Industry 4.0

April, 2021
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                                    Customer confidential

What if you could?

Get rid of the wires in your premise, factory or store? **01**

Keep all your data on your premises? **03**

Have a secure, reliable wireless network? **02**
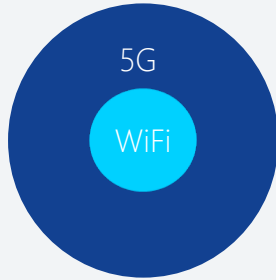
Manage it all from the comfort of your laptop? **04**

02

01

03

04

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A better wireless network

Private 5G fit for OT applications requirements

Wide and deep coverage
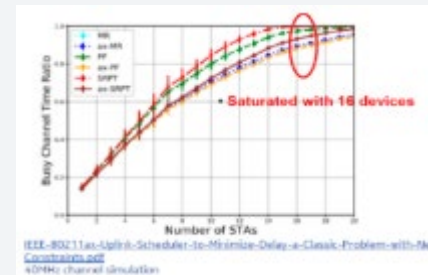
4-100x coverage

5G
WiFi

>3 extra walls of penetration

5G
WiFi

Predictable performance

Stable <15ms latency

25x multi-user capacity

Military grade security

Wi-Fi - WPA2/3

5G
SIM authentication
E2E encryption

One network for all apps

Wi-Fi 5/6
• Does not include IIoT LP capabilities

LTE integrates LPWAN
• Narrow band, low power applications on same radio

LTE-M   NB-IoT

High speed mobility

WiFi
Up to **15 sec** latency on fast hand-over

5G
Smooth hand over up to **350kph**
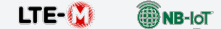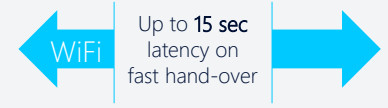
The ingredients for private wireless

It all starts with spectrum

- Spectrum is the critical resource. The choice of spectrum drives the design.

- There is a vast range of access points; indoor, outdoor; a few metres to tens of kilometres.

- There are mobile cores that scale down to enterprise requirements.

- Together that drives an end to end ecosystem.

Spectrum

Access Points

Core

End to End Ecosystem

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UK Mobile Spectrum

800 (B28, B67, B20)
- FDD uplink — 30 MHz for auction — 703 MHz – 733
- TDD — 20MHz for auction — 738 – 758 | FDD downlink — 30 MHz for auction — 758 – 788
- FDD downlink — 5 | 5 | 10 | 10 — 791, 796, 801, 811, 821
- FDD uplink — 5 | 5 | 10 | 10 — 832, 837, 842, 852, 862

900 (B8)
- FDD uplink — 5 | 5 | 4.6 | 7.6 | 4.8 — 880.1, 885.1, 890.1, 894.7, 902.3, 910.1, 914.9
- FDD downlink — 5 | 5 | 4.6 | 7.6 | 4.8 — 925.1, 930.1, 935.1, 939.7, 947.3, 955.1, 959.9

1800 (B3)
- FDD uplink — 5.8 | 5.8 | 15 MHz | 45 MHz — 1710.1, 1721.7, 1736.7, 1781.7
- FDD downlink — 5.8 | 5.8 | 15 MHz | 45 MHz — 1805.1, 1816.7, 1831.7, 1876.7

2100 (B39, B1)
- TDD — 10 | 5 | 5.4 — 1899.9, 1909.9, 1914.9, 1920.3
- FDD uplink — 14.6 | 10 | 14.8 | 20 MHz — 1920.3, 1934.9, 1944.9, 1959.7, 1979.7
- FDD downlink — 14.6 | 10 | 14.8 | 20 MHz — 2110.3, 2124.9, 2134.9, 2149.7, 2169.7

2300 (B40)
- TDD — 40 MHz — 2350 – 2390
- ISD Band - WiFi, Bluetooth, etc — 100 MHz — 2400 – 2500

2600 (B7, B38)
- FDD uplink — 20 MHz | 15 MHz | 35 MHz — 2500, 2520, 2535, 2570
- TDD — 25 MHz | 25 MHz | 20 MHz — 2570, 2595, 2620, 2640
- FDD downlink — 15 MHz | 35 MHz — 2640, 2655, 2690

