

Tomorrow's networks today

Network Infrastructure
progress update

June 2023

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NOKIA

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Welcome

1. Network Infrastructure	Federico Guillén
2. Fixed Networks	Sandy Motley
3. Optical Networks	James Watt
4. IP Networks	Vach Kompella
5. Submarine Networks	Alain Biston
6. Your questions	

Network Infrastructure

Federico Guillén

June 2023

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NOKIA

Many stories, one outcome



5G infrastructure and services



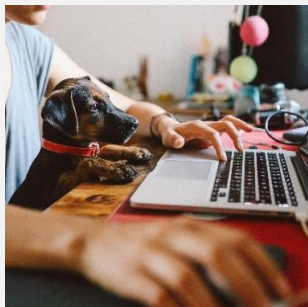
Enterprise digital transformation and cloud



Human augmentation



Digital-physical fusion



Residential broadband



Industry 4.0

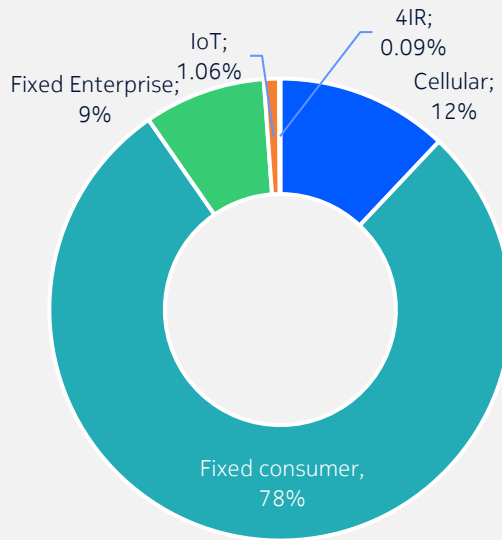
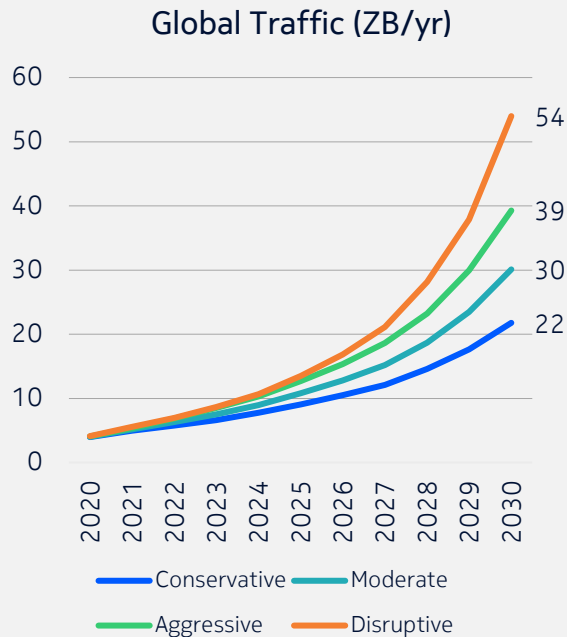


Metaverses

...today's new applications
need higher capacity networks...

...tomorrow's applications will
have even higher requirements

Global traffic grows at up to 28% CAGR to 2030



- Global traffic grows at up to **13x** between 2020 and 2030
- Acceleration in VR/AR beyond 2025 is driven by metaverses
- **Fixed consumer traffic** accounts for most growth; reaches **18 to 41 ZB/year**
- **Mobile traffic** grows at up to **13x** to reach **2.6 to 7.7 ZB/year**
- 5G traffic overtakes 4G by 2026
- **Enterprise traffic** grows at **13%-28% CAGR**, reaching **1.5 to 5.3ZB/year**

