Nokia

The edge of tomorrow

Broadband evolution for the AI era

At the edge of tomorrow

Imagine a world where smart homes and autonomous vehicles are just the beginning. A hyperconnected world that seamlessly extends physical reality into the digital realm. Filled with immersive and interactive user experiences powered by artificial intelligence (AI) that transform the way we live, play, work and connect —creating new opportunities for growth and innovation.

It may sound farfetched. Today's broadband networks can barely keep up with existing demand, let alone the emerging demands of tomorrow. They're built on legacy architectures that deliver basic, best-effort internet access and can't handle demands for higher data throughput, lower latency and secure protection from distributed denial-of-service (DDoS) attacks.

But what if you could empower your broadband edge to take on these new challenges and opportunities?

With the right architecture and technologies, you can enable more efficient, secure and innovative services that yield better user experiences and greater revenue today and well into the future.

Broadband for the AI era

An expanding digital world

Network operators have steadily increased broadband coverage, capacity and connectivity. Today, about 70% of broadband users enjoy high-speed internet access and connect a dozen or more devices per home. Video has been the dominant driver for faster access speeds and accounts for roughly 80% of internet traffic. Bigger screen sizes, higher-resolution content and on-demand viewing drove a steady increase in traffic. On average, broadband users spend seven hours per day online, including more than two hours on social media, mostly watching video content.

While traditional broadcast TV and IP video streaming is leveling off and may be reaching a saturation point, new immersive media and intelligent applications powered by AI are projected to grow rapidly. AI can tap into the vast resources of cloud data centers and edge compute to extract meaning and value from massive volumes of data, boost productivity and creativity, and augment our world with relevant digital information and insight.

Although AI may generate less traffic than video, it greatly differs in service value, quality and security aspects. As AI is infused in more devices and applications, it starts to shape broadband network evolution. To stay ahead of the curve and position your business for new growth opportunities in the AI era, you need a future-ready broadband edge to navigate these changes.

