Private Wireless Networks

For MYNOG sharing

What's 5G Private Networks?

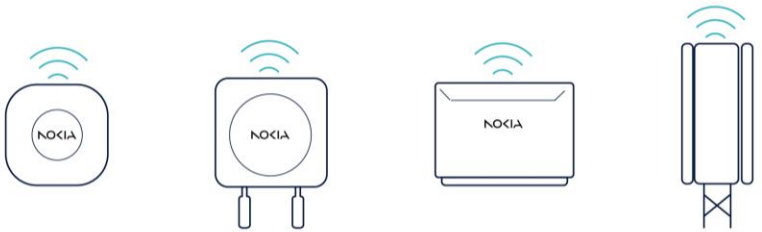
Private Networks

Imagine your smartphone network – but built and operational exclusively for your **Enterprise** (Port, Airport, Factory, Warehouse, Mining site ..etc

Edge applications
Data stays with you

Edge

Edge 5G Core & Industrial Edge for Applications



Pico
Coverage radius: 20–100m
Indoor

Micro
Coverage radius: 0.5–5km
Indoor/outdoor

Mini-macro
Coverage radius: <30km
Outdoor

Macro
Coverage radius: <50km
Outdoor

Devices

Comes with spectrum, edge computing, access points, applications and user equipment

Most common triggers to private wireless

Current wireless tech limitations

- Issues with existing use cases on existing wireless tech (e.g. AGV on Wi-Fi)
- Issue with existing wireless tech (e.g. aging PMR & PAMR network)

Introduction of new use cases

- Specific new use cases that require reliable wireless (e.g. Mine autonomous haulage)
- Remote sites (e.g. Offshore sites)

Incidents & External factors

- Worker safety (e.g. dangerous environments, ...)
- Site security breach
- Data privacy breach
- Major disasters

Innovation & Regulatory shift

- I4.0 “innovation” corporate projects
- Industry segment paradigm-shift (e.g. Distributed power generation)

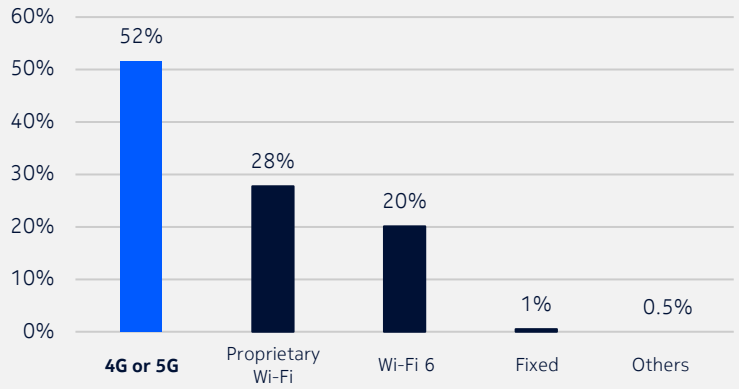
Broader Wireless connectivity...

- Greenfield sites
- Brownfield sites with no existing wireless networks

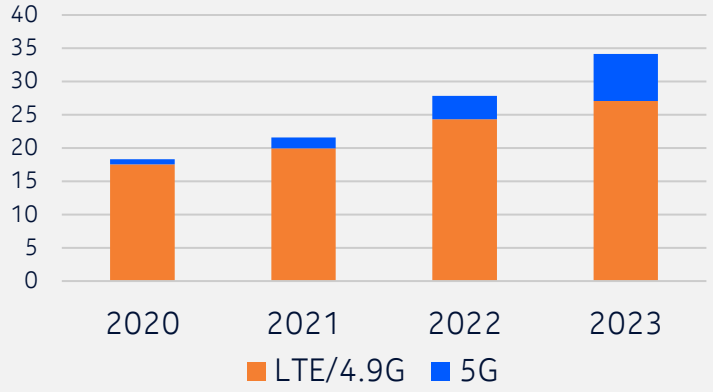
LTE/5G becoming wireless OT network technologies of choice

"43% of European enterprises consider **network transformation to be a key challenge** [..] recognizing that **current networks cannot support the future growth** [...] in areas such as **IoT and digital transformation"***

52% plan to leverage private LTE/5G for their future business/mission critical connectivity**



