

**NOKIA**

# Building sustainable leadership in wireless

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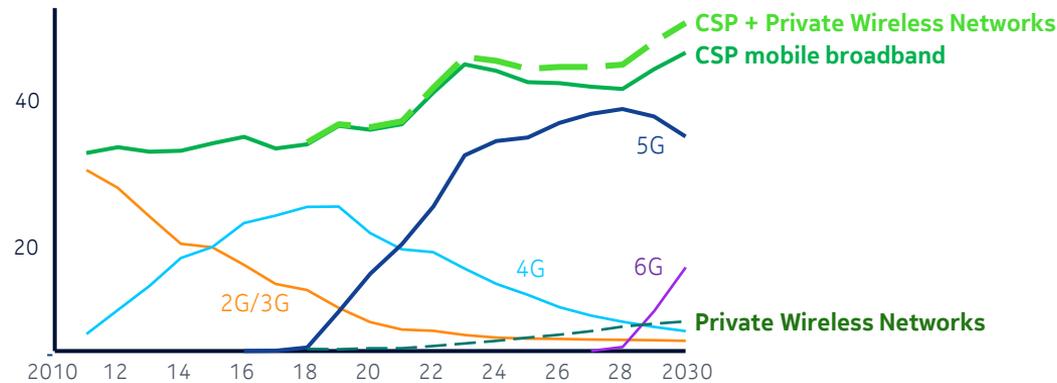
# Agenda

- 1 Dynamics in our addressable market
- 2 Mobile Networks well-positioned to capture growth
- 3 Future opportunities for sustainable leadership in wireless
- 4 Implications for our financial journey

# The 5G market has an extended peak

## Private Wireless Networks market growing at 28% CAGR

### Radio technology product and services market\* in EURbn



\*) excluding Mainland China  
Graph showing P09 2022 FX, CAGR figures on the right using const 2021 FX rates

Source: Nokia Business Intelligence estimate

Overall Mobile Networks market\* growth 2022-25

2% CAGR

2022: €52bn\* 2025: €57bn\*

Private Wireless Networks market\* growth 2021-30

28% CAGR

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# Mobile Networks is well-positioned to grow faster than the market

## Reset (2021)

- ✓ Major turnaround completed
- ✓ New Nokia operating model
- ✓ Mobile Networks fixed costs reset
- ✓ New AirScale products launched

## Accelerate (2022-23)

- ✓ High capacity and predictable R&D
- ✓ New portfolio, strong network performance
- ✓ Market share stabilized and in upswing
- ✓ Investments in supply chain resilience

## Scale (onwards)

- ✓ Trusted partner with access to advanced silicon technology
- ✓ Unlocking growth opportunities:
  - ✓ Enterprise
  - ✓ Geopolitical
  - ✓ Cloud RAN
  - ✓ 5G-Advanced

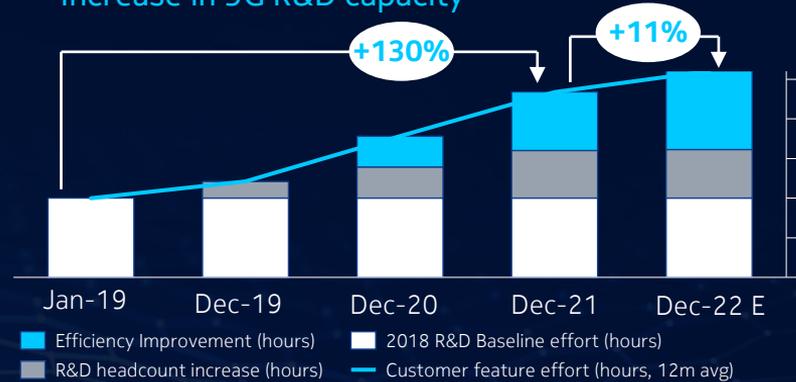
# We have now the R&D capacity, productivity, predictability and quality to lead the market