Socialize

Entertain

Work

Live

Learn

Play
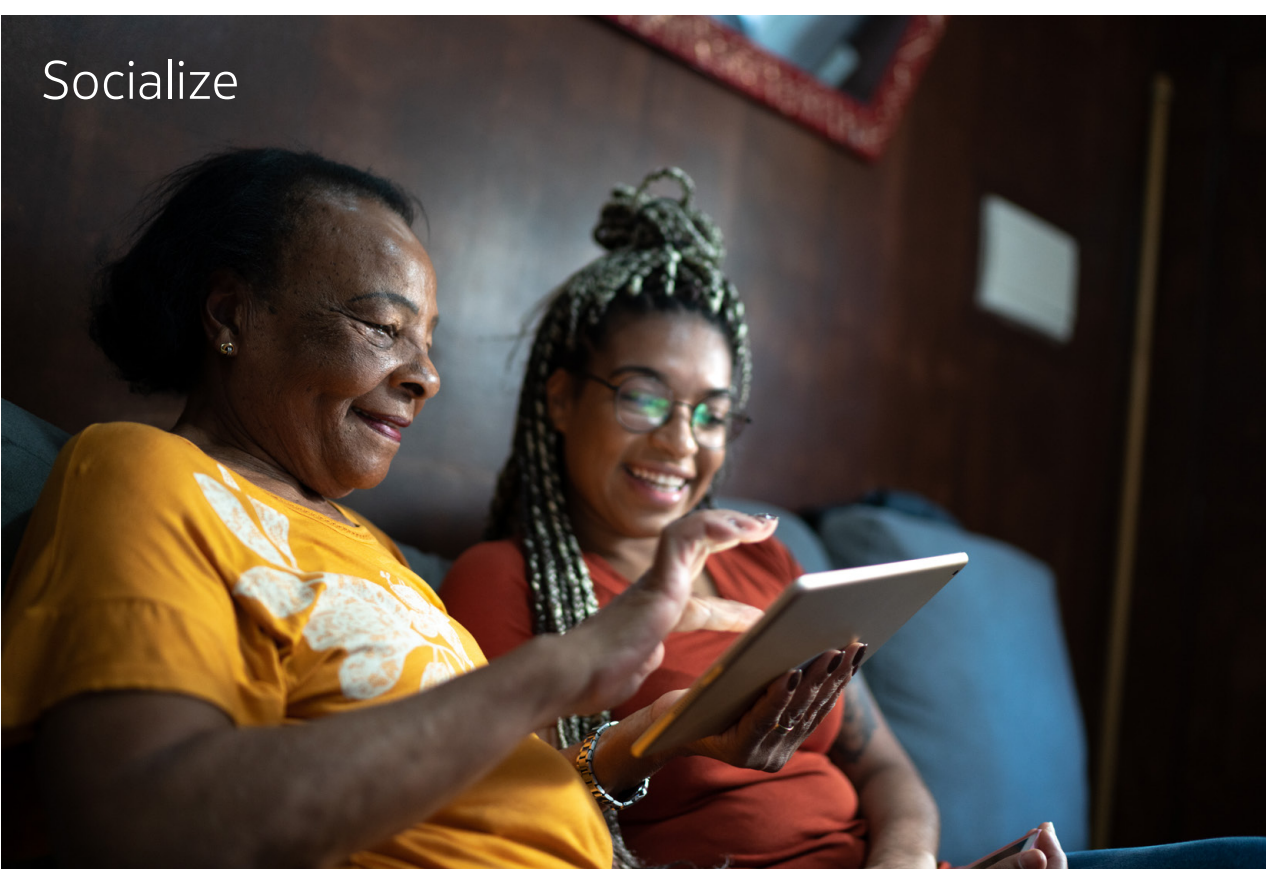
Journey to the edge of tomorrow

Universal broadband

Secure broadband

Broadband for the AI era

Converge your broadband edge on the Nokia Multi-Access Gateway

- Scale bandwidth capacity by replacing copper with fiber to the premises
- Expand coverage for underserved areas with 5G fixed–wireless access

Transform your broadband edge into a shield against DDoS attacks

- Secure connectivity for smart homes, Internet of Things and AI applications
- Protect subscribers and services, and improve your reputation and revenues

Evolve your broadband edge for emerging AI user applications

- Ensure deterministic QoS for high-bandwidth, low-latency data traffic
- Seize new market opportunities for AI edge compute hosting services

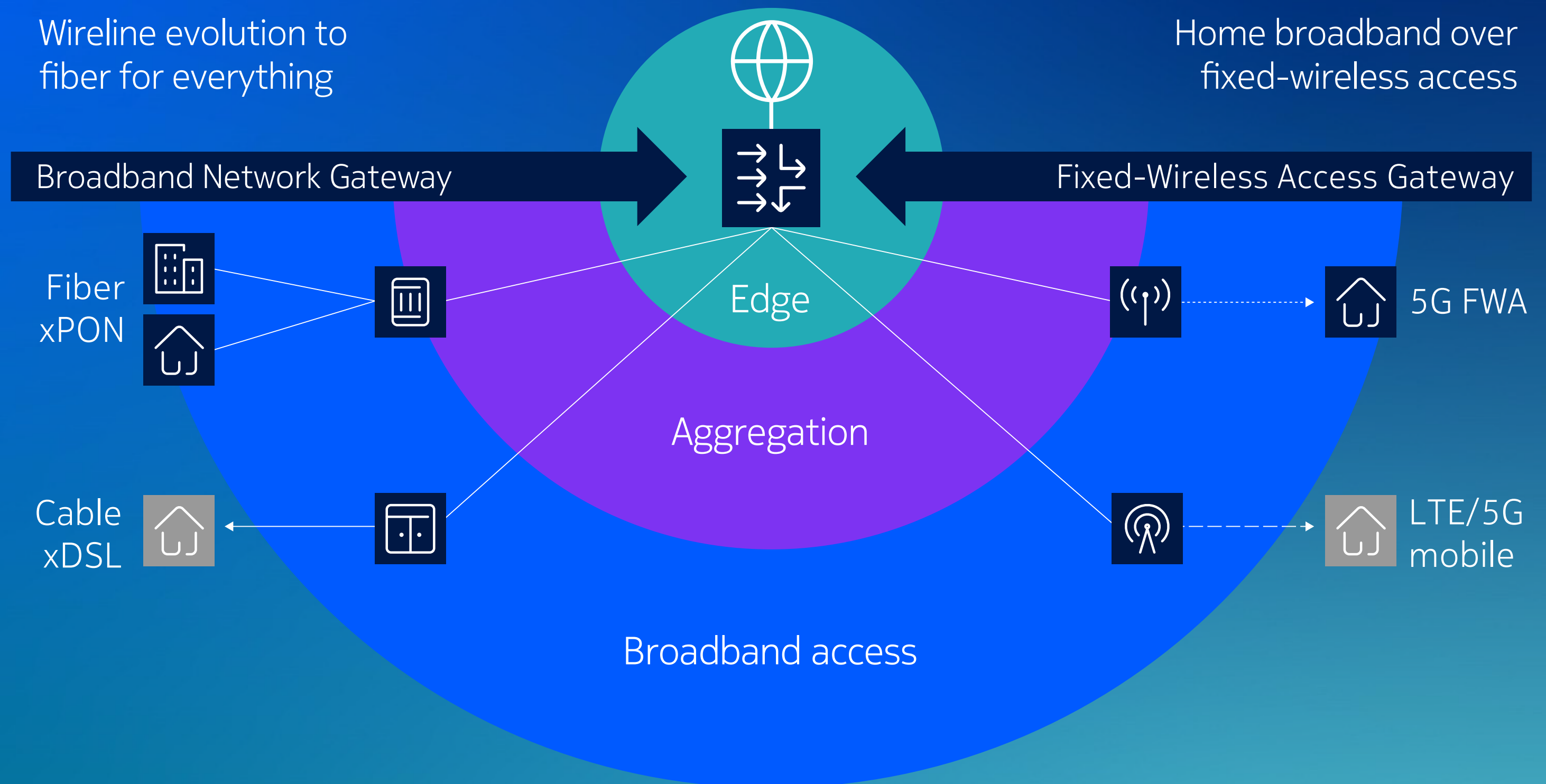| At the edge of tomorrow | Broadband for the AI era | Journey to the edge of tomorrow | The Nokia Multi-Access Gateway | Lay a foundation for sustainable growth | Secure broadband for everyone | Anticipating AI traffic growth | Broadband evolution for the AI era | Add value beyond connectivity | Key features and benefits | Why partner with Nokia? |

