

**FTTH Conference 2010**  
**ITU-T Standardization: from G-PON to 10G XG-PON**

**Review of G-PON standards  
and their application**

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# Outline

- Background
- Core G-PON system standards
- Ongoing improvements
- Major applications

# Background: Older PON systems

- ITU-T Q2/15 has a well established program of PON system development
  - 1996: G.982 – an early STM-PON
  - 1998: G.983 – the ATM-PON system
  - 2001: G.983.3,4,5 – the B-PON system
- B-PON was strongly influenced by the B-ISDN (ATM) network architecture
  - Not so relevant looking forward
  - Optics and microelectronics market changing
  - Explosion of Internet required more bandwidth

# Background: Motivations for G-PON

- In 2001, Q2/15 began G-PON project
- Key requirements
  - At least 1 Gb/s capacity
  - Full service (including legacy) support
  - Oriented towards IP services
  - Cost effective and FCAPS managable
- Key “non-requirements”
  - Compatibility with B-PON not required

# Core G-PON requirements (G.984.1)

## System parameters

- Rates >1Gb/s
  - A range supported, to permit economical options
- Efficient use of BW
  - Avoid linecodes
  - DBA supported
- Environmental
  - OLT indoors
  - ONU indoor or outdoor
- Protection possible
  - 50ms recovery

## Service parameters

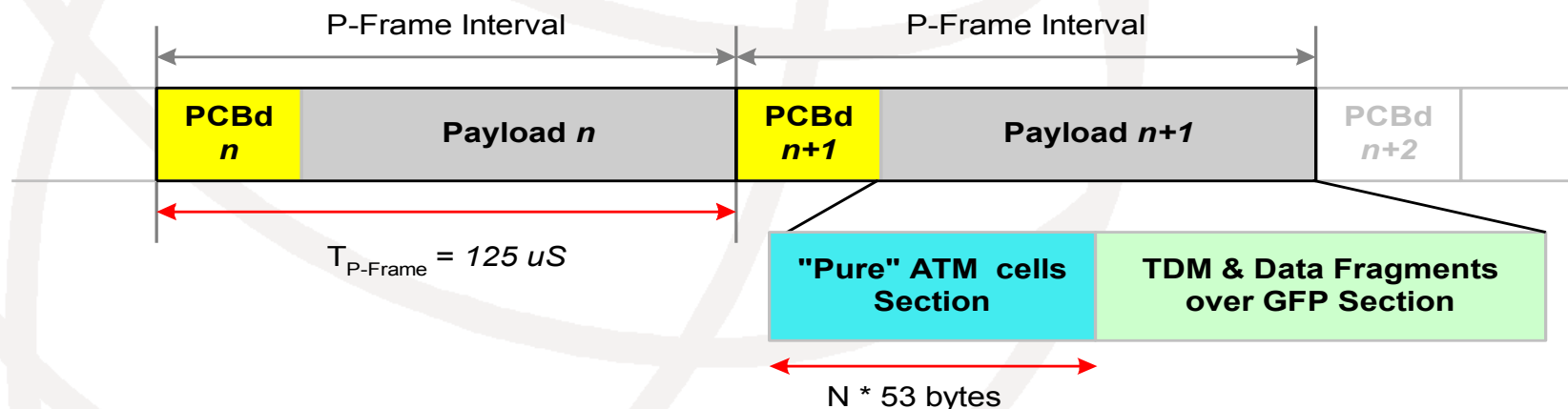
- Voice
  - POTS, leased lines, special services
- Data
  - 10, 100, 1000Base-T Ethernet
  - Other interfaces possible
- Video
  - IP-video over data path
  - RF-video overlay

# Core G-PON PMD layer (G.984.2)

- The PMD spec provided many options for implementers to find the optimum
  - Downstream rates: 1.2G and 2.5G
  - Upstream rates: 155M, 622M, 1.2G, and 2.5G
  - Loss Budgets: 20, 25, and 30 dB
- Distance
  - 20km physical reach
- Support for power leveling
  - Makes burst mode reception easier
- FEC option
  - Loss budget / ONU optics cost down