### 12-month rolling R&D expense (€m)



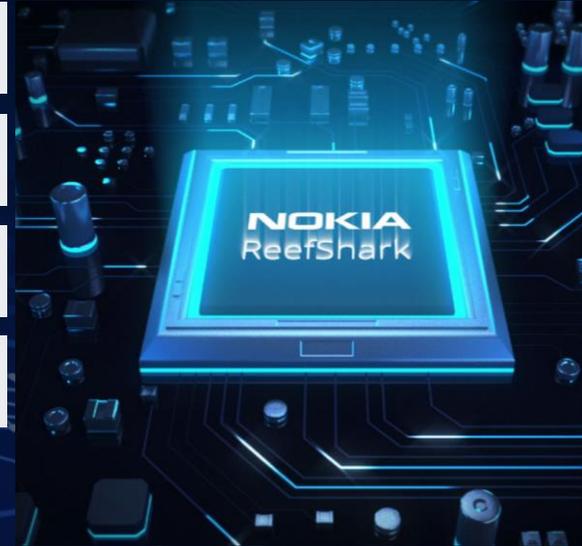
- R&D investments to secure portfolio competitiveness

### Increase in 5G R&D capacity



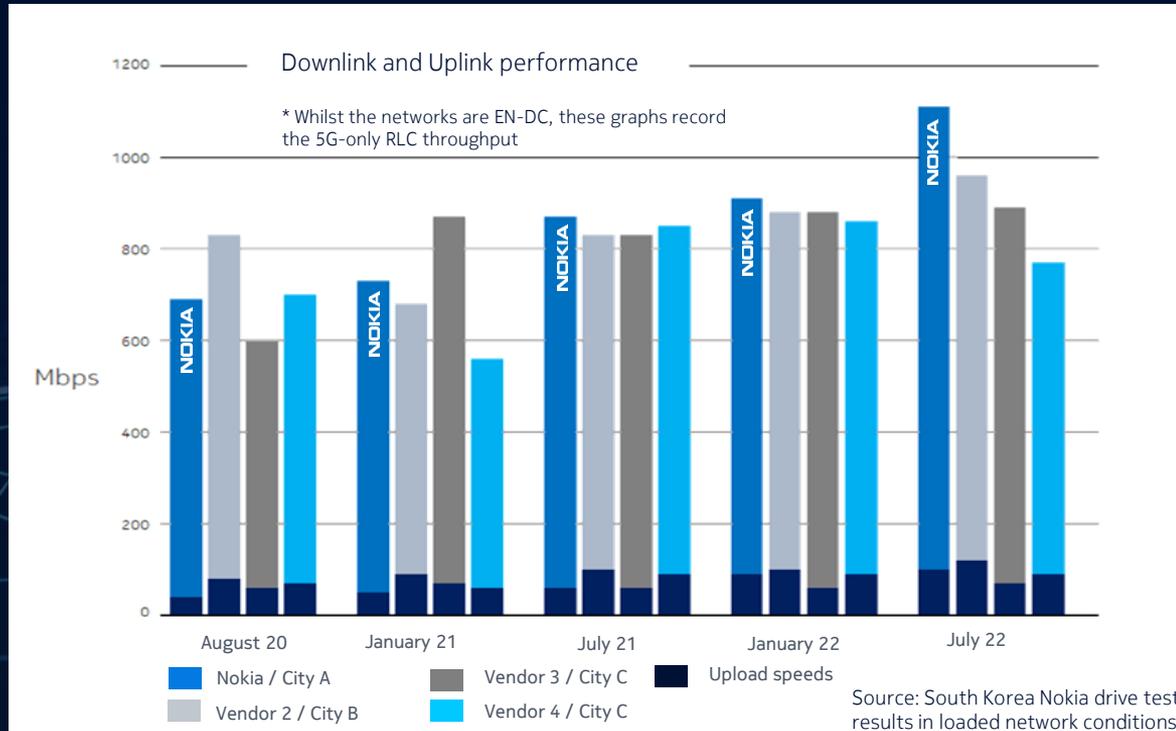
- Renewed R&D has also brought leaps in product quality over last two years

# ~100% System on Chip based portfolio by end of 2022



# Nokia leads in 5G downlink speed and has come on par in uplink

## Nokia roadmap is gaining leadership with the latest SW releases



## 1.11 Gbps DL

with Nokia in increasingly loaded networks

## 60%

Improvement in DL data rate over the past 24 months and UL data rate over the past 12 months

Nokia is now **leading in DL** performance and is **competitive in UL** performance in the world's most advanced 5G market

# Strong portfolio with recognized market leadership

Broad AirScale radio and small cells portfolio delivering capacity and coverage



Industry lightest high-power, 400MHz 32TRX Massive MIMO

Nokia #1 in overall baseband portfolio



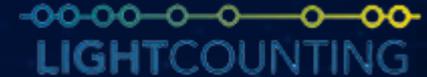
Market Landscape: RAN Vendors 2022  
May 2022

