



# WDM-PON technology

Profitable deployment scenarios in carrier networks

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October 2009

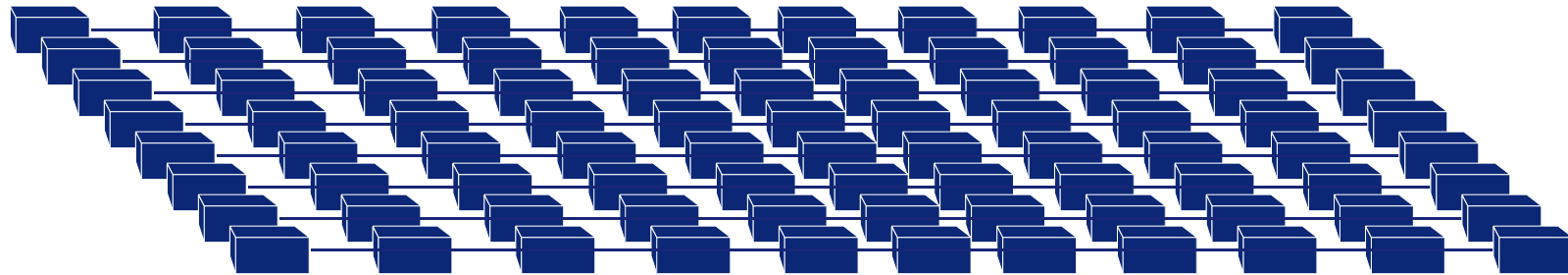
# Outline

- ▶ Introduction
- ▶ Next-Generation Access (NGA) drivers
- ▶ The role of WDM in NGA
- ▶ Profitable deployment scenarios – a case study
- ▶ The NGA solution center

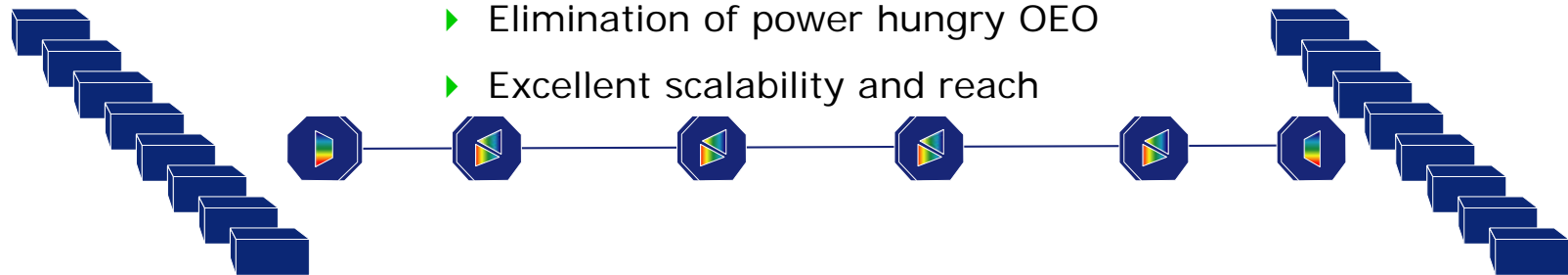
Many thanks to Dr. Klaus Grobe, principal engineer, ADVA Optical Networking

# WDM – the early years

## TDM networks



## WDM networks



- ▶ Elimination of sites
- ▶ Elimination of power hungry OEO
- ▶ Excellent scalability and reach

WDM radically changed the cost per bit km equation

# Be happy – we are in a growth industry

" ... the long term, bandwidth consumption is around **40% to 50% per year** on average.  
...The applications continue to be ... video and ubiquitous connectivity to the Internet."  
DellOro, January 2009

1



**Video  
AND ENTERTAINMENT**



"EAD worldwide revenue ...will reach \$1.6B in 2013,  
with a 2008-2013 **CAGR of 33%** ... This is a healthy and  
growing market that is strongly influenced  
by Ethernet service uptake."

2 **TRANSITION TO  
Ethernet**

Infonetics, May 2009

"... the growth rate of storage capacity in 2009 will be  
fairly consistent with prior years, at around **50%**"

Goldman Sachs Global Investment Research, February 2009

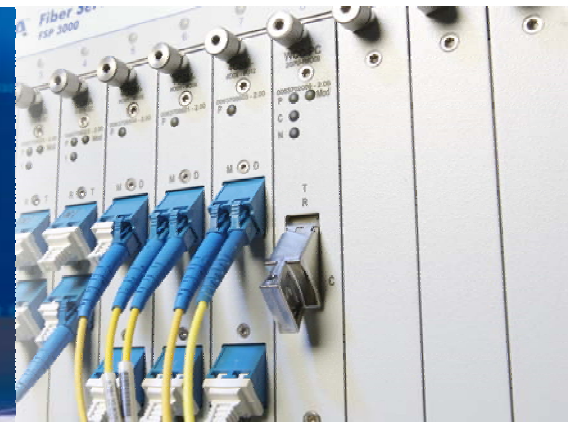
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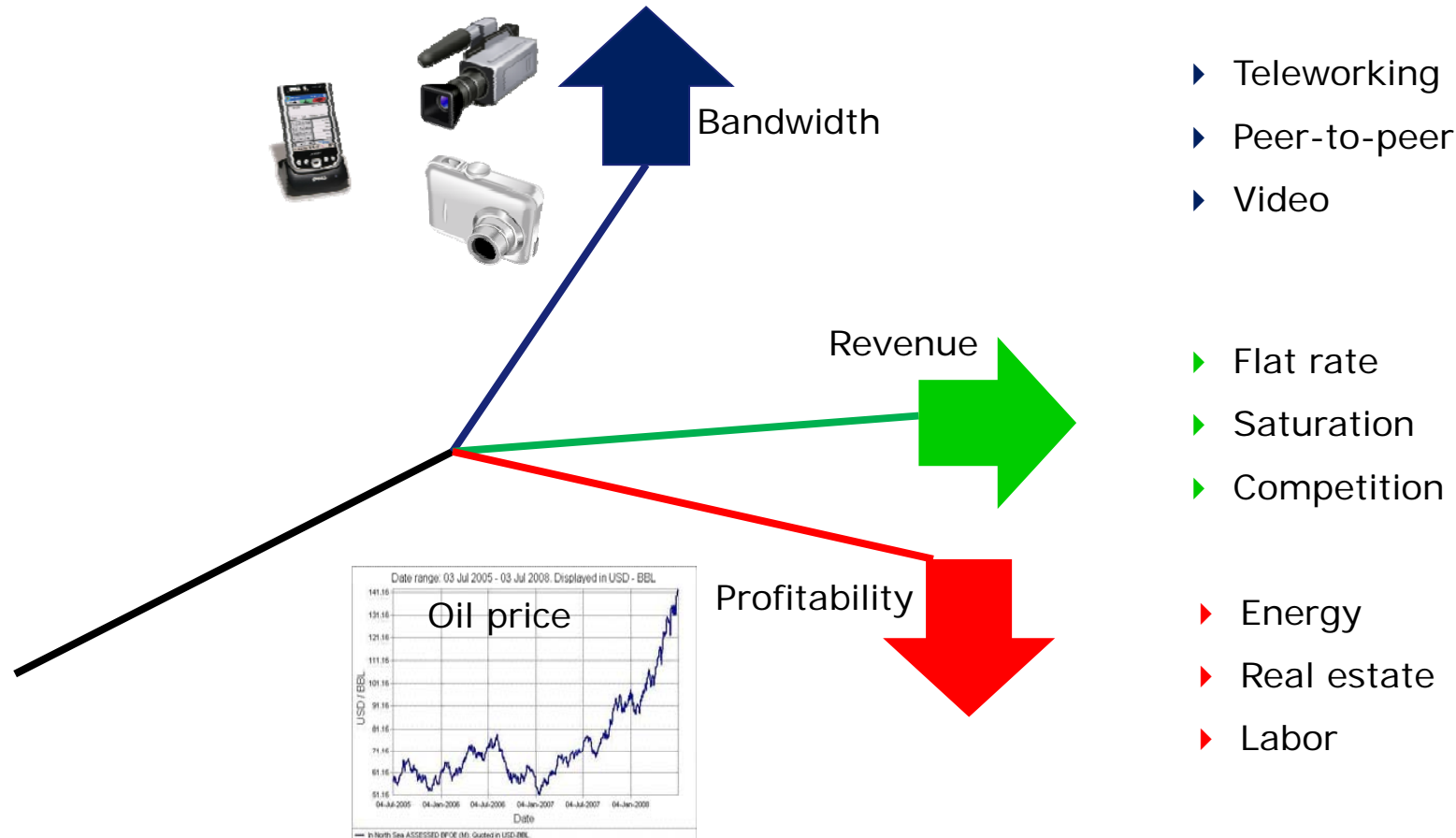
**Storage  
DATA CENTER CONNECTIVITY**