The Nokia Multi-Access Gateway

Access portal to the digital world

Network operators and governments around the world are investing to expand broadband capacity and coverage. Fiber is the fastest and most future-safe transmission medium with the lowest carbon footprint. 5G fixed-wireless access (FWA) can complement coverage where trenching fiber is too costly or time consuming.

The Nokia Multi-Access Gateway (MAG) enables you to fully capitalize on precious investments in faster broadband access. It can be deployed as a Broadband Network Gateway (BNG) or Fixed–Wireless Access Gateway and converge wireline access and FWA on a single edge.

With the MAG, you get a scalable, versatile and future-ready broadband edge solution for delivering a seamless user experience over any access technology with optimal cost and performance synergies.

Universal broadband with the Nokia Multi-Access Gateway

Wireline evolution to fiber for everything

Home broadband over fixed-wireless access

Broadband Network Gateway

Fixed-Wireless Access Gateway

Fiber xPON

5G FWA

Edge

Aggregation

Cable xDSL

LTE/5G mobile

Broadband access

The broadband edge is an essential network demarcation point for managing subscriber access to digital content and services on the internet and in private clouds. It plays a crucial role in delivering, assuring and monetizing universal broadband services. It must be flexible and adaptive to support multiple access technologies, higher data speeds, more users and more services. The Nokia Multi-Access Gateway offers a scalable and versatile solution for delivering residential, enterprise, industrial and wholesale broadband access services on a common and converged platform.

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edge of tomorrow

The Nokia
Multi-Access Gateway

**Lay a foundation for
sustainable growth**

Secure broadband
for everyone

Anticipating AI
traffic growth

Broadband evolution
for the AI era

Add value beyond
connectivity

Key features
and benefits

Why partner
with Nokia?

Lay a foundation for sustainable growth

A broadband edge that is future-ready today

Operational flexibility and efficiency are essential for achieving sustainable growth in changing conditions. The Nokia MAG leverages market-leading 7750 Service Routers powered by programmable FP network processors and the field-proven Service Router Operating System (SR OS) to scale service capacity and capabilities today and well into the future.

FP5 is our latest-generation packet processor. It offers 6 Tb/s forwarding capacity, fully buffered ingress and egress shaping, and granular per-subscriber and per-service QoS to ensure deterministic and assured performance at scale for all service combinations and usage conditions. Line-rate DDoS filtering and data encryption capabilities allow you to protect broadband subscribers and services against cybersecurity threats.

Wireline access providers can deploy the MAG as an integrated multiservice BNG on 7750 SR routers with SR OS software, or as a disaggregated BNG with control and user plane separation (CUPS) using the MAG controller (MAG-c). Converged access providers can cost-efficiently scale wireline and 5G/LTE FWA user plane functions (UPFs) on 7750 Service Routers while managing subscribers centrally through the MAG-c with a 3GPP 5G core.

The Nokia MAG can be deployed on a wide range of service routing platforms that scale from 1 to 100 Tb/s. Powered by FP5 silicon, these platforms allow you to quickly evolve services, neutralize security threats and satisfy growing capacity needs—all while maintaining optimal efficiency and performance.

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Secure broadband for everyone

Protecting smart homes and the IoT

Modern smart homes contain an increasing number of user devices, appliances and gadgets that connect to the Internet. Many of these devices are vulnerable to being hacked or infected by malware because they have outdated software versions, weak security or default factory passwords that were never changed.

