

ALPHA – Architectures for fLexible Photonic Home and Access networks



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ALPHA reference model for techno-economics in access networks

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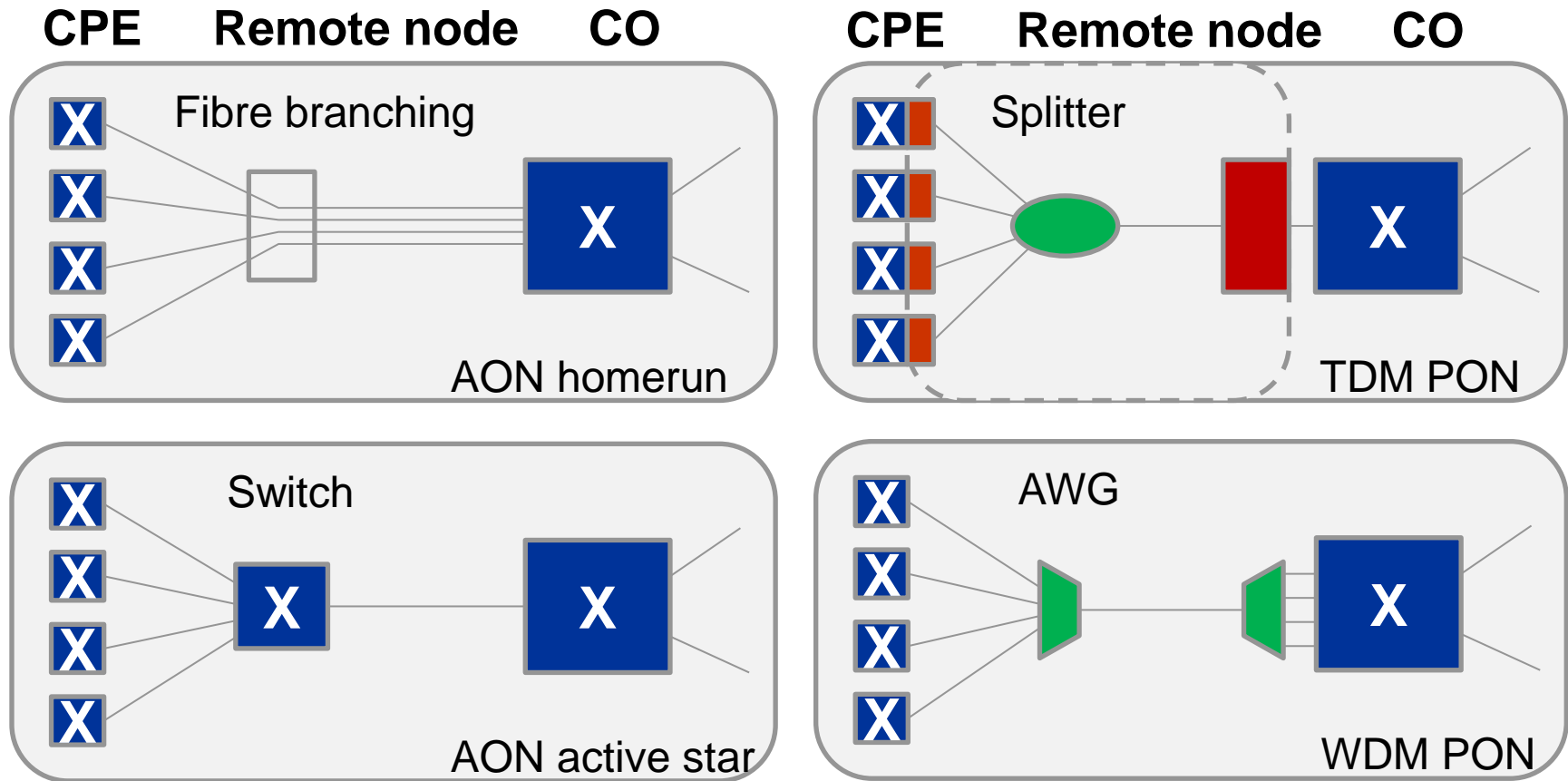


Outline

- Techno-economic reference model
 - Comparative model for different technologies
 - Cost elements
 - Equipment
 - Cable and fibre dimensioning
- Case: CAPEX evaluation for next-generation optical access (NGOA), focused on hybrid WDM/TDM PON
 - Benchmarked with 10G GPON and 1G AON
 - Different hybrid WDM/TDM PON options, for offering flexibility