**Three solid growth trends drive sustainable demand for  
our converged Optical+Ethernet transport solutions**

# Next Generation Access (NGA) drivers



# NGA – dilemma or opportunity?



**Need to deliver more bandwidth to more endpoints at lower OPEX**

# NGA requirements: more for less

1) More bandwidth to more endpoints

2) Energy-efficient and simple  
(using less power consuming equipment in fewer sites)

3) Serving all user groups  
(Residential, business, wholesale)

Scalable, supporting high fan-out ratios

Passive, transport-centric supporting long reach

Converged, using fewer purpose-built platforms

**From multiple purpose-built networks to unified next-generation access and backhaul**

# Services by user group

## Residential

... become more symmetrical

- ▶ 2 x HDTV (8 ... 16Mbit/s per channel),  
→ TV offering in total:
- ▶ High-speed Internet access:
- ▶ Voice communications (POTS/VoIP):
- ▶ Upstream services:



**Teleworking  
Image/video upload**

- 4 x SDTV (1.5 ... 4Mbit/s)  
22 ... 48Mbit/s
- up to 5Mbit/s
- 100Kbit/s
- up to 100Mbit/s

## Business

- ▶ TDM leased lines:
- ▶ LAN interconnection (VLAN):
- ▶ Virtual Private Networks (VPN):
- ▶ Storage Area Networking (SAN):
- ▶ High-performance computing:

- e.g., E1/DS1
- 100BT, GbE
- 100BT, GbE
- 1/10 GbE, 4/8/10G FC
- InfiniBand (2.5...10Gbit/s)

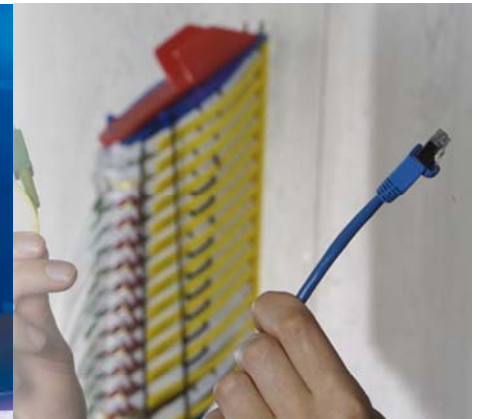
## Carrier wholesale

- ▶ xDSL backhaul: nx1GbE
- ▶ Hybrid Fiber Coax/CaTV network backhaul: nx1/10GbE
- ▶ Multi-Service Operator (MSO) network backhaul: nx1/10GbE
- ▶ Wireless network backhaul (e.g., connecting base stations): E1/DS1, 100BT, GbE

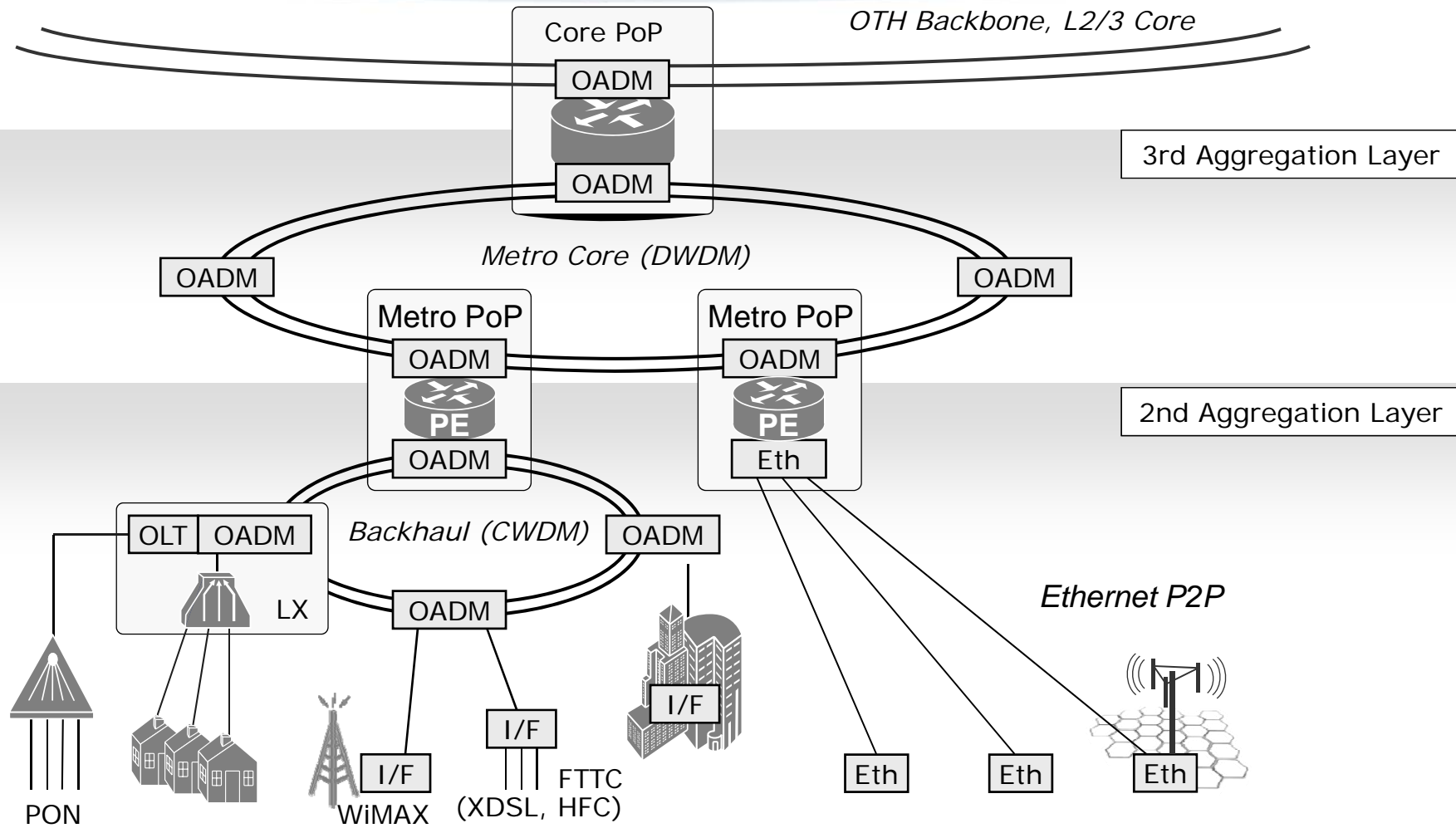
**Services become more alike (symmetrical, Ethernet centric)  
-> opportunity for convergence**