# Core G-PON TC layer (G.984.3)

- A lightweight system that adapts both ATM and Ethernet to the PON's TDMA nature
- Downstream frame
  - Bandwidth Map (PCB) – to manage the upstream
  - ATM partition – to support legacy services
  - GEM partition – to support packet services
- Upstream burst transmission
- PL-OAM, DBA, and protection included from the beginning



# Core G-PON management (G.984.4)

- Just making a data link is not enough for an access system
  - Operators need a full operations support system to provision, monitor, and troubleshoot the access network
- The ONU Management and Control Interface (OMCI) provides this
- OMCI was built on B-PON experience
  - Inherited much of the interoperability progress that was made with B-PON systems

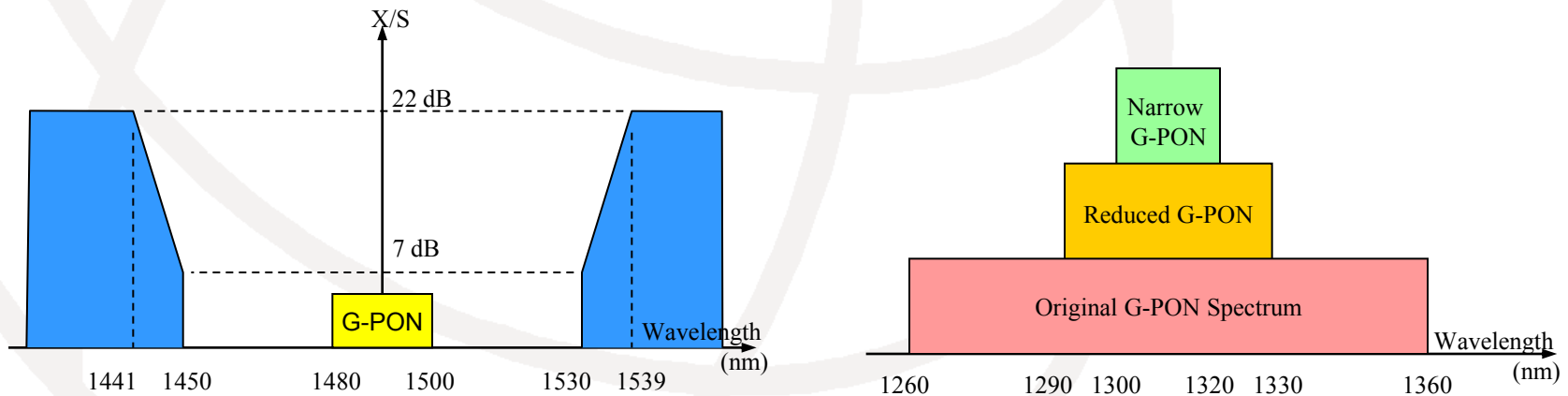


# Improve: G-PON Lite

- The first round of G-PON recommendations were ratified in 2004
  - These served as a basis for early implementers and deployment
- As the market matured, many of the options included in the first round were found to be extraneous
- Q2/15 has revised and narrowed the recommendations to reflect the market
- PHY layer:
  - Rate: 2.5G down, 1.2G up
  - Loss budget: 28 dB
- TC layer:
  - ATM partition dropped
  - Power leveling deprecated

