Mobile Networks progress update

Pekka Lundmark
President and CEO

Tommi Uitto
President of Mobile Networks

Disclaimer

It should be noted that Nokia and its business are exposed to various risks and uncertainties and certain statements herein that are not historical facts are forward-looking statements. These forward-looking statements reflect Nokia's current expectations and views of future developments and include statements preceded by "believe", "expect", "expectations", "commit", "anticipate", "foresee", "see", "target", "estimate", "designed", "aim", "plan", "intend", "influence", "assumption", "focus", "continue", "project", "should", "is to", "will" or similar expressions. These statements are based on management's best assumptions and beliefs in the light of the information currently available to it. Because they involve risks and uncertainties, actual results may differ materially from the results that we currently expect. Factors, including risks and uncertainties that could cause such differences can be both external, such as general, economic and industry conditions, as well as internal operating factors. We have identified these in more detail in our annual report on Form 20-F for the year ended December 31, 2020, under "Operating and Financial Review and Prospects—Risk Factors", and in our other filings or documents furnished with the U.S. Securities and Exchange Commission, including Nokia's financial results reports. Other unknown or unpredictable factors or underlying assumptions subsequently proven to be incorrect could cause actual results to differ materially from those in the forward-looking statements. We do not undertake any obligation to publicly update or revise forward-looking statements, whether as a result of new information, future events or otherwise, except to the extent legally required.

Nokia presents financial information on reported, comparable and constant currency basis. Comparable measures presented in this document exclude intangible asset amortization and other purchase price fair value adjustments, goodwill impairments, restructuring related charges and certain other items affecting comparability. In order to allow full visibility on determining comparable results, information on items affecting comparability is presented separately for each of the components of profit or loss. Constant currency reporting provides additional information on change in financial measures on a constant currency basis in order to better reflect the underlying business performance. Therefore, change in financial measures at constant currency excludes the impact of changes in exchange rates in comparison to euro, our reporting currency. As comparable or constant currency financial measures are not defined in IFRS they may not be directly comparable with similarly titled measures used by other companies, including those in the same industry. The primary rationale for presenting these measures is that the management uses these measures in assessing the financial performance of Nokia and believes that these measures provide meaningful supplemental information on the underlying business performance of Nokia. These financial measures should not be considered in isolation from, or as a substitute for, financial information presented in compliance with IFRS.

Nokia is a registered trademark of Nokia Corporation. Other product and company names mentioned herein may be trademarks or trade names of their respective owners.

Public

NOKIA

Welcome

Pekka Lundmark
President and CEO

Tommi Uitto
President Mobile Networks

NOKIA

Investor communication plan
Periodic BG progress updates to increase transparency

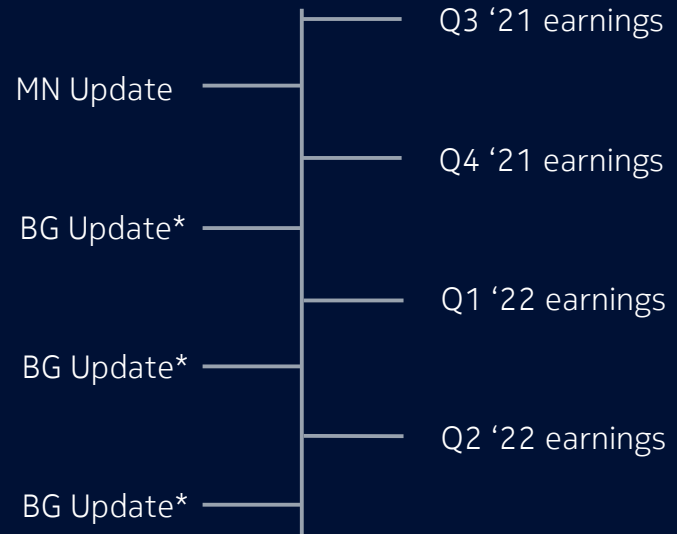### Improving our investor communication

Streamlined financial reporting

Transparency to business performance

Balanced and transparent outlook

Focus on ESG

Periodic business group progress updates

Q3 '21 earnings

MN Update

Q4 '21 earnings

BG Update*

Q1 '22 earnings

BG Update*

Q2 '22 earnings

BG Update*

*Exact dates and order of business
group updates is still to be confirmed

Public

NOKIA

Our reset phase is on track, accelerate ahead
Three-phased journey to deliver sustainable, profitable growth and technology leadership

