Optical Access Networks for 5G and Beyond

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Orange Labs
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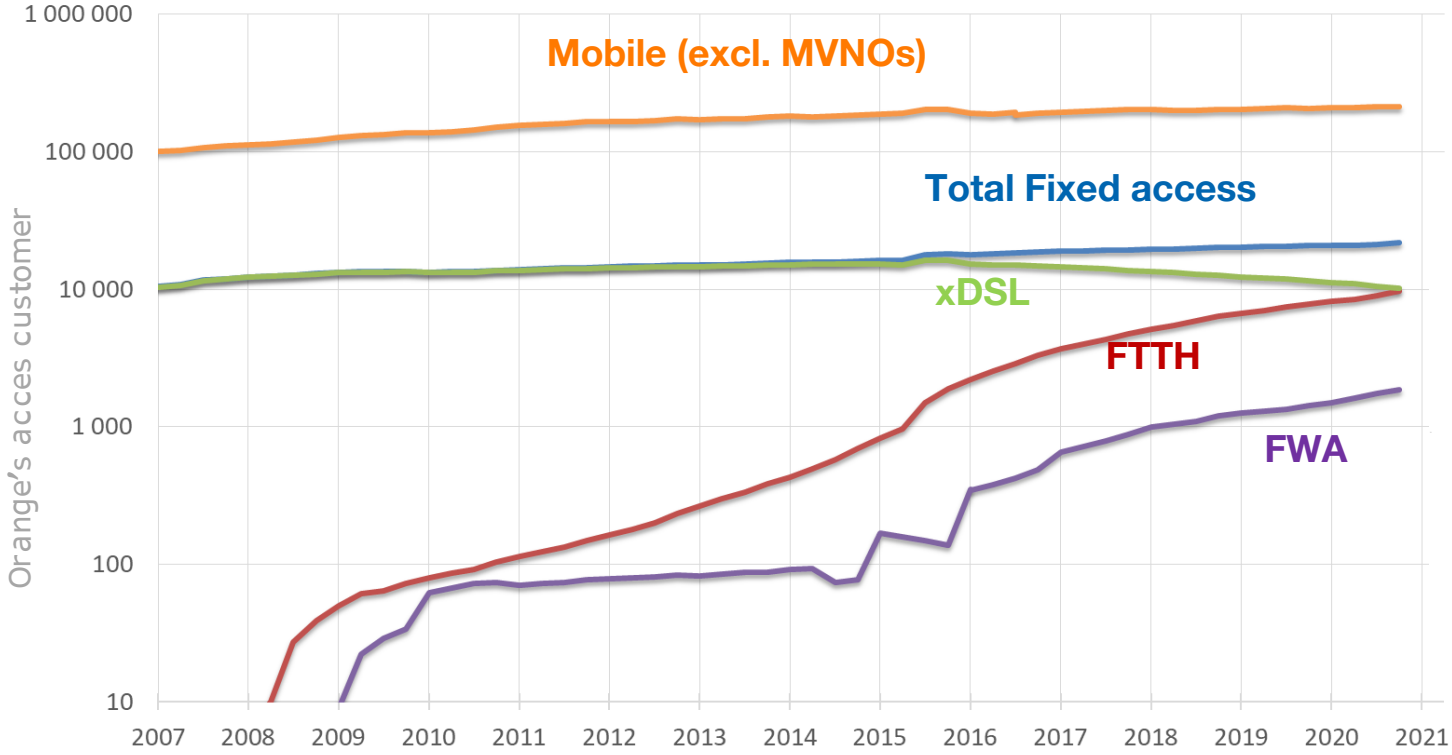
Orange's Mobile and fixed accesses customers

[customer base x 1000]



Orange around the world

FWA: Fixed Wireless Access
FTTH: Fiber to The Home
xDSL : Digital Subscriber Line
MVNO: Mobile Virtual Network Operator

The right technology to maintain high quality fixed access

Standard started
Standard finished
Deployment begins
Deployment ends
Deployment Orange begins

OLT PON

G-PON ?

XGS-PON

HS-PON ? ?

Post HS-PON ?

Access infrastructure medium

Only Copper — Full Fiber

Access infrastructure software & hardware

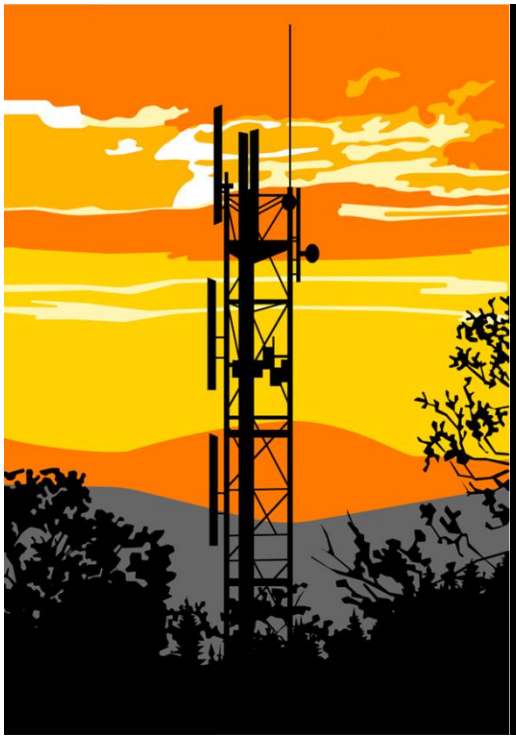
Dedicated hardware & Proprietary manager