# The role of WDM in NGA

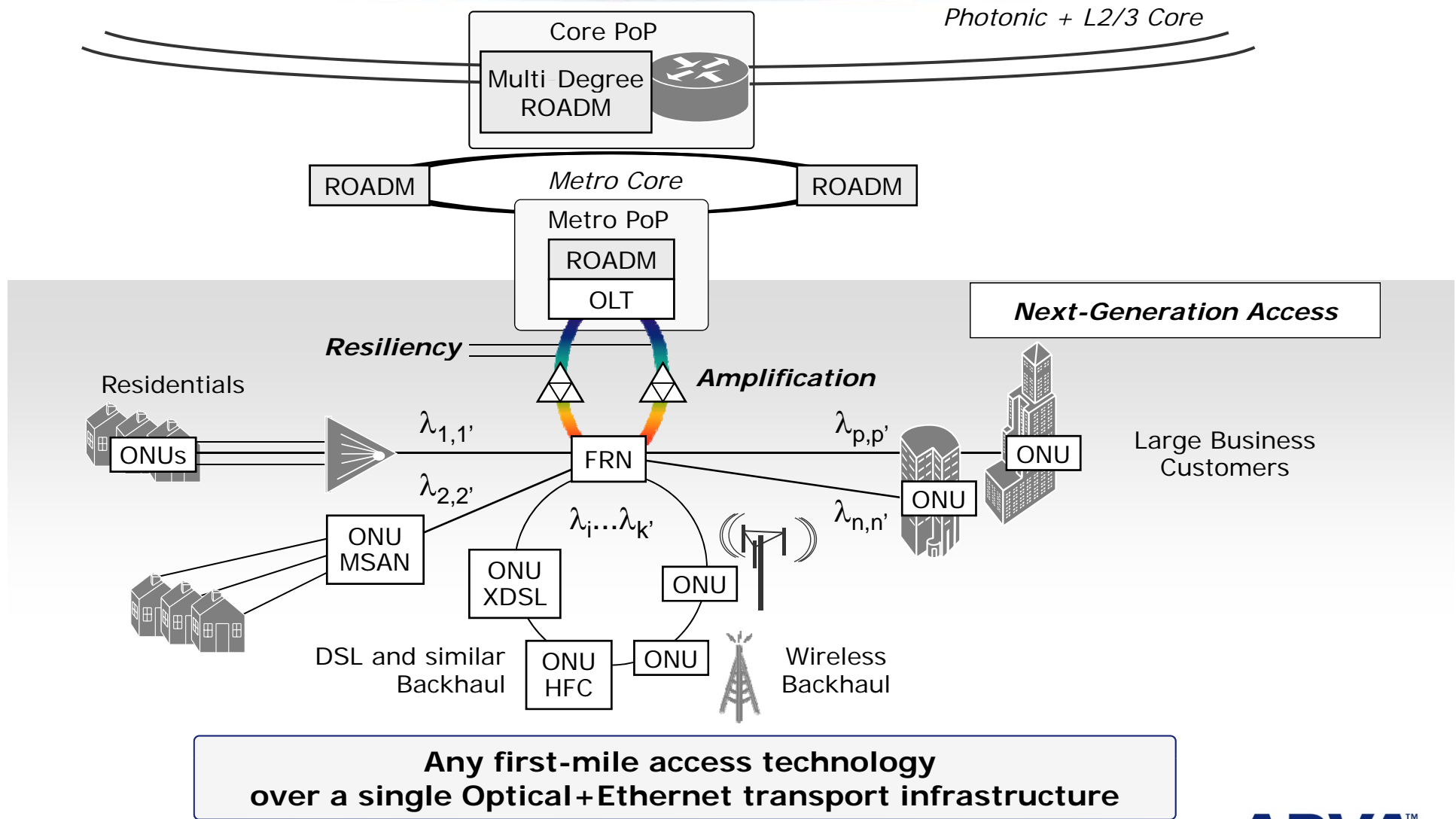


# Metro network today

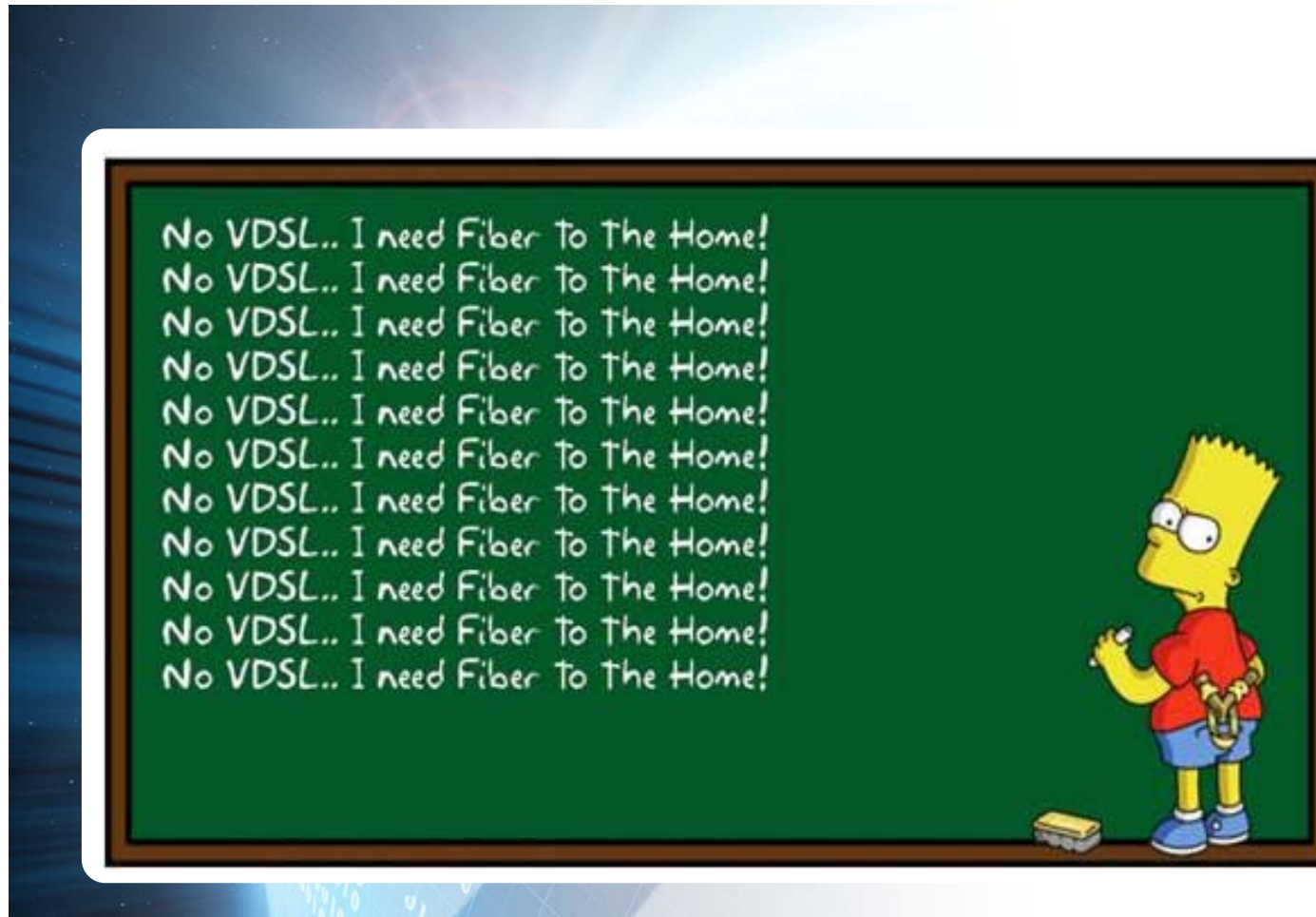


**Need to simplify and unify access and backhaul**

# Future de-layered