Global pWireless BTSes shipments (k)***



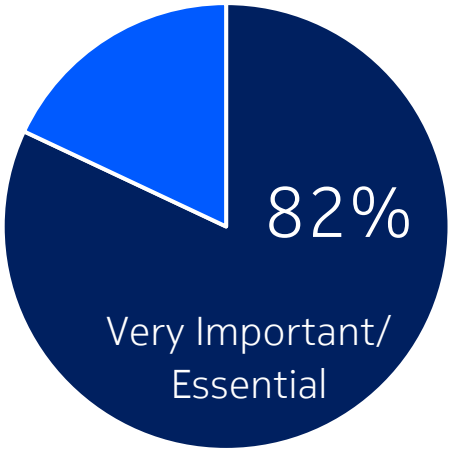
* IDC, European Enterprise Communications Survey
** 2022 Nokia-ABI research, 600+ manufacturers survey
*** Omdia 2022 - Global pWireless BTSes shipments. Results are not an endorsement of Nokia . Any reliance on these results is at the third-party's own risk.

Why not Wi-Fi
for critical connectivity?

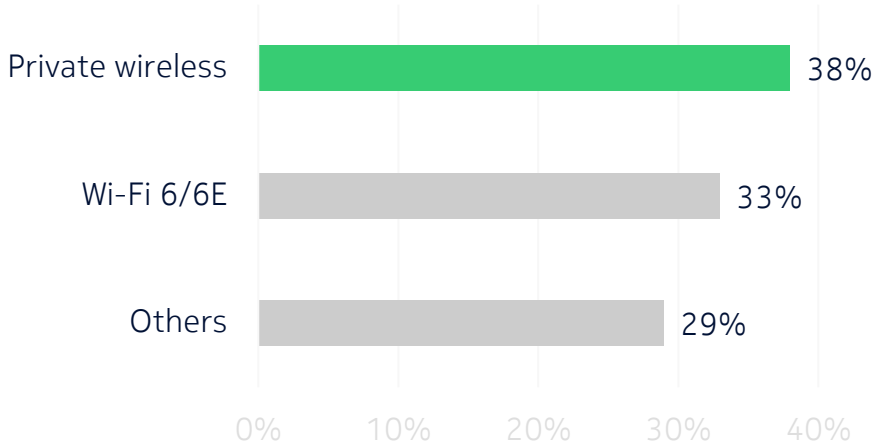
4.9G/5G becoming OT wireless network technologies of choice

...but Wi-Fi remain a strong competitor....

Role of wireless networks in the digital transformation of manufacturing operations



Primary wireless technology for manufacturing operations



Wi-Fi very wide adoption in enterprise IT, makes it the main & default competitor when it comes to OT wireless technology choice

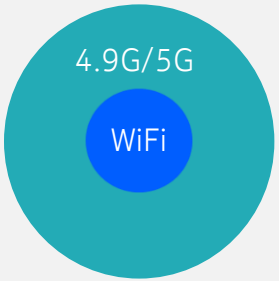
Nokia commissioned ABI manufacturing survey end of 2021, 1080 manufacturers interviewed

Wi-Fi 6: better capacity, latency and data rate but still IT centric…

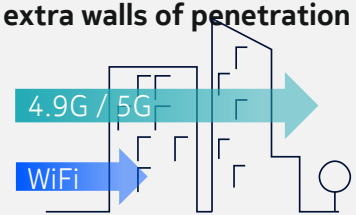
Private LTE/4.9G & 5G fit for OT applications requirements

Wide and deep coverage

4-100x coverage

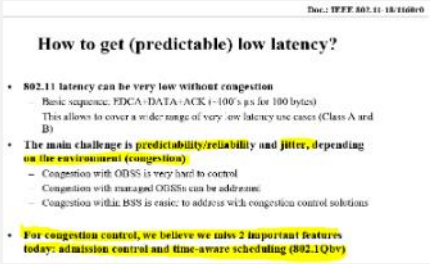


>3 extra walls of penetration



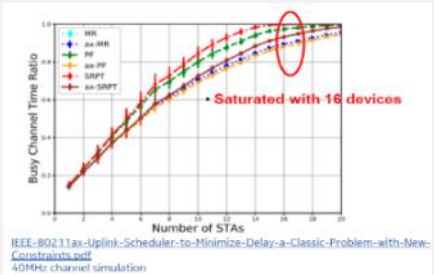
Predictable performance

Stable <15ms latency


How to get (predictable) low latency?