2021 focus　　　　　　　　**2022 and mid term**

Scale

- New use cases
- New business models
- Invest in 6G standardization

Accelerate

- Enhance technology leadership
- Lead in O-RAN/Cloud RAN
- Drive 5G Advanced standard
- IP/Optical convergence
- Digitalization
- Automation
- Emerging opportunities
- Cloud / Network-as-a-Service

Reset

• Technology leadership	on track
• Operating model	on track
• Mobile Networks	ahead of plan
• Lower cost base	in progress
• Purpose and culture	defined
• Leadership team	complete

　　　　　　　　Public　　　　　　**NOKIA**

Our strategy is improving our financials (Q1-3 2021)

Net sales

€15.8bn

Q1-3 2020: €15.3bn

Net sales growth y-o-y (constant currency)

+6%

EPS, diluted (comparable)

€0.24

Q1-3 2020: €0.11

Operating margin (comparable)

11.8%

Q1-3 2020: 6.7%

Gross margin (comparable)

40.5%

Q1-3 2020: 37.8%

Net cash

€4.3bn

Q3 2020: €1.9bn

Public

NOKIA

Mobile Networks

Tommi Uitto
President Mobile Networks

Public

NOKIA

We have delivered on what we promised at March CMD

Recap of March CMD '21 plan:

Reset

✓ Secure full portfolio competitiveness

✓ Continue 5G momentum with CSPs and for private wireless customers

✓ Launch Cloud RAN and O-RAN solutions

✓ Reset fixed costs

What we have delivered:

AirScale portfolio launch in June 2021
Industry's lightest high power 400 MHz 32TRX mMIMO antenna

Stabilised 4G/5G conversion ratio
Private wireless customers expanded from 260 to 380+

June product launch O-RAN ready
Nokia Cloud RAN in trials

Significant R&D productivity improvements
Operating margin assumption raised in July 2021

Public

NOKIA

All bases covered to secure 5G technology leadership

New AirScale radios, including the industry's lightest high-power, 400MHz 32TRX Massive MIMO
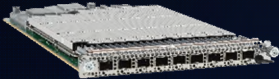
Energy efficient AirScale baseband: industry benchmark for flexibility and capacity

On track to power full portfolio with ReefShark System-on-Chips in 2022

5G with Single RAN – common software trunk for speed and quality

'Great to see you back in 5G,

Johan Wibergh
Group Technology
Officer, Vodafone

vodafone

   Public   NOKIA

Our new SoC-based multi-radio baseband is now the industry benchmark

Leadership in the six product characteristics that matter in baseband platforms

- Data throughput capacity
- Subscriber connectivity
- Cell connectivity
- Power consumption
- Scalability
- Future-proofness

1 - 2 Common Units for L3 and Transport
1 - 6 Capacity Units for L1 and L2
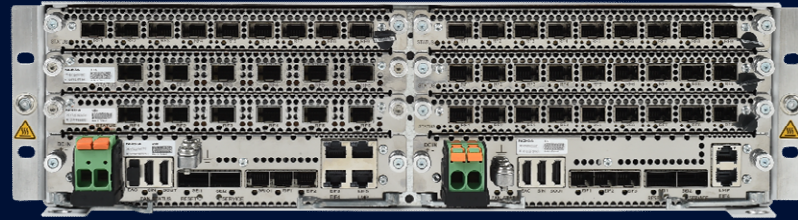
Ultra-lean variant with same SoCs and SW

Public

NOKIA

Comprehensive radio portfolio for capacity and coverage
Huge selection of 5G ready radios (FDD and TDD)

Macro radios

6T6R RFM

FDD RRH
2T2R/4T4R

TD RRH
8T8R

TD mMIMO
32TRX

TD mMIMO
64TRX

TD mMIMO
dual-band

TD mMIMO
Integrated
Antenna

FDD mMIMO
16&32TRX

Small Cell / mmWave radios / microwave

ASMR Compact
mmWave

4T4R
Micro RRH

AirScale Indoor

Femto

DAS

UBT

Over 5 million Nokia radios capable of supporting 5G	Over 260 radio variants in the Nokia portfolio	A choice of radios increases network performance and decreases site costs