Generic hardware & Open controler

2000 2005 2010 2015 2020 2025 2030 2035 2040

5G, what's more compared to 4G

Network backhauling impact



For 5G backhauling

Provide more Ethernet flow to the antenna site

1 - 10 Gb/s

5G

1M /km²

Smart city

1-10 ms

99,999%

Offer ultra-reliable and low latency networks

… but it will happen very gradually

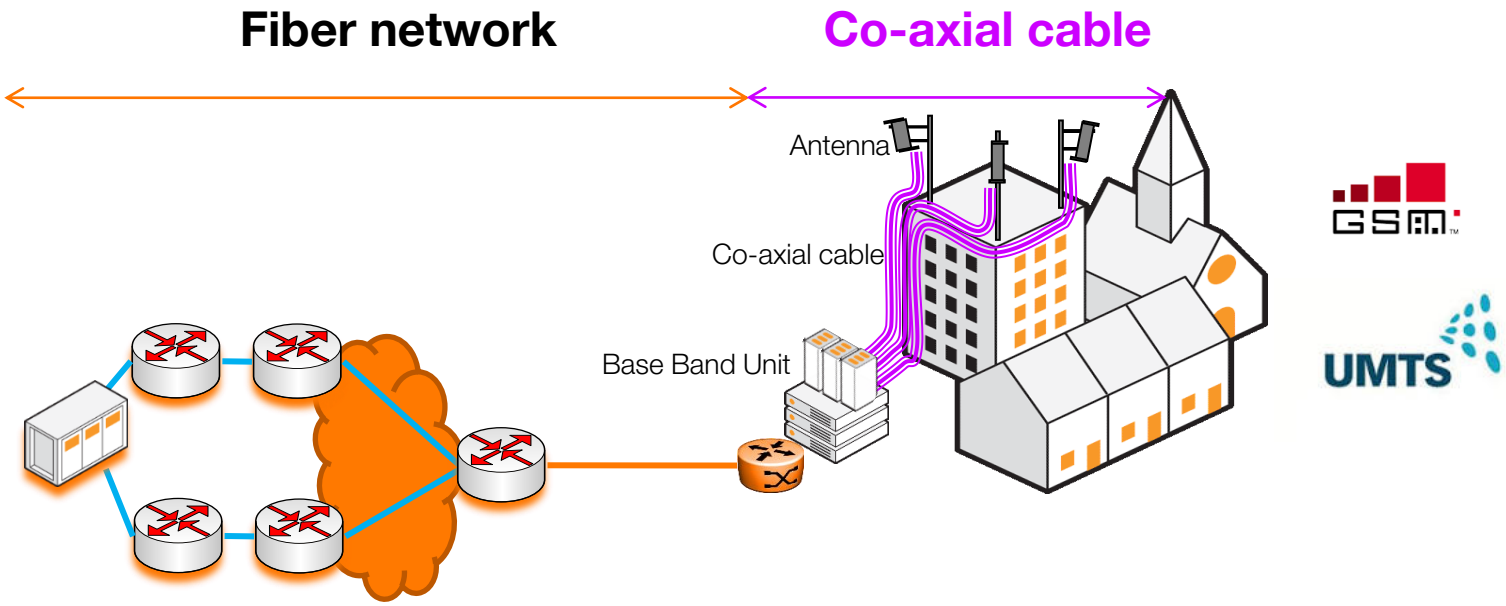
Forecast introduction in our network

+ Ethernet flow — From 2020

+ Reliability + latency — from 2022

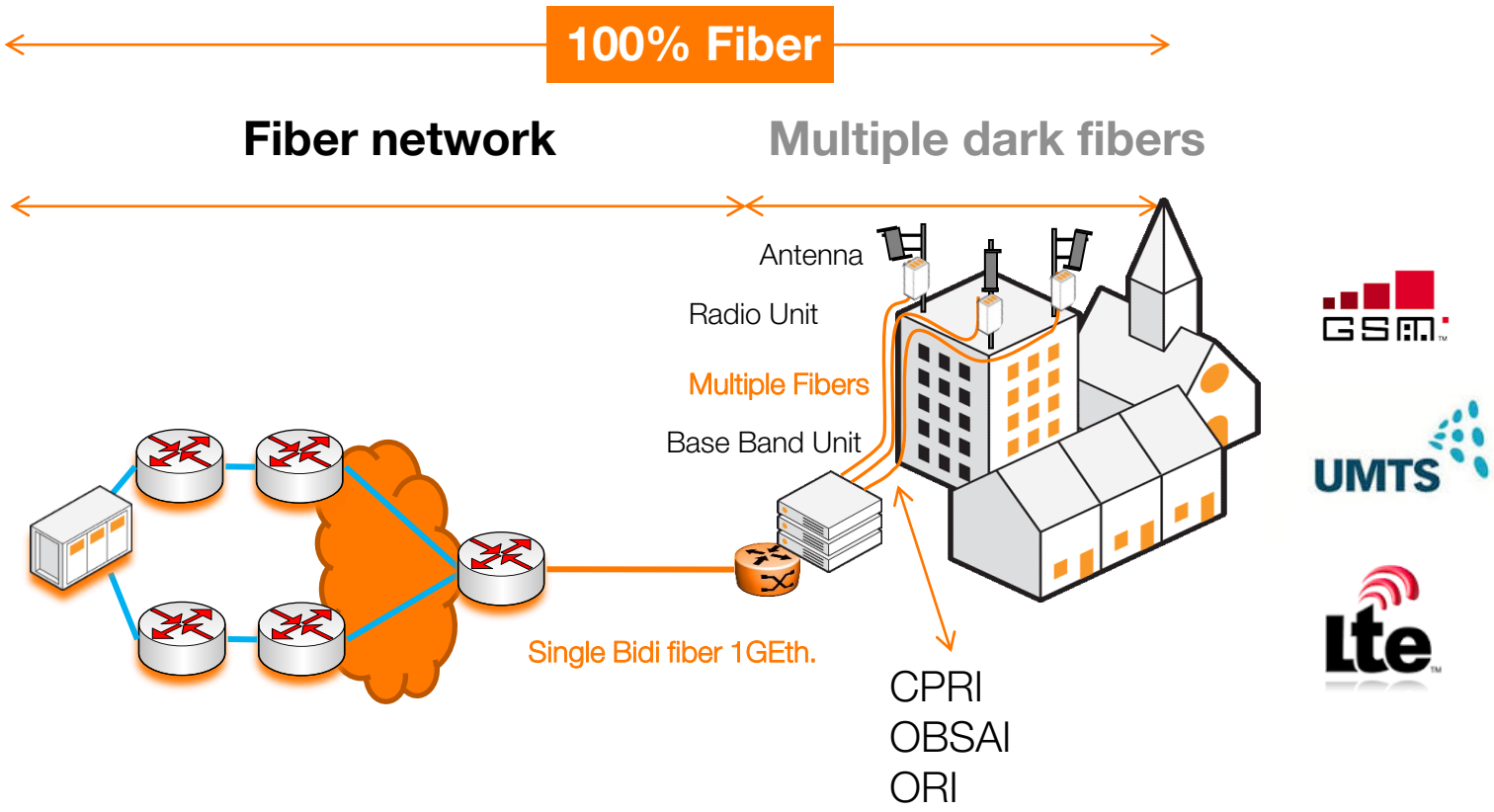
+ massive IoT

Fiber goes further and further with 5G

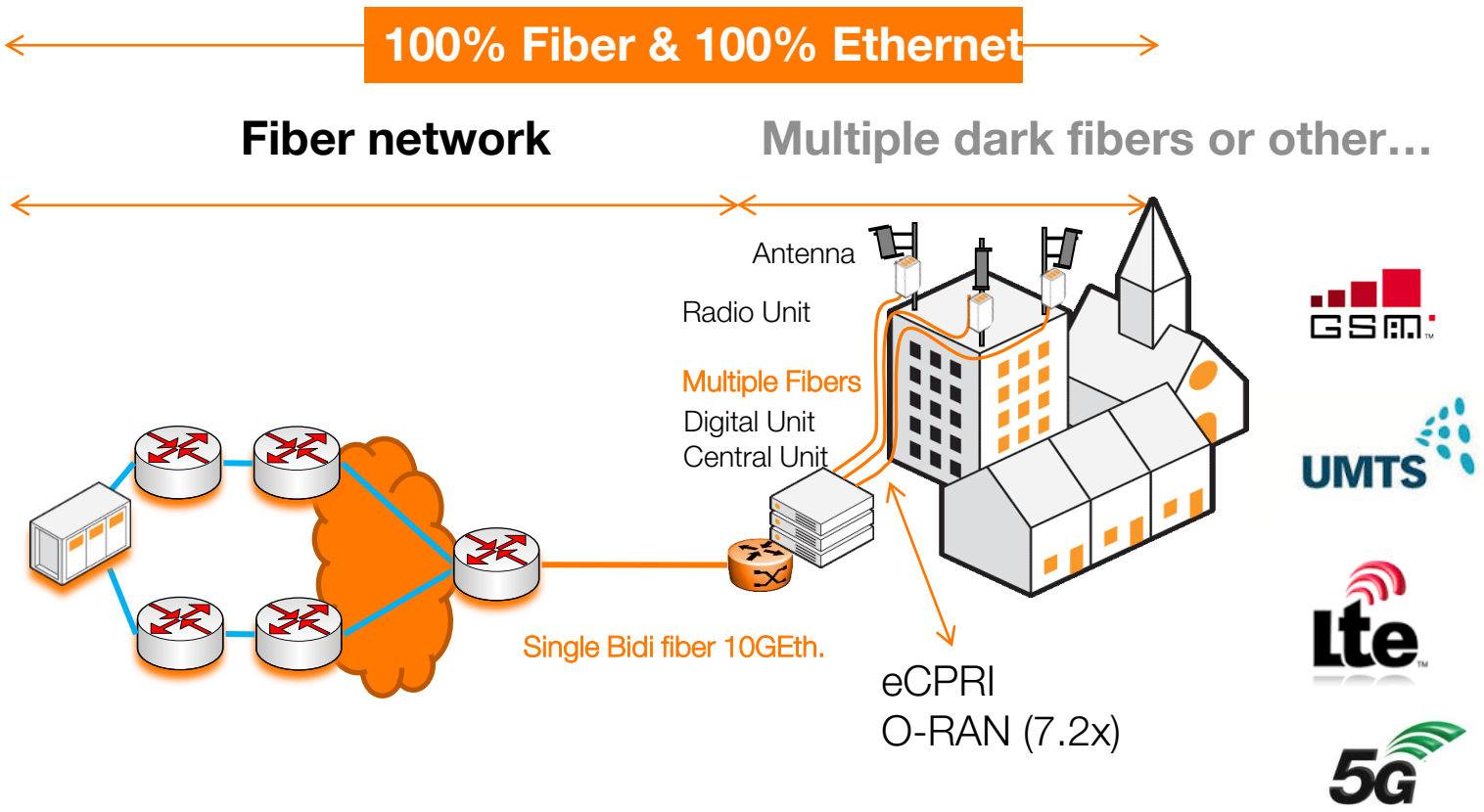


Legacy backhaul is based on PtP Ethernet (Switch or Router connected at a dark fiber)

