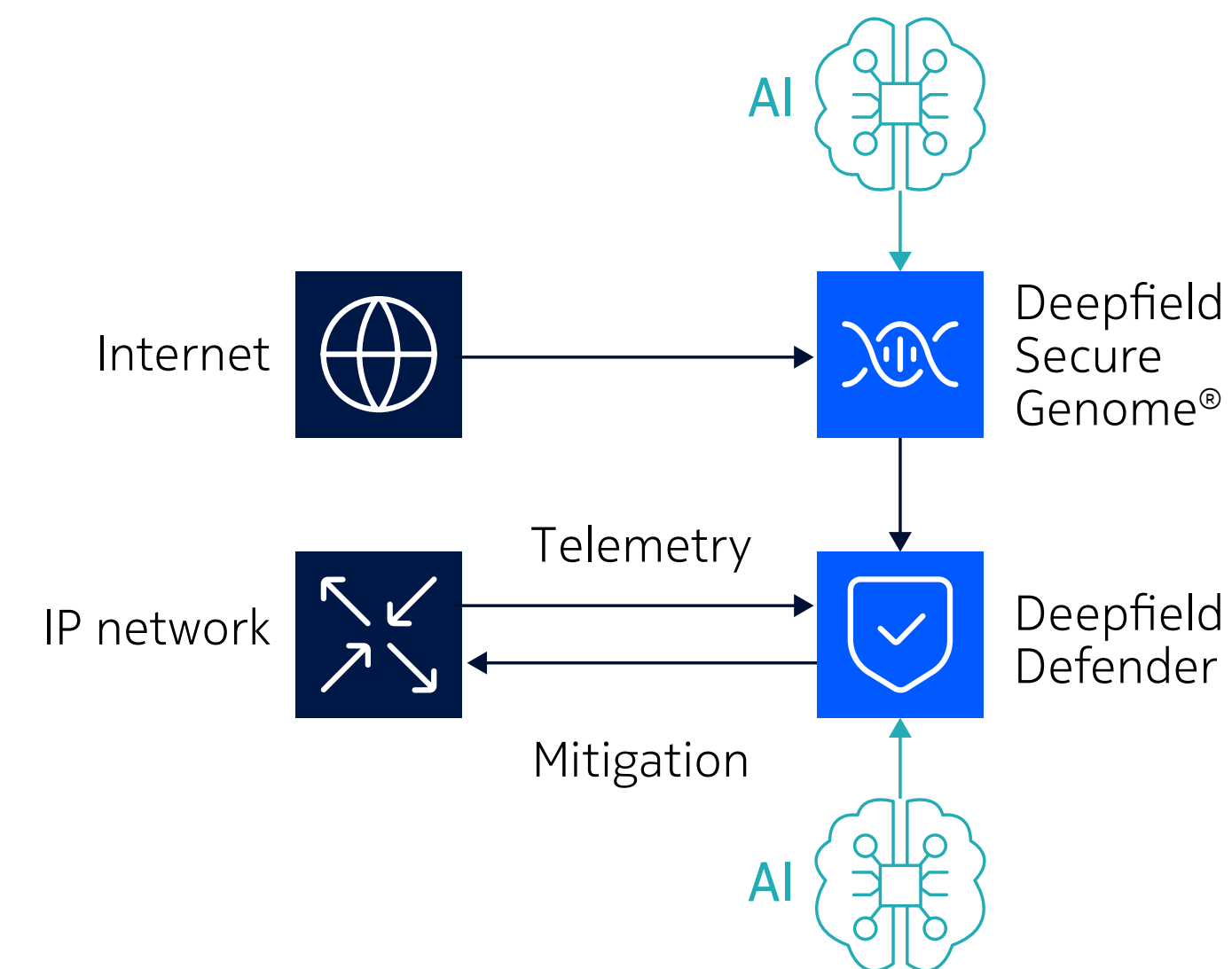
As the network threat landscape continues to worsen, AI-driven attacks only add to the risks. AI-driven Distributed Denial of Service (DDoS) attacks compound existing challenges by more cleverly detecting and exploiting vulnerabilities. As well, advances in quantum computing are threatening to break the encryption that protects our most valuable data.

Nokia takes a multi-level approach to network security. Features to protect against threats to the routers themselves are built into both our silicon and software. Then additional safety applications for DDoS protection and encryption are layered on.

Industry-leading protection against DDoS

As millions of IoT devices and AI users connect with data centers over gigabit uplinks, the attack surface for hackers and malware grows – as does the risk of DDoS attacks.