NOKIA

We are back on SoC path and "all bases are loaded"
5G Massive MIMO example

Compute function	2019	2020	2021	2022	2023
L1	Commercial large FPGA		ReefShark SoC		Next Gen ReefShark SoC
L2/L3/TRS	ReefShark SoC		ReefShark SoC		Next Gen ReefShark SoC
eCPRI	Commercial large FPGA		ReefShark SoC		Next Gen ReefShark SoC
RF DFE	Commercial large FPGA		ReefShark SoC		Next Gen ReefShark SoC
L1-Low Beamforming	Commercial large FPGA		ReefShark SoC		Next Gen ReefShark SoC
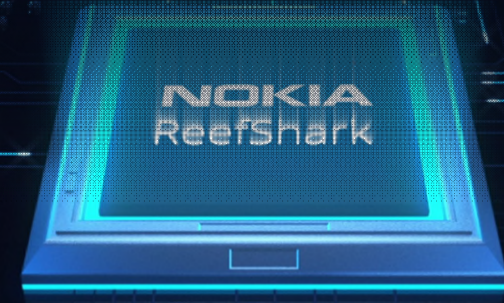
SoC design team size tripled – working with three SoC partners

© 2021 Nokia

NOKIA

We made significant progress throughout 2019 – 2021 increasing R&D output and productivity

Nominal 5G R&D capacity increase (headcount)

+60%

Jan-19   Dec-19   Dec-20   Dec-21 E

■ 5G R&D Capacity (HC)
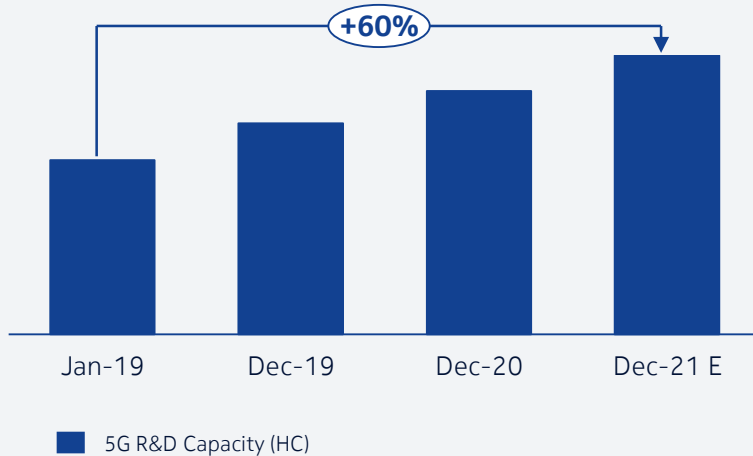
Increase in 5G customer SW feature effort (hours)

+130%

Jan-19   Dec-19   Dec-20   Dec-21 E

■ 5G R&D headcount increase (hours)   — Customer feature effort (hours, 12m avg)
■ Efficiency Improvement (hours)   ■ 2018 R&D Baseline effort (hours)

© 2021 Nokia   Public   NOKIA
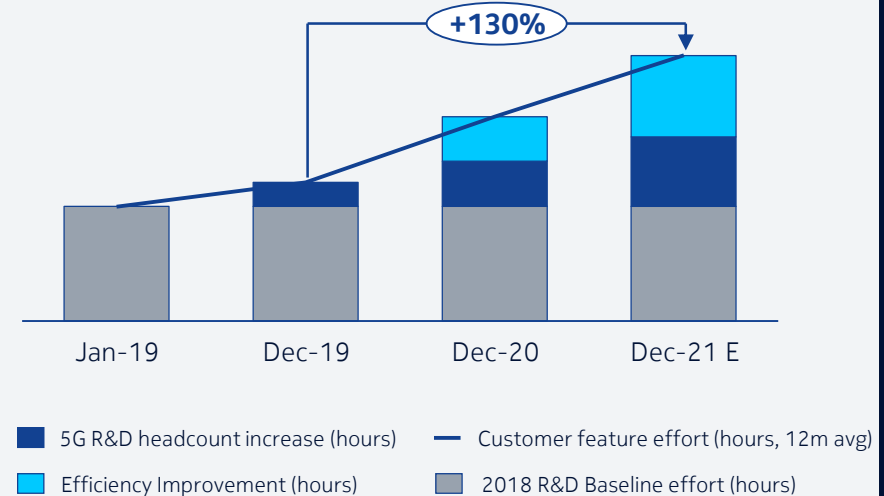
Digitizing service delivery for speed, quality and TCO

Driveless acceptance

- 75% time reduction for acceptance
- Manual to automated data processing
- Reduction of CO2 associated with drive testing

Site design automation
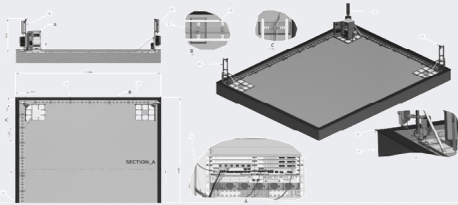
- Simplify , improve quality and accelerate the site design process
- Site design based on the input collected during technical site survey
- Faster site design and lower TCO