Fiber goes further and further with 5G

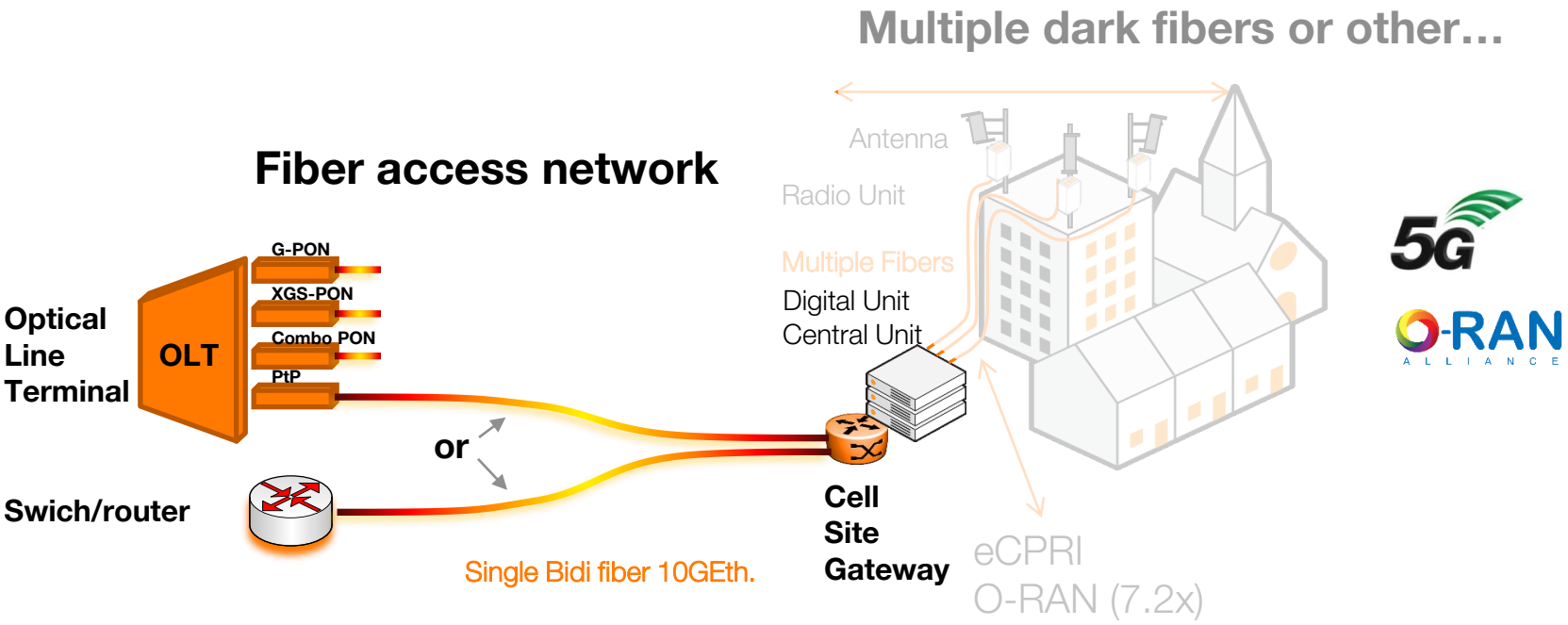


Fiber goes further and further with 5G



Fiber goes further and further with 5G : backhaul

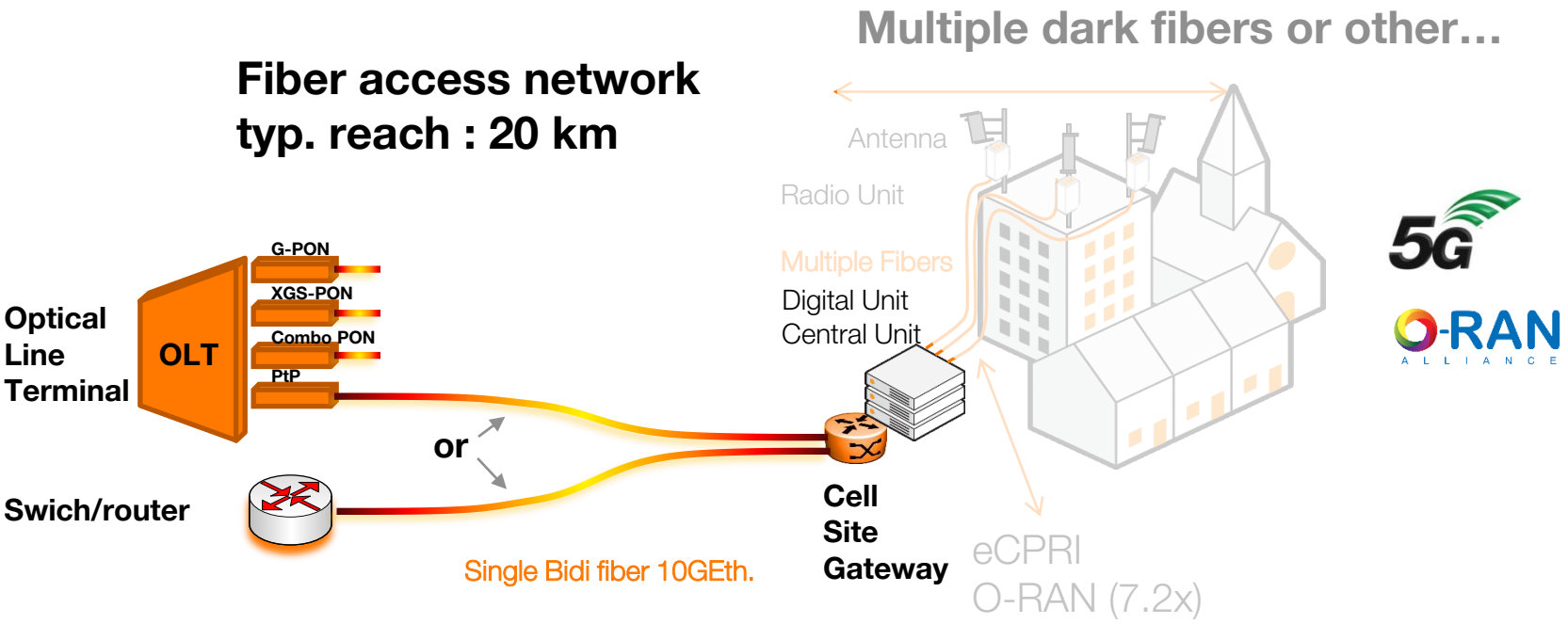
100% Fiber & 100% Ethernet



Orange Countries (sample)	France	Belgium	Luxembourg	Poland	Moldova	Romania