3500 (B42, n78)
- TDD — 50 MHz | 40 MHz | 40 MHz | 40 MHz | 20 MHz — 3410, 3460, 3500, 3540, 3580, 3600

3700 (B43, n78)
- TDD — 80 MHz | 120 MHz for auction — 3600, 3680, 3800

Legend: Vodafone | O2 / Telefonica | EE / BT | Three / UK BB

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UK Shared Spectrum

Low cost licences
£80 per 10 MHz per annum

Low power licences
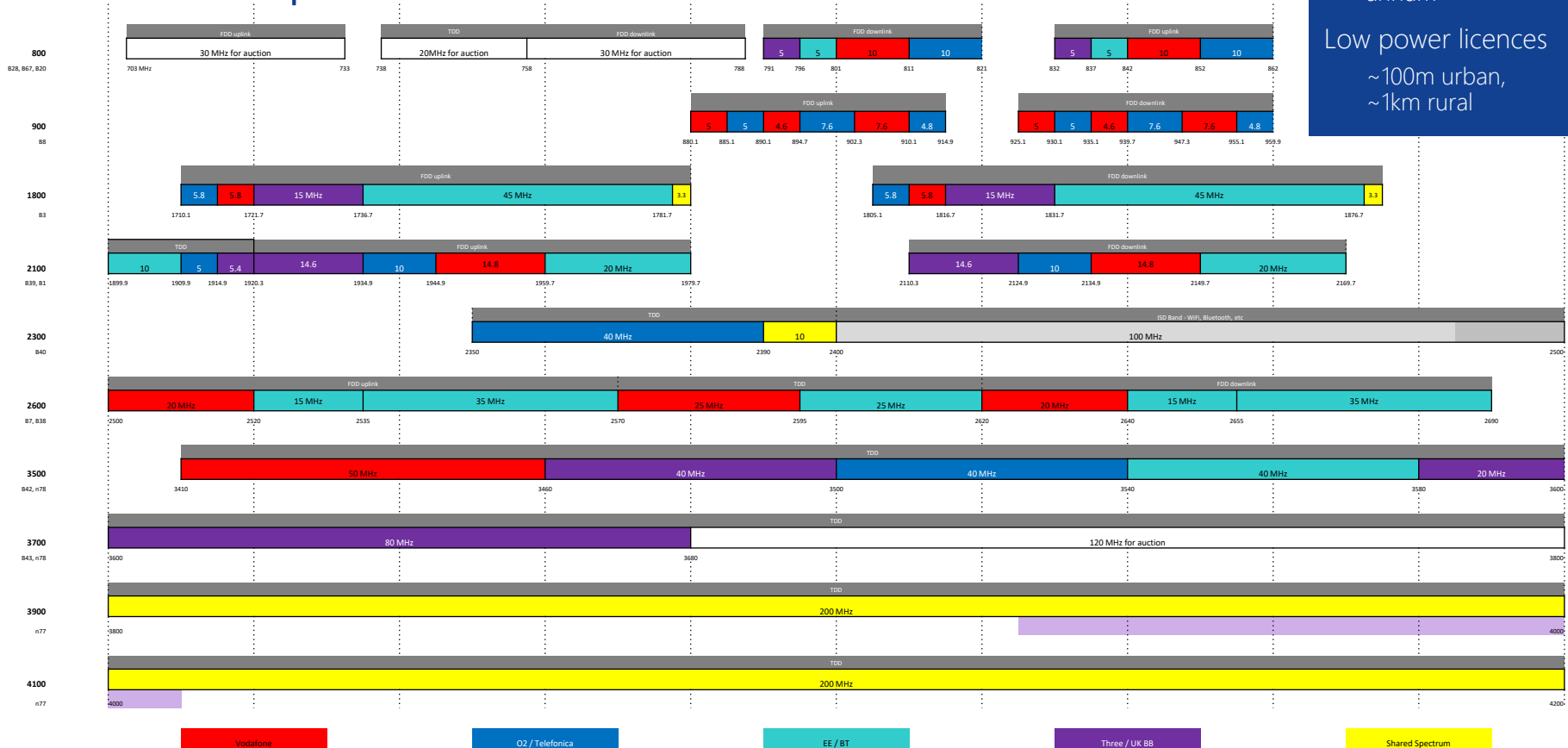~100m urban, ~1km rural
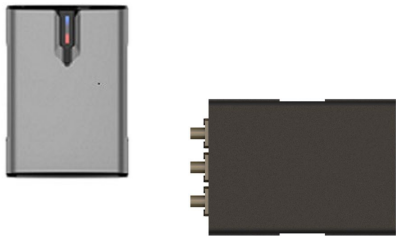
800 (B28, B67, B20)
FDD uplink — 30 MHz for auction (703 MHz – 733)
TDD — 20MHz for auction (738 – 758)
FDD downlink — 30 MHz for auction (758 – 788)
FDD downlink: 5 | 5 | 10 | 10 (791, 796, 801, 811, 821)
FDD uplink: 5 | 5 | 10 | 10 (832, 837, 842, 852, 862)