FTTx comparative model

Equipment, topology, architecture



Ethernet equipment

TDM equipment

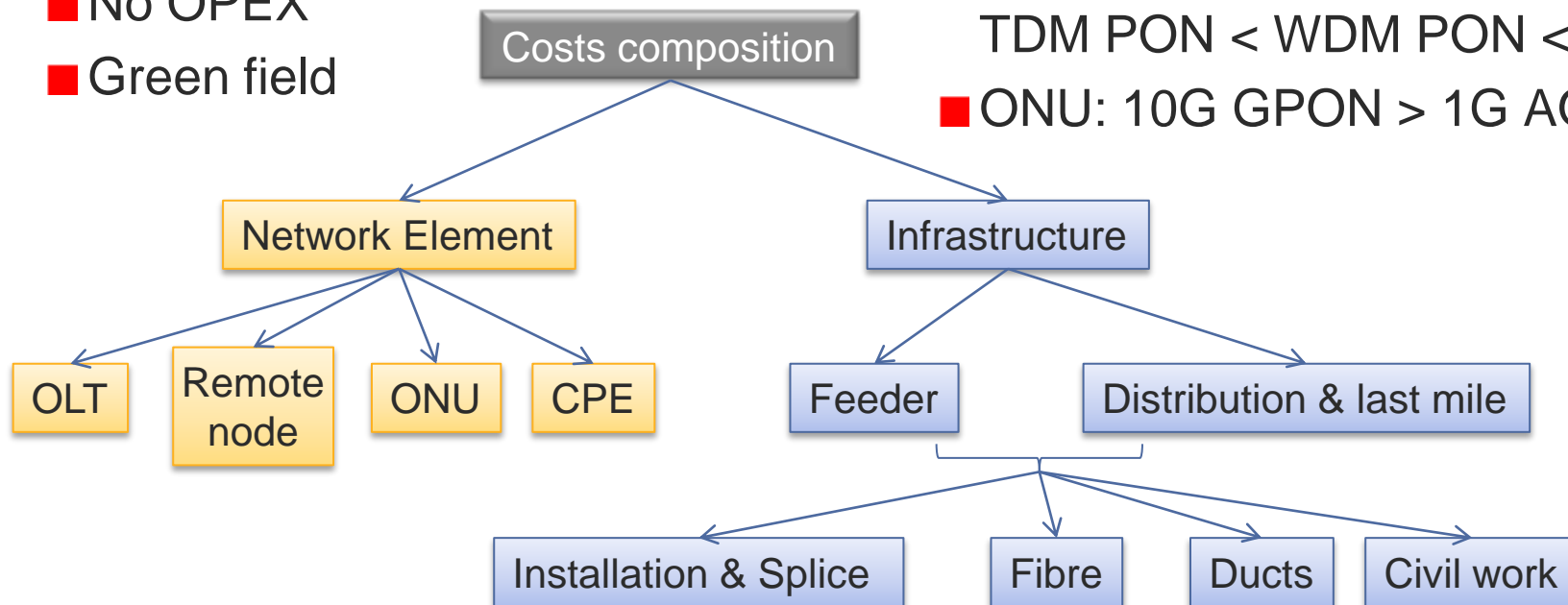
Optical equipment

Cost comparison 10G GPON vs. 1G AON

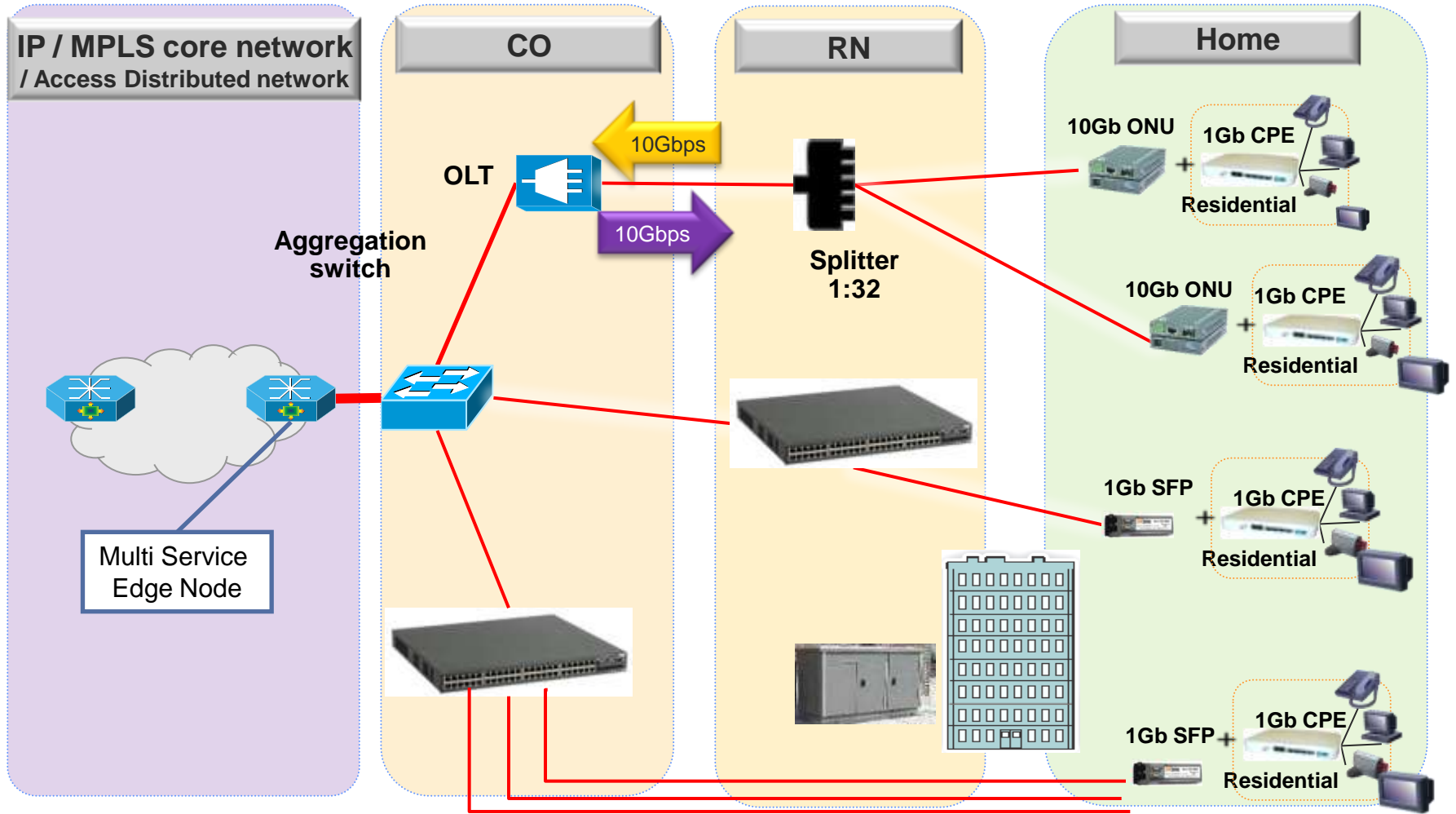
Assumptions

- Sustainable bandwidth 312Mbps
- Peak bandwidth 1Gb/s