Nokia **Deepfield Defender** detects, analyzes and drives mitigation of DDoS attacks in seconds. It uses AI-driven big data technology to detect threats, then works with our **7750 SR** and **7730 SXR** platforms using our in-house **FP** and **FPcx silicon** to quickly and accurately stop DDoS attack traffic before it enters the network. The Deepfield anti-DDoS solution transforms your IP network into a shield against DDoS from compromised user devices and IoT botnets that are weaponizing AI technology to disrupt your services and customers.



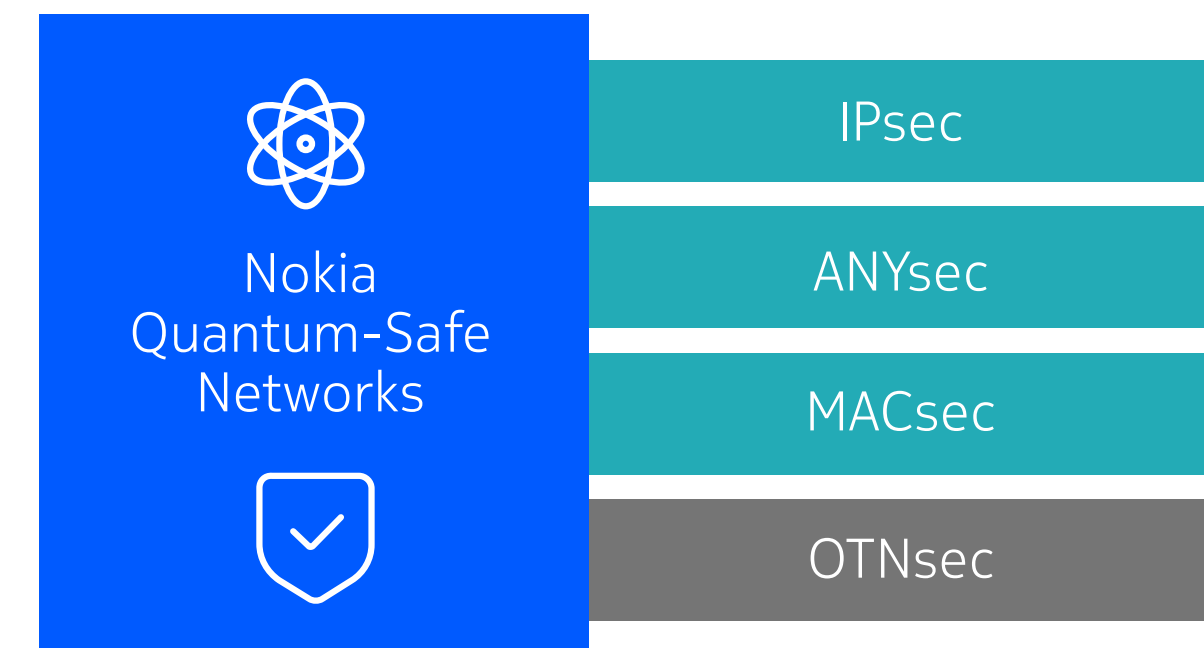
Security

Quantum-safe networks

Many AI applications rely on exchanging highly sensitive, valuable or private data that may be compromised by hacking, eavesdropping or man-in-the-middle attacks.

[Nokia Quantum-Safe Networking \(QSN\)](#) provides multi-layer IP and optical network cryptography for in-flight data with a defense-in-depth approach. This reliably safeguards the confidentiality, integrity and authenticity of data traversing the network, even as the quantum landscape evolves.

Our quantum-safe network cryptography solutions include [IPsec](#), ANYsec, MACsec and OTNsec to deliver secure and trusted network connectivity across IP, MPLS, Ethernet, and optical network layers.



Defense-in-depth, secure and trusted
IP and optical network connectivity

Reliability and sustainability

Reliability and sustainability are at the heart of your profitable growth and long-term success. With AI applications and their users relying on you to deliver their data, your IP network can make or break both the user experience and the usability of AI applications.

Nokia routers are engineered for resiliency, featuring redundant hardware and hitless failover mechanisms. Our robust software systems and fault-tolerant design provide non-stop routing, non-stop services and in-service software upgrades. They remain operational even in the event of failures, ensuring uninterrupted support for AI applications.

Streaming telemetry with granular insights helps identify issues with greater depth and breadth than standard monitoring tools. This aids with proactive fault detection, performance optimization and predictive maintenance.