- 802.11 latency can be very low without congestion
  - Basic sequence: EDCA+DATA+ACK (~100's µs for 100 bytes)
  - This allows to cover a wider range of very low latency use cases (Class A and B)
- The main challenge is predictability/reliability and jitter, depending on the environment (congestion)
  - Congestion with OBSS is very hard to control
  - Congestion with managed OBSSs can be addressed
  - Congestion within BSS is easier, to address with congestion control solutions
- For congestion control, we believe we miss 2 important features today: admission control and time-aware scheduling (802.1Qbv)

25x multi-user capacity



Military grade security

Wi-Fi
WPA2/3
compromised

4.9G/5G
SIM authentication
E2E encryption

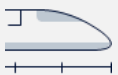
One network for all apps

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

4.9G/5G — Smooth hand over up to **350kph**

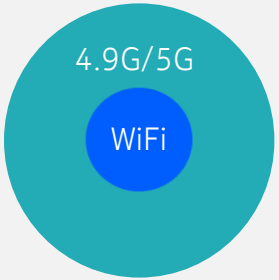
Wi-Fi 7: further enhancement but still IT centric…

Private LTE/4.9G & 5G fit for OT applications requirements

Wide and deep coverage

No enhancement in Wi-Fi7

4-100x coverage



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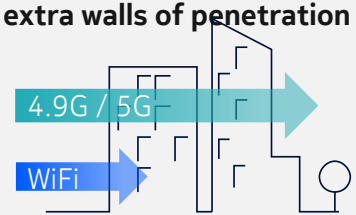

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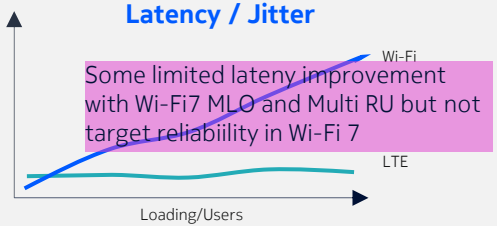
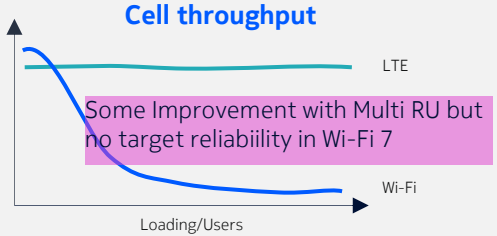


25x multi-user capacity



Military grade security

Wi-Fi
WPA2/3 compromised

No enhancement in Wi-Fi7

4.9G/5G
SIM authentication
E2E encryption

One network for all apps

Wi-Fi 5/6

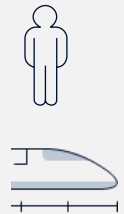
Reduce power consumption of IoT devices with static target wake time

LTE integrates LPWAN

- Narrow band, low power applications on same radio

LTE-M NB-IoT

High speed mobility



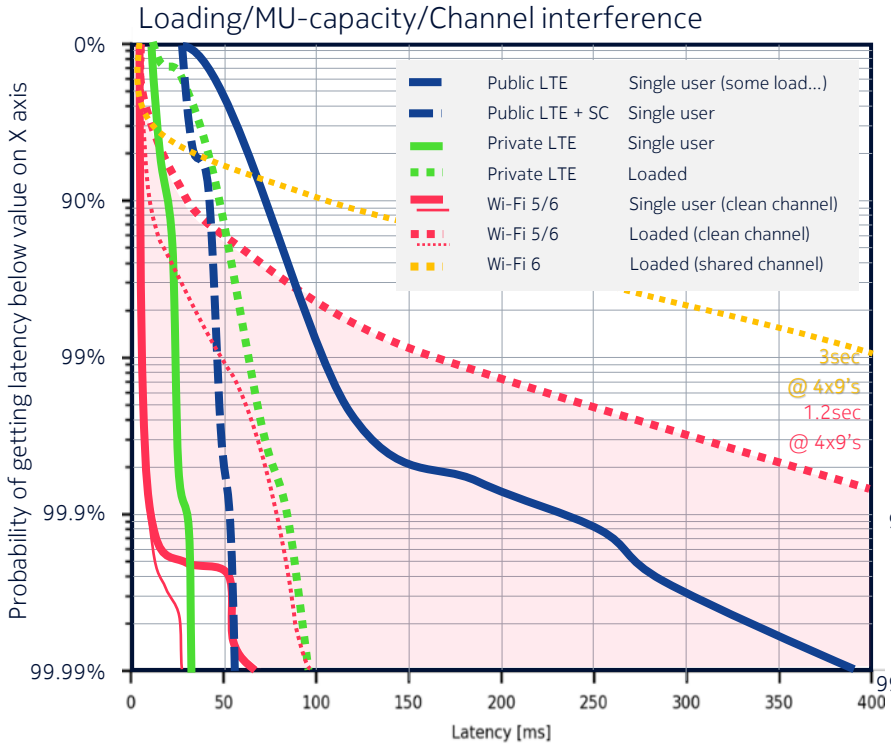
WiFi — Up to **15 sec** latency on fast hand-over