- Number of subscribers
- End to End services
- No OPEX
- Green field

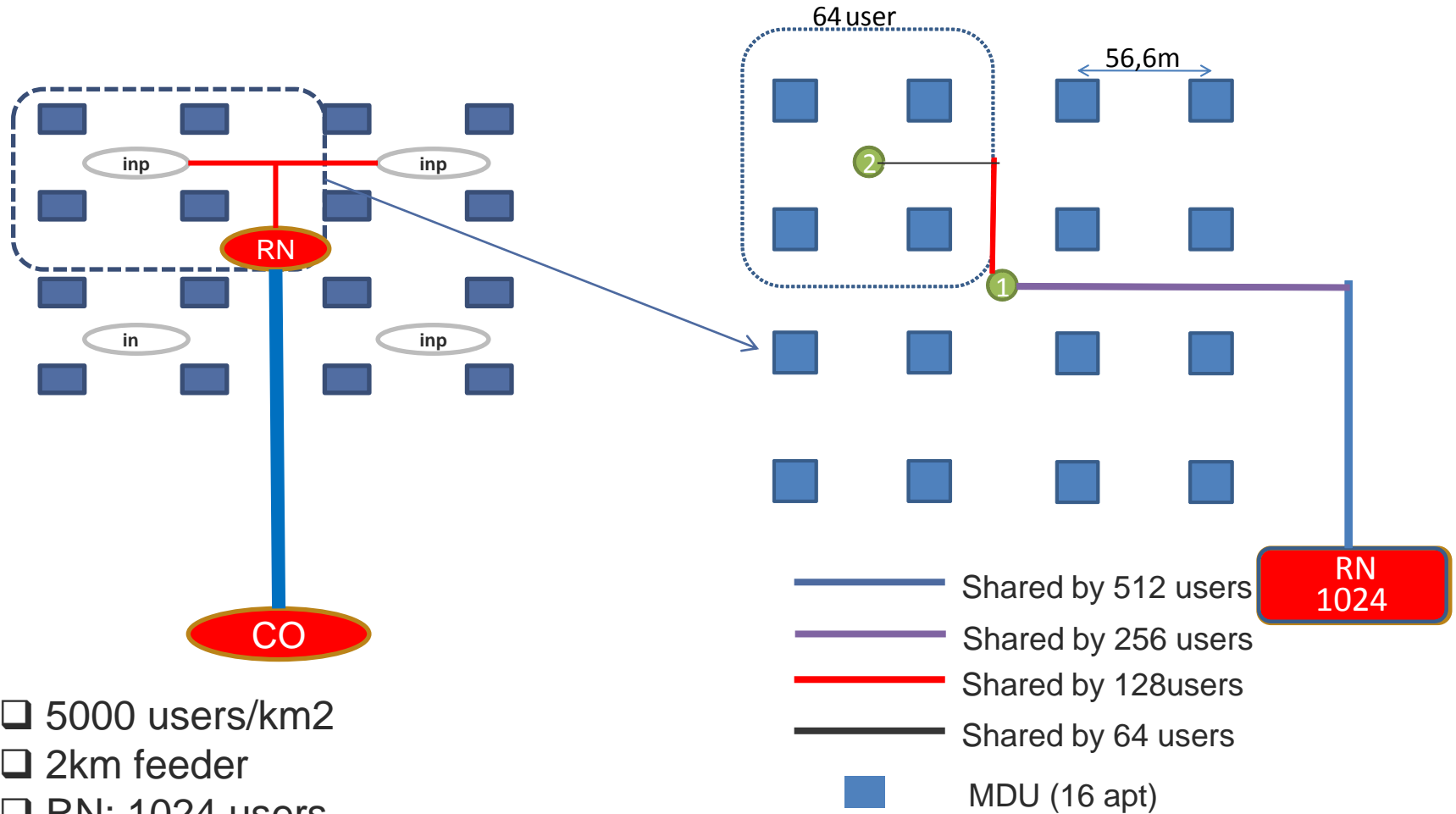
- PON 1 fibre solution, AON 2 fibre
- AON +10% costs @ civil works, ducts, fibre installation (closer to end user, the less add-on cost)
- Remote node costs:
TDM PON < WDM PON < AON
- ONU: 10G GPON > 1G AON