Nokia “Leader” in Network Design and Optimization



Nokia Managed Infrastructure Services  
February 2022

Nokia continues to lead the SON market for the 7th consecutive year



Network Automation: SON, RIC, SMO  
October 2022

# Nokia is committed to helping customers achieve their energy saving targets

## Hardware evolution

Nokia ReefShark SoCs in baseband and RF and latest technology innovations (e.g., Power Amplifiers), energy efficient microwave

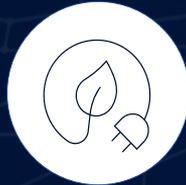


## EdenNet SON and RIC with AI/ML

Automatic configuration and AI/ML based optimization of energy savings functionality

## Software features

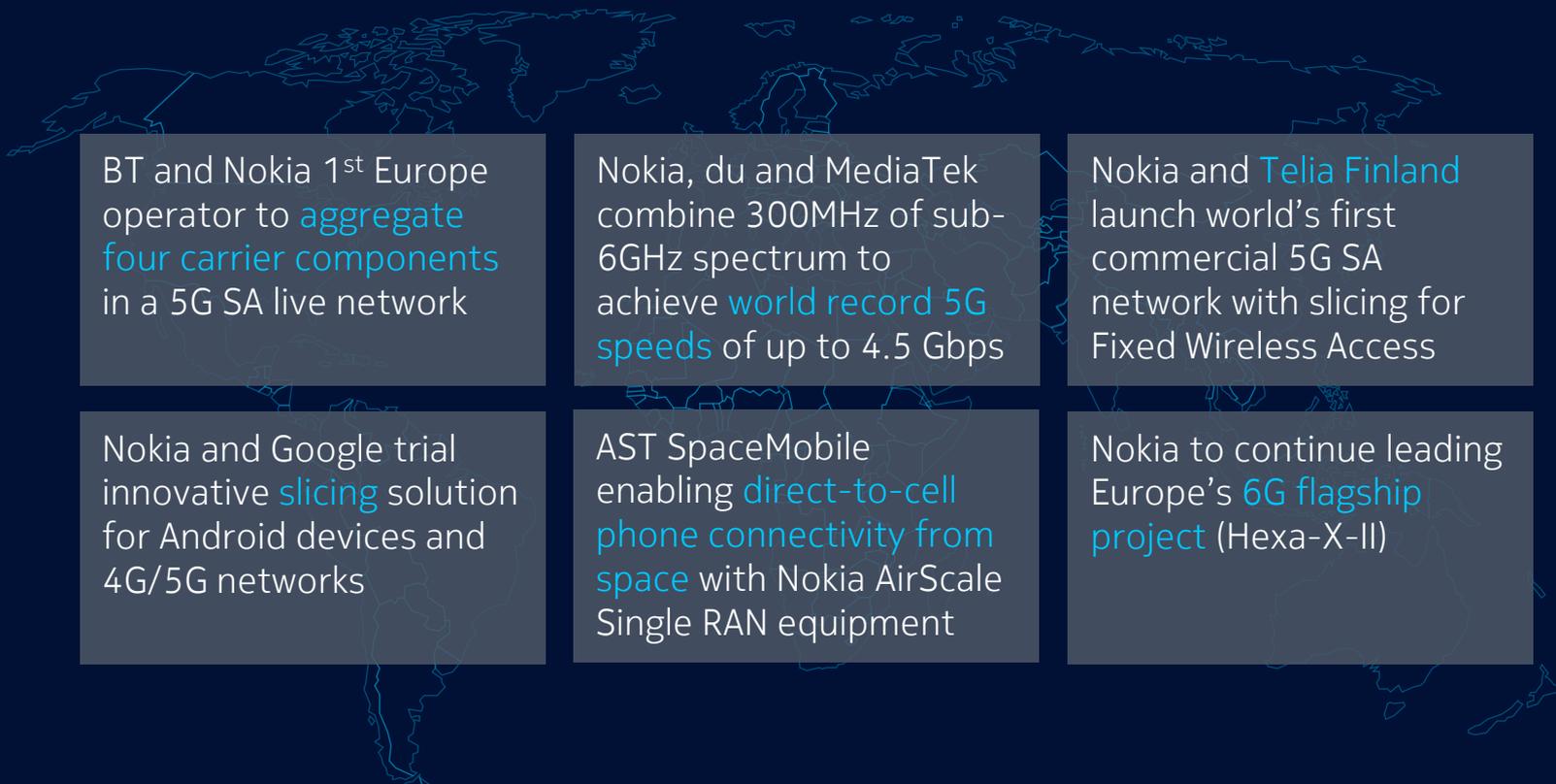
Intelligent switch-off of unused resources with Micro DTX, Cell switch off, MIMO muting and Deep sleep modes