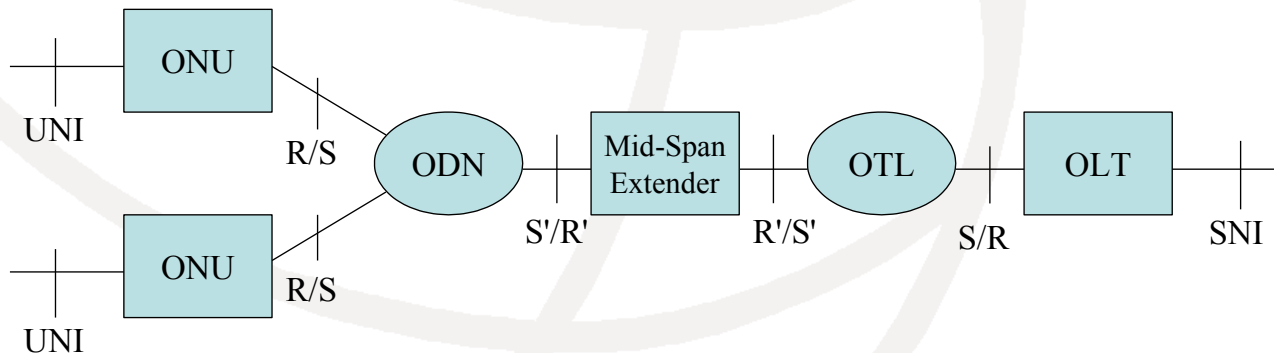
# Improve: Ready for XG-PON (G.984.5)

- Operators expect that G-PON will be widely deployed by the time XG-PON will come
  - It is important that the evolution to XG-PON will be as easy as possible
- G.984.5 prepares G-PON for this by
  - Specifying the blocking filter for G-PON ONU Rx's
  - Specifying reduced upstream bands for ONU Tx's



# Improve: Reach extenders (G.984.6)

- The basic PON link is good for 20km
  - ▶ This reaches 90% of customers in the US market (a relatively sparse population density)
- Extending the reach can be one part of a strategy to reach the “last 10%”
- G.984.6 creates the specifications for mid-span reach extenders
  - ▶ Total distance: 60km
  - ▶ Total loss budget: 56 dB



# Improve: OMCI and Interoperability

- The OMCI is what turns raw bandwidth into billable services
- G.984.4 has been constantly improved to add new services and interfaces to the PON system
  - VDSL – to enable FTNode and FTTB
  - MoCA – in-home networking
  - IGMP management – IPTV support
  - Optical line supervision – to reduce Ops costs
- Interoperability has been a focus of Q2/15, in conjunction with the FSAN Interop group and the Broadband Forum
  - Nine test events so far
  - Nearly perfect plug-and-play results achieved