Connecting more devices at faster speeds also increases the frequency and magnitude of DDoS attacks. These botnet attacks direct malware-infected applications and IoT devices to generate huge volumes of bogus traffic that can congest your network, cripple bandwidth and latency-sensitive services, and cut off users. Moreover, malicious actors are weaponizing AI to make DDoS attacks even more effective and harder to detect.

Our latest Threat intelligence report of 2024, found that DDoS traffic growth continued to surpass the growth rates of all other network traffic types and increased in volume 166% year over year. Botnets accounted for about 60% of traffic monitored by the Nokia Deepfield Emergency Response Team (ERT).
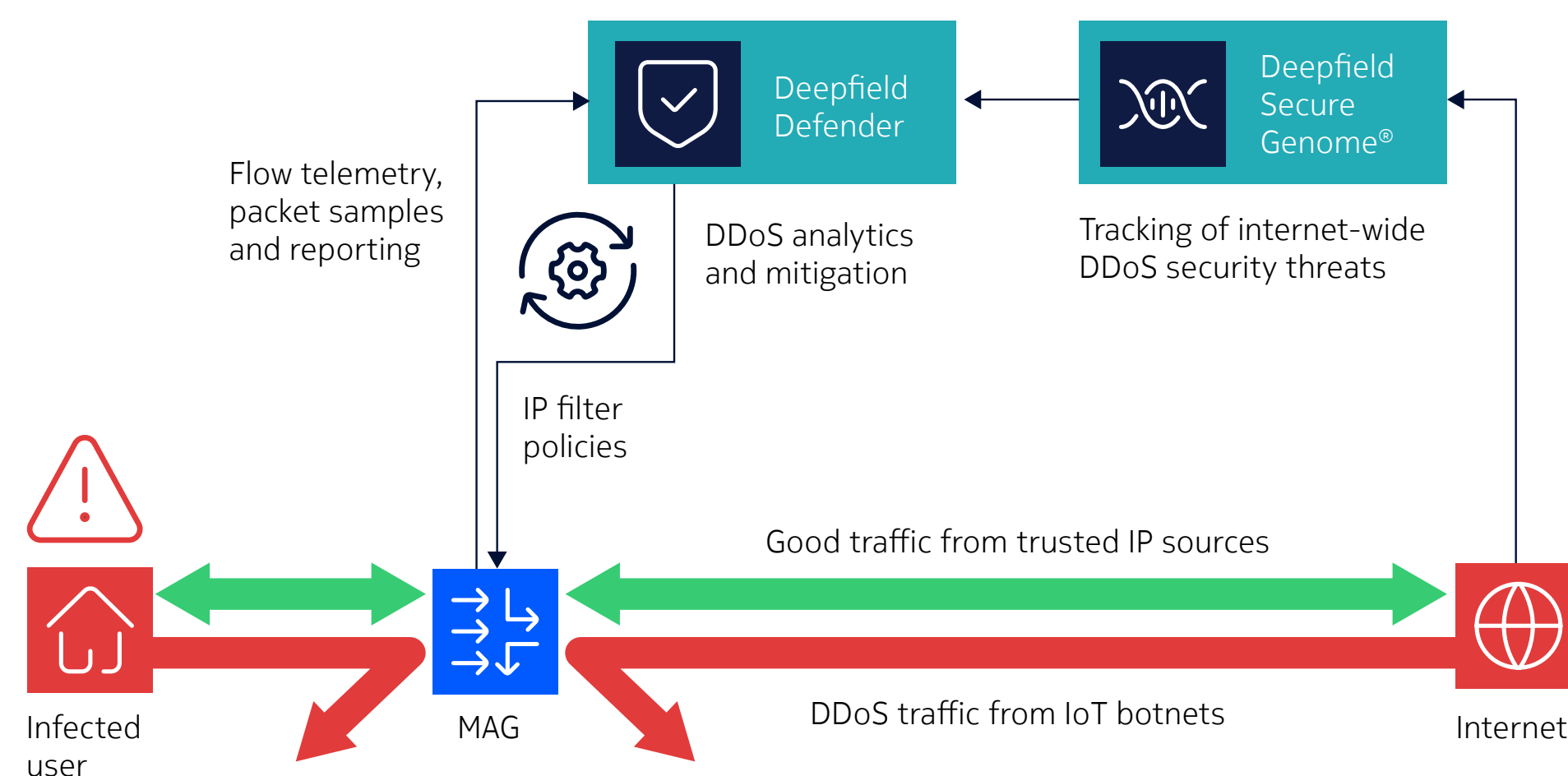
Transform your edge into a shield against DDoS attacks

A secure broadband edge will help you assure the user experience, increase brand loyalty and attract new customers. Offering a secure broadband experience can also be a source for new revenue and give you a leg up on your competitors.