Source: Nokia Bell Labs Consulting

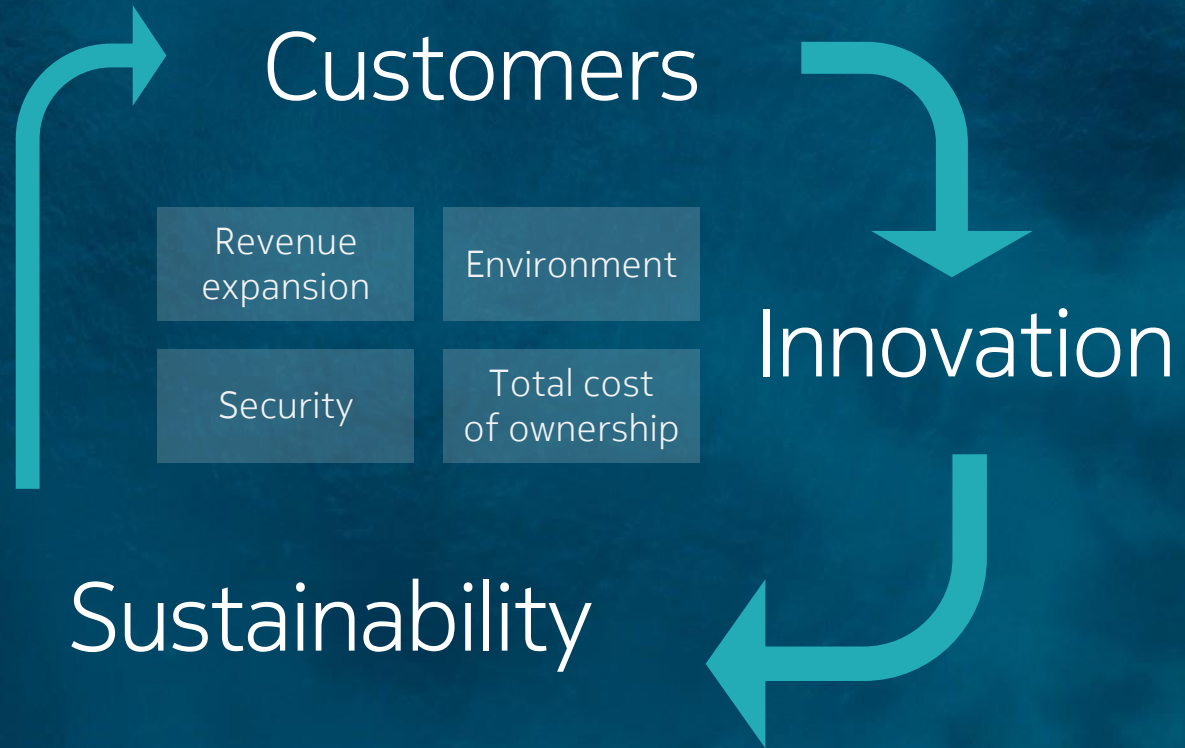
Parameters determining conservative to disruptive scenarios include estimates of: 5G adoption rate; gaming time in aggregate; high resolution video adoption rate; virtual reality application streaming rate; augmented reality bandwidth per device; augmented / virtual reality device use time

Traffic growth will drive expansion in our addressable markets...

	Addressable market CAGR 2022-2025	Growth aspiration
IP Networks	3%	Grow faster than the market
Fixed Networks	4%	Grow with or faster than the market
Optical Networks	2%	Grow faster than the market
Submarine Networks	Single-digit	Grow with the market

Source (all data): Nokia Business Intelligence
All figures at constant currency

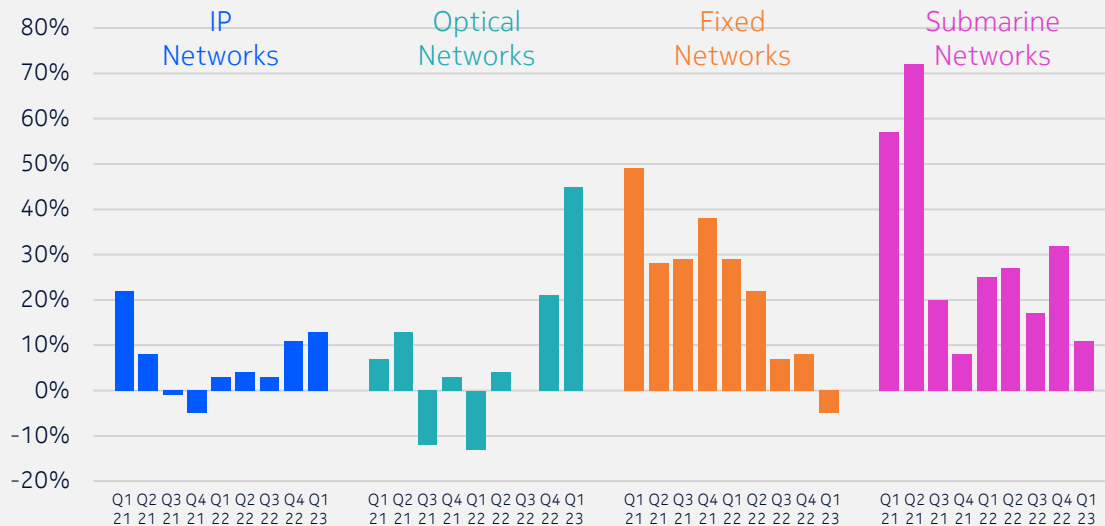
Converging market influences drive the networks of the future



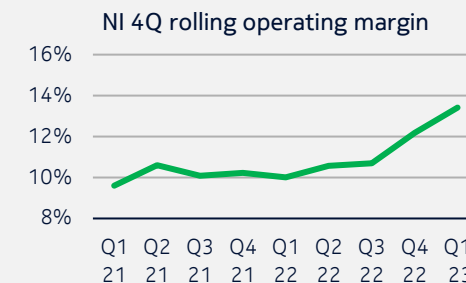
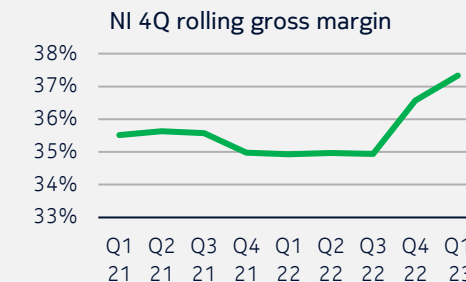
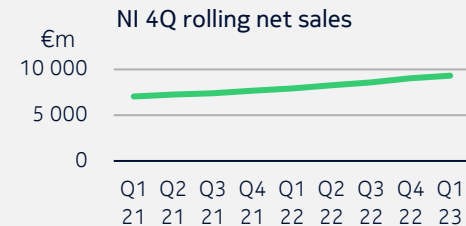
Network Infrastructure:

delivering successive quarters of profitable growth

NI growth YoY by business line



All net sales changes presented are year-on-year in constant currency



Strategic silicon investments...

...complete Network Infrastructure's end-to-end portfolio



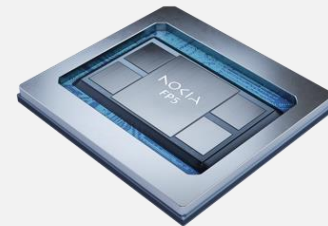
Quillion access processing

- 50% reduction in power consumption vs. previous generations
- Lightspan MF-14: the world's most advanced fiber broadband platform



PSE-6s coherent optics

- Opportunity to leap-frog competition
- 60% less network power consumption per bit



FP5 IP packet processing

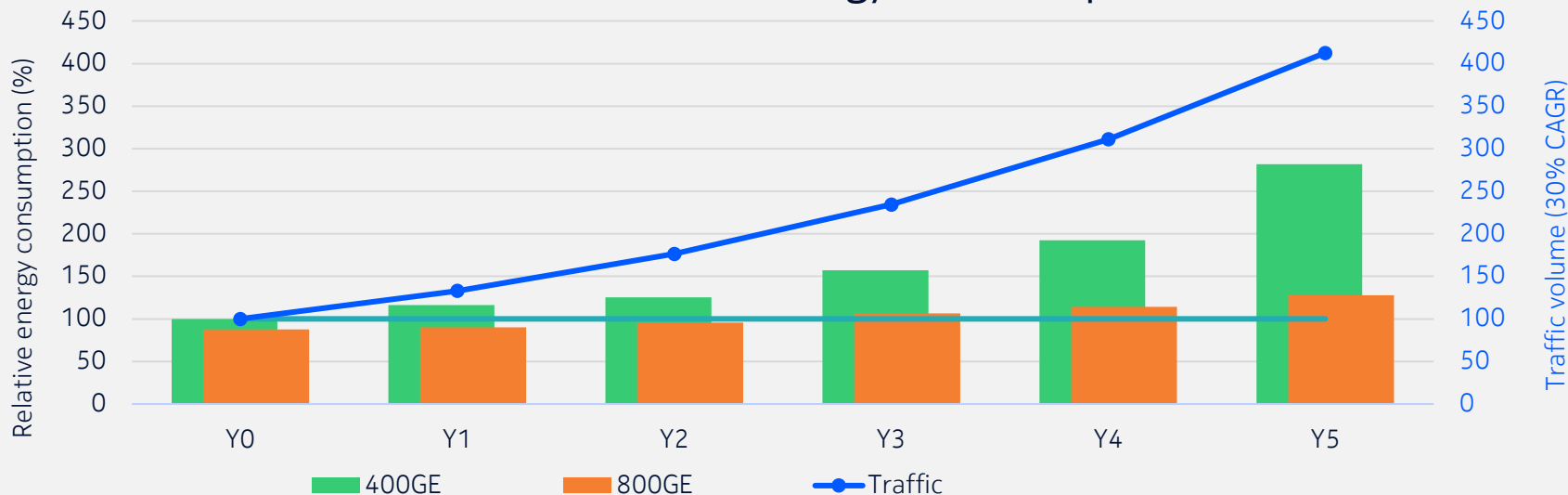
- 50+ FP5 contracts
- 75% reduction in power consumption vs. previous generations
- Additional 25-43% power savings with 800G optics vs 400G