Intelligent issue resolution

- Advanced selfcare and information access with Nokia Digital Assistant
- Automated log identification and collection
- AI based root cause analysis accelerating case handling

NOKIA

Great Nokia 5G NSA performance development
Crowdsourced data – major South Korean operator – 2021

5G NSA (ENDC) DL Throughput Trend (Mbit/s)

NOKIA
Supplier B
Supplier C

September City level DL Throughput (Mbit/s)

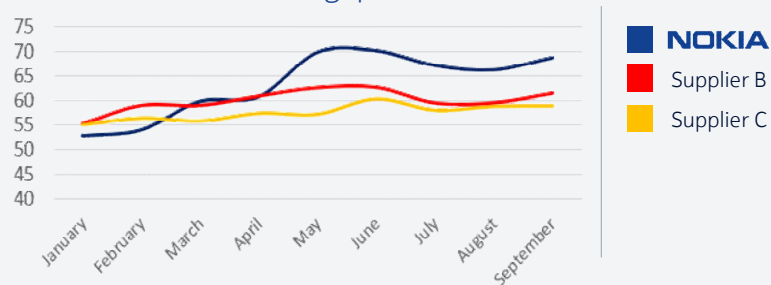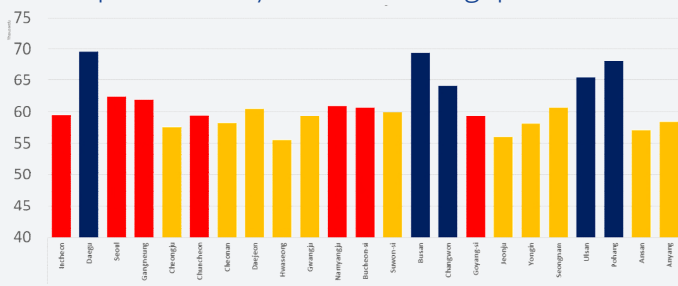Nokia analysis based on crowdsourced data from Tutela Technologies, Ltd.

Video Conferencing*

	NOKIA	Supplier A	Supplier C
Excellent	95,40%	92,72%	92,44%
Good	1,30%	4,10%	4,53%
Fair	1,66%	1,32%	1,13%
Poor	0,17%	0,31%	0,34%
	0,58%		
Unacceptable	1,47%	1,55%	1,56%

Cloud Gaming*

	NOKIA	Supplier A	Supplier C
Excellent	87,02%	83,08%	68,02%
Good	7,21%	6,52%	21,05%
Fair	1,69%	4,50%	5,26%
Poor		1,58%	1,84%
Unacceptable	3,49%	4,04%	3,83%
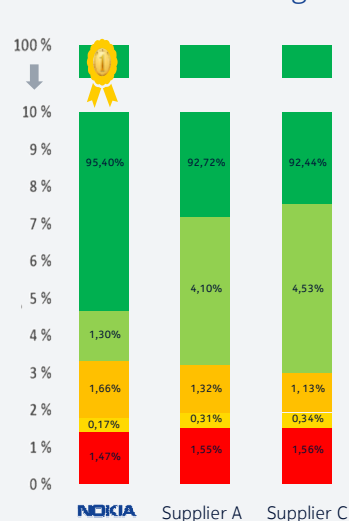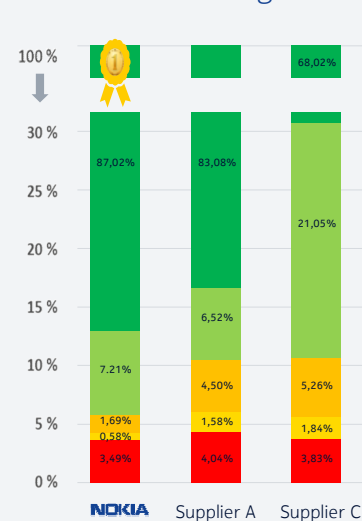
Unacceptable   Poor   Fair   Good   Excellent

Nokia analysis based on crowdsourced data from Tutela Technologies, Ltd. (1-31 Sept '21)

Public

NOKIA

~40% of 5G networks in the world are powered by Nokia

30
New RAN customers since the start of 2019

23
Customers increased their RAN share with Nokia

~90%
4G to 5G conversion rate, excluding China

~25–27%
4G+5G market share, excl. China

NOKIA

We are leading the market in private wireless networks
Private wireless and IoT expand critical networks market into Enterprise

Aircraft engine inspection over 5G

Lufthansa Technik

- Nokia 5G solution deployed by Lufthansa Technik for virtual engine part inspection.
- Allows customers to remotely attend engine parts inspections.
- Entering pilot stage just prior to the pandemic the solution quickly demonstrated its value and quickly moved from trial to business-critical infrastructure.