## Energy efficient site solutions

Zero footprint site with outdoor pole mountable power systems and minimized footprint sites with All-in-One Cabinets

# Recent Nokia technology leadership highlights



BT and Nokia 1<sup>st</sup> Europe operator to **aggregate four carrier components** in a 5G SA live network

Nokia, du and MediaTek combine 300MHz of sub-6GHz spectrum to achieve **world record 5G speeds** of up to 4.5 Gbps

Nokia and **Telia Finland** launch world's first commercial 5G SA network with slicing for Fixed Wireless Access

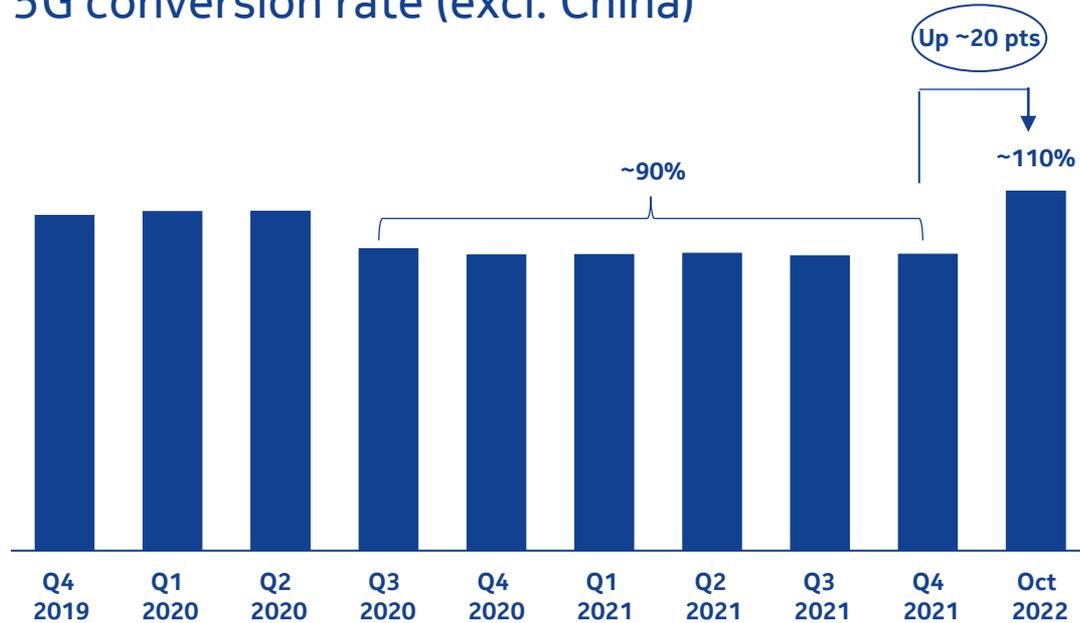
Nokia and Google trial innovative **slicing** solution for Android devices and 4G/5G networks

AST SpaceMobile enabling **direct-to-cell phone connectivity from space** with Nokia AirScale Single RAN equipment

Nokia to continue leading Europe's **6G flagship project** (Hexa-X-II)

# Radio Access Network market share was stabilized and is on upswing

## 5G conversion rate (excl. China)



Since early 2019, we have won 38 new CSP RAN customers and increased share with 28 existing RAN customers



# Improved supply chain resilience to meet growing hardware delivery outlook into 2023 and enable long-term growth

## Q3 2022

- ✓ Highest volumes delivered since start of pandemic
- ✓ Late deliveries have reduced significantly, peaking at end of Q2
- ✓ Improved inventory health
- ✓ Supply remains tight due to strong demand; broader market showing signs of easing