You can use the powerful AI capabilities of Nokia Deepfield, a software-based DDoS detection and analytics solution, to process and analyze the massive volumes of streaming telemetry data generated by MAG routers.

In combination with cloud intelligence from Deepfield Secure Genome®, Deepfield Defender can positively identify botnet DDoS attacks, along with their methods, sources and targets. In seconds, it automatically determines and deploys surgical countermeasures on the MAG to block volumetric DDoS traffic, without impacting legitimate user traffic.

Flow telemetry, packet samples and reporting

Deepfield Defender

DDoS analytics and mitigation

Deepfield Secure Genome®

Tracking of internet-wide DDoS security threats

IP filter policies

Good traffic from trusted IP sources

Infected user

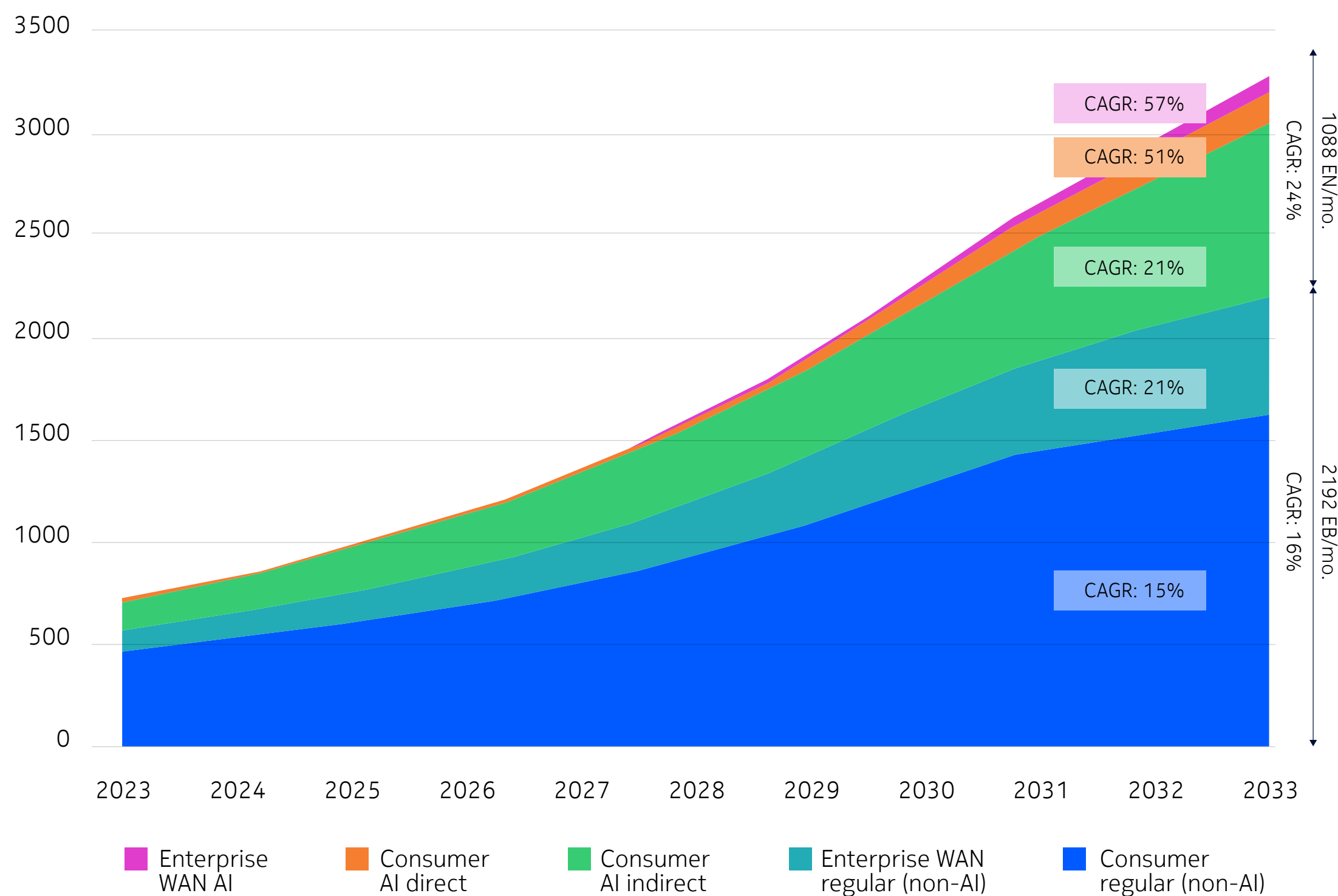MAG

DDoS traffic from IoT botnets

Internet

Anticipating AI traffic growth

Global AI WAN traffic forecast

AI has significant potential to impact long term traffic growth. Assuming moderate growth, Nokia Bell Labs projects consumer AI traffic to reach 1006 Exabyte/Month by 2033 at a compound annual growth rate (CAGR) of 23% and enterprise AI traffic to reach 81 Exabyte/Month at 57% CAGR.