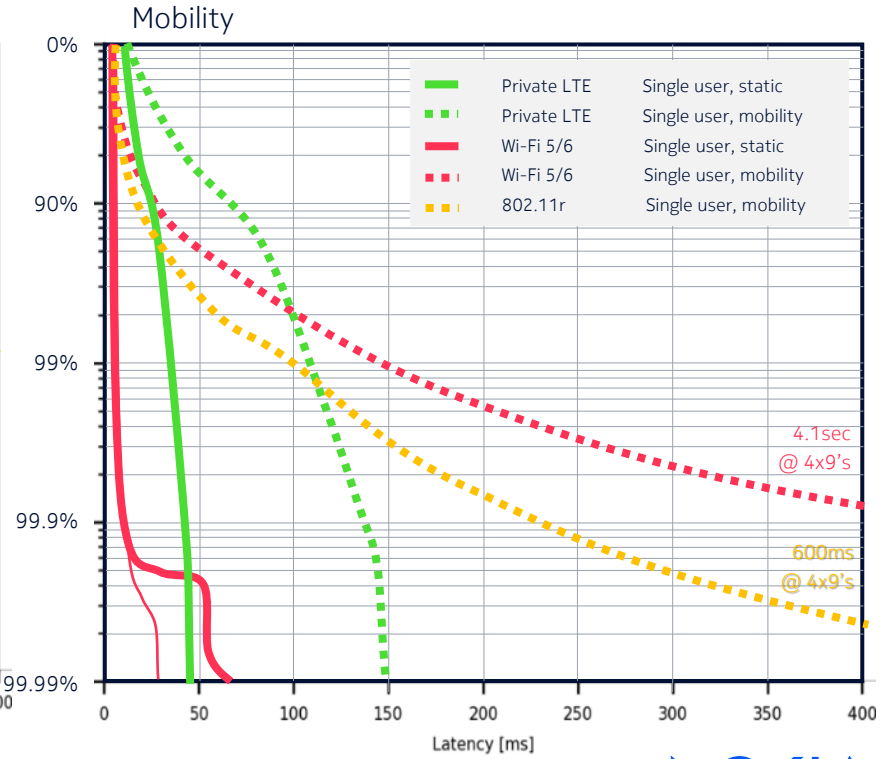
No enhancement until Wi-Fi8

4.9G/5G — Smooth hand over up to **350kph**

Predictable performance: Reliable latency testing (vs Wi-Fi vs public networks)

Bell Labs & Aalborg University: Manufacturing location testing

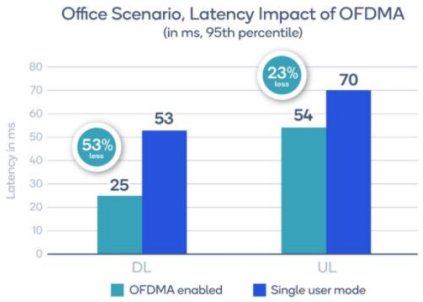




After IEEE members, Qualcomm own Wi-Fi 6 testing confirm our views

IT environment testing confirms no fit for OT

20 users/AP
No interference
No mobility
Mix traffic:
- 8x VOIP or document editing
- 3x Email sync
- 5x browsing
- 4x video streaming