## Building resilience:

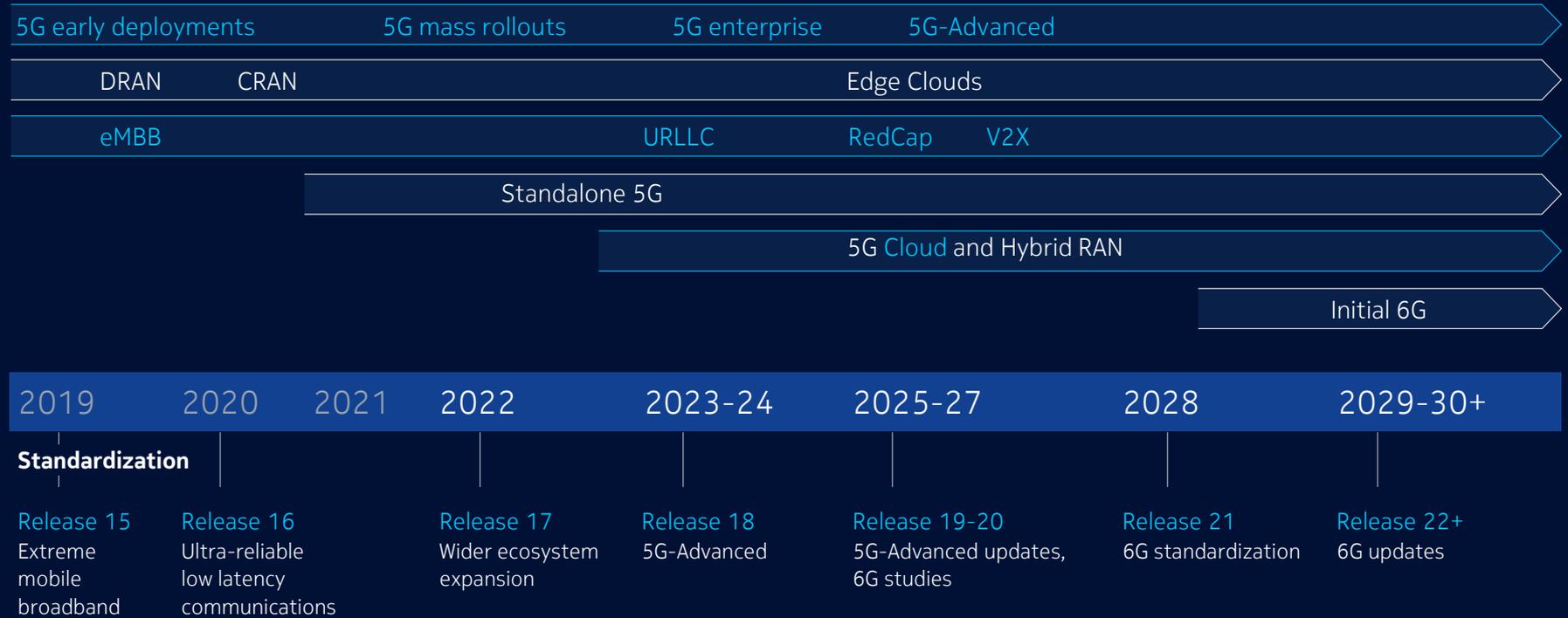
- Normalizing inventory levels and quality; geopolitical risks considered
- Increasing regionalization of manufacturing and logistics with more live dual source lines
- Designing products for resilience: more multisource components and reuse across platforms

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# 5G is at the beginning of a long journey

Private Wireless, Cloud RAN and 5G Advanced will create new opportunities



# Nokia private wireless focus segments

We have 500+ private wireless customers, 100+ with 5G

## Energy



- Power utilities, water utilities
- Oil & gas
- Mining

## Transportation



- Nationwide rail, urban rail
- Aviation
- Maritime

## Government and cities



- Public safety
- Federal government, defense
- Digital agenda: smart cities, education/smart campus

## Manufacturing & supply chain



- Manufacturing (automotive, discrete & process)
- Supply chain logistics

# Digitalization of energy and water infrastructure in Germany

## Wide Area Network for energy transition to decarbonization and decentralization



### Business drivers

 450connect

"In view of the major challenges involved in setting up the 450 MHz platform, we are pleased to have Nokia as a strong and capable partner at our side for the long-term, with whom we can meet the high technical requirements of our customers as operators of critical infrastructures."

