Improving the environmental sustainability of IP networks

Nokia IP networks

White paper

Digital communication networks provide tremendous benefits, connecting people and things across communities, businesses and supply chains. These networks have become a critical lifeline for society. At the same time, they are a contributor to greenhouse gas (GHG) emissions; therefore, network operators need to continually strive to minimize any potential negative impacts these networks have on the planet.

Nokia is placing sustainability at the heart of our purpose by creating technology that helps the world act together. At Nokia, we believe we have a unique opportunity to address some of the world's biggest challenges where connectivity and digitalization will play a critical role. Through technology leadership we enable critical digital communication networks to help address global issues such as climate change.

This paper discusses how the Nokia IP Networks team is committed to combatting climate change through industry-leading IP innovations and sustainable operations, to deliver a sustainable IP networking portfolio.

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Industry environment

Cloud applications and services are driving our customers' networks whether they be 5G, ongoing digital transformation in enterprise, or the migration to the consumer, enterprise or industrial metaverse.

Connectivity and digitalization, supported by Nokia's customers, play a key role in this evolution, making industries and communities more productive, resource efficient and equitable.

There are currently around five billion global active internet users (as of January 2023), and this number continues to grow. However, this cannot happen without evolution of the IP network infrastructure. Key concerns are continued capacity growth of around 29 percent with changing traffic patterns; the need to support a broadening range of services with stringent and diverse requirements; and the need to secure these critical IP network infrastructures.

The UN Paris Agreement target of limiting the average rise in global temperatures to 1.5 degrees Celsius by 2050, compared to pre-industrial levels, will not be achieved without innovative solutions.

These are important commitments because an increasing concern is the impact of rapidly growing energy consumption and carbon emissions on our climate. At current rates, the cloud's share of carbon footprint is estimated to grow from 3.8 percent in 2020 to 8 percent in 2030.

However, the ICT industry can have a strong net positive effect on greenhouse gas (GHG) emissions by helping other industries increase their productivity while reducing their energy consumption in areas as diverse as transportation, mining, energy, agriculture and manufacturing. ICT equipment operators who transition to renewable energy sources will make a further contribution to the reduction of GHG emissions from fossil fuel.

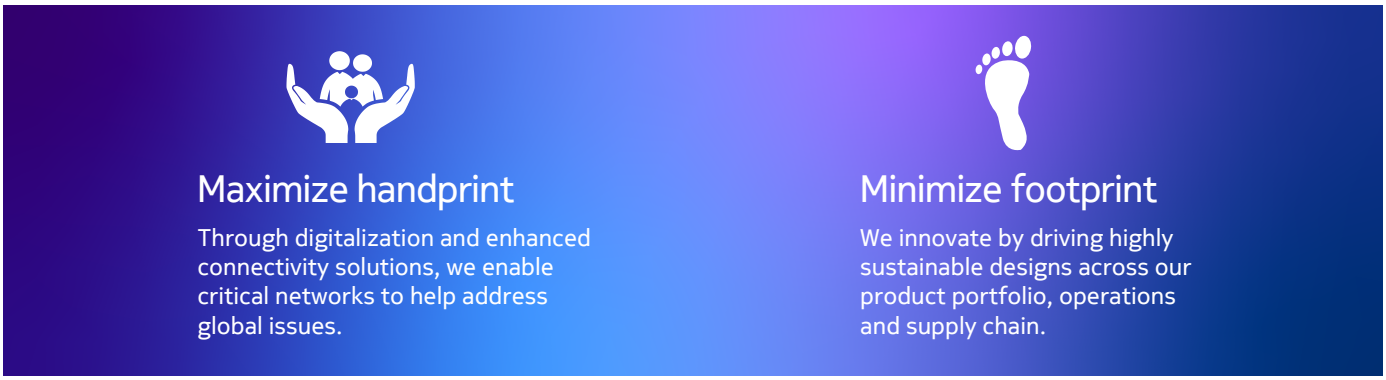
Sustainability is an important part of the corporate strategy of many large companies, including service providers. As an example of ICT industry commitment, operator groups representing 44 percent of global mobile connections and 63 percent of these by revenue have committed to setting Science-Based Targets (SBTs) as part of a sector-specific decarbonization pathway that allows ICT companies to set targets in line with the latest climate science.