Network elements

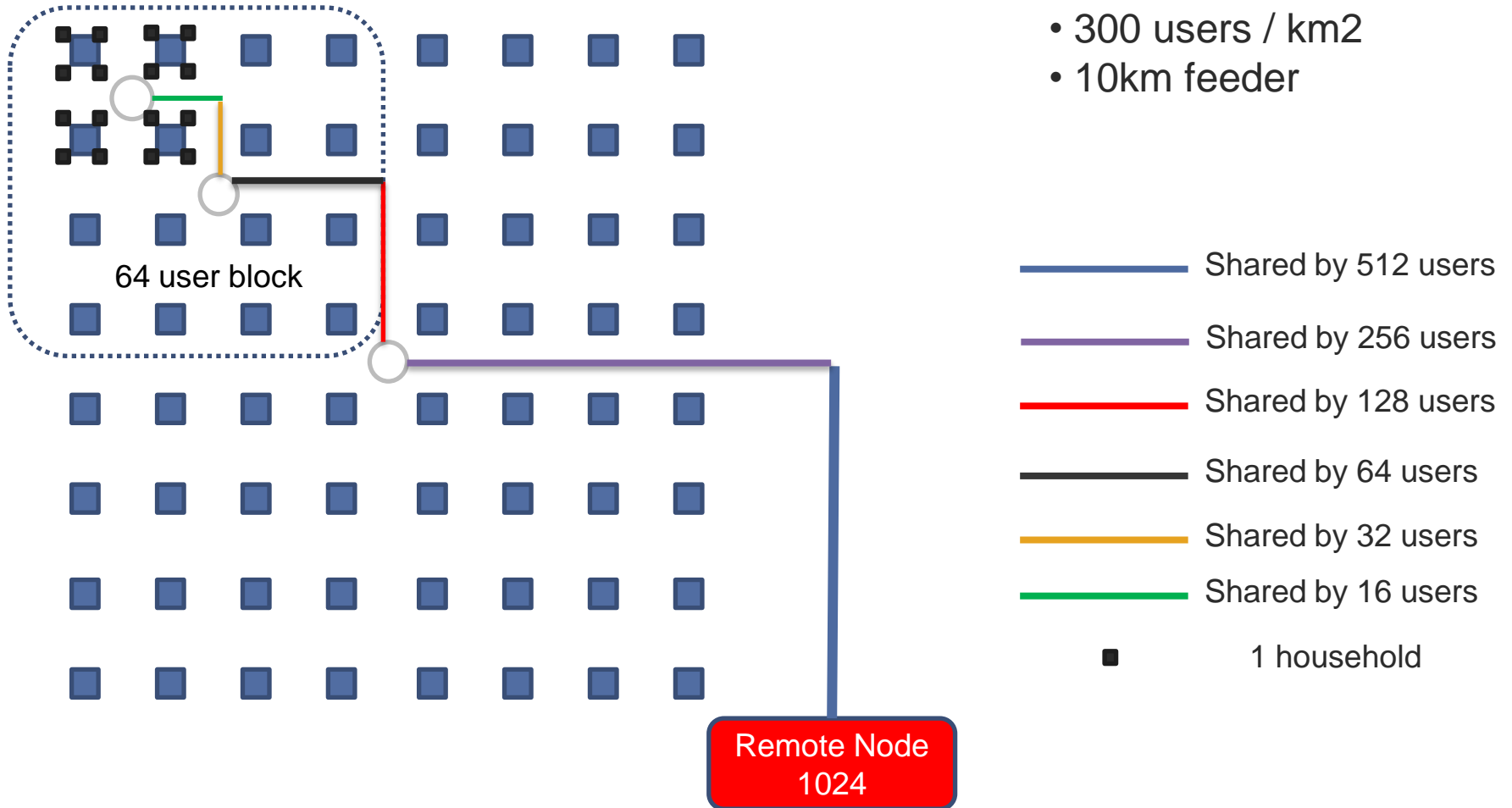


Dimensioning: Urban



- ❑ 5000 users/km²
- ❑ 2km feeder
- ❑ RN: 1024 users

Dimensioning: Rural



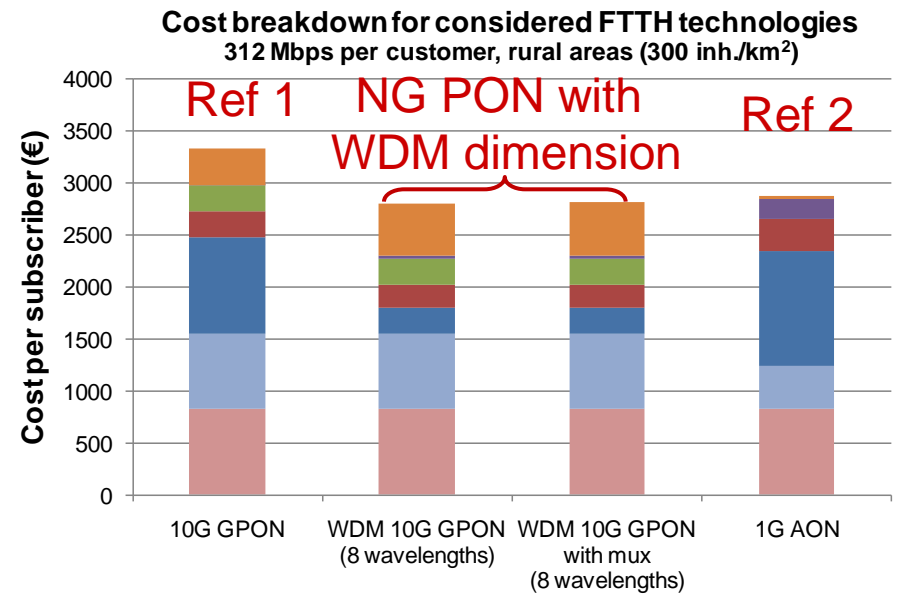
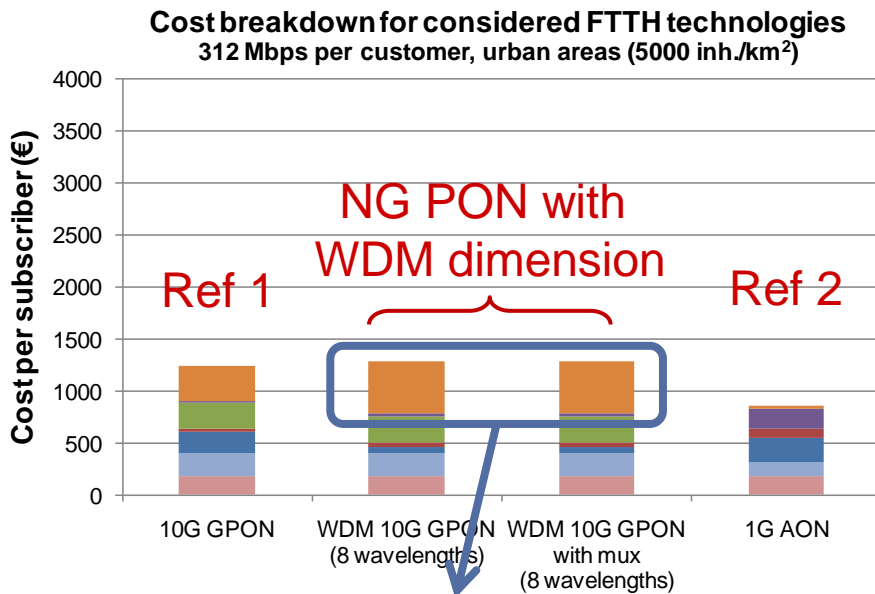