5G SA for mining operation

AGNICO EAGLE FINLAND

- Operational 5G SA network deployed by Telia and Nokia for Agnico Eagle.
- Deployed at the Kittilä mine in northern Finland.
- Above and below ground operations.
- Connectivity of people, sensors, devices and vehicles up to 1km below surface.
- Enhances operational efficiency and supports highest level of safety.

Energy | Mining | Transportation | Ports | Manufacturing | Public Safety

Private Wireless Networks sold to 380+ customers via CSP or direct, of which 70+ are 5G

Public

NOKIA

Our Mobile Networks ambition expands beyond 2023

Strategic focus

Success factors

Scale
- Convert Nokia 4G CSP customers to 5G
- Continue winning new CSP customers
- Continue winning in Enterprise segment

Product competitiveness
- Build on product platform and R&D turn-around
- Increase 5G R&D capacity further
- Continue reducing product and service cost

Shaping the market
- Leading solutions for e2e slicing and private wireless networks
- Make O-RAN commercial reality to gain share
- Bring cloud computing benefits to mobile networks

Resetting fixed cost base
- Reap the benefits of the new operating model
- Significantly lower fixed cost base to fund R&D increase
- Continue improving R&D productivity

Comparable Operating Margin in 2023…

5%-8%

… and in longer term

10+%

© 2021 Nokia   Public

NOKIA

Addressable market outlook

Public

NOKIA

The 5G market has an extended peak

Private Wireless Networks market growing at 29% CAGR

Radio technology product and services market* in EURbn constant

- CSP + Private Wireless Networks
- CSP mobile broadband
- 5G
- 6G
- Private Wireless Networks
- 4G
- 2G/3G

Overall Mobile Networks market* growth 2021-24

2% CAGR

2021: €46bn**   2024: €50bn**

Private Wireless Networks market* growth 2021-30

29% CAGR
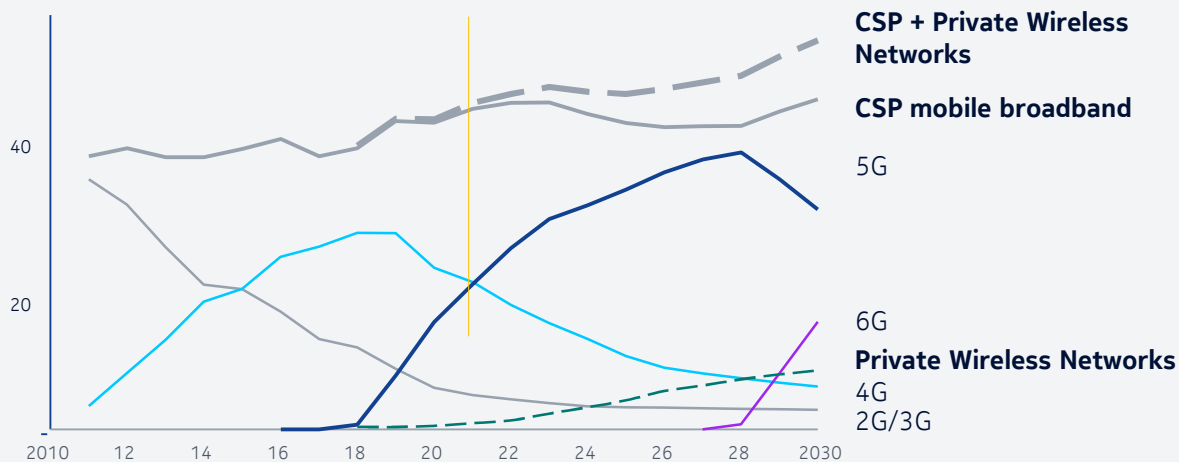
*) excluding Mainland China
**) Mobile Networks market size calculated assuming actual currency rates for first ten months of 2021 and end of October EUR/USD rate of 1.16 continues for the remainder of 2021. Growth rates based on constant currency.