More bits with fewer watts

Sustainable IP networks growth with 800GE, available today



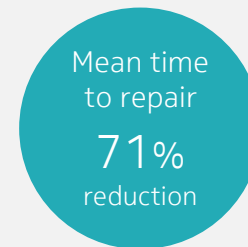
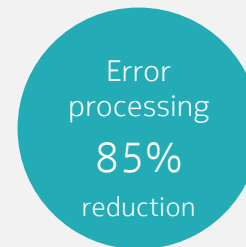
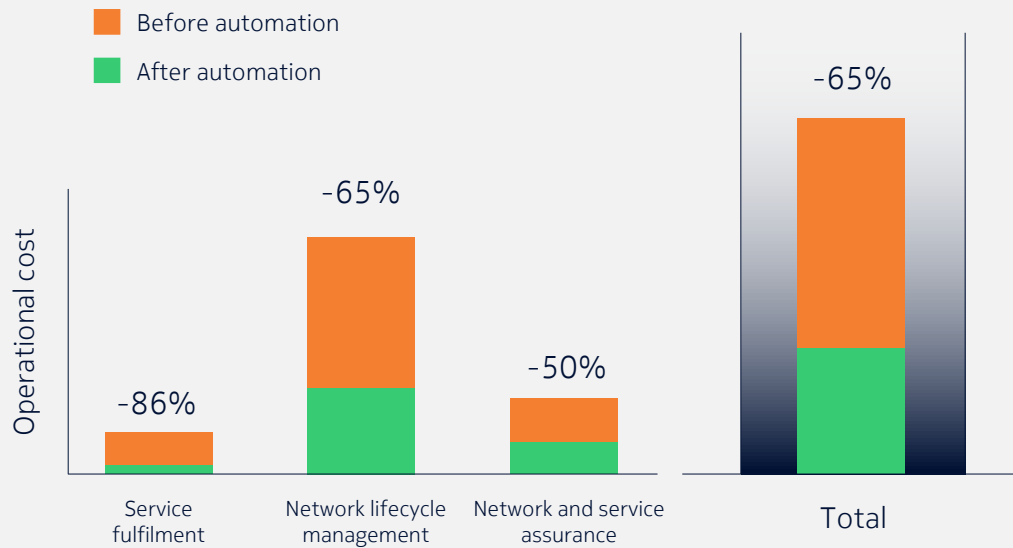
Network traffic vs energy use (incl. optics)



Source: Nokia Bell Labs Consulting

Automation addresses cost and time to revenue

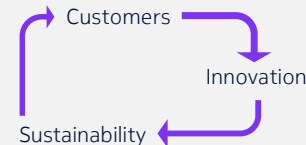
Quantified benefits from Network Services Platform deployments



Source: Nokia and Analysys Mason

Security with 10x scale and 10x cost reduction

Drastic reduction of undesired traffic in the network



- ✓ High-capacity best scaling DDoS filtering for FP silicon + Deepfield
- ✓ Quantum resistant transport with ANYsec flow-based, line-rate encryption
- ✓ Quantum safe encryption at both the IP and optical layers

New revenues

- Low-latency services
- Critical connectivity services
- DDoS defense services

Cost savings

- Up to 85% cost savings over external appliances*

* Source: Nokia Bell Labs Consulting

Fixed Networks

Network Infrastructure progress update

Sandy Motley

June 2023

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Nokia Fixed Networks - a strong business

Business

~3bn

Just under €3bn revenue in 2022

0.5bn+

DSL, VDSL,
Vectoring, XGS lines
& GPON ports
shipped to date

Leadership

#1

In xPON OLT,
XGS-PON (OLT & ONT) and G.fast*
(*) Source: Dell'Oro BB Access Report Q1 2023

300+

Fiber customers
in 130 countries

Innovation





1st

First ADSL, GPON,
G.fast, Vectoring, XGS-PON,
25G PON, 100G PON, multivendor SDAN

Own tech

In-house Quillion chipset,
mmWave technology

Market dynamics are in our favor

			
Solid demand that drives FN TAM growth 4% CAGR 22-25	Governments putting up billions of dollars for FTTH projects	Infra. and PE funds investing in FTTH companies or projects	Fiber market shifts to regions and tech where we lead

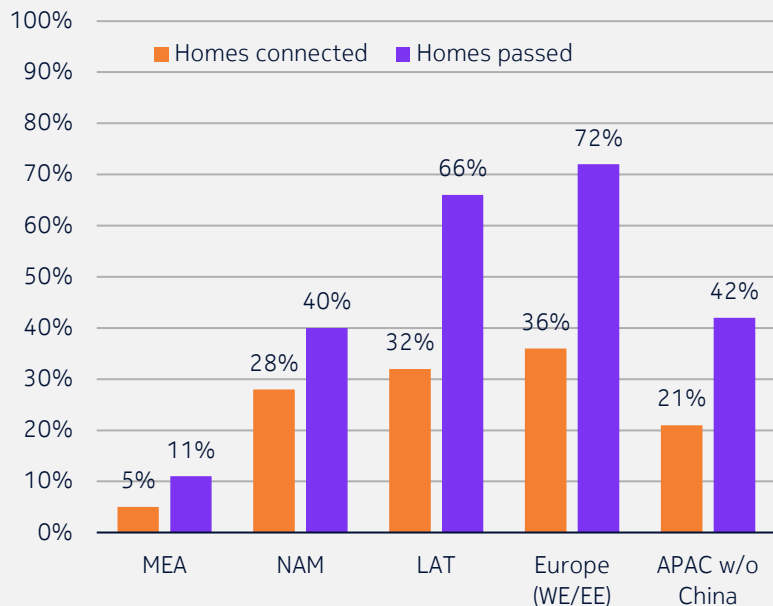
Our strategy puts us in the right place at the right time