Carsten Ullrich, CEO of 450connect

### Nokia solution & benefits



Industrial-grade private 4.9G/LTE + LTE-M solution optimized for M2M applications and critical voice communications



Nationwide 450MHz private radio network, Geo-redundant core, microwave radio. Implementation & maintenance services until 2040



Further secure the energy supply of different processes

# 5G private wireless network, Posiva, Finland

## Supporting the safe disposal of spent nuclear waste



### Business drivers



- Safe disposal of spent nuclear fuel in underground tunnels via automated robots handling the hazardous materials
- Ultimate human safety
- Increased operational efficiency and productivity through automation

### Nokia solution & benefits



5G Standalone (SA) for control data between robots operating underground and the central control system



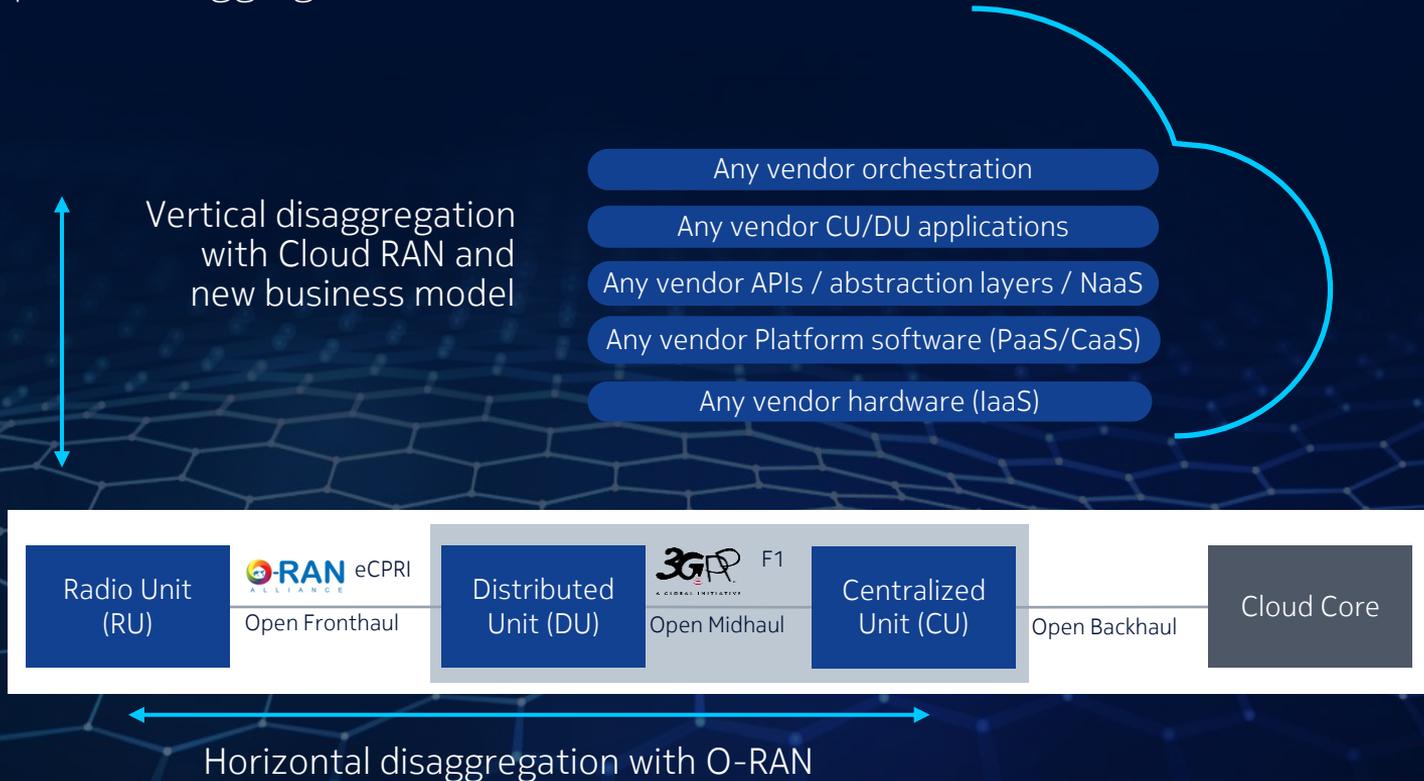
Private compact core platform using 5G cmWave deployed underground



- Critical traffic is fully secured
- Improves process safety for employees.