Fibre backhaul site	88%	59%	70%	58%	49%	100%

Fiber goes further and further with 5G : backhaul

100% Fiber & 100% Ethernet



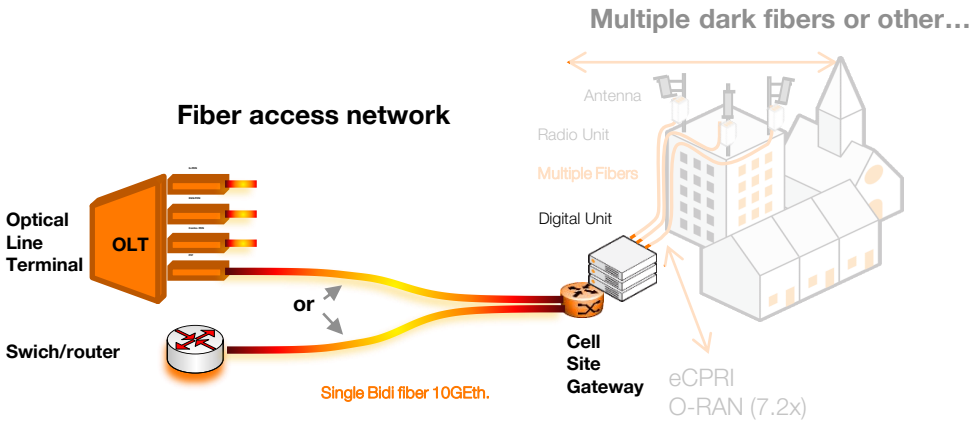
Legacy backhaul is based on PtP Ethernet 10GEth with PtPv2 synchronization feature, in future 25GEth.