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CAPEX evaluation for NGOA systems

Benchmarked with 10G GPON (ref. 1) and 1G AON (ref. 2)

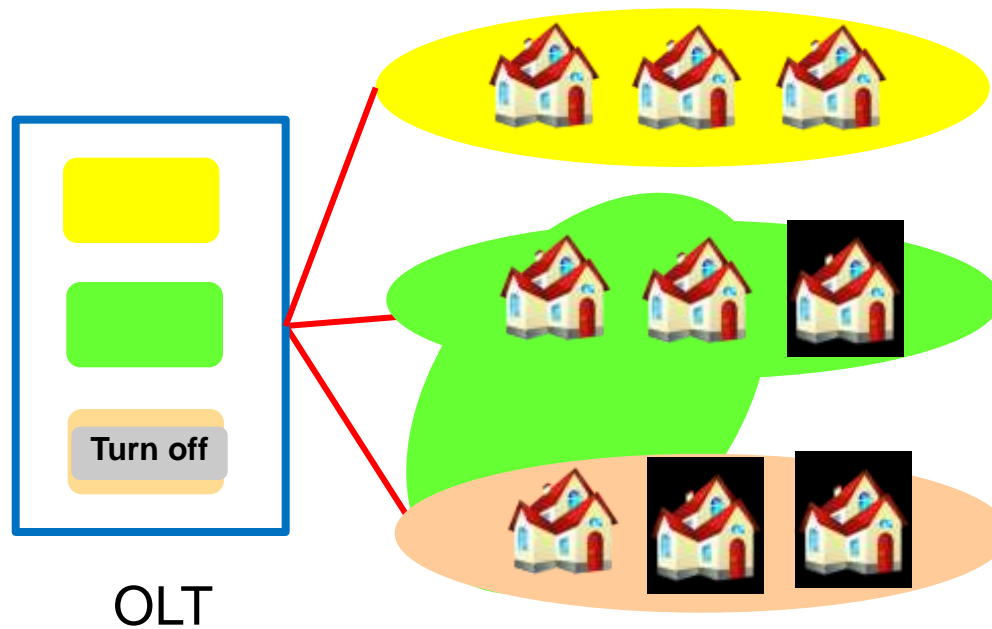
- AON, 10G GPON, WDM 10G GPON
- Urban vs. rural