Chart legend:
- Enterprise WAN AI (CAGR: 57%)
- Consumer AI direct (CAGR: 51%)
- Consumer AI indirect (CAGR: 21%)
- Enterprise WAN regular (non-AI) (CAGR: 21%)
- Consumer regular (non-AI) (CAGR: 15%)

1088 EN/mo. CAGR: 24%
2192 EB/mo. CAGR: 16%

Indirect AI traffic

About 80% of all consumer AI traffic is "indirect", which reflects traffic growth resulting from personalized AI-driven recommendations across platforms such as video streaming, social media, audio streaming, and online marketplaces.

Indirect AI traffic behaves like regular (non-AI) traffic with the difference of using AI/ML algorithms for content search and selection. While the use of generative AI cloud applications such as ChatGPT and Gemini will increase user engagement by helping to find and compile relevant and personalized content more quickly and efficiently, indirect AI traffic is not expected to drive disruptive changes.

Direct AI traffic

Direct AI traffic is highly diverse, dynamic and interactive in nature and data is typically generated and consumed on-the-fly. Consumer applications such as computer vision, extended reality (XR) and spatial computing use generative AI to augment the physical world with digital information. High throughput and low latency data transport is critical to ensure a sufficiently high resolution of image data and other sensory inputs needed to make accurate AI inferencing decisions in real-time and assure a responsive and seamless user experience.

Enterprise AI applications typically focus on improving operational efficiency such as predictive maintenance, autonomous operations, video and image analytics and AI-enhanced customer interactions. They need flexibility to run AI applications in the public cloud, private datacenters or on premise with reliable and secure connectivity in between. Your broadband edge must evolve to address these requirements.

Broadband evolution for the AI era

Legacy broadband for internet and over-the-top video

Current IP networks are designed and dimensioned for best-effort internet and IP video streaming. Although video is susceptible to fluctuations in bandwidth, packet loss and latency, most content is public, prerecorded and cacheable for on-demand viewing. When network congestion occurs, streaming protocols can dynamically lower the video resolution and adapt bit rates (ABR) to prevent stalling. Live TV broadcast feeds can use IP multicast replication and buffering to enable efficient and reliable streaming to a large audience.

Deterministic QoS and security for AI applications

None of the caching and congestion management mechanisms used for video delivery are viable for emerging real-time AI applications. The Nokia MAG allows you to add new capabilities such as network slicing, hierarchical QoS and priority queuing to your broadband edge to deliver deterministic bandwidth and latency guarantees. It also facilitates a seamless integration of AI edge compute servers in the end-to-end data path and can secure your broadband edge against cyber threats to protect vulnerable users, services and infrastructure.

Present network

Web browsing
Internet video

Oversubscription
Shaping/policing

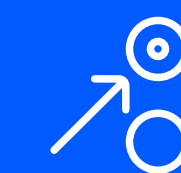Edge caching
ABR/buffering

Public content
Shared media

New requirements

Real-time
interactive

Network slicing
Priority queuing

Edge compute
CIR/low latency

Data privacy
DDoS ssecurity

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Add value beyond connectivity