# Standards in Action: Implementation

Leading System vendors



HUAWEI



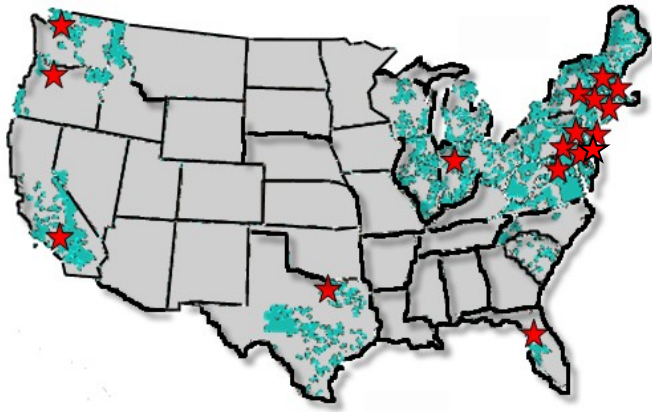
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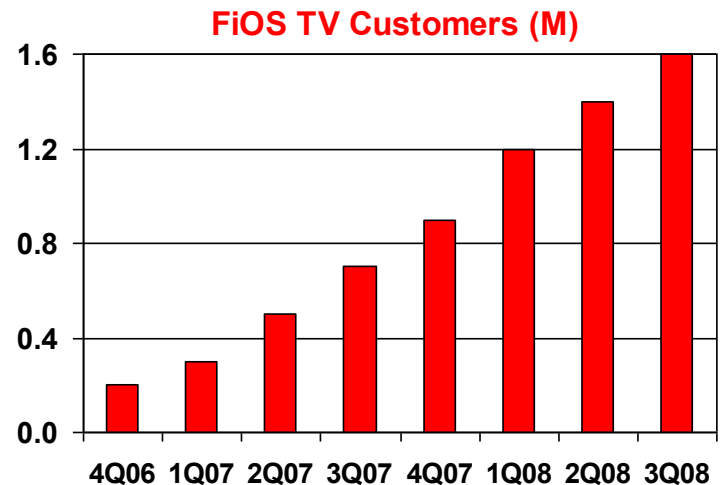
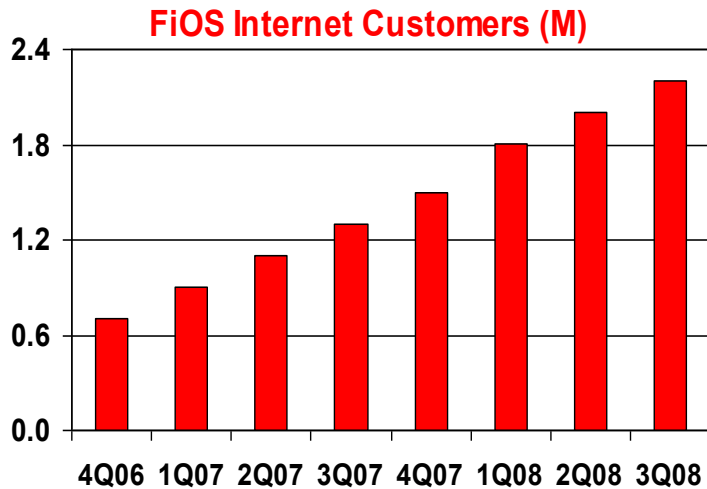
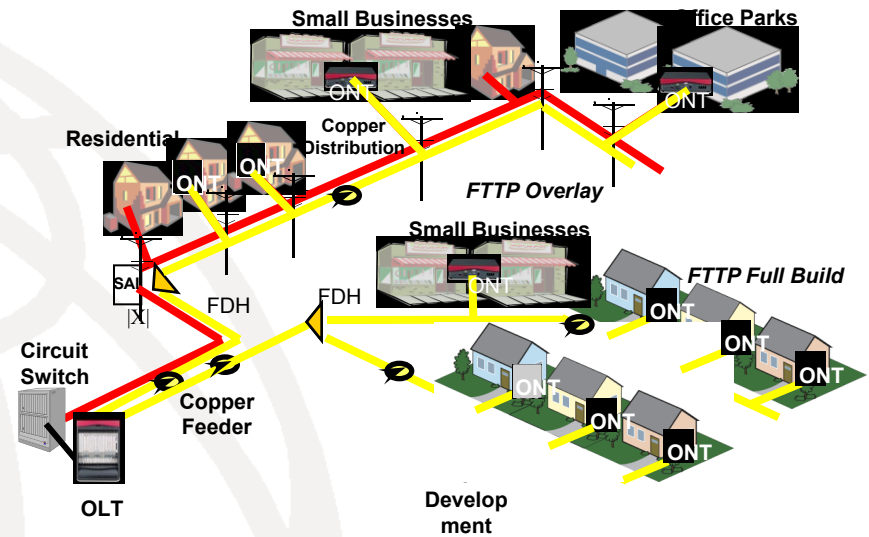
ZTE中兴



# Major Application: Verizon FiOS



- FiOS Available in 16 States & Washington DC
- 12M HHs Passed YE2008; 18M HHs Passed 2010
- BPON Deployment Starting in 2004
- GPON Introduced in 4Q 2007