900 (B8)
FDD uplink: 5 | 5 | 4.6 | 7.6 | 7.6 | 4.8 (880.1, 885.1, 890.1, 894.7, 902.3, 910.1, 914.9)
FDD downlink: 5 | 5 | 4.6 | 7.6 | 7.6 | 4.8 (925.1, 930.1, 935.1, 939.7, 947.3, 955.1, 959.9)

1800 (B3)
FDD uplink: 5.8 | 5.8 | 15 MHz | 45 MHz | 3.3 (1710.1, 1721.7, 1736.7, 1781.7)
FDD downlink: 5.8 | 5.8 | 15 MHz | 45 MHz | 3.3 (1805.1, 1816.7, 1831.7, 1876.7)

2100 (B39, B1)
TDD: 10 | 5 | 5.4 (1899.9, 1909.9, 1914.9, 1920.3)
FDD uplink: 14.6 | 10 | 14.3 | 20 MHz (1920.3, 1934.9, 1944.9, 1959.7, 1979.7)
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2300 (B40)
TDD: 40 MHz | 10 (2350, 2390, 2400)
ISD Band - WiFi, Bluetooth, etc: 100 MHz (2400 – 2500)

2600 (B7, B38)
FDD uplink: 20 MHz | 15 MHz | 35 MHz (2500, 2520, 2535, 2570)
TDD: 25 MHz | 25 MHz | 20 MHz (2570, 2595, 2620, 2640)
FDD downlink: 15 MHz | 35 MHz (2640, 2655, 2690)

3500 (B42, n78)
TDD: 50 MHz | 40 MHz | 40 MHz | 40 MHz | 20 MHz (3410, 3460, 3500, 3540, 3580, 3600)

3700 (B43, n78)
TDD: 80 MHz | 120 MHz for auction (3600, 3680, 3800)

3900 (n77)
TDD: 200 MHz (3800 – 4000)

4100 (n77)
TDD: 200 MHz (4000 – 4200)

Legend:
Vodafone | O2 / Telefonica | EE / BT | Three / UK BB | Shared Spectrum

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5G SA devices

workpads

handhelds

dongles

fixed access

routers

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Industry 4.0 use cases apply in a variety of manufacturing contexts

Digital Factory Campus

- Digital Factory Twin
- Facility Management
- Security & Surveillance
- Multi-functional Drones

M2M Communication

Automated Shop Floor

- Collaborative Robots
- Cloud Robotics
- Quality Management

Smart Asset

- Predictive Maintenance
- Automated Guided Vehicle
- Asset Condition Monitoring
- Remote Configuration & Control
- Remote Maintenance

Connected Worker

- Augmented Worker
- Wireless Safety
- Connected Wearables
- Remote Expert Support
- Wireless Human Machine Interface
- Voice & Video Communication
- Virtual Reality

Enabling Connectivity

- Industrial Private Wireless Network
- Industrial Fixed Network
- Multi-Site Inter-Connect
- Seamless Global Connectivity

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5G Remote inspection for overhaul procedures
Lufthansa Technik, Hamburg