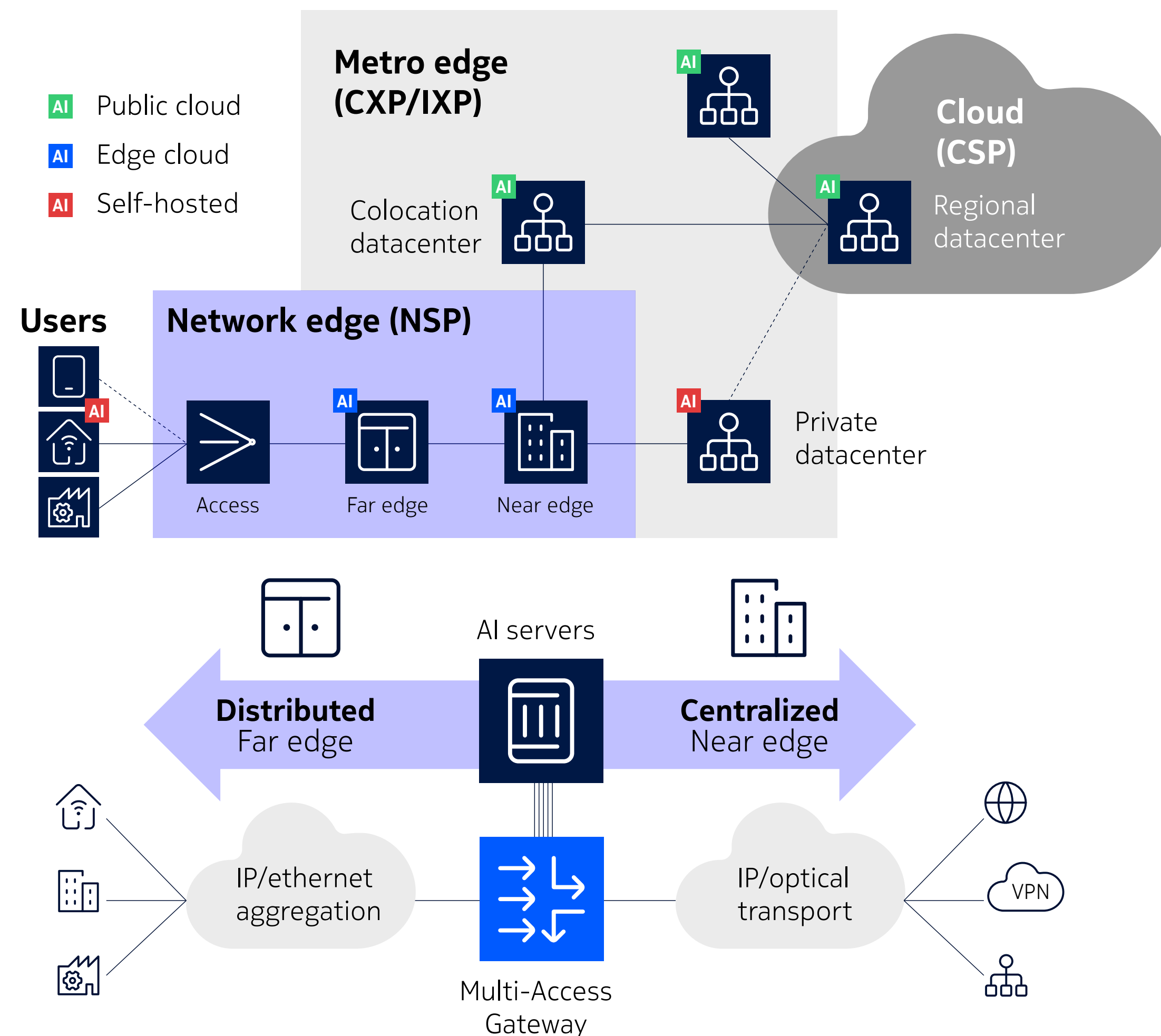## Connecting and hosting distributed AI edge infrastructure

As AI deployments transition from model training to inferencing, opportunities emerge for network service providers (NSPs) to add more value. AI inferencing is the interaction of end users and devices with trained AI models. It is highly dynamic, compute-intensive and distributed in nature as it must serve millions of AI user queries per day.

Hosting AI inferencing servers at the network edge can be an attractive alternative to deployments at the customer premises or in data centers that offers lower bandwidth costs, reduced security risks and a better user experience. Moreover, offering hosting and colocation services enables NSPs to increase revenues and customer loyalty.