Our programmable FP and FPCx routing silicon allow your IP network to grow with your needs. Given that bandwidth requirements will only accelerate with greater AI adoption, the energy efficiency of Nokia high-capacity routers can reduce your operating costs and help you meet your environmental targets.

At Nokia, we are dedicated to reducing the environmental impact of both our products and our own operations. This includes a commitment to using 100% renewable energy in our operations by 2025 as well as, by 2030, a 50% reduction in greenhouse gases and a 95% circularity rate.



IP networks powered by AI

AI is already providing benefits when used in IP network operations. We expect its value to increase with further innovations and as AI enhancements become more widely integrated.

For operations, the [Nokia Network Services Platform](#) (NSP) is an open, programmable platform that includes an extensive suite of ready-to-use functions for network management, control and optimization use cases. Plus, its open API interfaces enable you to quickly create and deploy your own automation use cases.

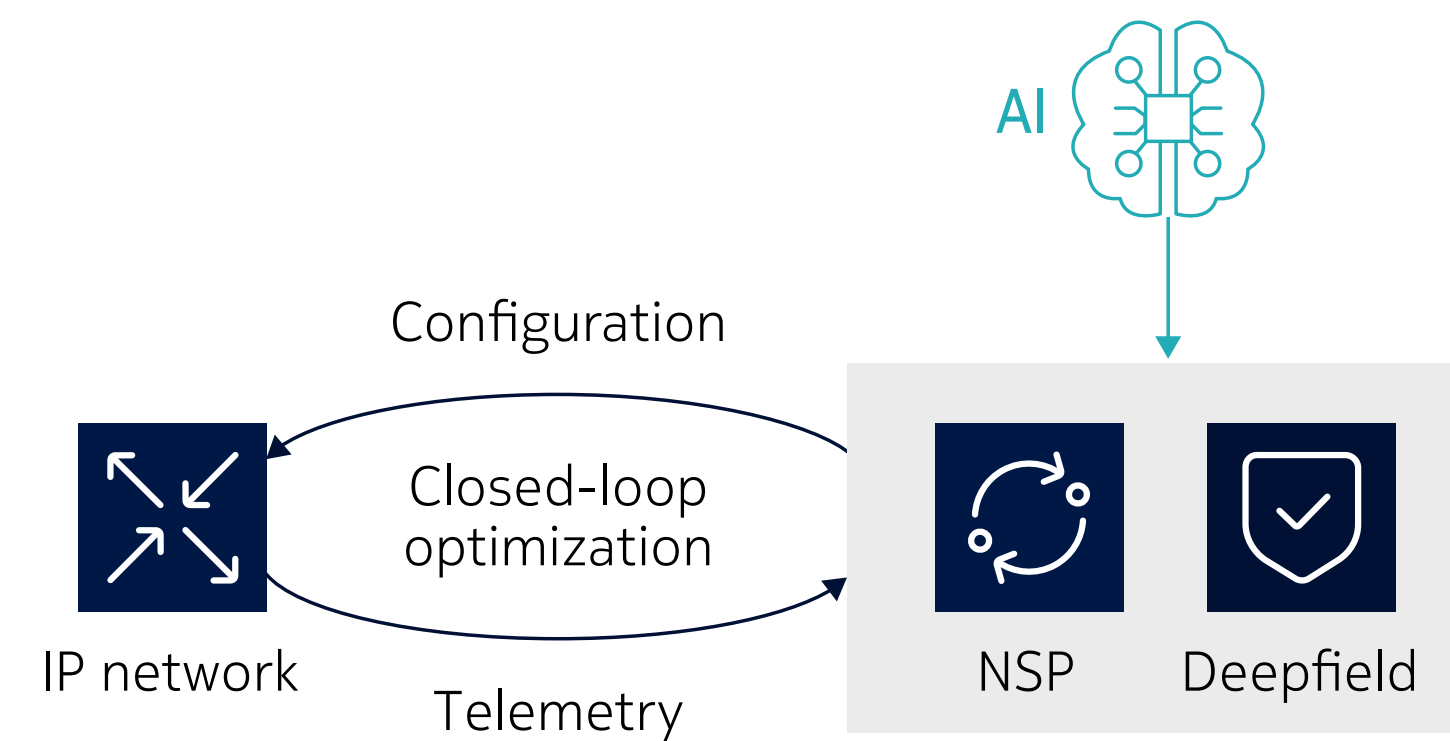
The [Nokia Deepfield](#) portfolio of AI-driven, big data IP analytics and security products, enhanced by [Deepfield Cloud Genome](#)® and [Deepfield Secure Genome](#)® data feeds,

provides detailed and holistic views of how applications, content and services are delivered and consumed, and enables network-wide DDoS protection.