Currently, its customers travel to Hamburg to carry out components inspections when engines are overhauled, which means that they are entirely disassembled and inspected in utmost detail. With the new system, Lufthansa Technik will trial inspections of individual engine parts collaboratively over a fast, high-definition video link.
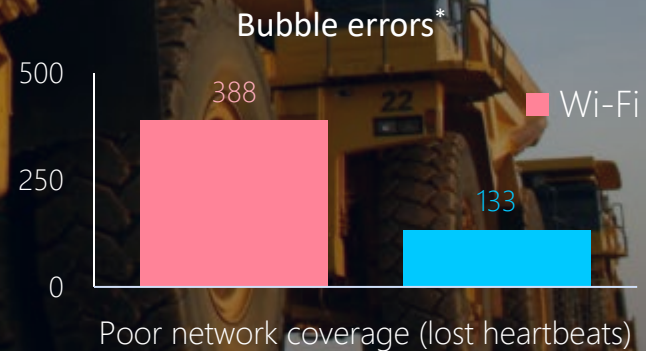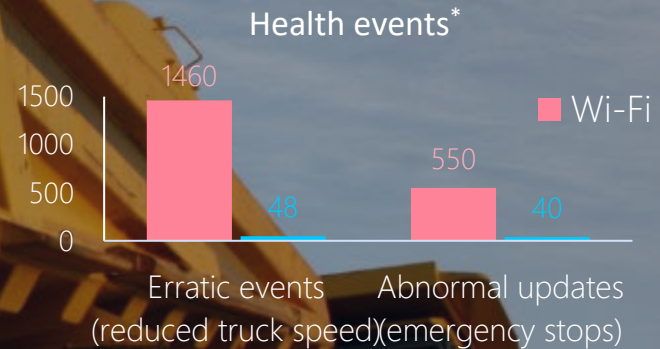
Industry automation – case Konecranes

Increase of automation and analytics

New wireless services for machine-to-machine communications, IIoT security, and machine learning

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Case study: an open-pit iron ore mine in Australia

- 50+ connected autonomous trucks.

- **>10 M€ savings** from replacing ~150 Wi-Fi trailers by 6 LTE CoWs.

- Productivity increase of **~75 hours/year** per truck and **1.5 million tons/year**, resulting in a **top-line growth of >50M€ per annum**.

- **Lower operational costs** thanks to less disruption (-90% stop events, -65% bubble events), lower fuel consumption (-7%) and less downtime (+1,3% AHS fleet utilization).

- Increased worker health and safety, due to **less human intervention**, keeping people away from high-risk areas.

Health events*

| | Wi-Fi |

- 1460 (Erratic events, Wi-Fi)
- 48 (Erratic events)
- 550 (Abnormal updates, Wi-Fi)
- 40 (Abnormal updates)

Erratic events (reduced truck speed)   Abnormal updates (emergency stops)

Bubble errors*

| | Wi-Fi |

- 388 (Wi-Fi)
- 133

Poor network coverage (lost heartbeats)

    * Measured daily averages; some of these events/errors are process related   **NOKIA**

Bosch deployed 5G private wireless in their plant in Stuttgart-Feuerbach for Industry 4.0 use cases

Bosch
- Leading global technology provider focusing on mobility, industrial solutions, IoT, energy and building solutions, headquartered in Germany
- Blueprint factory in Stuttgart-Feuerbach selected for 5G trial to prepare global rollout to 270 factories globally
- Long-lasting Nokia partnership through Nokia Bell Labs research projects and ARENA2036

Use Cases & Private Wireless
- Fully-fledged 5G private wireless network deployed, based on Nokia Digital Automation Cloud and local enterprise spectrum
- Transform Bosch factories, but also blueprint the smart factory of the future
- Industrial use case incubation includes
  - Automated guided vehicles
  - Wireless safety applications
  - Human machine interaction
  - Advanced and cloud robotics
  - Predictive maintenance
- Outlook: Artificial Intelligence, ML

Business Benefits
- Improve production efficiency, human and machine safety, shop floor flexibility, sustainability and more

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Factory automation – case Nokia Oulu factory