Transceiver bidirectional (single fiber):

- **10G / 25G / 50GETh : ITU-T G.9806**
- **100GEth: initiative launched at ITU / IEEE**

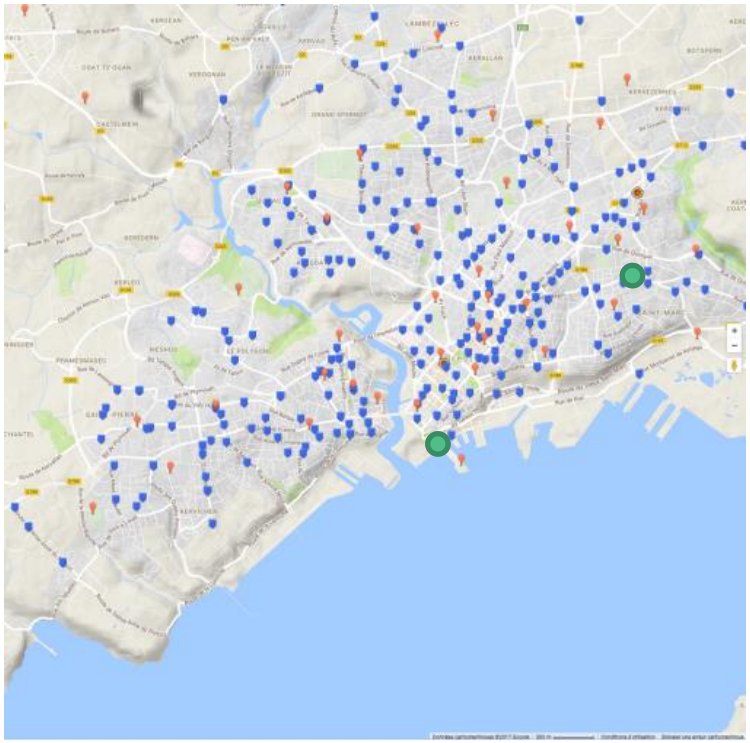
Fiber goes further and further with 5G : backhaul

100% Fiber & 100% Ethernet



5G

O-RAN ALLIANCE



Cell density of 5G could be similar to 4G

→ **1 antenna every 300m - 400m**

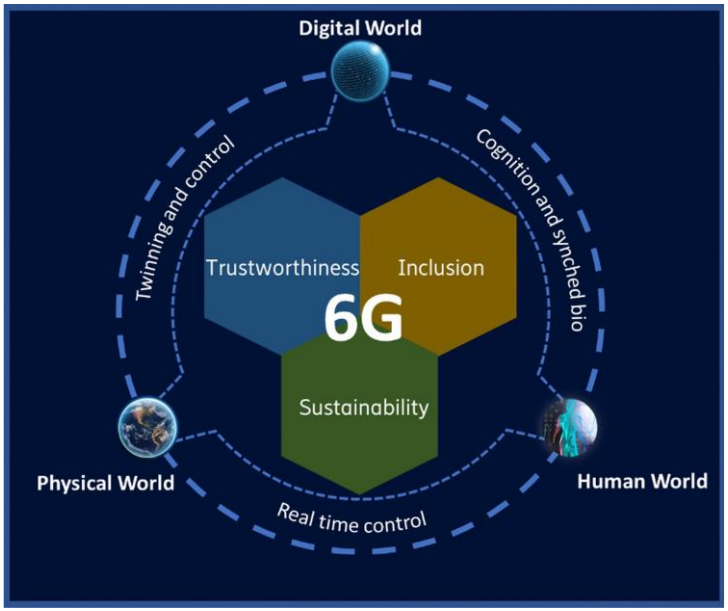
- **FTTH Central Office**
- **Fiber cabinets hosting optical splitters > 300 home passed / point**
- **Antenna sites (2G/3G/4G/5G)**