These automation and security platforms continuously receive streaming data from the IP routers in the network and can issue commands to the IP routers. Both NSP and Deepfield are using AI to enhance their capabilities.

We see AI's benefits for network operations in three broad areas:

1. Assistance
2. Assurance
3. Analytics



Network operations AI benefits:

Assistance

Efficient network operations require good knowledge of your management system. But this isn't always easy. When uncertain, you might need to get more training, search in the menu, use the help function, or read the product documentation – all of which are time consuming. Some tasks, such as generating code to automate network operations, are more complex than others and take a long time to complete, even for the most experienced personnel.

With our innovative AI assistant for the Network Services Platform, we are unlocking a new way forward for operations.

The NSP AI assistant uses a large language model (LLM) to interact with you in natural language. Powered by a complete knowledge of Nokia IP routing capabilities through our NSP technical documentation, the tool can provide immediate recommendations on how to do the tasks you want to do. The AI assistant also has a view on the network state and can provide contextual suggestions for troubleshooting or optimizing the network.

There are many examples of how the NSP AI assistant can help.

- Help you understand or construct an API.
- Explain NSP functionalities and how to access them.
- Help you with a prescriptive explanation to aid in troubleshooting the network.
- Help you generate software artifacts (intents, workflows), enabling you to expand your network and introduce new services to your customers faster.
- Help you design dashboards for day-to-day network operations.

NSP AI assistant will lower the barrier to entry for operators that want to use NSP and will help them simplify and accelerate their network operations.



Network operations AI benefits:

Assurance

To operate high-performance and adaptive networks, you need meaningful and deep insights into your network. You must collect the right data, then triage, correlate and analyze that data. This is often cumbersome, time consuming and expensive.

NSP AI and machine-learning (ML) capabilities help you overcome these challenges. They augment the capabilities of your operational staff by delivering the insight required to make effective business- and network-impacting decisions in a timely manner.

The NSP uses ML algorithms to analyze vast real-time data streams collected from the network, helping you predict and mitigate potential disruptions before they escalate, impact services and cause network downtime.

The NSP's AI and ML functionality:

- Organizes collected data from your network into reports and dashboards for effective visualization, and a multitude of trending and root-cause analysis
- Uses outlier detection and clustering predictions to aid in troubleshooting
- Proactively predicts exhaustion or failure of network resources
- Helps with capacity planning, performance and quality analysis, utilization and congestion KPIs, customer and service uptime for compliance reporting
- Enables automatic triggering of corrective actions upon detecting network events and anomalies

You can rely on the NSP's predictive AI functionality to help you ensure optimized network performance and continuous adherence to SLAs.



Network operations AI benefits:

Analytics

To run your network efficiently, you need a holistic view of the types of traffic running over it as well as knowledge of where internet content is coming from and how it is delivered and consumed by your subscribers.

Conventional network management analytics and assurance apps are already using ML to set thresholds, define baselines, identify anomalies and act. Going forward, AI will take a more prominent role in assisting with identification of abnormal events and prediction of future trouble spots.