Nokia's commitment

Nokia was one of the first 100 companies in setting ambitious SBTs based on the UN Paris Agreement. In April 2021, Nokia reaffirmed our SBT commitment to sustainability across our own operations and the life of our products: to reduce absolute Scope 1, 2 and 3 GHG emissions 50 percent by 2030 from a 2019 base year. Further, in November 2021 we committed to use 100 percent renewable electricity in our facilities by 2025, aligning with the requirements of the RE100 initiative.

Nokia is placing sustainability at the heart of our purpose by creating technology that helps the world act together. At Nokia, we believe we have a unique opportunity to address some of the world's biggest challenges where connectivity and digitalization will play a critical role. As shown in Figure 1, we aim to maximize our positive impact — our handprint — while we work to minimize any negative impact on the environment — our footprint.

Figure 1. Nokia's dual approach to combatting climate change



Through technology leadership we enable critical digital communication and hence networks to help address global issues such as climate change. The enhanced connectivity solutions we provide help the world decarbonize and dematerialize, limit the use of natural resources, increase the reuse of materials, reduce waste, and bring more inclusive access to digitally delivered services to ensure no one is left behind. These benefits represent the handprint of digitization and connectivity.

At the same time, we continually strive to minimize any potential negative impacts of networking technology, making our footprint on the world around us as small as possible. To reduce our environmental impact, Nokia sets ambitious environmental sustainability goals to help customers and ourselves reduce energy consumption and GHG emissions from networks. These goals are outlined in Nokia's annual People and Planet report.

We realize that our customers are fully committed to achieving their SBTs and that 93 percent of Nokia's total carbon footprint comes from our Scope 3 emissions from the use of sold products in our customer networks. So, one of our largest opportunities for impact is to focus on the environmental footprint of our products in our customer networks, which we are actively and innovatively undertaking.

We are thinking through our internal operations holistically and are also involved in stakeholder engagement throughout our value chain, considering the environmental, social and governance (ESG) goals and impacts from our suppliers to customers.

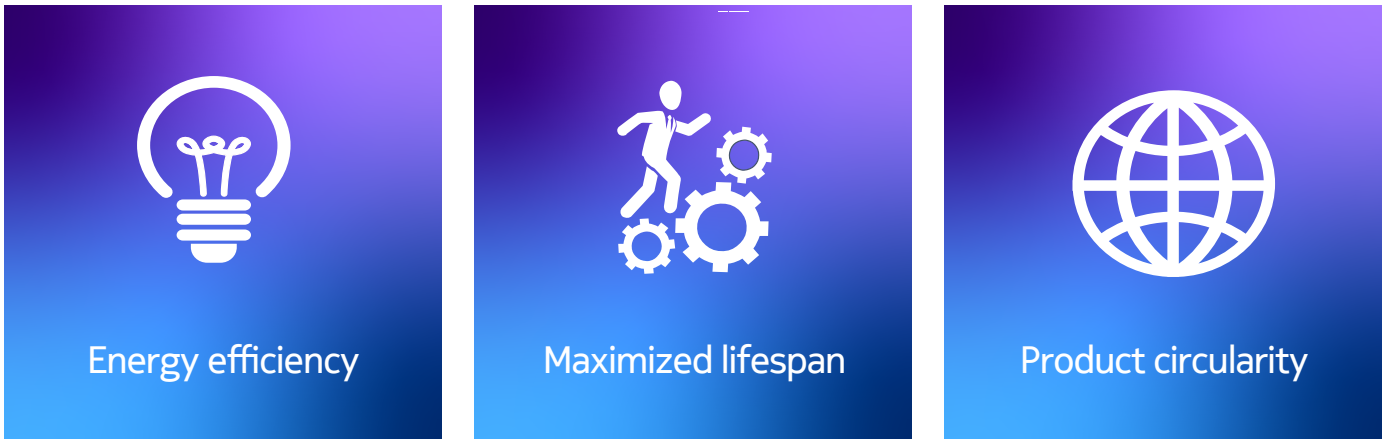
Nokia IP Networks

The focus of the Nokia IP Networks team has always been on delivering quality solutions and expertise to solve the world's IP networking challenges. Today, our expertise and technologies are building the world's most critical IP networks. We are building today's networks to enable the applications of tomorrow.