Source: Nokia Business Intelligence

The future starts now

5G

- **Industrial 5G use cases** supported by classical and Cloud RAN / O-RAN solution
- **Network efficiency and optimization** utilizing 4G/5G slicing, AI/ML and energy efficiency

5G - Advanced

- **New 5G usage areas,** e.g. **5G satellite networks** and **Sub-5 MHz carrier** for railways and smart grid
- **Boosted 5G experience,** enhanced coverage, 50% higher energy efficiency with small packet optimisation
- **Boosted 5G services,** e.g. high accuracy and low cost **positioning methods** for e.g. industrial automation, IoT

6G

- **Seamless 6G evolution** of radio architectures, chipsets, software and 5G/6G platforms
- **Adaptive AI interface** and deep learning

Rel 15
Extreme mobile broadband

Rel 17
Wider ecosystem expansion

Rel 16
Ultra-reliable low latency communications

Rel 18
5G Advanced

Rel 19 -20
5G Advanced updates, 6G studies

Rel 21
6G standardization

Rel 22+
6G updates

| 2019 | 2020 | 2022 | 2023-24 | 2025- 27 | 2028-29 | 2030+ |

Public

NOKIA

5G Advanced provides new usage areas and services
Expected characteristics of 5G-Advanced

5G Extension

Extending the reach of 5G to wider footprints and new use-cases

Link budget improvements; enhanced beamforming; reduced capability devices (RedCap).

5G Experience

Truly immersive digital experiences with extended reality

Edge Compute; cloud gaming; use case mobility enhancements; XR QoE.

5G Expansion

Expanding from providing the 'what' to the 'where and the 'when' with accurate precision and timing

High accuracy positioning; network timing; support for industrial automation and IoT.

5G Excellence in operations

Optimal cognitive use of available resources to deliver unprecedented performance

Traffic splitting and steering; energy efficiency measures.

EXTENSION

EXPERIENCE

EXPANSION

eMBB

mMTC

URLLC

EXCELLENCE

NOKIA

Leadership in O-RAN and Cloud RAN

Public

NOKIA

O-RAN was formed by operators to lower TCO
RAN openness, programmability, HW vs SW separation

O-RAN ALLIANCE

- Launched June 2018
- Merging of the xRAN Forum with the C-RAN Alliance
- O-RAN Alliance announced collaboration with TIP in February 2020
- 10 key working groups led by operators with vendors co-chairing

30
operators

290
contributors

Objectives

1. Adopt **open RAN interfaces and infrastructure** to allow multi-vendor combinations
2. Achieve **faster time-to-market** and **easier innovation leverage**
3. **Efficient TCO** by increased competition and **white box approach**
4. Rapid and broad industry promotion, adoption of **open standards, interfaces and APIs**
5. **RAN programmability** and service optimization through leverage of AI and Machine Learning

Public

NOKIA

Nokia active in all O-RAN working groups
Co-leads RIC and Fronthaul groups

Use cases and overall architecture — #1

Non-real-time RIC and A1 — #2

Near-real-time RIC and E2 **Nokia co-chaired** — #3

Operations and Maintenance — #10

Open Fronthaul **Nokia co-chaired** — #4

Open X-haul Transport — #9

Open F1/W1/E1/X2/Xn — #5

Stack Reference Design — #8

White-Box hardware — #7

Cloudification and Orchestration — #6

Nokia active contribution / co-leading

Public

NOKIA

O-RAN architecture – defines fronthaul specification and a new element RIC
Functions and interfaces can be selected/deployed independently
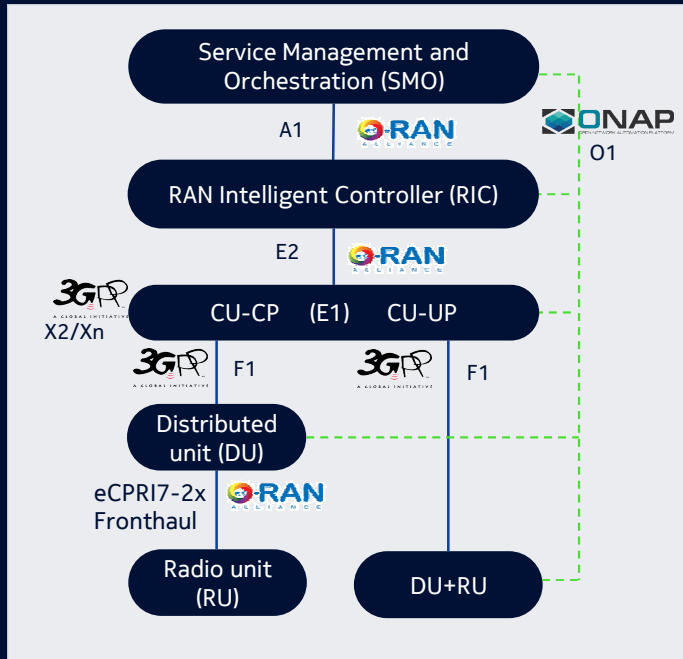
O-RAN architecture

RAN Intelligent Controller (RIC)
- New virtualized function
- RAN programmability / Self Optimized Network type functions