Fiber leadership	Own ASIC	Services	Supply chain
Leader in 10G PON; only vendor with a 25G solution; Fiber for Everything, campus connectivity	In-house silicon for differentiation & supplier independence	Network design and build & cloud integration service to support CSPs, new entrants, and smaller players	We have supply & we can deliver

Fiber deployment remains strong

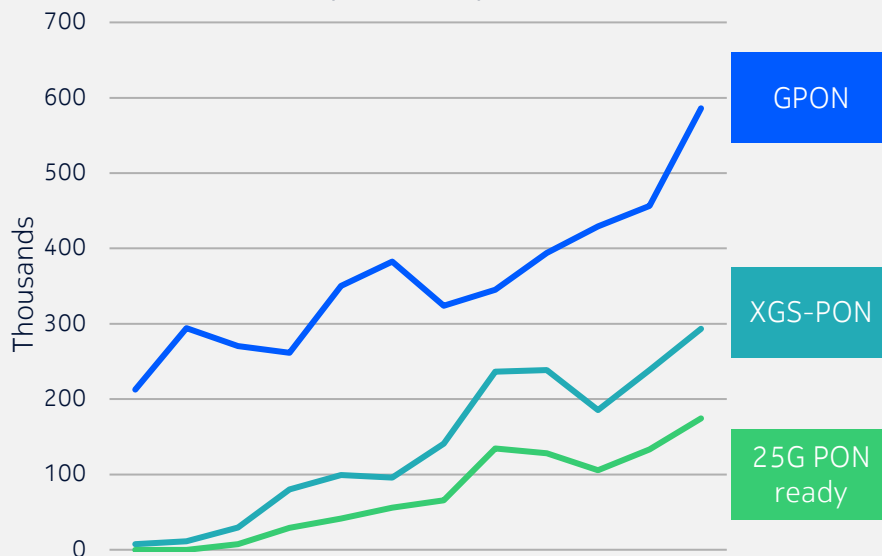
50% of homes globally to be connected + 10G(+) upgrade wave

FTTH Penetration Status (2022)



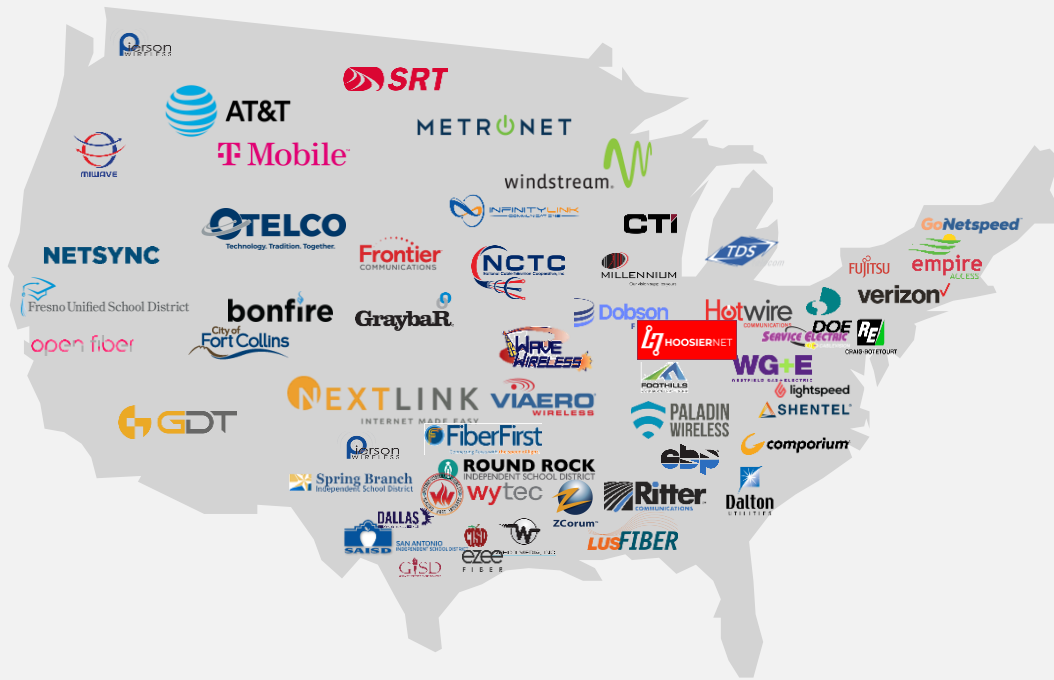
Source: IDATE World FTTX market, Dec 2022

Nokia OLT ports shipments



Source: Nokia

Ready to seize the government-funded broadband opportunity



#1
in NAM

#1
in US Tier-2

#2 in US Tier-3, overtaking Adtran

7/10
US fiber lines are
served from
Nokia equipment

77%
CAGR 2020-22
in US non-T1

\$42bn
BEAD funding
June 30, 2023

Optical Networks

Network Infrastructure progress update

James Watt

June 2023

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Optical Networks: leadership through innovation