The IP Networks team is committed to helping our customers improve the performance, scalability, reliability and programmability of their IP networks. Equally as important, the team is committed to helping customers reduce the environmental impact of the use of our sold products.

From an environmental perspective, we are working with our customers to help them master the sustainability challenge for their critical IP networks through a lens of energy efficiency, maximizing network lifespan, and product circularity (see Figure 2).

Figure 2. IP Networks portfolio innovation



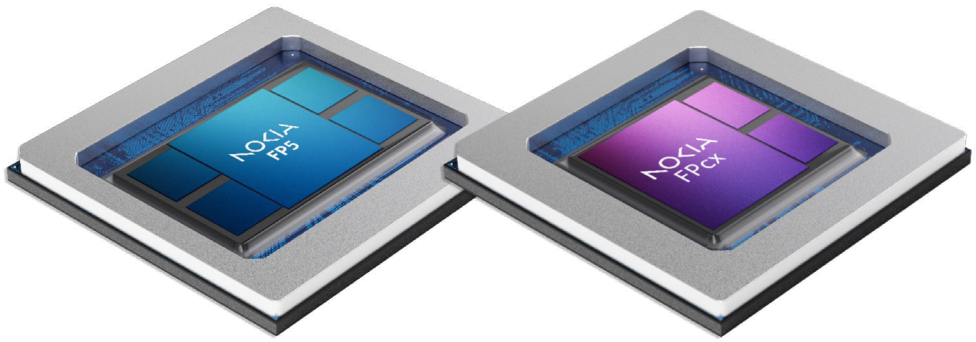
Energy efficiency

We are working with our customers to help reduce energy consumption to reduce both energy costs and Scope 3 GHG emissions in the face of continued growing network capacity demands, scaling of the network infrastructure, diverse and granular SLAs, and IP network security threats. Because we believe in the competitive advantage of industry-leading solutions and are committed to our set SBT, we aim to lead in the energy efficiency of IP network products, silicon, software and systems.

Through our IP portfolio breadth, we provide our customers with the choice to suit their application and network roles both across the WAN (including edge, core, access and aggregation) as well as within and between data centers. Our portfolio gives customers technology choices that incorporate a balanced approach for platforms to meet network requirements using ”fit for application” silicon technologies. These are designed for optimal performance, power, features, scalability and physical footprint.

Our network operating system software has a common software base with a proven quality history. The software delivers enhanced NetOps capabilities, developed through a pipeline with a heavy investment in test automation to simplify and reduce operational and integration costs.

Figure 3. Silicon innovation with Nokia FP5 and FPcx



We continue our silicon innovation with the FP5 and FPcx network processors (see Figure 3). They are the industry’s most advanced IP network processor silicon specifically designed and optimized to meet the stringent network operating requirements of service providers.