O-RAN fronthaul
- Facilitates different suppliers for the DU and RU
- O-RAN alliance defines IoT profile interoperability testing (IOT) for O-DU and O-RU from different vendors

Virtualization
- HW / SW separation of network elements (especially DU and CU)

High level view of the difference between Cloud RAN and O-RAN

Example 1:
O-RAN with purpose-built BTS

O-RAN eCPRI
open

open

Core Network

Example 2:
O-RAN / Cloud RAN with vDU and vCU

O-RAN eCPRI
open

vDU

F1
open

vCU

open

Core Network

Example 3:
Cloud RAN with Campus Network

vDU & other workloads

vCU

Core Network

SW Application		
vDU, vCU		

Standard Hardware
DataCenter x86

Cloud RAN
- "Vertical openness"
- Independent HW and SW

O-RAN
- "Horizontal openness"
- Open interfaces between network elements

Front-haul	Mid-haul	MANO / other
eCPRI	F1 (vRAN)	E2, O1, X2

Complexity

Public

NOKIA

O-RAN enables CSPs to deploy multi-vendor RAN solutions
Additional complexity, time-to-market and performance risks to be addressed

How O-RAN can benefit operators

- **RAN programmability** for network optimization, new use cases and slicing.
- Stimulate **innovation** by open API and interfaces.
- More **flexibility in vendor selection** for RAN elements (e.g. RF and BB). Allows the insertion of **new players.** In theory could lower TCO.
- Reduce **vendor lock-in** with open interface between baseband and RF.

Challenges to be addressed

- Adoption **not consistent across major vendors**.
- **Need for system integration** to ensure feature alignment, performance and lifecycle management.
- **Co-existence and inter-working with legacy networks**
- Product **cost and power** consumption challenging as standard hardware not optimized vs. custom silicon.
- Possible **risk of industry fragmentation** leading to sub-scale vendors.

Public

NOKIA

Nokia O-RAN: Growing number of customer engagements
Strong interest in understanding Nokia's position in O-RAN ecosystem