metro network

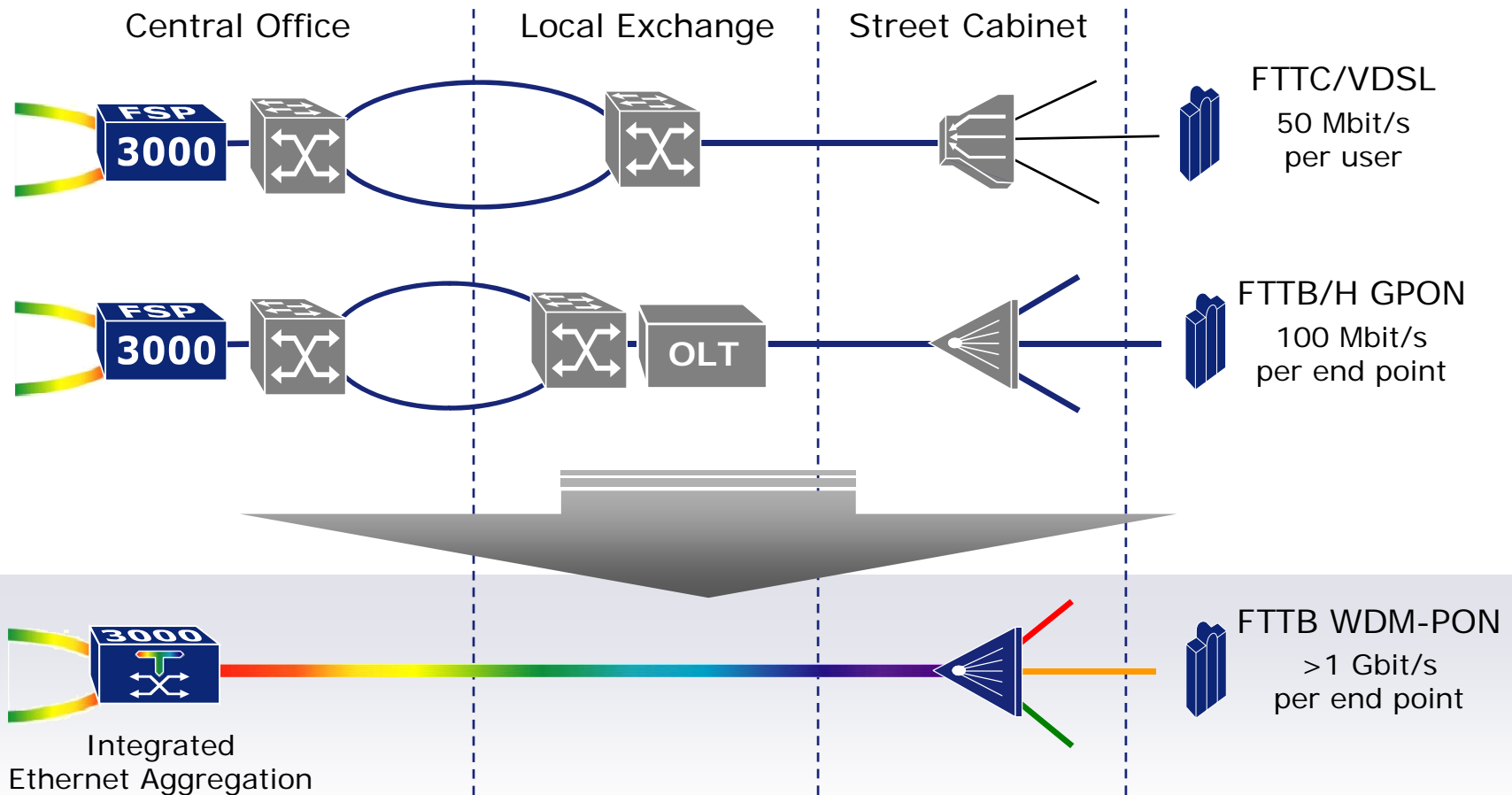


# All that talk about FTTH



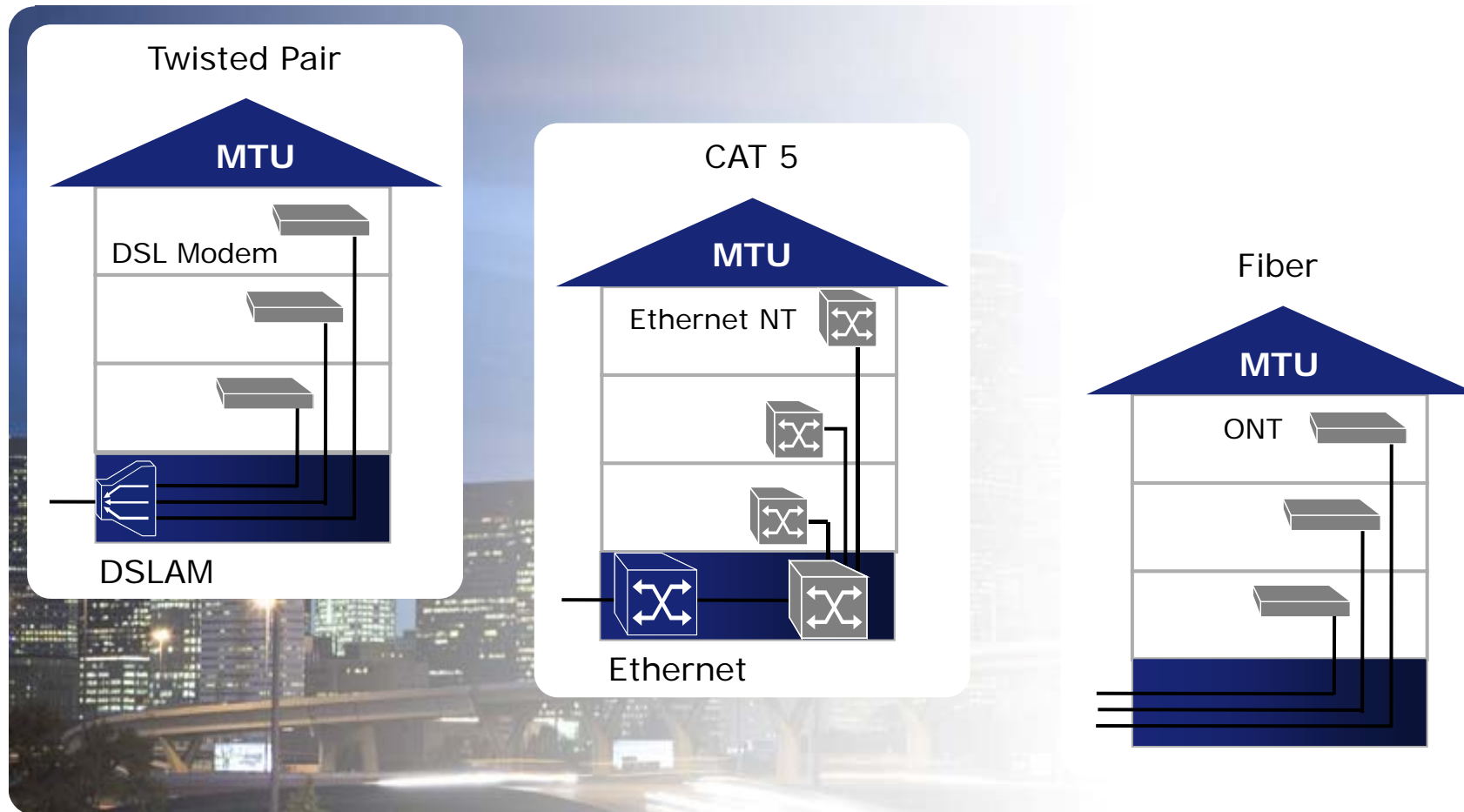
**This presentation is not about wavelengths to the home or desk**