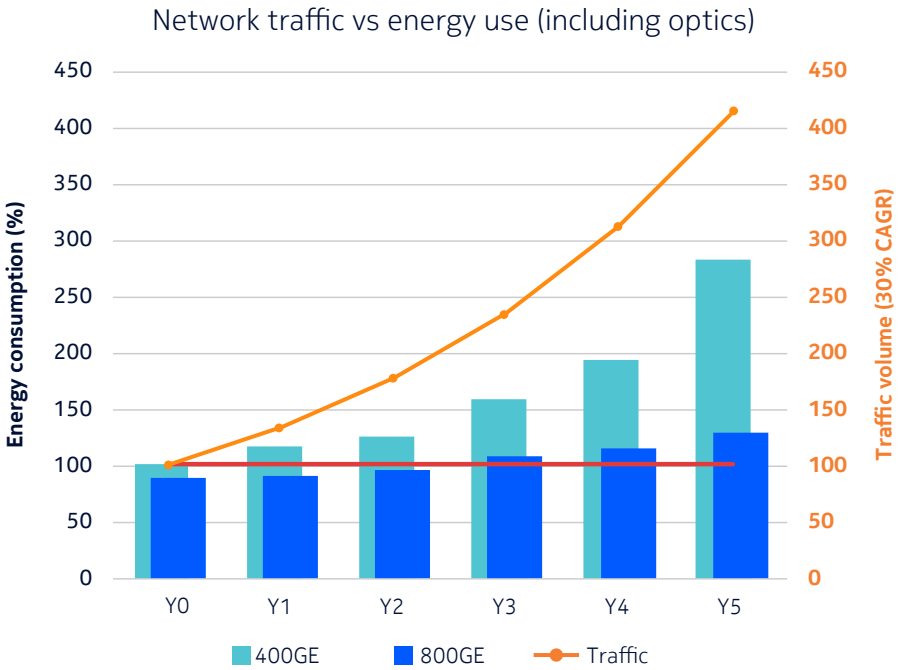
With full features enabled on FP5 and FPcx silicon, we reduce power consumption by 75 percent from the previous FP4 generation. At the same time with FP5, there is more than 3X increase in capacity in the same power envelope. With FP5's intelligent aggregation, power consumption drops even further. Built-in highly scalable and programmable line rate security helps to secure critical IP networks while further reducing both network power consumption and physical footprint.

Our system design innovation includes dual-sided PCB design, systems architecture, technology adoption and integration, combined with innovative airflow. Together, these features deliver unmatched high-density optics cooling, lower fan speeds and reduce overall system energy consumption.

Our systems already support high-density 400G coherent optics. With the recent availability of 800G digital coherent pluggable optics, we also deliver the industry's highest-density 800GE routing that can be deployed in existing Nokia 7750 Service Router (SR) systems today. The deployment of 1 x 800G pluggable optics can offer from 20-40 percent power savings over equivalent 2 x 400G pluggable optics.

A recent Nokia Bell Labs study shows that the application of our silicon innovation with FP5 and 800GE routing can help our customers deliver sustainable traffic growth with better energy and space efficiencies (see Figure 4).

Figure 4. Sustainable IP traffic growth with FP5 and 800GE routing



In the case study model, a common network architecture connects access networks to the appropriate cloud location. The model assumes a 30 percent CAGR in traffic over five years, which aligns with historic and projected traffic growth figures.

The model identifies that Nokia customers can double IP network traffic capacity in their existing energy, connectivity and physical footprint with FP5's 800GE routing combined with deterministic performance and services delivery without compromise. The use of FP5 and 800GE routing continues to deliver significant energy and space efficiencies over the five-year model timeline.

With our network automation, we enable our customers to track and optimize their IP networks with common principles and tools that manage the entire IP network infrastructure across WAN and data center. Model-driven management and streaming telemetry drive closed-loop automation. Advanced diagnostics deliver increased levels of automation, assurance and optimization in the network. These diagnostics can provide our customers the opportunity to expand remote maintenance, to enable self-healing capabilities for routine tasks, or to reduce the network equipment required to provide resiliency. Streamlining network operations and optimizing network resource utilization can help increase energy efficiency and reduce GHG emissions.

Maximize network lifespan

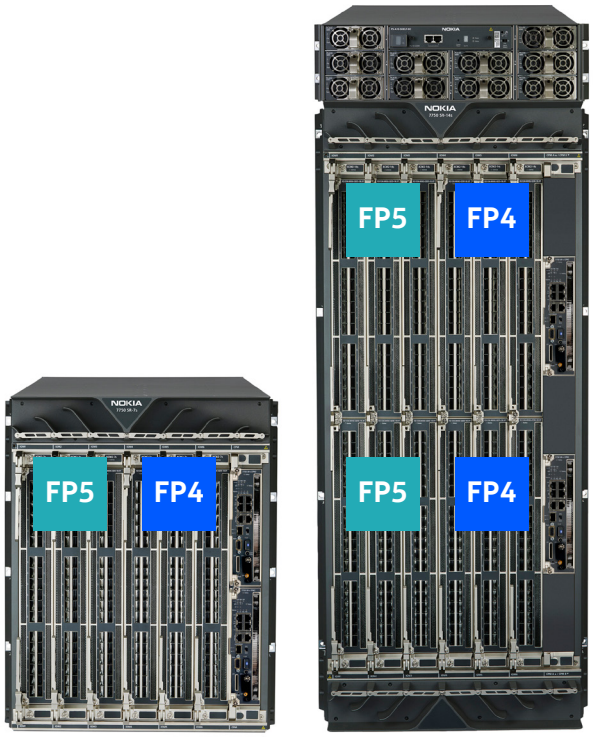
Enabled by our commitment to innovation, we have established a history of investment protection and system deployment longevity. Maximizing the network lifespan improves network reliability, lowers network TCO and offers several sustainability benefits. For example, over the life of the network there will be a reduction in natural resource extraction for replacement parts and a reduction in network components destined for landfills or otherwise potentially carbon-intense processing. There will also be a reduction in embodied emissions associated with the life cycle of new parts and deployment. Not only does network longevity contribute to a circular economy, but it also adds direct value to customer networks.