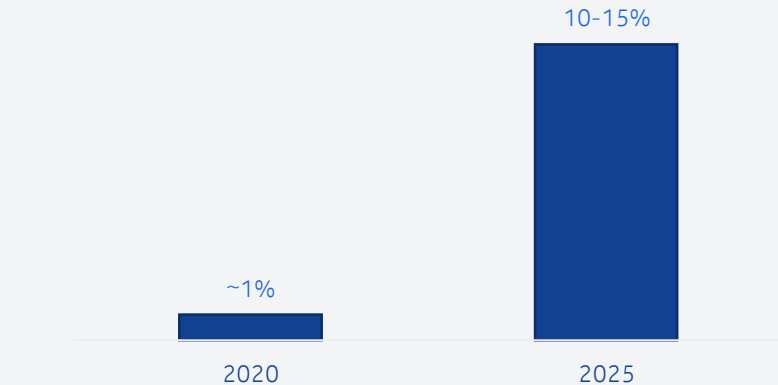Customer
engagements

50+

Public

NOKIA

Open RAN penetration still limited through 2025
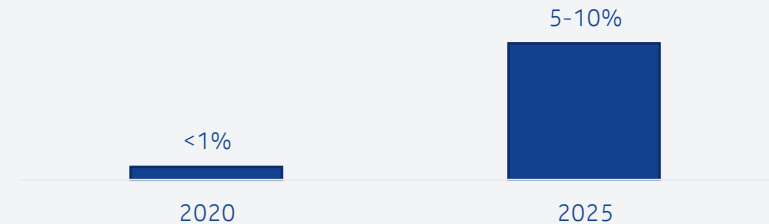## Dell'Oro forecasts 13% Open RAN and 6% vRAN share by 2025
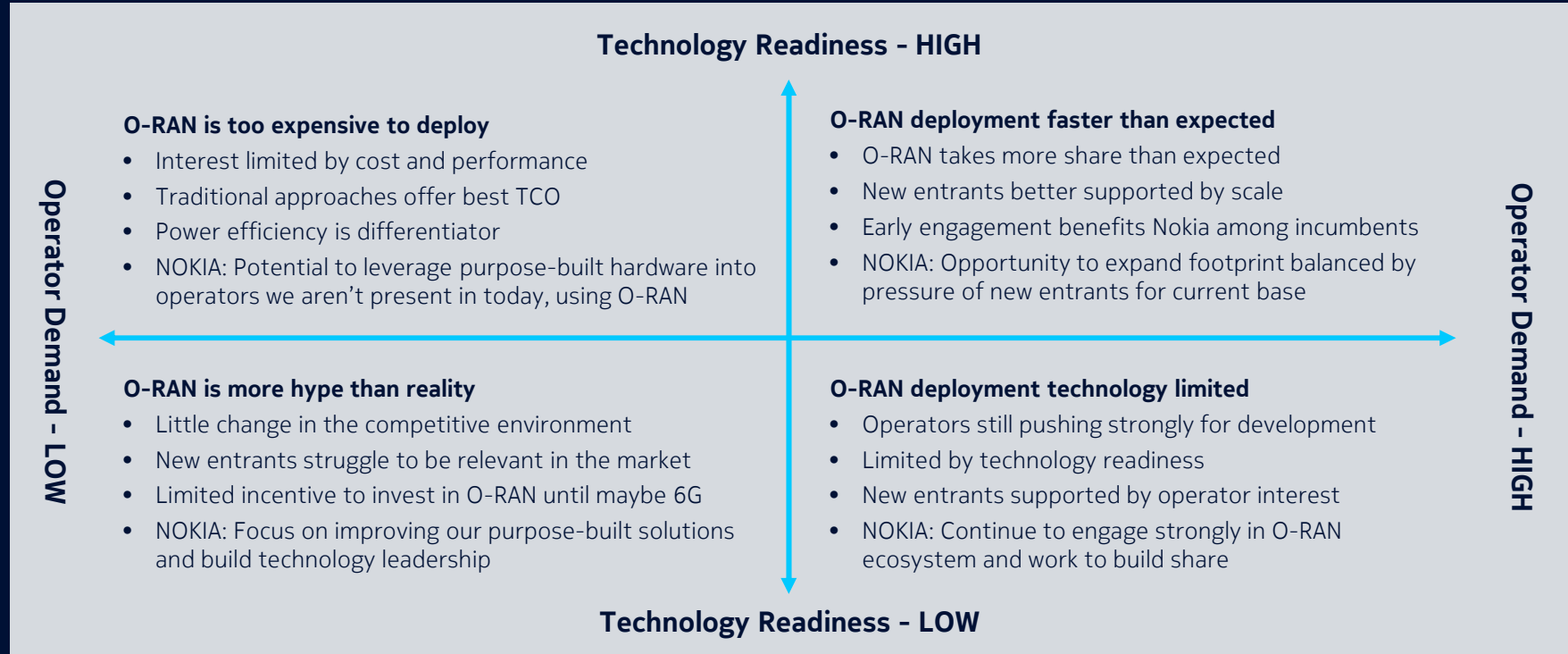
Open RAN % Share of RAN market (by value)

- 2020: ~1%
- 2025: 10-15%

Source: Dell'Oro

vRAN % Share of RAN market (by value)

- 2020: <1%
- 2025: 5-10%

Source: Dell'Oro

NOKIA

O-RAN scenarios – a lot still to be determined
Our strategy should position us well no matter how quickly O-RAN evolves

Technology Readiness - HIGH

Operator Demand – LOW

Operator Demand – HIGH

O-RAN is too expensive to deploy
- Interest limited by cost and performance
- Traditional approaches offer best TCO
- Power efficiency is differentiator
- NOKIA: Potential to leverage purpose-built hardware into operators we aren't present in today, using O-RAN

O-RAN deployment faster than expected
- O-RAN takes more share than expected
- New entrants better supported by scale
- Early engagement benefits Nokia among incumbents
- NOKIA: Opportunity to expand footprint balanced by pressure of new entrants for current base

O-RAN is more hype than reality
- Little change in the competitive environment
- New entrants struggle to be relevant in the market
- Limited incentive to invest in O-RAN until maybe 6G
- NOKIA: Focus on improving our purpose-built solutions and build technology leadership

O-RAN deployment technology limited
- Operators still pushing strongly for development
- Limited by technology readiness
- New entrants supported by operator interest
- NOKIA: Continue to engage strongly in O-RAN ecosystem and work to build share

Technology Readiness - LOW

NOKIA

Conclusion

1. **We have delivered on our objectives for Reset in 2021**
   - We have closed the gap to competition
   - Increased our R&D investments to drive towards technology leadership
   - Stabilized our footprint after the challenges faced in 2019/20

2. **We see a robust market demand through 2024**
   - While market growth may slow – we still see 2% CAGR 2021-2024
   - We remain optimistic on the pace of growth we might see in private wireless

3. **O-RAN as much an opportunity as a threat**
   - There is still much to be developed technology wise
   - But we have a strategy that can deliver regardless of the speed of O-RAN adoption

            Public   **NOKIA**

Q&A

Public

NOKIA