# Focus on access AND backhaul



**Increases reliability while reducing network maintenance costs associated with fewer active locations**

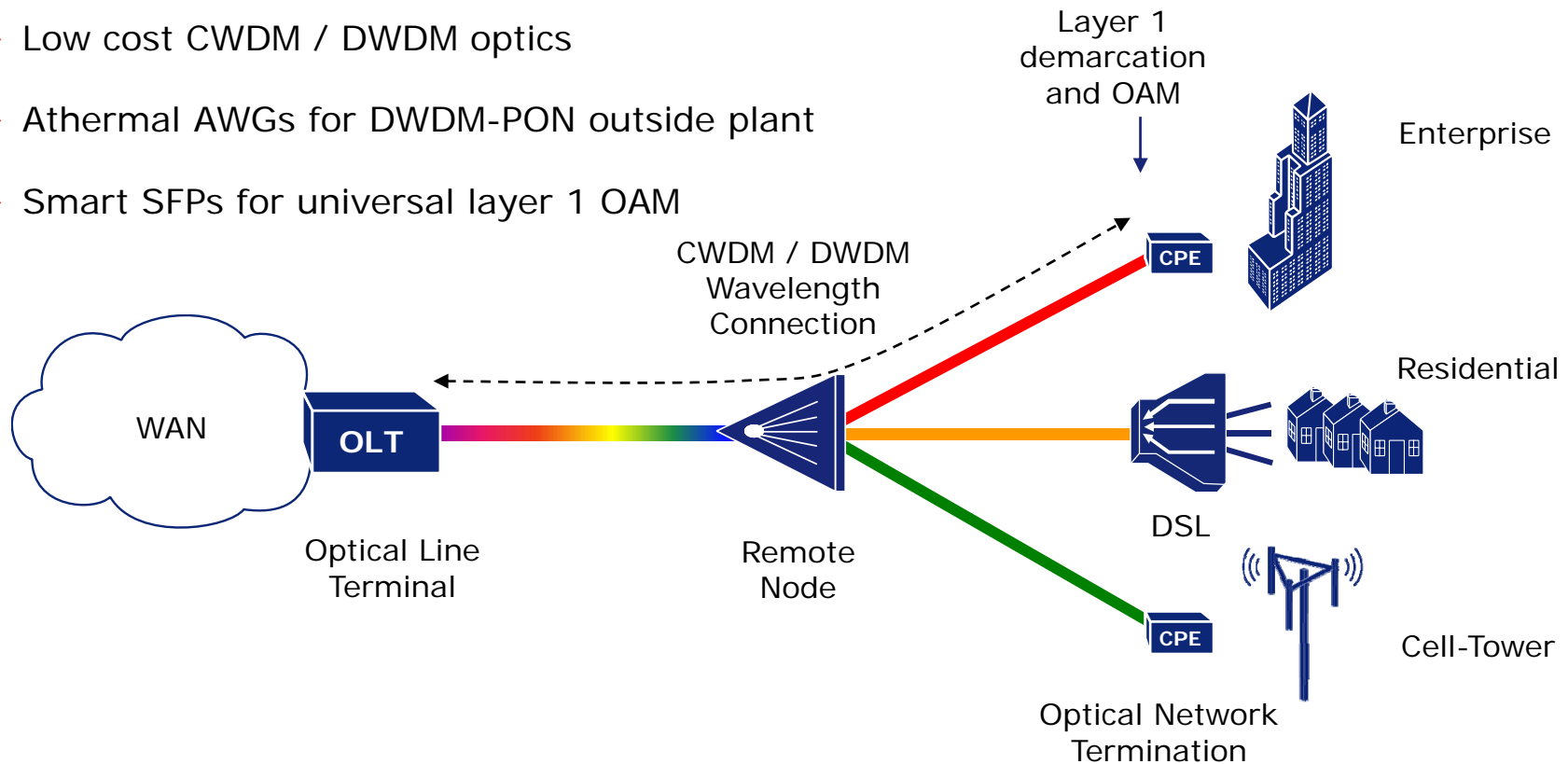
# Common FTTx in-house solutions



# Unified access and backhaul

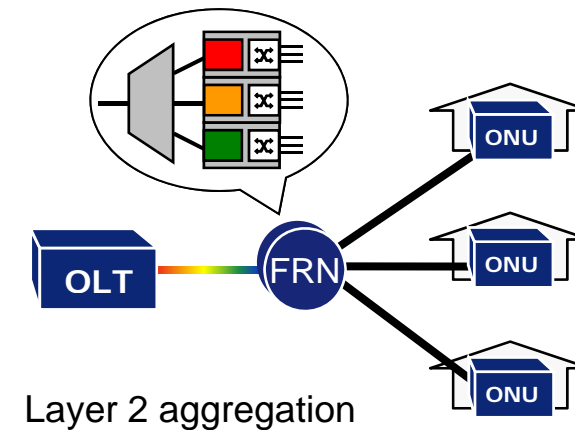
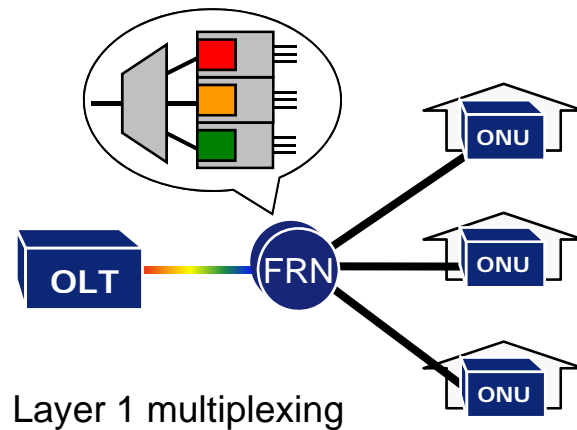
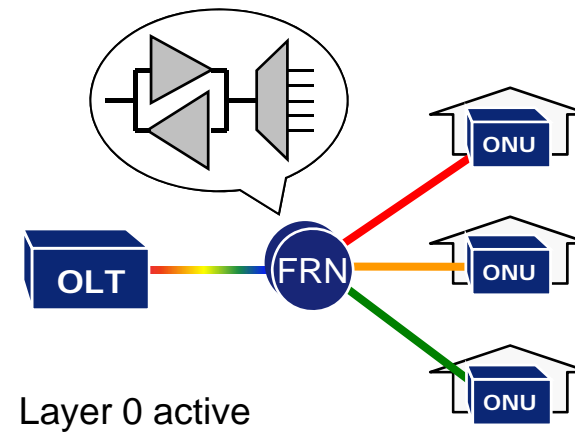
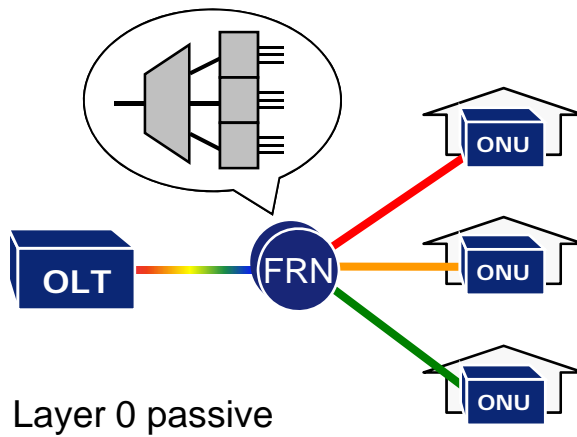
## Technology drivers

- ▶ Low cost CWDM / DWDM optics
- ▶ Athermal AWGs for DWDM-PON outside plant
- ▶ Smart SFPs for universal layer 1 OAM



**Combining point-to-multi-point topology with Point-to-point secure traffic separation and scalability**

# Flexible Remote Node (FRN)

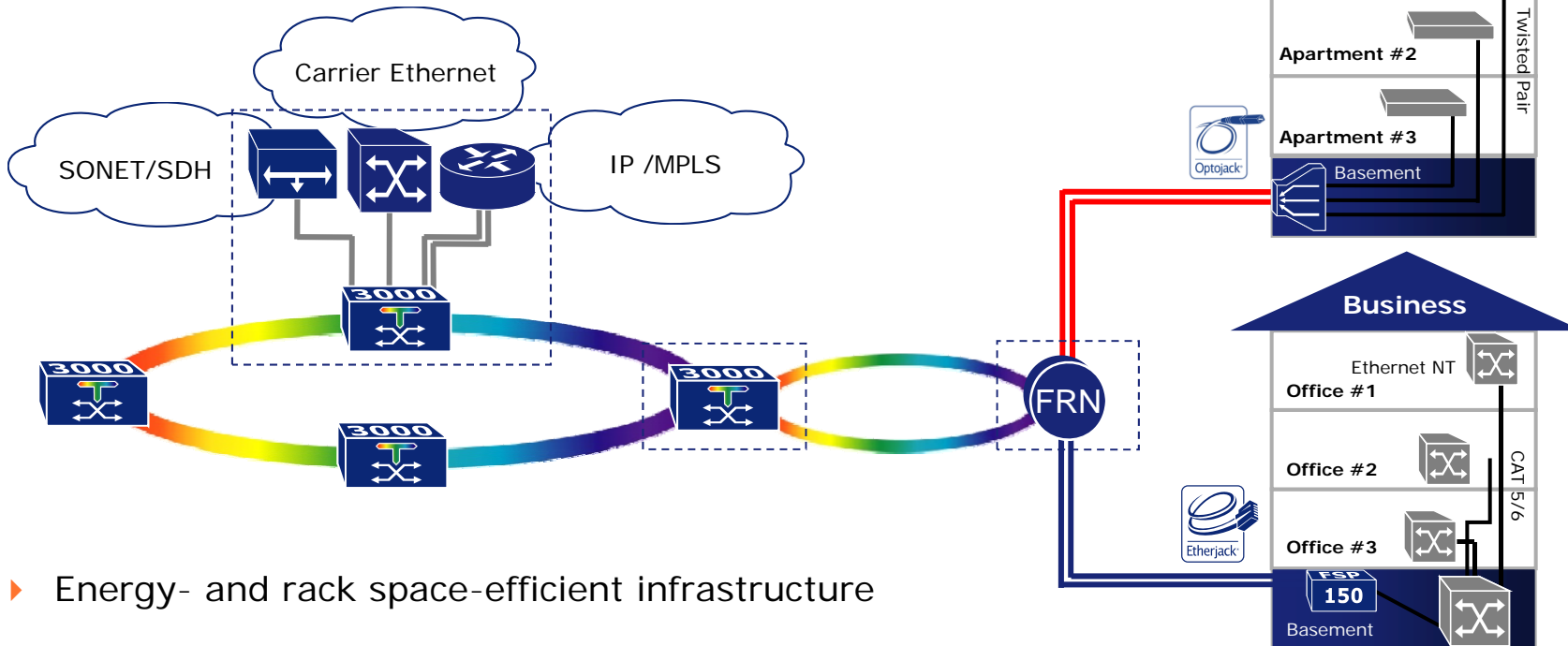


**FRN: flexibility, reach, scalability, secure traffic separation**



# NGA using point-to-multipoint WDM

- ▶ Cost-effective and fiber-effective solution
- ▶ Scalable and transparent service and bandwidth per customer
- ▶ Each customer can be upgraded independently