Keep ONU costs under control

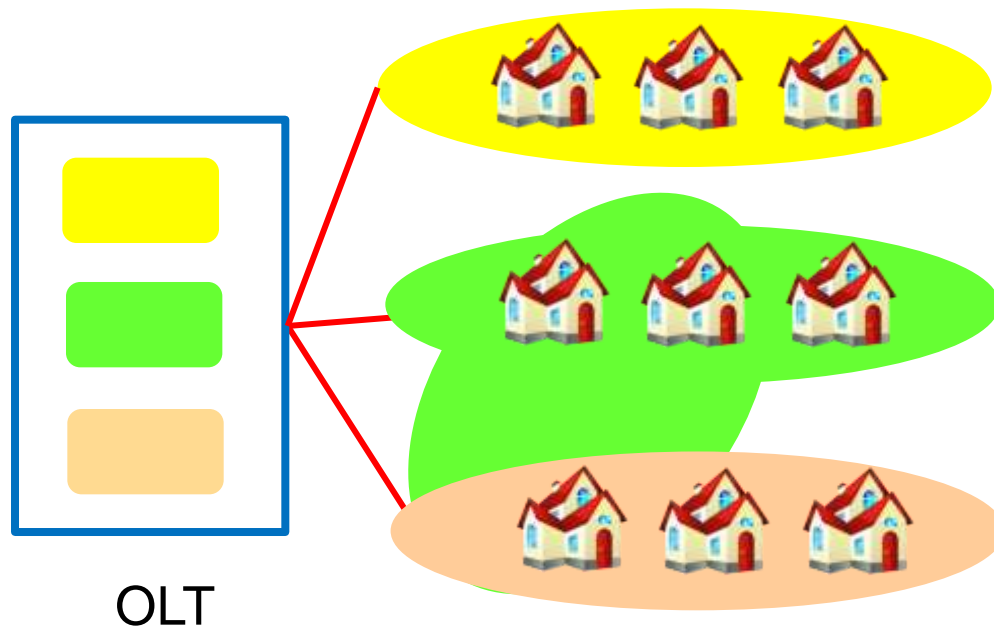
- Higher TDMA rates seem infeasible from a cost perspective
- Other multiple access techniques come into the picture, like OFDMA

Hybrid WDM/TDM PON offers additional flexibility



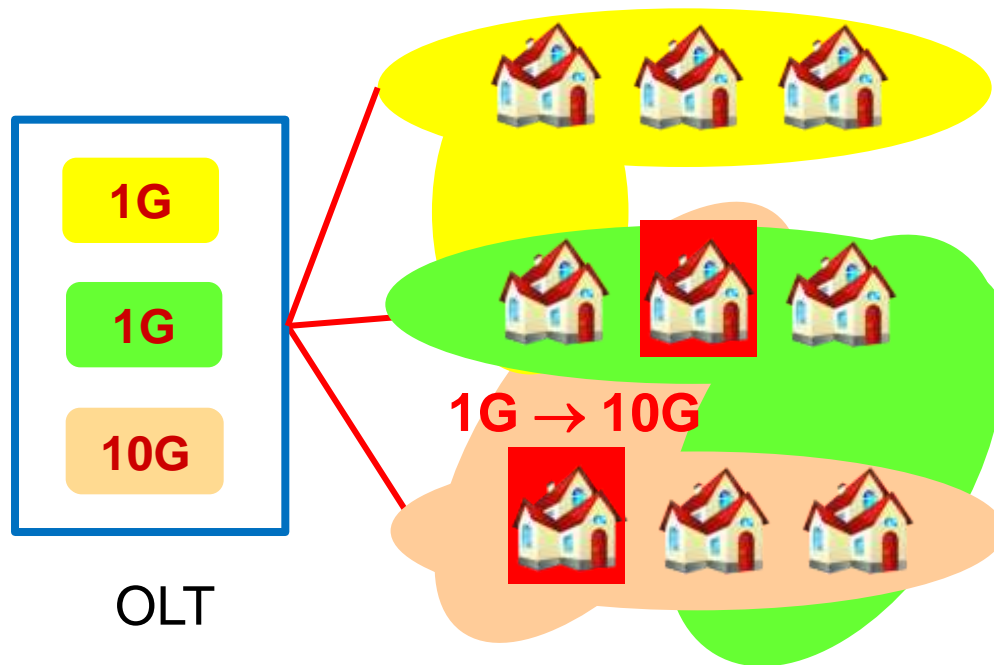
1. Better bandwidth utilization, leading to **energy savings**

Hybrid WDM/TDM PON offers additional flexibility



2. Easier network upgrades and extensions

Hybrid WDM/TDM PON offers additional flexibility



3. Easier network evolution and migration

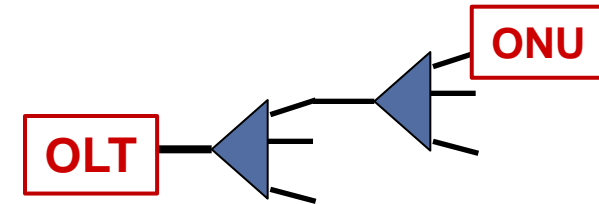
Hybrid WDM/TDM PON technologies for NG PON systems