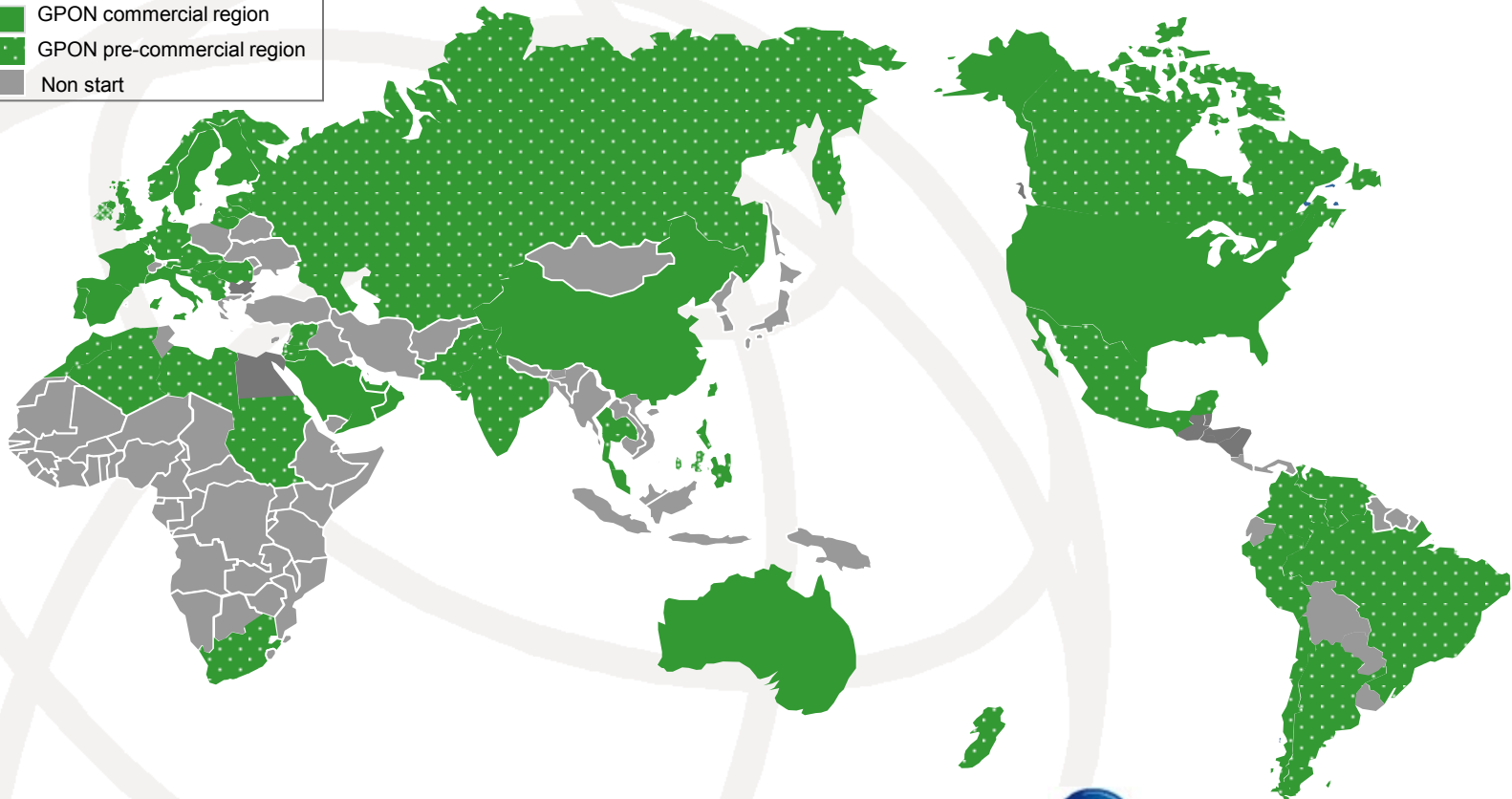
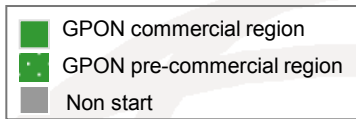