- ▶ Energy- and rack space-efficient infrastructure

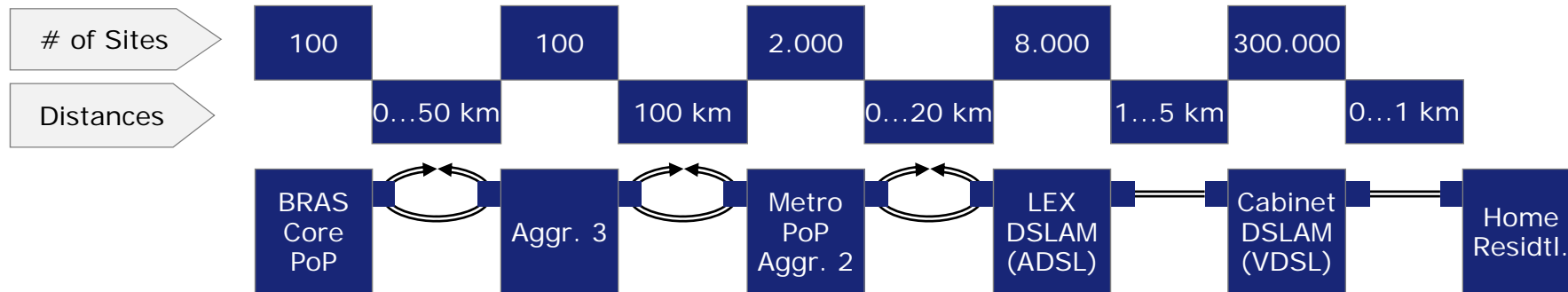
**Unified access and backhaul for residential, business and wholesale**