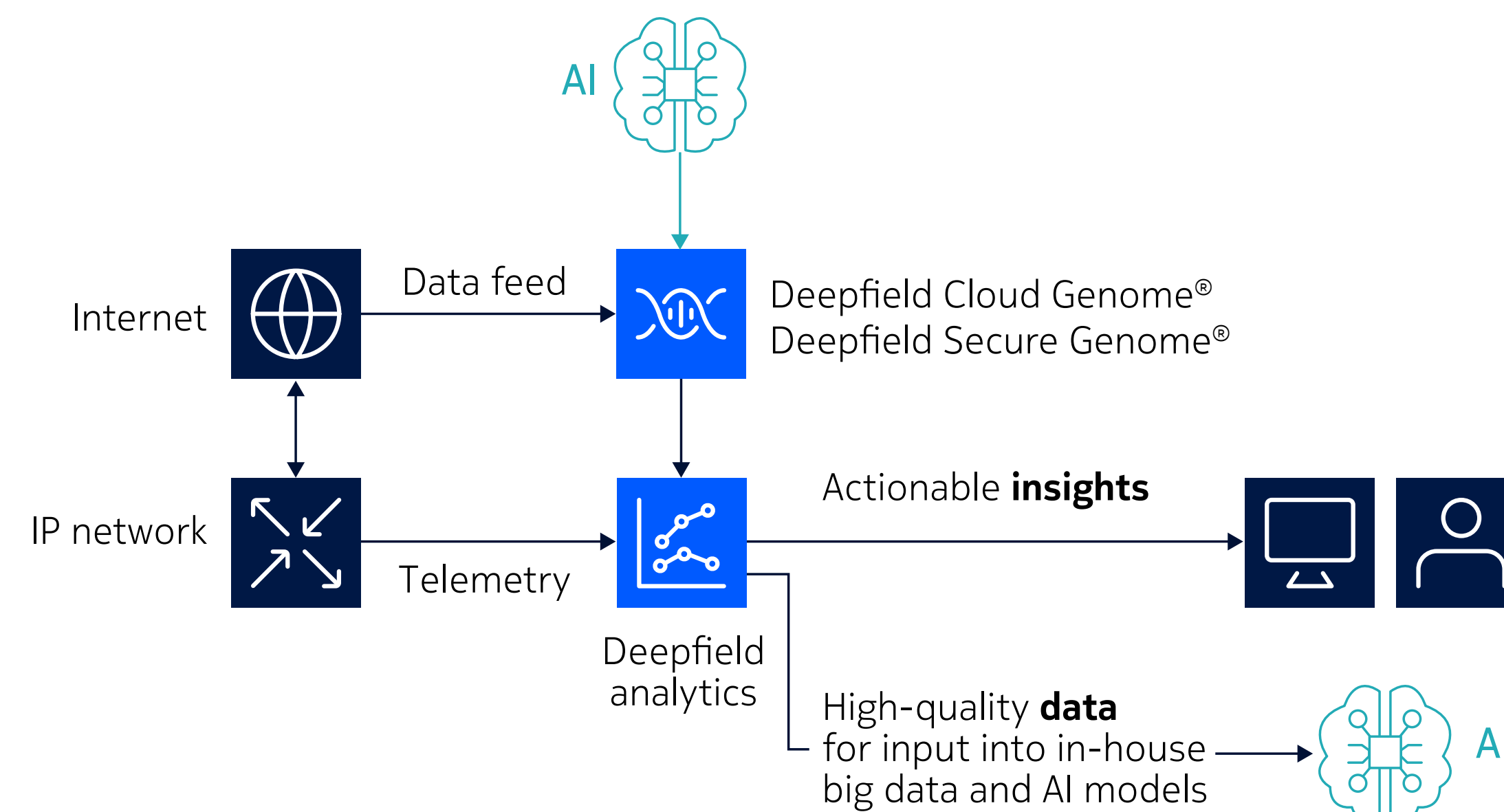
The [Nokia Deepfield](#) portfolio of analytics and security applications uses ML and AI to continuously scan the internet, amassing detailed knowledge about internet content, applications, services and security in the [Deepfield Cloud Genome®](#) and [Deepfield Secure Genome®](#) data feeds. These data feeds contain information about over 5 billion active IPv4 and IPv6 addresses, tagged against CDNs, ISPs, servers and hosting companies. The data

feeds also use over 100 ML rules for automatic classification and categorization across more than 30 different traffic categories.

The Deepfield analytics portfolio uses AI to analyze network data, correlate it with the Genome information and provide you with actionable insights about content, applications, services and consumption patterns. In turn, you can use these insights as inputs into your network and security operations, network planning and optimization, customer care and marketing.

These tools also provide high-quality data that you can input into your own AI/ML models for use in your business intelligence, data science, marketing and customer care functions.

AI-driven analytics can improve your network performance, reduce your operations costs, enrich your user experience and open doors to new revenue-generating opportunities.



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IP networks are critical for the success of AI applications today and in future. How well they do their job can make or break the user experience and the business model.

The evolution of AI will challenge your IP network in areas like secure and trusted network connectivity, bandwidth, latency and reliability. Success depends on anticipating these challenges and being ready to meet them.

Nokia is a global leader in high-performance IP network solutions for the world's most demanding operators and mission-critical applications. We would be delighted to help you:

- Build an IP network that puts you on a solid footing to deliver the experience and value of AI to its users.
- Secure your IP network to create a reliable and safe environment for AI applications and all its users.
- Operate your IP network, leveraging AI to automate and scale operations and better serve your customers.

For more information, please contact your Nokia sales representative or visit us at www.nokia.com/ip-networks/ai/.

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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.

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.

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