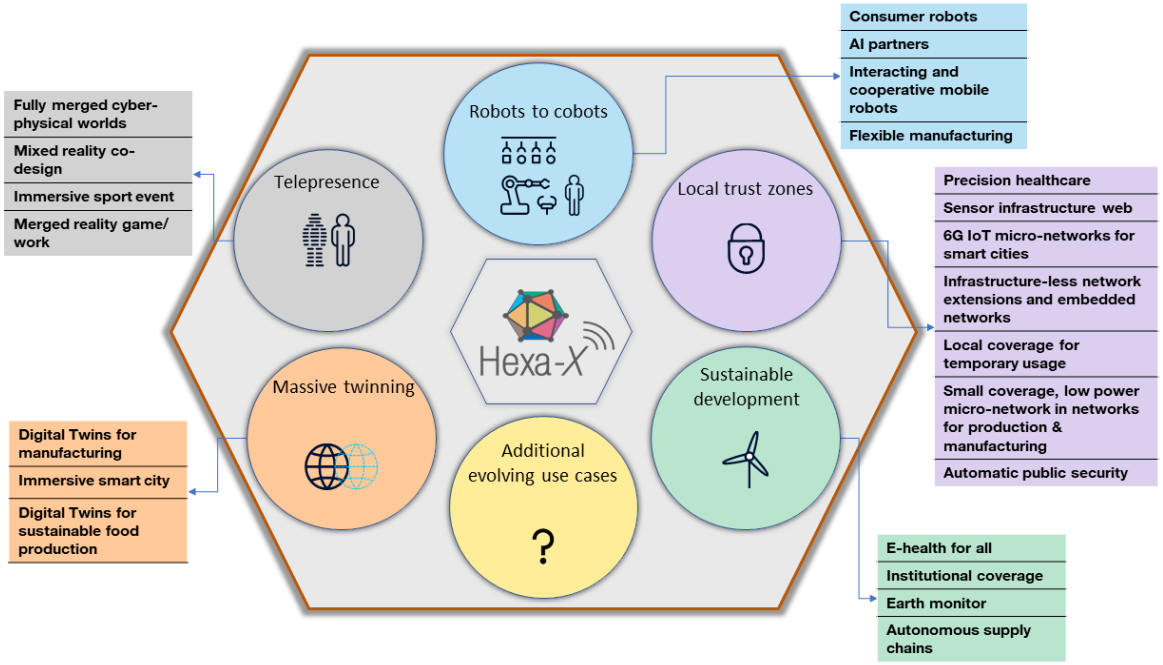
Mobile X-Haul density of terminations will remain very low compared to Residential market

→ **FTTH (PON) is not a solution for macro & micro cell sites**

6G, what's more compared to 5G

6G Flagship European project Hexa-X defined a set of use cases, gathered into 5 use case families





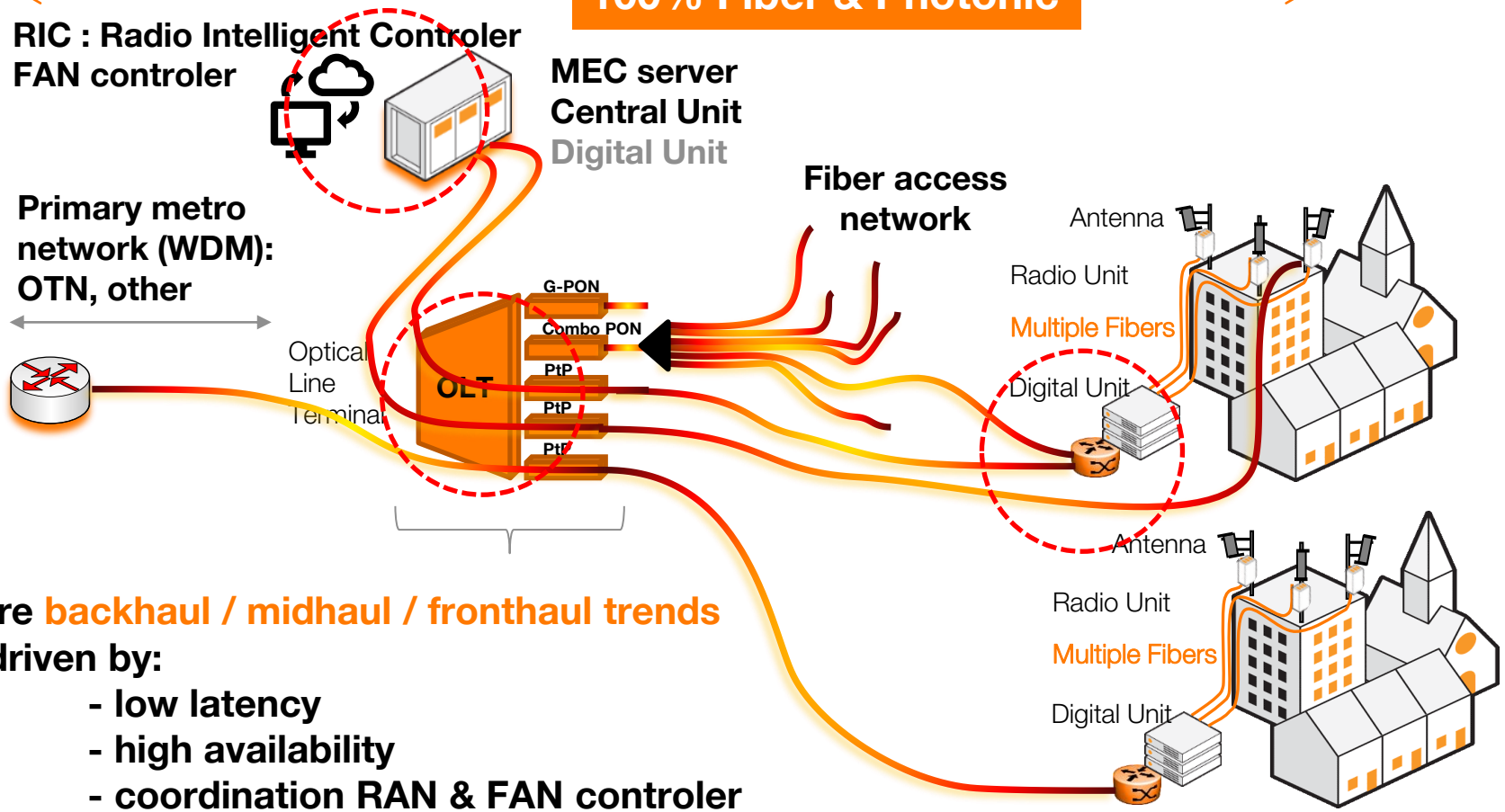
Capture values:

- Peak data rates : 100Gbps – 1Tbps
- 0.1 ms radio latency
- E2E very low latency < 1ms
- 10cm precision positionning (eg. synchronisation)
- Relibility nine or seven « 9s »

Fiber goes further and further with 5G beyond & 6G : backhaul

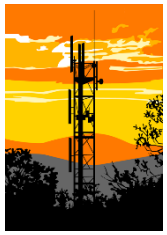
Latency | Reliability | Coordination

100% Fiber & Photonic



Future backhaul / midhaul / fronthaul trends are driven by:

- low latency
- high availability
- coordination RAN & FAN controler



Conclusion

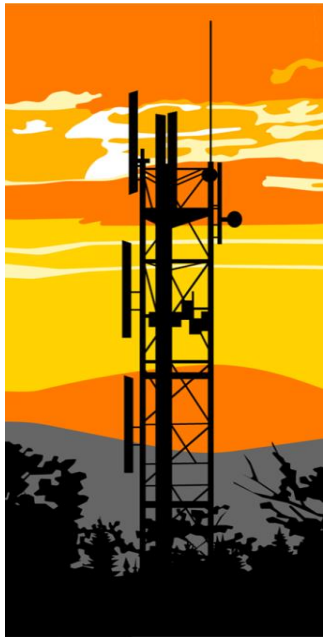
4 key points for **Optical Access Networks for 5G and Beyond**

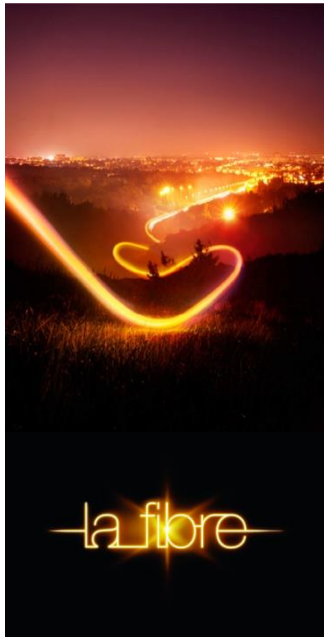
1 F5G allows enlighten the future of access

2 F5G goes with the “smooth” fixed network migration to follow mobile requirements

3 Latency
Reliability
Coordination between controler

4 Fibre to Everywhere and Everything with more and more photonics





Join our research team **as a post doc !**
Open position in **Orange Lannion, France** on **Future Optical access networks with physical layer and related SDN works.**
Contacts : gael.simon@orange.com ; fabienne.saliou@orange.com

Thank You.

- H2020 ICT-52 5G Project : MARSAL
- H2020 ICT-20-2019-2020 : 5G Complete

Latency & Availability

Latency

1 0 0 0 ms

Sensors

9 9 %
4 days / year

Latency

1 0 0 ms

Chatbots
Video

9 9. 9 %
8 hours / year

Latency

Smart Grid

1 0 ms

Intelligent Transportation Systems

Cloud-assisted driving
Augmented worker
Remote training
Power grid control

9 9. 9 9 %
50 minutes / year

Latency

Motion Control

1 ms

Factory Automation
Automated Guided Vehicle
Tactile Internet

Remote control vehicu
Autonmous vehicule

Intelligent Transportation Systems

9 9. 9 9 9 %
5 minutes / year

Factory 4. (machine control)
Tactile Internet

Factory Automation
Motion Control

9 9. 9 9 9 9 %
30 secondes / year