Mobile robots: Telepresence and material transport to the production line

IoT devices: Multiple sensors utilize the private network for communication

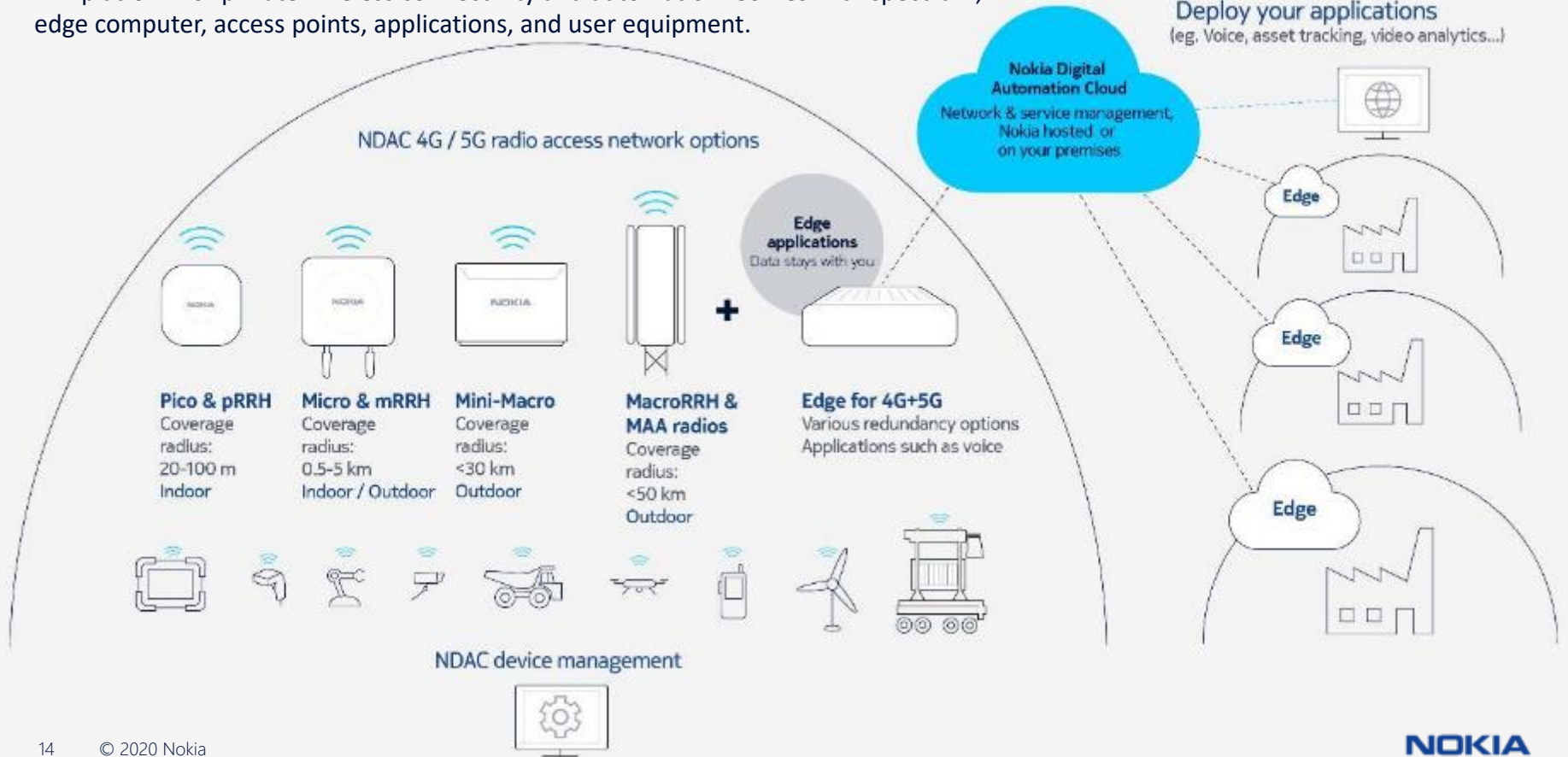Indoor positioning

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Nokia Digital Automation Cloud – plug & play pWireless