Our IP routing silicon is highly programmable and has demonstrated longevity and functionality upgrades beyond what merchant silicon allows. A highly programmable network processor gives us the ability to pivot to meet changing market, standards and protocol needs — from MPLS to EVPNs, from segment routing to 5G transport networks. We have demonstrated that we can repurpose the same hardware for numerous use cases with no compromise to performance or function — and extend the network deployment lifespan.

With the future in mind, FP5 silicon has been designed with the capability to support up to 1.6T clear channel interfaces. This capability enables support for 400G and 800G today and for 1.6T clear channel in the future.

Each generation of our FP silicon technology has been designed with backwards compatibility in mind. FP5 cards will work in existing 7750 SR platforms and can co-exist with FP4 line cards, with both FP4 and FP5 cards concurrently running full features at full line rate without compromise (see Figure 5). The introduction of FP5 does not require the upgrade of the system power and cooling. This backwards compatibility preserves the lifespan of deployed services, line cards and systems. Combined with flexible licensing, this provides economic scaling to meet evolving needs.

Figure 5. Maximize network lifespan with FP backwards compatibility

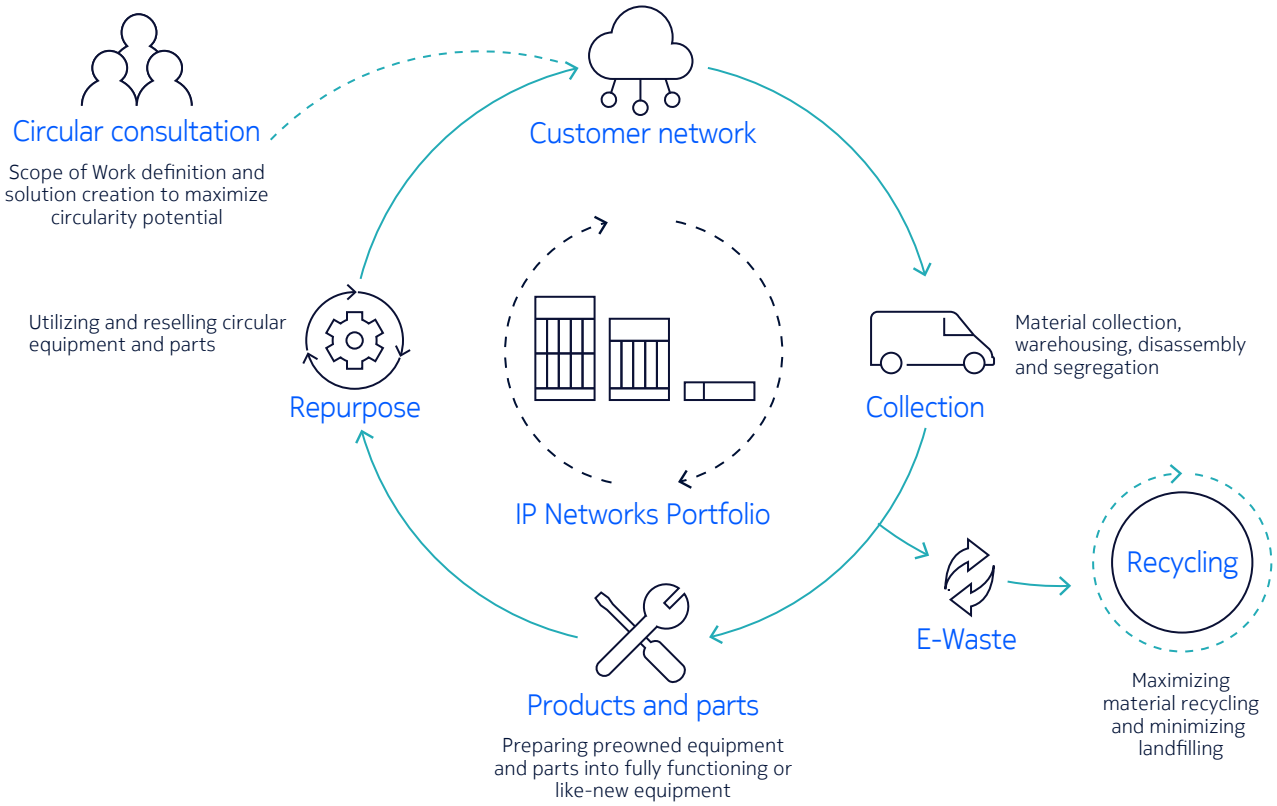


We design to ensure the maximum network lifespan of our systems and technologies in our customer networks, providing investment protection for our customers and helping reduce our systems' impact to the environment.

Product circularity

After 25 years of implementing well-established circular practices (see Figure 6), we are still continuously looking at how we can enhance our existing circular approach to our operations. Nokia is a member of the Remanufacturing Industries Council (RIC) and uses ANSI-approved standards to remanufacture to a "like-new condition". We are proactively looking to increase product take-back from our customers and to ensure the quality of our remanufactured products. In 2022 we saw a 31 percent increase in customers of our circular products and a 17 percent increase in the number of remanufactured products.

Figure 6. Leadership with our well-established circular practices



We also continue to increase the amount of recycled materials in our products. Modular components and products that cannot be reused or repurposed at end-of-life are sent to recycling and recovery vendors to generate reclaimed material for another application or industry. Compared to manufacturing products from new raw materials, up to 95 percent of GHG emissions are avoided for direct reuse of products, and up to 80 percent of GHG emissions are avoided when greater than 5 percent of components are replaced (per our life-cycle-assessment approximation calculations in line with accepted GHG protocol methods for the ICT sector).