Whether hosting AI server equipment for yourself, for cloud service providers (CSPs) or enterprises, the Nokia MAG enables you to connect broadband users with distributed AI edge server installations and data centers in an efficient, reliable and secure way:
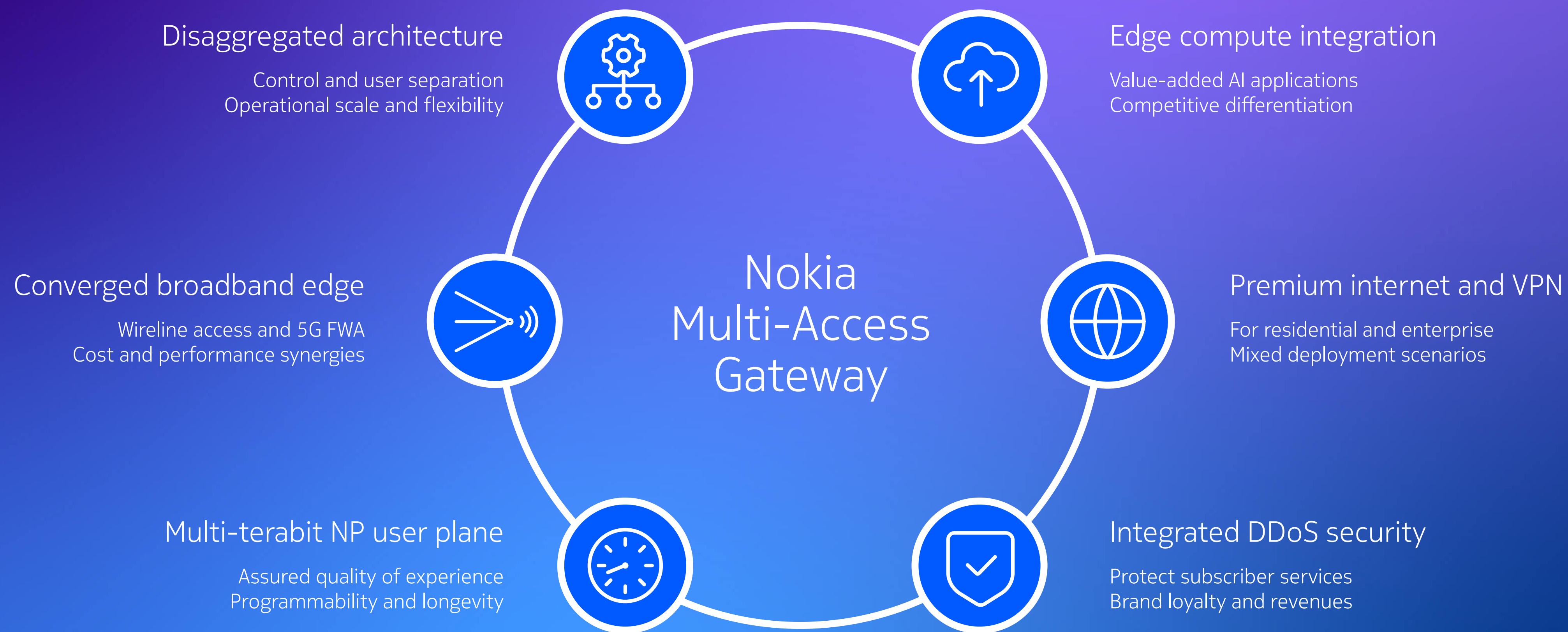
- **Multi-access:** Efficiently share hosted AI servers at distributed or centralized edge locations across wireline and fixed-wireless access users.

- **Multi-user:** Serve the needs of residential, small business and enterprise users with a single, scalable and secure broadband edge platform.

- **Multi-service:** Grant secure subscriber access to the internet, virtual private networks (VPNs), content delivery networks (CDNs) and cloud data centers.

The Nokia MAG supports both distributed and centralized edge deployments as well as disaggregated deployment with control and user plane separation (CUPS). A rich set of support features including geo-redundancy, load-balancing, network slicing, non-stop routing and forwarding, anti-spoofing and DDoS filtering, ensure that your broadband edge has the resiliency needed for mission-critical AI applications.

Key features and benefits of the Nokia Multi-Access Gateway

Disaggregated architecture
Control and user separation
Operational scale and flexibility

Edge compute integration
Value-added AI applications
Competitive differentiation

Converged broadband edge
Wireline access and 5G FWA
Cost and performance synergies

Nokia Multi-Access Gateway

Premium internet and VPN
For residential and enterprise
Mixed deployment scenarios

Multi-terabit NP user plane
Assured quality of experience
Programmability and longevity

Integrated DDoS security
Protect subscriber services
Brand loyalty and revenues

In summary, the Nokia Multi-Access Gateway is a scalable, versatile and future-ready broadband edge platform to help you address the emerging challenges and opportunities of the AI era. To learn more, please visit the Multi-Access Gateway product page.

AI is an essential technology for managing and monetizing data in the digital world. It has tremendous potential to power intelligent new services that will challenge your broadband network in areas such as bandwidth capacity, latency and reliability—and open new avenues to add value and grow your business. The Nokia Multi-Access Gateway empowers your edge to successfully master the challenges and opportunities of the AI era.

Why partner with Nokia?

Nokia is a global leader in broadband access. We pioneered digital subscriber line technology and are the market leader in GPON, 10G PON (XGS), 25G PON and 5G FWA. More than 300 operators rely on Nokia BNG and FWA Gateway solutions to deliver broadband everywhere.

We have a worldwide presence and pride ourselves on being one of the few vendors capable of providing you with complete, end-to-end broadband solutions.

Where can I find more information?

A great place to start is our broadband edge solution page. If you want to dive into technical details, visit the Multi-Access Gateway product page. To learn more about our broadband edge routers, refer to the 7750 SR product page.

For more context on the role of AI in networking, visit www.nokia.com/artificial-intelligence/. Please contact a Nokia sales representative if you have further questions or didn't find what you were looking for.

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.