# Disaggregation is evolving, with focus shifting to Cloud RAN

O-RAN uptake is lagging behind commercial 5G



# Four cornerstones to make Cloud RAN successful

1

To make cloud RAN feasible, server HW must be competitive in hardware cost per cell and power consumption per cell

2

To achieve consistent network performance, Cloud RAN needs feature and performance parity from Day 1

3

To materialize the typical benefits of cloud computing, DU/CU software must be truly cloud-native and managed with the same orchestration as many other workloads

4

To benefit from the capabilities of the entire ecosystem, Cloud RAN must be compatible with 3rd party elements

# Nokia Cloud RAN for openness, scalability and agility

Cloud Native RAN Software  
Container-based 5G vDU and vCU applications

vCU application

Containers

vDU application

Containers

Cloud platform Containers-as-a-Service (CaaS) SW

Nokia blueprint



Nokia AirFrame OpenEdge



Nokia AirFrame Rackmount

X86 infrastructure HW

3rd party infrastructure



vmware WNDVR



Hewlett Packard Enterprise

Webscale collaboration PoCs



Powered by Nokia RAN network interface card (Smart NIC)



# 5G-Advanced opens opportunity for market share growth driven by modernization, new wins and enterprise growth

## Boosted 5G experience



XR traffic, latency and mobility 



Beamforming boost and Distributed mMIMO for UL performance

## Boosted 5G operability



AI/ML enhancements



Radio Energy efficiency

## Boosted 5G services usage



IoT optimized RedCap support



UAV (Uncrewed Aerial Vehicle) 



Space-Air-Ground Networks

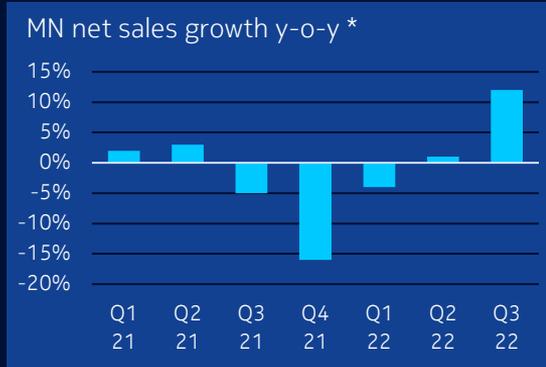


= Leader role (rapporteur) in 3GPP Rel 18 work

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# Significant financial progress in the past two years