Our design approach helps to ensure we create technologies that incorporate environmentally sustainable principles, such as to strive towards circularity. We apply holistic product-life-cycle thinking to minimize environmental impacts and ensure compliance with both regulatory and our own policies as early as possible in the product and packaging design and development process.

In addition to energy efficiency and maximizing network lifespan, our design practices help us to maximize the success of our take-back program through designing for modularity, repairability, remanufacturing and ease of deconstruction for material recycling. Our take-back program also helps us to minimize the volume and negative environmental impact of materials used.

As part of our commitment to sustainability across our own operations and from our products and packaging, we are committed to improving circularity throughout our IP portfolio.

Summary

Technology plays a key role in fighting climate change and its impacts both directly by function and indirectly through handprint benefits.

The IP Networks team is committed to helping combat climate change through industry-leading IP innovation combined with continuous engagement with our customers, to deliver a sustainable IP networking portfolio.

We are helping our customers deliver sustainable growth with our high-performance IP networking portfolio and maximize the network lifespan of their equipment and systems. This is combined with our continued investment in product circularity for our IP Networks portfolio.

We are building today's critical IP networks to enable the applications of tomorrow with sustainability at the heart of our investment.

Abbreviations

5G	5th generation mobile
ANSI	American National Standards Institute
CAGR	compound annual growth rate
EVPN	Ethernet virtual private network
G	gigabit per second
GE	gigabit Ethernet
GHG	greenhouse-gas emissions
ICT	information and communication technology
IP	Internet Protocol
MPLS	multiprotocol label switching
RE100	renewable energy 100 (100% renewable energy)
SBT	science-based targets
SLA	service level agreement
SR	Service Router
T	terabit per second
TCO	total cost of ownership
WAN	wide area network

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.

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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Document code: CID210560 (August)