>1,000

1830 PSS customers

>100

PSE-V customers

#2*

Market share worldwide
(excl. China) Q1 2023

Technology differentiation

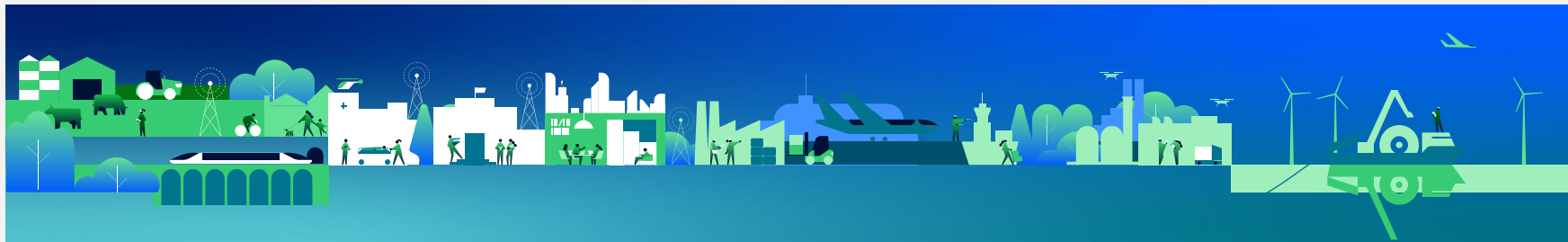
- Lowest cost/power per bit combined with greatest scale
- Market leading:
 - Wavelength module capacity
 - OTN switching
 - IP / Optical integration
 - Fiber capacity/spectral efficiency
- Unmatched data security

7%

TTM CAGR Q2 2020 – Q1 2023
vs. addressable market CAGR of 2%

>€2bn

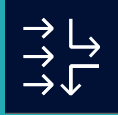
Sales
Q2'22 – Q1-23 LTM



* Total optical market worldwide (excluding China) Source: Dell'Oro Q1 2023

Scale made simple

Enable scale



Coherent Transponders



Line Systems

Market leading C+L line systems



P-OTN Switching

Simplify operations



Automation

Enable scale; simplify operations. Reduce TCO



Network architectures

Coherent Routing



Professional services

Application-optimized platforms



The next frontier in optical networking

PSE-6s → enabling network growth and sustainability

Scale



- **2.4Tb/s** in a single line card
- **1.2Tb/s** per wavelength

Performance

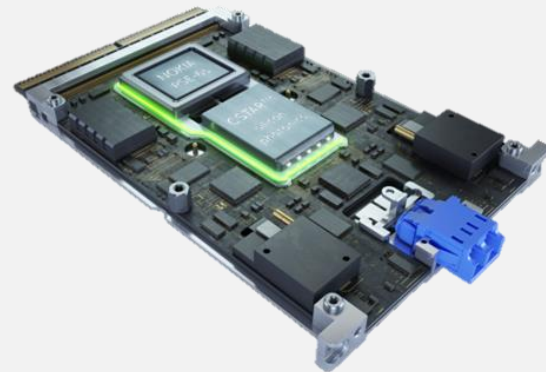


- **3x** the reach at 800G (2000km+)
- **50% less** coherent optics deployed

Sustainability



- **60% lower** network power consumption
- **Upgrade** existing platforms gracefully, datacenter interconnect, [ultra] longhaul, OTN, submarine line terminating equipment



Achieving our ambitions

Technology leadership and global presence

CSP

- End-to-end scale and performance in a highly competitive environment
- 3x the reach @ 800G (2,000km)
- Greatest photonic line scale
- Proven strategic supplier
- Exceptional power efficiency



WebScale

- Massive scale coupled with unmatched performance
- Lowest TCO
- Simplest operations
- Greatest automation
- Best spectral efficiency / fiber capacity



Enterprise

- Evolving from mission-critical to business and society-critical
- Portfolio-application fit
- Address digital transformation needs with 10G → 100G+ upgrades



IP Networks

Network Infrastructure progress update

Vach Kompella

June 2023

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NOKIA

Accelerate Growth in the IP Networks Business Between 2023 and 2026...