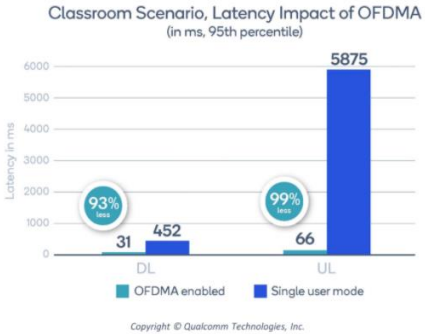


79 ms **average roundtrip latency**

Huge perf variation depending on AP vendors (chipset+sw) but also the devices connected

In same conditions…
4.15x difference
77ms vs 320ms

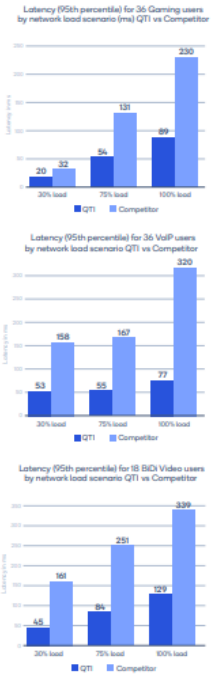
20 users/AP
No interference
No mobility
Mix traffic + heavy video streaming
- 20x video streaming
- 4x document editing
- 8x email/IMs



97 ms **average roundtrip latency**

Higher loading impact due to simpler, less featured scheduler and less TTI vs 4.9G/LTE

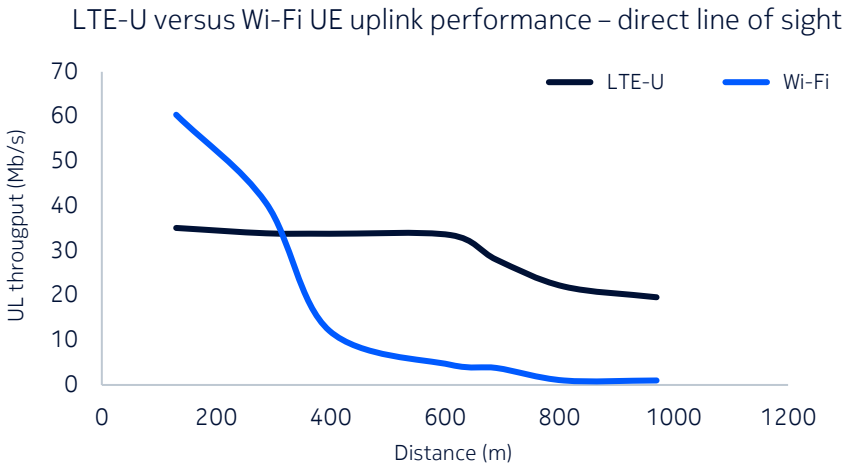
Low data rate burst traffic
4.45x difference
20ms vs 89ms



*Reduced latency benefits of Wi-Fi 6 OFDMA | Wi-Fi Alliance (wi-fi.org) & the-benefits-of-ofdma-for-wi-fi-6-a-technology-brief-highlighting-qualcomm-technologies-competitive-advantage.pdf