- WBS-PON: Wavelength Broadcast&Select PON

- Only power splitters

- + : Simple / high flexibility

- : High power loss / Low security

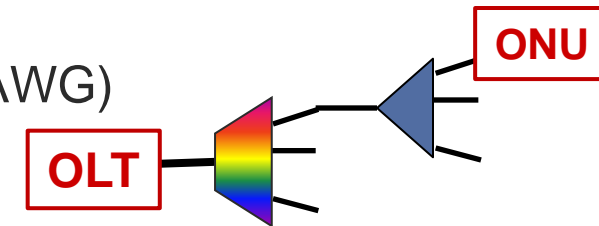


- WS-PON: Wavelength Split PON

- Power splitters and wavelength splitters (e.g. AWG)

- + : Low power loss / High security / Little complex

- : No flexibility

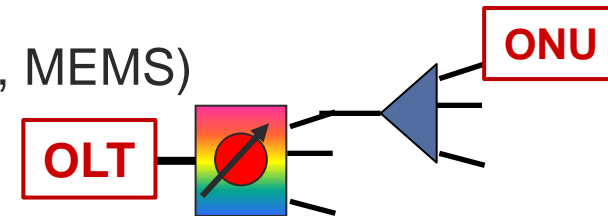


- WR-PON: Wavelength Routed PON

- Power splitters and optical switches (e.g. SOA, MEMS)

- + : High flexibility / High security

- : High power loss / Complex

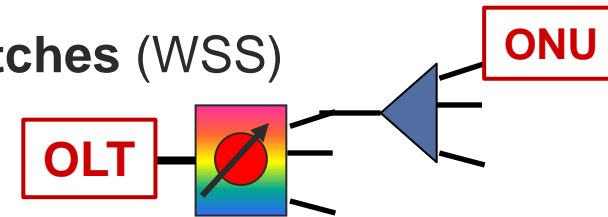


- WSS-PON: Wavelength Selective Switched PON

- Power splitters and Wavelength Selective Switches (WSS)

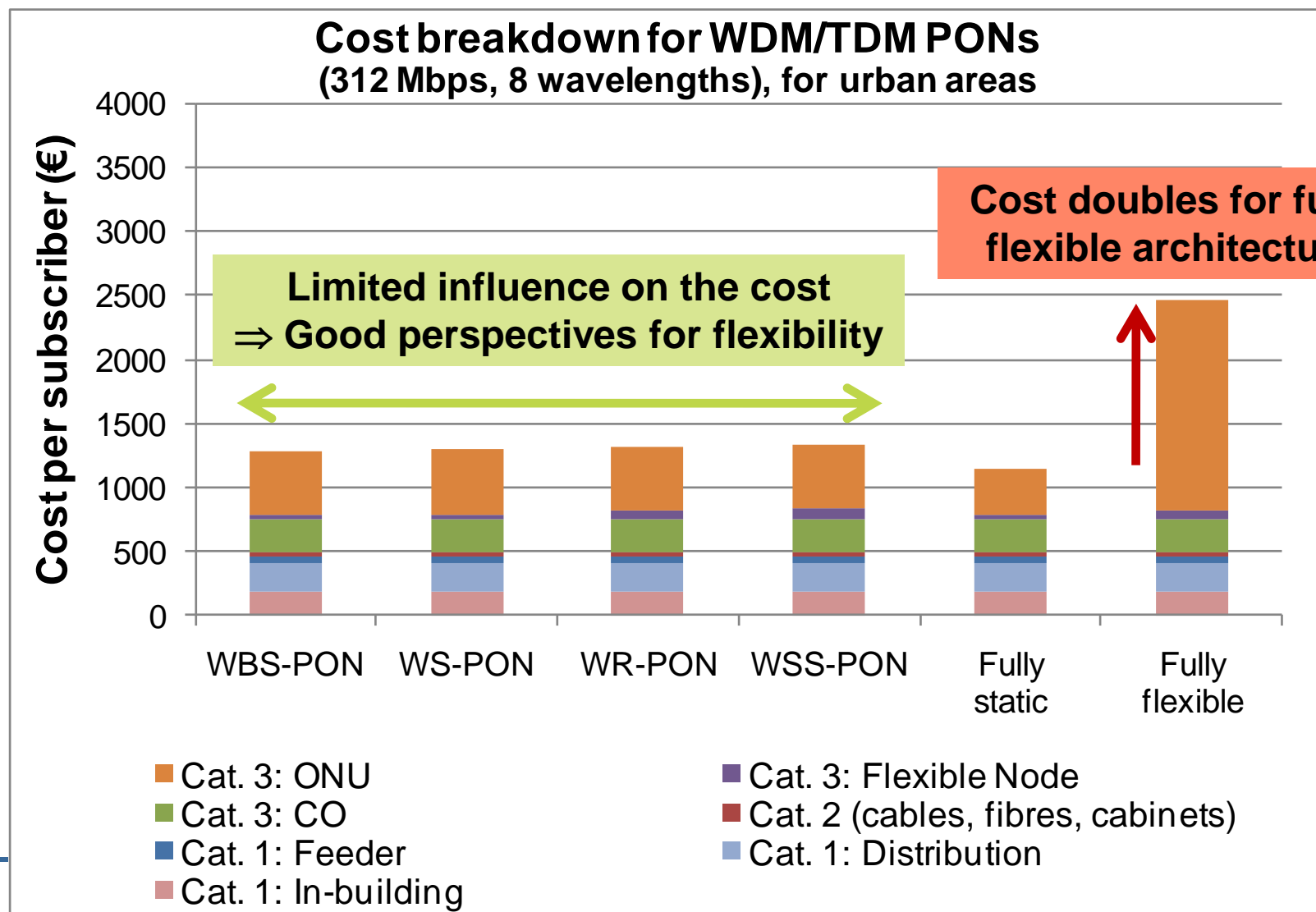
- + : Low power loss / Partial flexible / High security