# Major Application: Europe



■ Fast emerging GPON market

# Worldwide Deployment of G-PON



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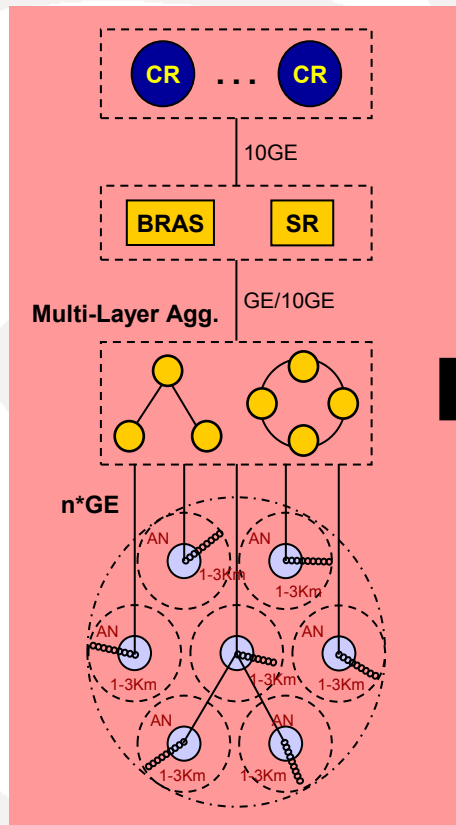
# G-PON enables network simplification

Backbone

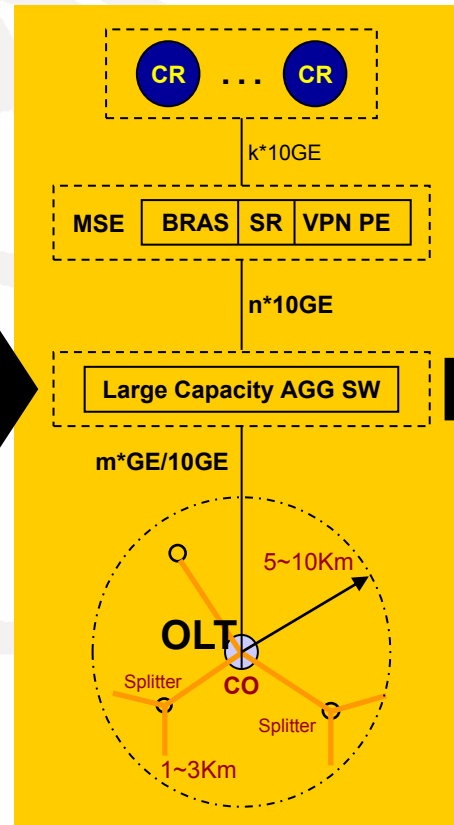
Service POP

Metro

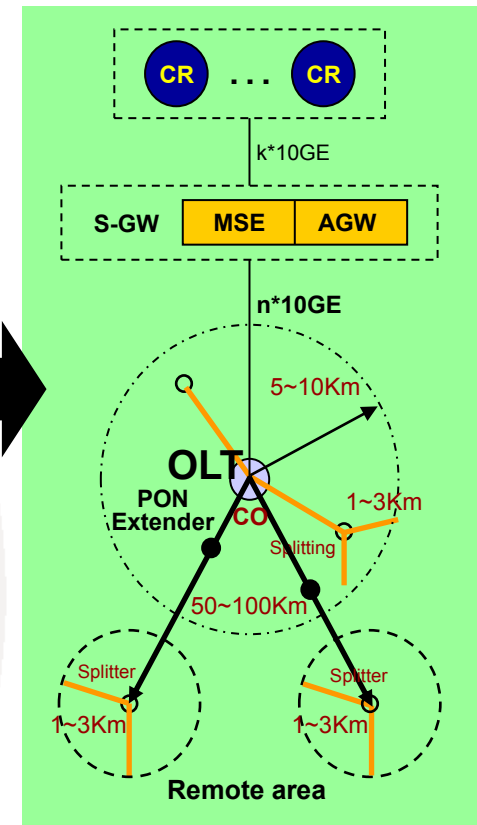
Access



So Far (~2008)  
Large AN Sites  
Multi-Layer Structure



Medium-Term (2008~2010)  
OLT Centralized  
Single-Layer 10GE Aggregation  
Multi Service GW Convergence



Long-Term (2010~2016)  
PON Extender for Remote Area  
3-Layer Network Architecture  
Fixed-Mobile POP Convergence



**Thank You!**

For more information, contact

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