Renewed competitiveness is now driving growth

We are gaining market share and we see further opportunities ahead

\*in constant currency



Significant improvements in our product/service cost and quality

Favorable product/services and regional mix also helped

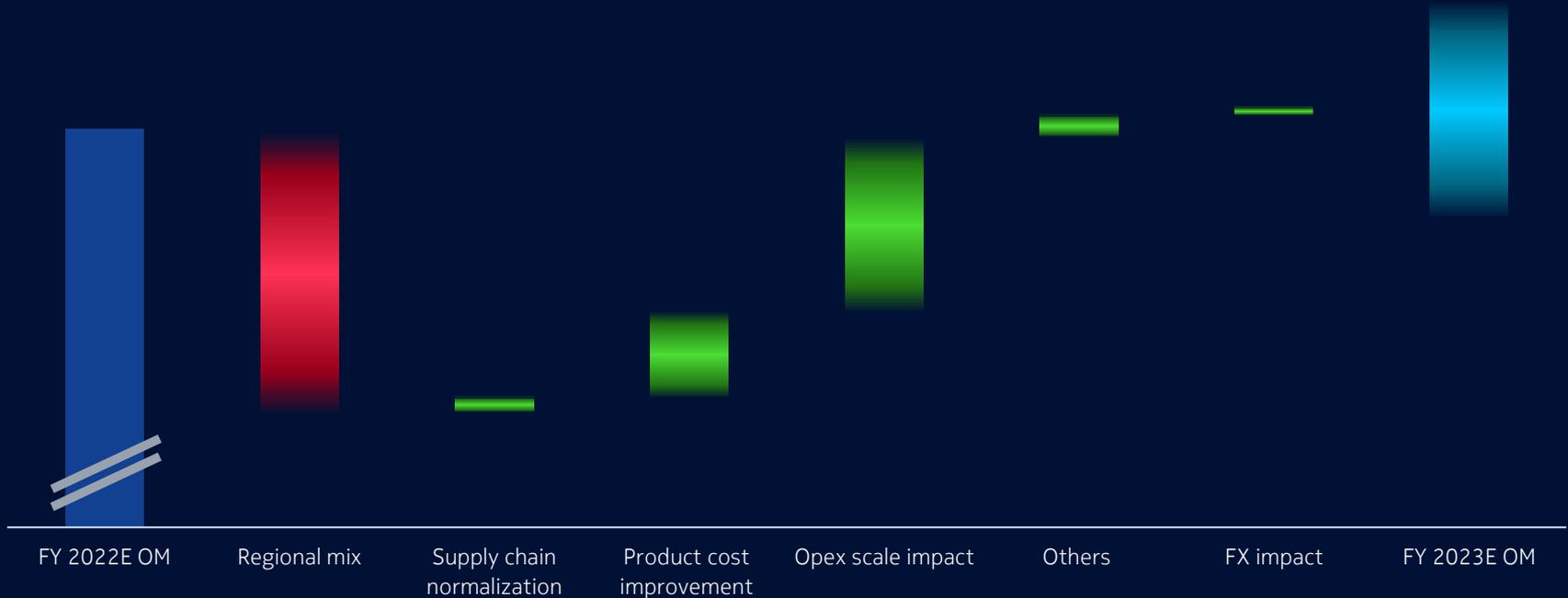


Increased investment into R&D to ensure long-term competitiveness

Continued delivery despite the supply chain challenges seen

# Scale effects can offset weaker regional mix in 2023

Sensitivity scenario analysis for Mobile Networks operating margin in 2023

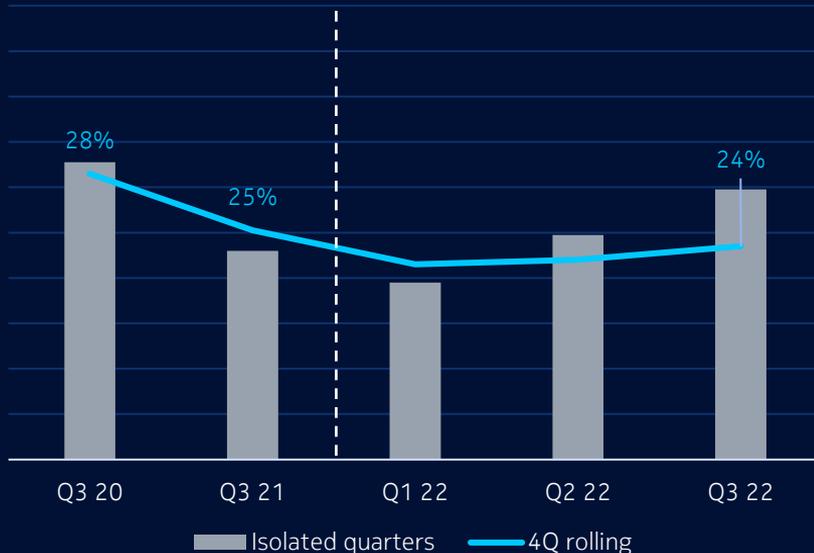


# Long-term financial considerations for Mobile Networks

## Growing through the cycle – opportunities to gain share and improve profitability

### Opportunities to gain share – we've turned the corner

Nokia 4G/5G excluding China market share 2019 - 2022  
Dell'Oro Mobile RAN reports 2019 - 2022



### Long-term opportunities to expand margins to 10+%

#### Scale

- Convert Nokia 4G CSP customers to 5G
- Win new CSP customers and grow
- Continue winning in Enterprise segment

#### Product competitiveness

- Further key steps on roadmap in 2023
- Reduce product and service cost further
- Invest in 5G-A and 6G preparedness

#### Product maturity

- Margins can improve as demand moves from coverage to capacity investment
- Prior cycles saw significant improvement

#### Maintain efficient cost base

- Continued refinements to operating model
- Digitization to maintain efficient cost base
- Continue improving R&D productivity

# Key take-aways

- The 5G market has an extended peak and Nokia is well positioned to grow faster than the market.
- We have clear plans to address opportunities in enterprise, geopolitical environment, Cloud RAN, and 5G-Advanced to build sustainable leadership in wireless.
- We have made significant financial progress and believe scale effects can offset weaker regional mix in 2023.

# Q&A

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