Grow
CSP
Market Share

Expand
Enterprise

Overdrive
Webscale

Leadership through innovation

€3.1bn

Net Sales 2022

#1

IP Edge Router
Global, EMEA*

1400

CSP and Cloud
Provider Customers

1100

Non-CSP Customers

Leader

Edge & Core Routing,
5G transport**

#2

IP Total Router North
America, EMEA, CALA*

1.7m

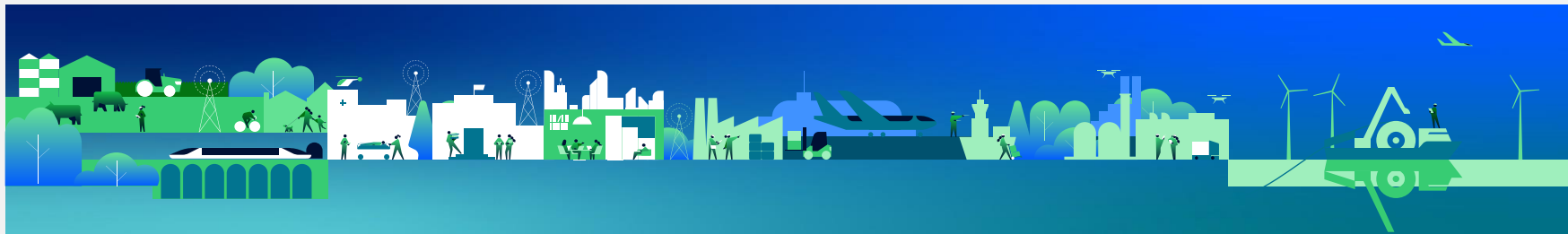
Routers Shipped

50

FP5 Contracts

Technology differentiation

- Deterministic performance without compromise
- Unmatched power efficiency at unrivalled speeds
- A multi-layer embedded approach to IP network security

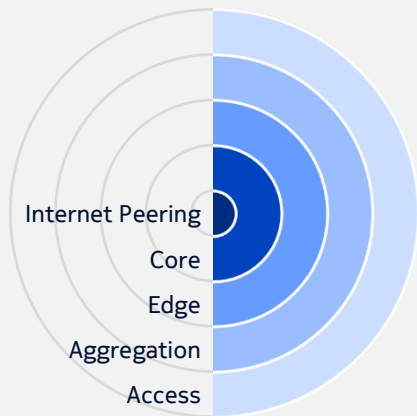


* 1Q23 Dell'Oro SP Routing

** GlobalData Competitive Landscape Assessment

Grow share with CSPs

IP Networks



Mobile Services

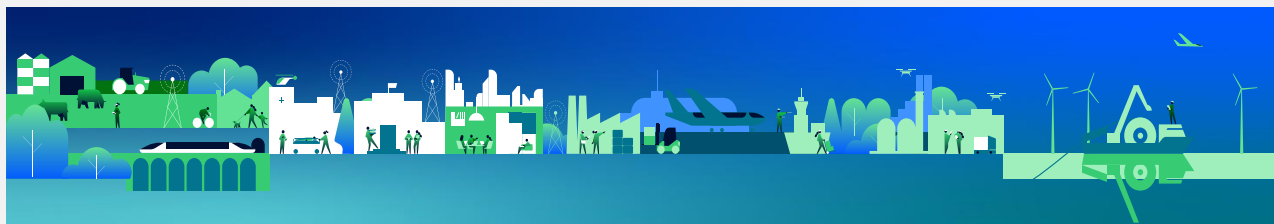
- Global 5G rollouts still driving network investments
- Growing bandwidth requirements from Fixed Wireless Access

Broadband Services

- Fixed broadband capacity driving IP buildouts
- Bridging the digital divide

Business Services

- Data centers moving closer to users
- Meeting the demands of dynamic digital transformation



Robust

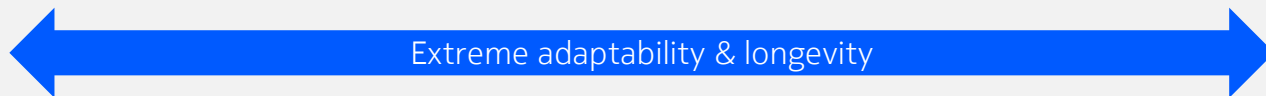
resilient & secure

Performance

deterministic

Sustainable

efficient



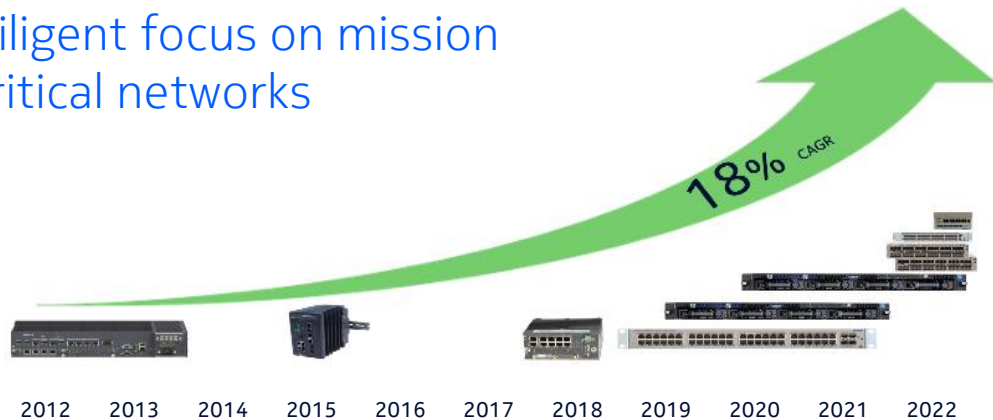
Building enterprise networks that matter, at scale