E2E platform for private wireless connectivity and automation. Comes with spectrum, edge computer, access points, applications, and user equipment.
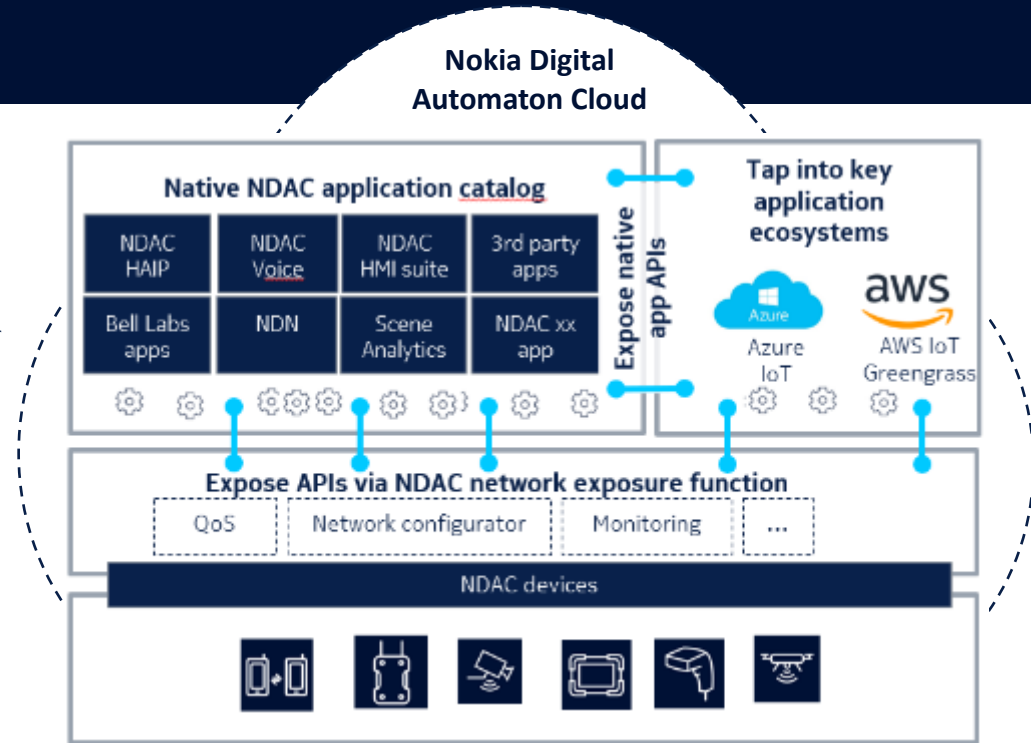

Create & manage multi-local networks

Deploy your applications
(eg. Voice, asset tracking, video analytics...)

Nokia Digital Automation Cloud
Network & service management,
Nokia hosted or
on your premises

NDAC 4G / 5G radio access network options

Edge applications
Data stays with you

Pico & pRRH
Coverage radius:
20-100 m
Indoor

Micro & mRRH
Coverage radius:
0.5-5 km
Indoor / Outdoor

Mini-Macro
Coverage radius:
<30 km
Outdoor

MacroRRH & MAA radios
Coverage radius:
<50 km
Outdoor

Edge for 4G+5G
Various redundancy options
Applications such as voice

Edge

Edge

Edge

NDAC device management

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Nokia DAC Application Framework – value beyond connectivity

- Native application offering via NDAC or tapping into major existing application and developer ecosystems
- Automated application management with modern cloud architecture, applications running at customer edge
- Enabling and ensuring e2e application specific network configuration capability
- Isolated own application space
- "Click & deploy" → easy sell
- Smooth 3rd party integration through own sandbox and easy onboarding
- APIs enabling 2-way resource / asset exchange.

Nokia Digital Automaton Cloud

Native NDAC application catalog

| NDAC HAIP | NDAC Voice | NDAC HMI suite | 3rd party apps |
| Bell Labs apps | NDN | Scene Analytics | NDAC xx app |

Expose native app APIs

Tap into key application ecosystems

aws

Azure IoT

AWS IoT Greengrass

Expose APIs via NDAC network exposure function

QoS | Network configurator | Monitoring | ...

NDAC devices

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