LTE unlicensed – wide and deep coverage

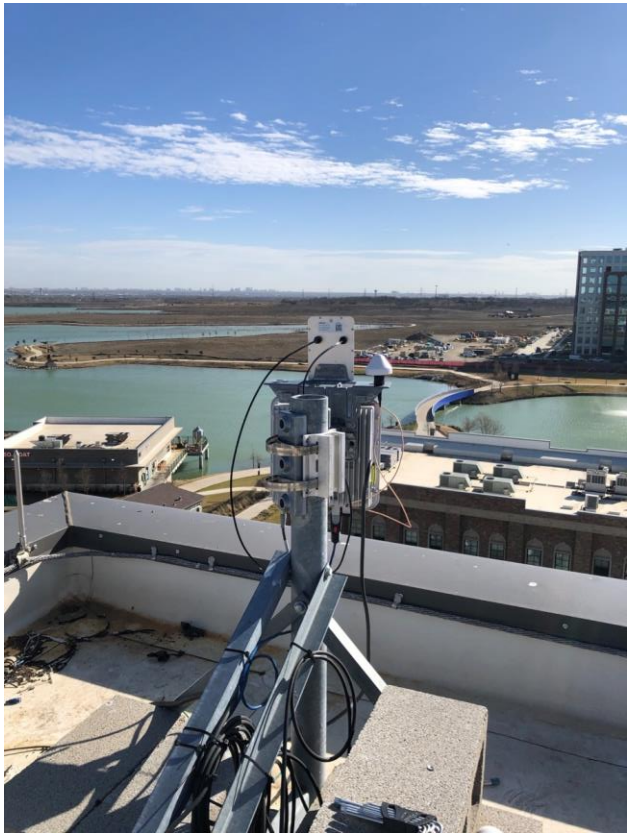
Suitable for OT critical use cases



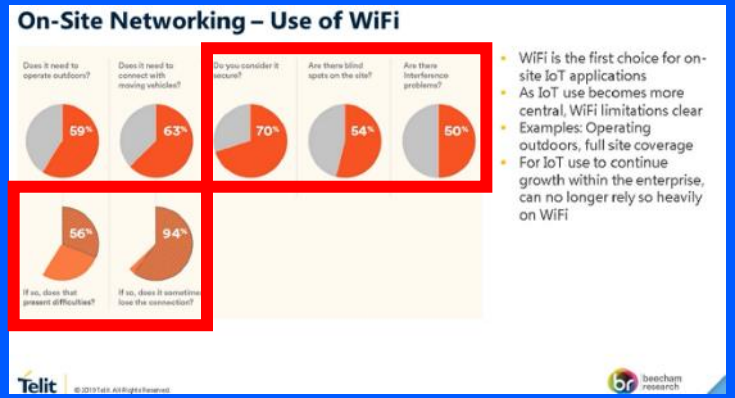
LTE-U benefits versus Wi-Fi

~2x cell range
~4x coverage area

+1 extra wall
of penetration



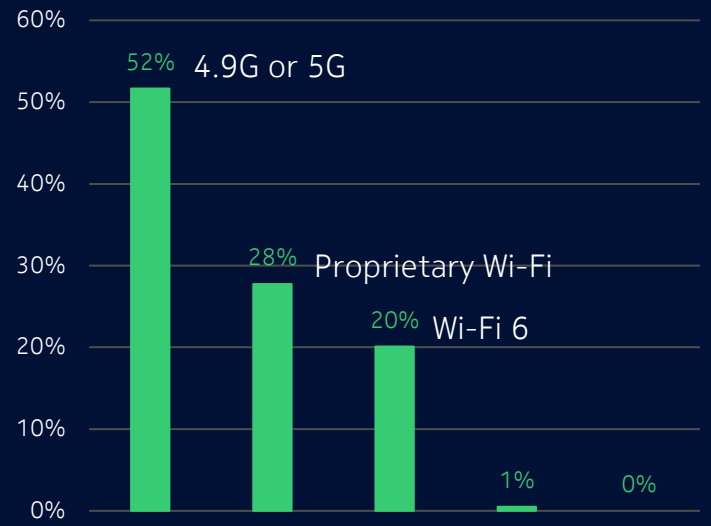
Wi-Fi operation use – market view



Learnings

- **56% complain about outdoor coverage**
- **54% have indoor coverage challenges**
- **94% complain about mobility issue**
- **50% have interference problems**
- 30% do not consider Wi-Fi secure

52% plan to leverage private LTE/5G for their future business/mission critical connectivity



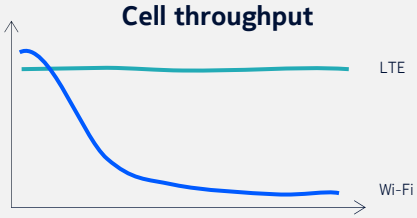
Wi-Fi vs Private Wireless Quantitative Comparison

pWireless vs Wi-Fi 6

Reliable OT wireless connectivity doesn't cost the "earth" and often cheaper than Wi-Fi6

4-100x coverage

10-20x MU capacity & better interference handling



1. **Less cells**
2. **Easier/cheaper planning**
3. Install and forget (no post deployment re-optimization)

Single network for all OT use cases with critical voice + IoT

1. **Shut down legacy/app specific networks**
2. Simplify management and operation
3. Future proof for new applications

LTE-M NB-IoT P25 sigfox TETRA LoRa

Key TCO factors compensate for the need for:

- Core network
- Spectrum cost
- Steeper learning curve

TCO tool available
Model your network TCO

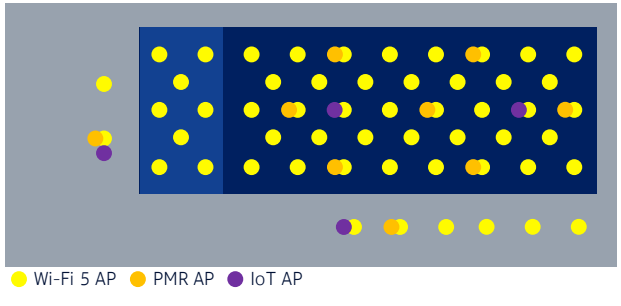
Private wireless networks very cost competitive

- >25-50k sqm* industrial indoor sites
- Any industrial sites with challenging radio environment (almost all)
- Outdoor or mixed indoor/outdoor sites

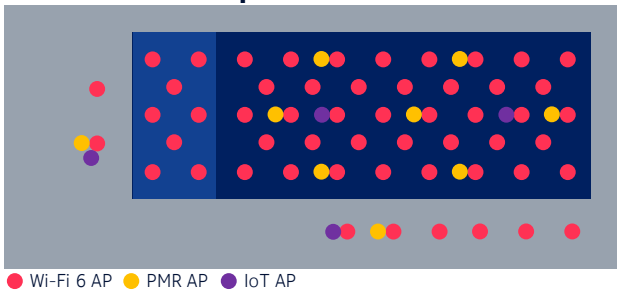
pWireless TCO vs Wi-Fi 6

TCO tool simulates the different environments to give a clear answer

TODAY



INDUSTRY 4.0 option 1 – Evo to Wi-Fi 6



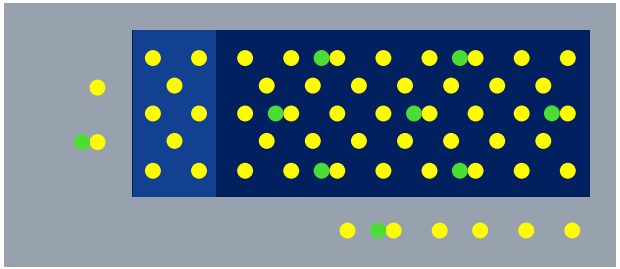
Apps connectivity domains

IT LAN + Wi-Fi 6

OT LAN + Wi-Fi 6 + (PMR) + IoT

360x Wi-Fi 6 AP required*

INDUSTRY 4.0 option 2 – pWireless add



Apps connectivity domains

IT LAN + Wi-Fi 5

OT LAN + pW (crit data/PMR/IoT)

59x 4.9G SC required

20% lower TCO*

minus cost reduction due to simplification

Industrial site application connectivity domains

IT = LAN + Wi-Fi 5

- Business apps, VoIP, end-user devices, …

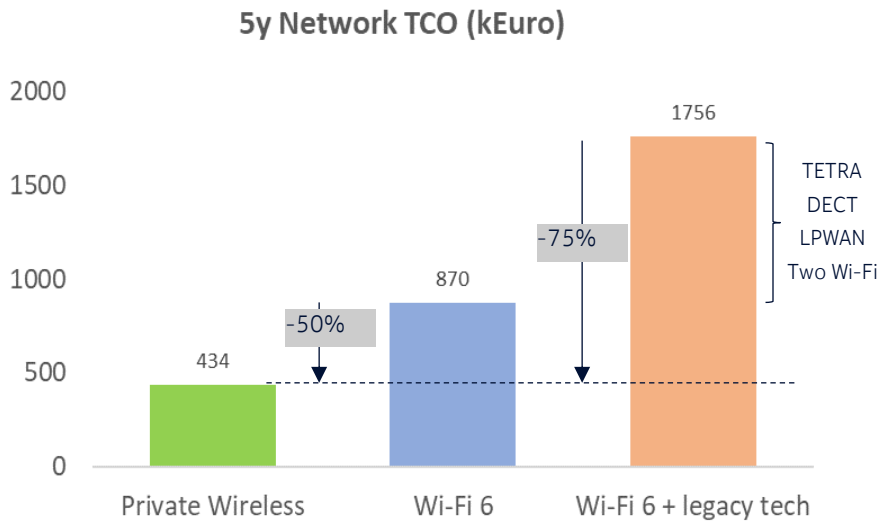
OT = LAN + multiple wireless

- LAN - machines, robots, etc…
- Wireless - Critical voice PMR (Tetra, X25)
- Wireless - Sensors (LoRA, Sigfox, Bluetooth, etc…)
- Wireless – Critical data (Wi-Fi 5, “special” Wi-Fi)