# Case study

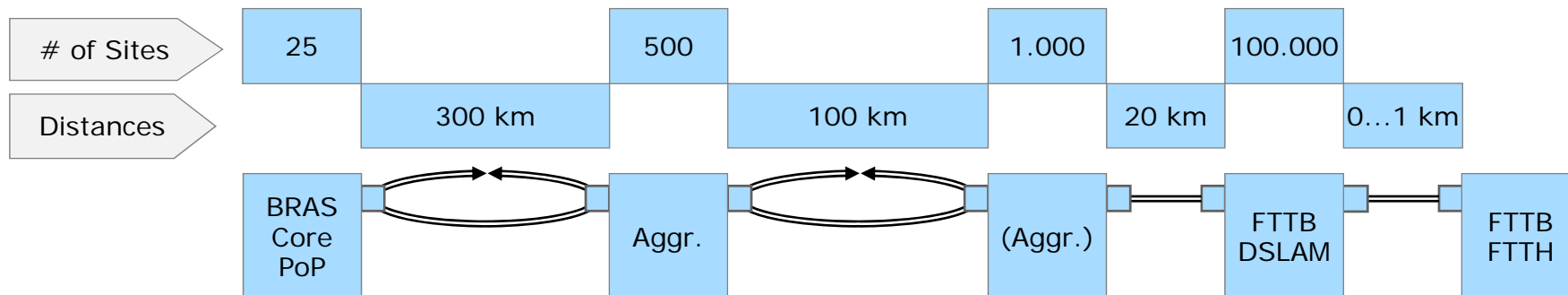


# Site and power reduction scenario

## Typical scenario of European incumbent today



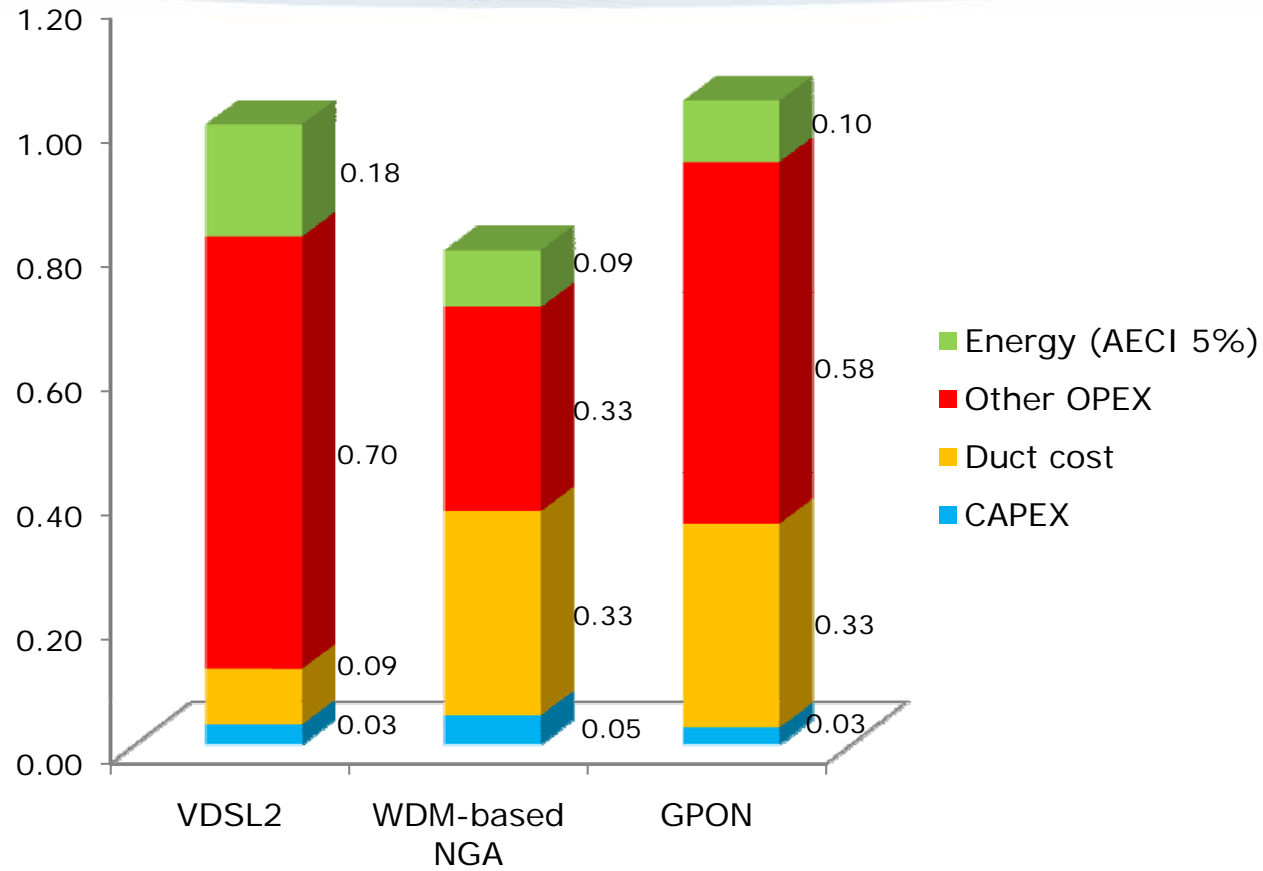
## Targeted next-generation network



# TCO analysis

- ▶ TCO for 3 NGA scenarios compared
- ▶ 25 years lifetime, incl. 3 systems generations, considered to account for the massive invest for new passive fiber infrastructure
- ▶ 1,000,000 residential clients w/ ~75Mb/s symmetrical CIR (non-oversubscribed)
- ▶ 10,000 enterprise customers, 90% w/ GbE and 10% w/ 10GbE dedicated access
- ▶ All scenarios protected for the feeder part
- ▶ CapEx (cost) considered in detail
- ▶ OpEx drivers considered
  - ▶ Energy (AECI 2%, **5%**, 10%)
  - ▶ Planning, Provisioning
  - ▶ Operations, administration, maintenance
  - ▶ General overhead
- ▶ Annual Energy Cost Increase (AECI) has clear impact (80 €/MWh assumed for Year 1)
- ▶ Final result does not change significantly when any single parameter is changed
- ▶ Most relevant is the capability to save on sites and feeder fibers

# TCO result

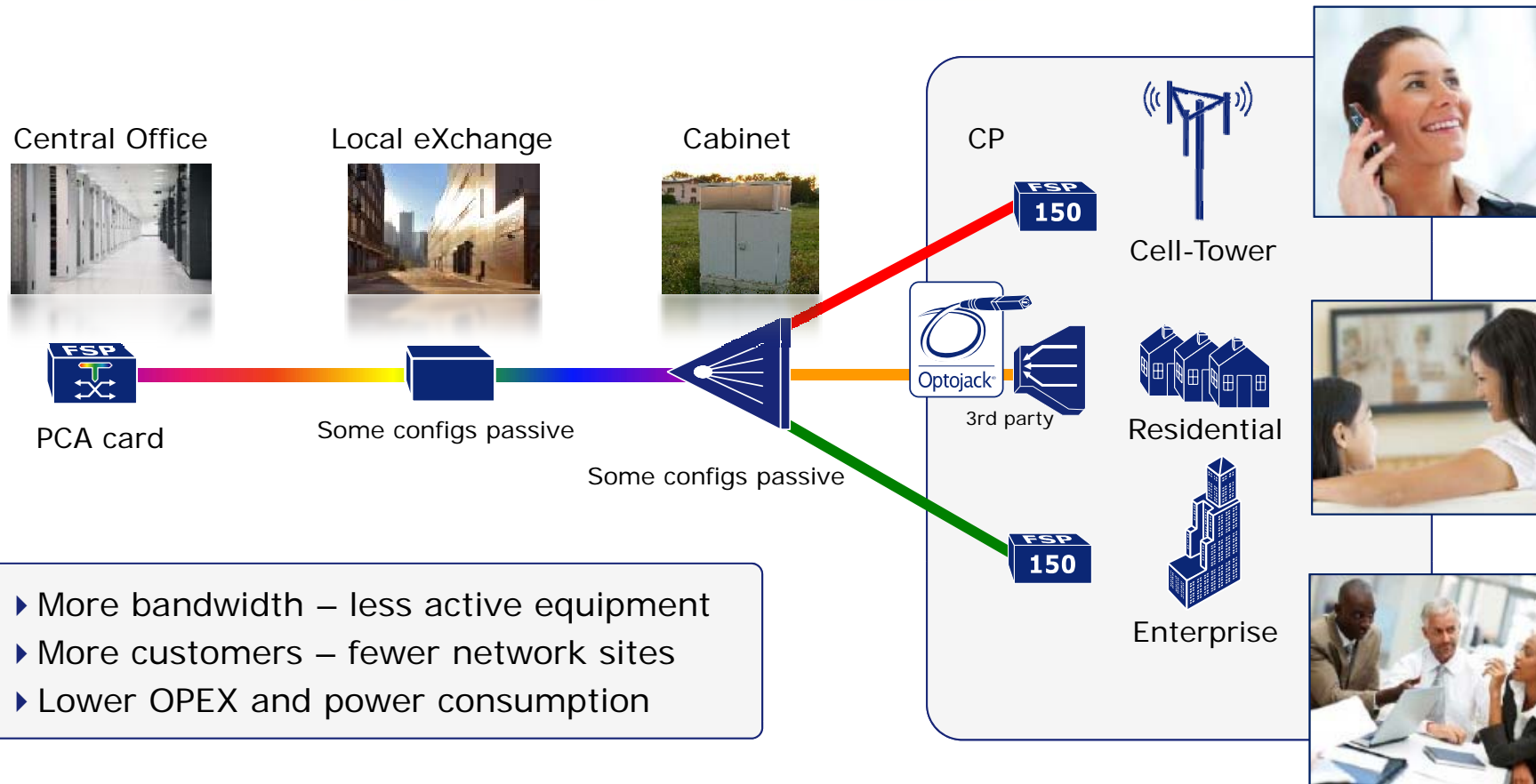


**Long reach, high-splitting ratio and Optical+Ethernet integration make point-to-multipoint WDM with L2 aggregation the best solution for NGA and backhaul!**

# Quick explanation

- ▶ “GPON OLT placed in LX/FRN” has limitations
  - ▶ Higher energy consumption due to TDMA running on aggregate bit rate
  - ▶ GPON/pWDM does not support business customers efficiently
  - ▶ GPON more difficult to upgrade
  
- ▶ “Active WDM-PON + L2” outperforms all other approaches
  - ▶ Best energy efficiency; L2 concentrated in FRN, instead being dispersed (TDMA)
  - ▶ Cheapest grey (i.e., colorless) SFPs for the multitude of ONUs
  - ▶ Best BW efficiency and optical power budgets
  
- ▶ “WDM + (VDSL2) DSLAMs” expensive long term (though cheaper in CapEx)
  - ▶ Higher energy consumption for copper drivers – even for VDSL2
  - ▶ Shorter (copper, last mile) reach, more difficult to upgrade

# NGA solution center



**WDM-based NGA: combining point-to-multi-point fiber topology with secure point-to-point traffic separation and scalability**

The ADVA logo is a large, light blue circular emblem with a stylized 'A' shape inside, positioned on the right side of the slide. The background of the slide is a dark blue gradient with abstract light patterns and the word 'ADVANCE' in a light blue font on the left side.

ADVANCE

# Thank you

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