Mission Critical

- Utilities
- Transportation
- Mining
- Public Safety



Diligent focus on mission critical networks



Purpose built

Teleprotection, Legacy interfaces

Multi-generational

Seamless migration

Robust

Ruggedized, resilient

Extreme productivity enabling business outcomes

NOKIA

Building enterprise networks that matter, at scale

Expanding from OT to IT networks to maximize impact

Mission Critical

- Utilities
- Transportation
- Mining
- Public Safety



Society Critical

- Research & education networks
- Bridging the digital divide
- Government & defense



Business Critical

- Healthcare
- Financial services
- Logistics & retail



Purpose built

open, cloud-friendly

Forward looking

Secure 800 GE

Robust

Digital twin

Extreme productivity enabling business outcomes

NOKIA

Webscale

Riding the wave through ongoing technology leadership

Nokia ranked “Leader”
& “Outperformer”



50+ Customer Wins



Public Transport
Authority



“We regularly upgrade our data center equipment with technology to increase efficiency and reduce energy consumption. Using Nokia's new system will enable better networking and routing capabilities in our Viborg, Denmark facility”

Adam Bechtel,
Vice President and Networking lead at Apple

“Nokia brings density, performance and flexibility to Microsoft's data center networks and cloud environments and is partnering with Microsoft to deliver chassis switches running the open-source networking operating system SONiC.”

David Maltz, Technical Fellow and Corporate Vice President,
Microsoft Azure Networking

Proven

systems

Cloud-Native

open & extensible

Hyper-Scale

green & performant

Extreme scale at speed

NOKIA

Submarine Networks

Network Infrastructure progress update

Alain Biston

June 2023

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Our success is driven by digital transformation and internet growth

35%

International traffic
CAGR, '21 – '26*

1Pb/s –
5Pb/s

Requested cable
capacity by 2030*

x20

Predicted internet
traffic increase
by 2032**:

#1

Market leader
in submarine
networks***

Only one

Industry's only
end-to-end
turnkey supplier

€7bn

Opportunities
identified to
end 2024

99%

Internet traffic
carried by
submarine cables*

Increasing
customer
diversity:

Telecoms,
Hyperscalers,
Oil & Gas, Services

€1bn

Sales in 2022
(sales doubled
between
2019 and 2022)

* Nokia estimate

** Credit Suisse: 'A guide to the Next-Gen internet, 2022'

*** Based on orders on three-year rolling basis

We are well-placed for growth and margin expansion

Capacity enhancements complete

- five main lay vessels
- two maintenance vessels
- 96,400 m² manufacturing plant

New R&D program to meet capacity and climate change demands

Submarine / Terrestrial

- SLTE (submarine line terminal equipment coordinated roadmap - common coherent transponder)



Improved profitability towards mid, then high single digit OM (commercial management; Ts&Cs; marine resources)

More than €2bn revenue in long-haul systems by end 2025



EllaLink

6,000 km
Portugal to Brazil
4 FP



West Africa

8,500 km
(five countries)
2 FP



Equiano

15,000 km
Portugal to South Africa
(six countries)
12 FP



SX NEXT

13,700 km
Australia to USA
(six countries)
4 FP



Amitié

6,750 km
USA to Europe
12/16 FP



2Africa

45,000 km
Europe / Africa / Middle East
(33 countries)
8/16 FP



Africa-1

10,000 km
France to Pakistan
(nine countries)
8 FP



Bifrost

15,000 km
Singapore to USA
(five countries)
12 FP



Blue & Raman

Blue: 15,000 km
Raman: 7,000 km
(six countries)
16 FP

€7bn in upcoming opportunities (until 2027/2028)

3 Atlantic

Three transatlantic &
European deals
(>€840m)

5 Middle East

Five deals (~€2bn)

5 Intra-Asia

Five deals (~€3bn)

5 Other Telco

Five deals (>€1.4bn)

Oil & Gas

Several deals
(~€400M)

*If won these opportunities then support revenues from 2025 and beyond

Driving new environmental standards

DAS

(Distributed Acoustic Sensing)

- Real time detection of threats to submarine environment
- Seismic activity monitoring
- Oceanographic and environmental conditions monitoring

Offshore field digitalization

(Oil and gas production, carbon storage, scientific research)

- Delivering power and communication to subsea assets
- Connecting offshore assets to fiber for remote operations
- Producing high resolution images of reservoir for efficient reservoir operation

SMART

(Scientific Monitoring and Reliable Telecommunications)

- Wet plant embedded sensors
- Disaster warning (tsunami, earthquakes), sea level rise, climate change
- Supports governments, scientists and marine science institutes

Modernization

(Global transformation program)

- Fleet rejuvenation
- 5G private network for factory digitalization in Calais and Greenwich
- State-of-the-art end-to-end business processes and tools deployed

There are opportunities for growth in our markets

- Fast-developing technologies depend on network infrastructure, driving demand

We are well placed to take advantage of those opportunities

- We continue to invest in our leading, differentiated portfolio
- We have a strong foundation in Fixed Networks and momentum in IP Networks and Optical Networks

We offer superior technologies and customer-focused innovation...

- ...giving us opportunities to outperform the market

NOKIA