- : Complex



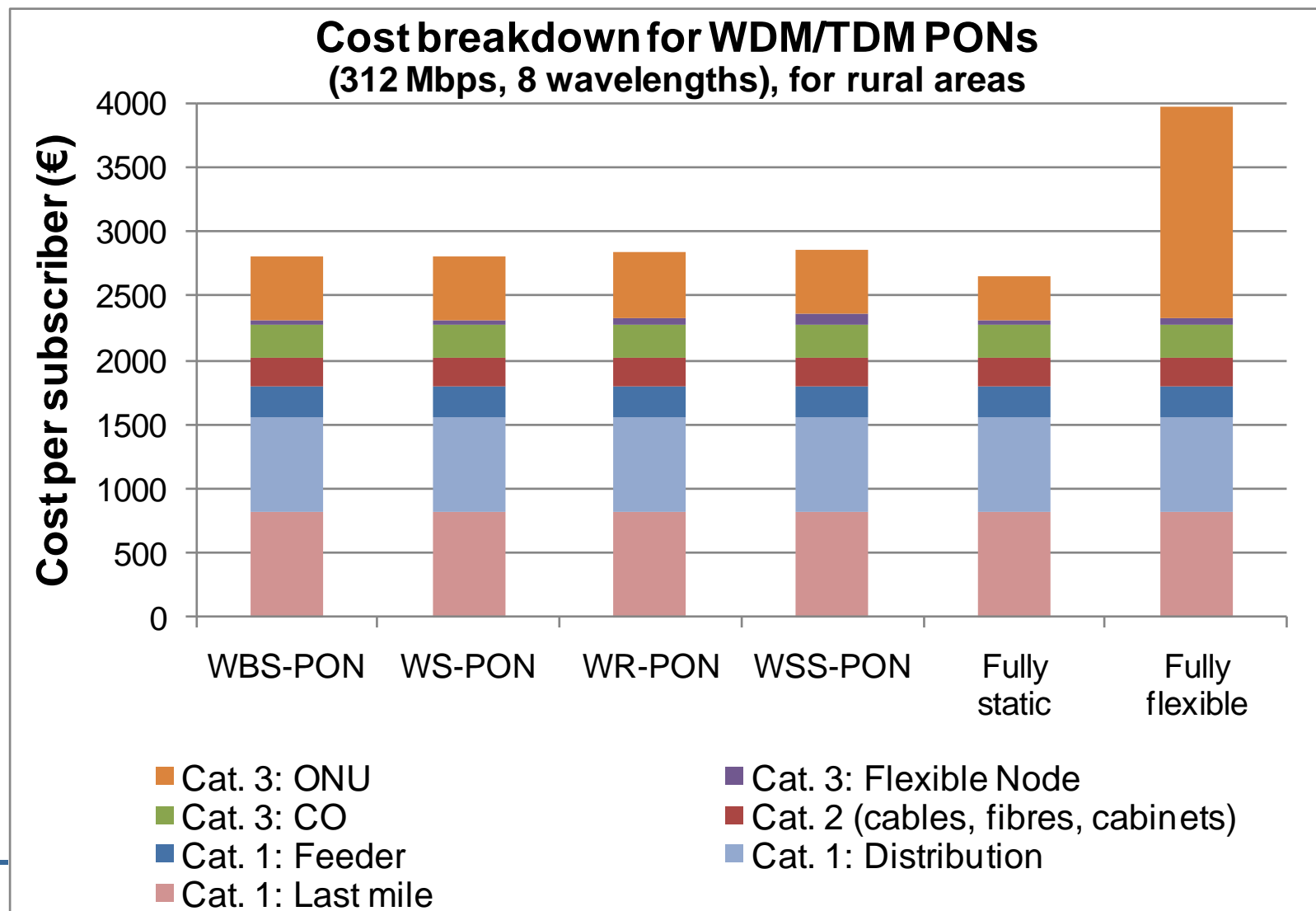
Hybrid WDM/TDM PON technologies

Cost breakdown (urban area) – cost/subscriber



Hybrid WDM/TDM PON technologies

Cost breakdown (rural area) – cost/subscriber



Conclusions

- Short/medium term
 - 10G GPON and 1G AON are competitive solutions for offering higher bandwidths at the subscriber sides (cf. 312 Mbps / subscriber)
- Longer term
 - Hybrid WDM/TDM 10G GPON
 - New functionalities with extra flexibility are made possible
 - Load balancing (possibility to offer full bit rate of 10G)
 - Energy saving
 - Network extensibility and migration
 - Comparable CAPEX cost as 10G GPON or 1G AON systems
 - Cost of transponders (ONU side) is an important issue that must be solved!
 - ➔ **Good candidate for a NGOA (NG PON) system**
 - Hybrid AON systems
 - By combining active switching and WDM PON and AON can offer even other functionalities

Thanks!



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