Outdoor | Low ceiling indoor (office) | High ceiling indoor (industrial)

pW economic savings

For a medium manufacturing site (1,5 km2, 0,15 km2 indoor), 5 years

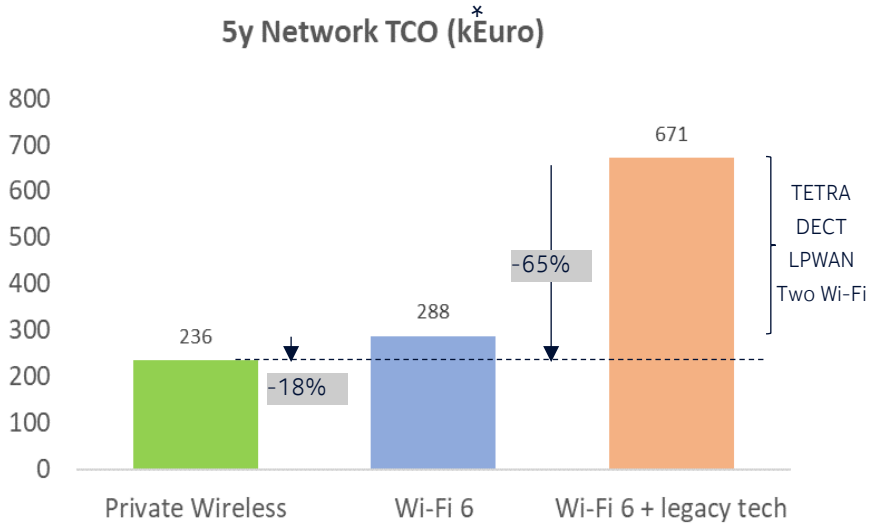


- Devices and applications cost savings also expected
- Number of devices per worker is signicantly lower with LTE (from ~4 to 1)
- New device cost not accounted for pW and Wi-Fi6, as normal device refresh will happen during the next 5 years.

Number of Wi-Fi Access points	Number of LTE Access points
253	23

pW economic savings

For medium warehouse (0,5 km2), 5 years



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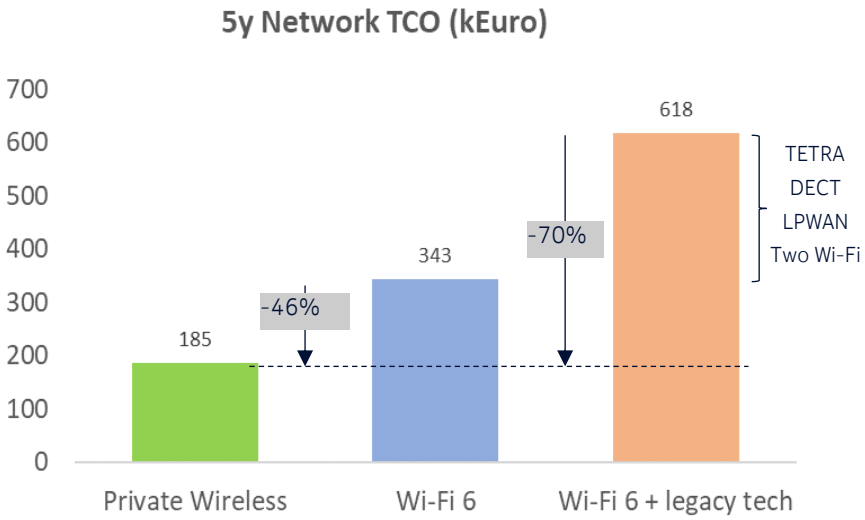
Number of Wi-Fi Access points	Number of LTE Access points
79	8

pW economic savings

For a medium port (1,2 km2), 5 years



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Number of Wi-Fi Access points	Number of LTE Access points
51	3


NOKIA