Joint ITU-T/IEEE Workshop on Next Generation Optical Access Systems

Standards Overview of ITU-T SG15/Q2

David Faulkner

ITU/SG15/Q2 Rapporteur

Objectives of this Presentation

- Review SG15/Q2 on Optical Systems for Fibre Access
    - G.984.x series of Recommendations for Gigabit-Capable Passive Optical Networks (G-PON)
    - Focussing on recent revisions and additions

- Report progress on
    - G-PON Enhancements
    - Point-to-point Ethernet-based optical access systems
    - Interoperability Showcase Events

- Promote discussion between ITU-T and IEEE on how to
    - Maximise reuse of ODN (for future upgrade)
    - Respond to Power Saving initiatives in ITU and IEEE
    - Minimize the variety of the OAN systems

G-PON - Where we are in G.984 series?

- **2.5/1.25 Gbit/s transport system**
  - Efficient packing of IP/Ethernet Cells
    - 90% and above
  - Compatible with Optical Distribution Network used in previous PON implementations
    - Up to 20km and 32 way-split
- **G.984.6 (latest in series) consented February 2008**
  - Extends physical layer reach to 60km using class C+ optics and 'mid-span' extenders
    - matches the 60km reach of the Transmission Convergence layer

G-PON Recommendations #1

- Feb 2008

  G.984.1 Revised " General characteristics for Gigabit-Capable Passive Optical Networks (G-PON)

  overall architecture and service requirements

- Jan 2003 (plus Amendment 2 Feb 2008)

  G.984.2 "Gigabit-capable Passive Optical Networks (G-PON) : Physical media dependent (PMD) layer specification"

  Wavelength plan, optical power budget, reach and split rate

  Plus 2 Amendments including class C+ optics (32dB)

- Feb 2008

  G.984.3 Revised "Gigabit-Capable Passive Optical Networks (G-PON): Transmission Convergence Layer"

  Generic Encapsulation Method to allow variable packet lengths to be transmitted efficiently

  OAM messaging and Dynamic Bandwidth Assignment

  Plus G.984.3 GPON GTC Implementers' Guide

G-PON Recommendations #2

- Feb 2008

    G.984.4 Revised "Gigabit-capable Passive Optical Networks (GPON): ONT Management and Control Interface specification"

- June 2007

    G.984.5 "Enhancement band for Gigabit Capable Optical Access Networks"

    NGA blocking filter at the user end, WDM at network provider end

- Feb 2008

    G.984.6 "G-PON optical reach extension"

    Outlines the architecture and interface parameters for G-PON systems with extended reach (to 60km). Both optical amplifier and regenerative versions are included. Some consideration of next generation access systems is made

Point-to-point Ethernet-based optical access systems #1

- G.985 (January 2003) 100Mbit/s point-to-point Ethernet based optical access system
  - P2P Optical distribution network (ODN) and physical layer (single fibre bi-directional transmission system only)
  - Requirements for the OAM (operation, administration and maintenance) including loop-back and performance monitoring
  - Based upon IEEE Standard 802.3-2000
- *G.985 Amendment (for consent in Dec 2008)*

  To include silent start mode

  This reduces risk of interference of P2P systems with PON if the incorrect ONU is connected

# Point-to-point Ethernet-based optical access systems #2

- G.gbe "1-Gbit/s point-to-point Ethernet-based optical access system"
  A 1 Gbit/s successor to G.985
  Class A and Class B optics (30km) are under consideration
  December 2008 is planned deadline for Consent

- Management functions required include
  UNI configuration*
  UNI status notification*
  UNI loop-back test*
  Loop status notification
  Fault management
  These are not in IEEE Std 802.3 Clause 57

Recent Liaison with IEEE on P2P systems

- Q2/15 experts require a managed 1Gbit/s P2P system similar to the 100 Mbit/s system
- IEEE802.3 replied to a liaison document from Q2
  - "Call for feedback on new work on a 1-Gbit/s point-to-point Ethernet-based optical access system"
- Q2/15 reviewed the IEEE response at the Tokyo meeting in April
  - IEEE do not have specific working group to work on this topic
  - We will therefore exercise responsibility to continue with the work with reference to existing IEEE standards and feedback progress to IEEE
  - We will add an Amendment to G.985 and begin work on a new draft Recommendation "G.gbe"

Interoperability Showcase Events

- SUPERCOMM, June 2005, Chicago
  - Focus was on B-PON
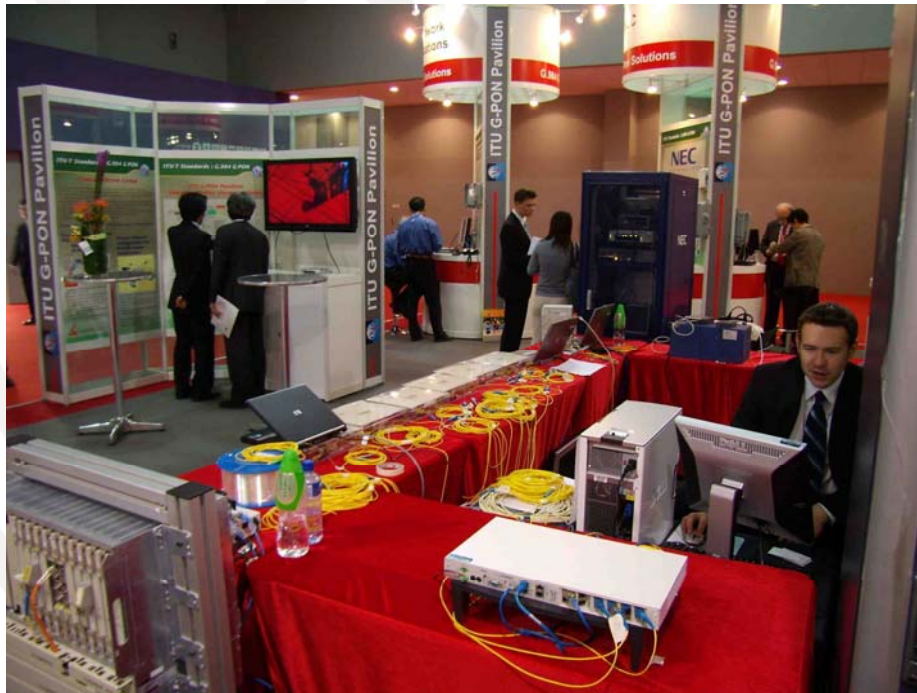
- ITU Telecom World, 2006 Hong-Kong
  - Focus was on G-PON
- NXTcomm, June 2007, Chicago
- NXTcomm, June 2008, Las Vegas

  To include reach extender to G.984.6

Why do we need Interoperability and How do we Achieve it?

- System Interoperability-Rationale
  - Reduce costs (by reducing number of variants)
  - Accelerate the competitive market
  - Minimise risk (avoids stranded assets)

- To achieve interoperability of the PON systems open interfaces are required at
  - Physical layer
  - TC layer
  - Control and management layer

What are the Key Priorities as we Move Forward in Standards?

- ITU-T has developed optical access systems based on key requirements from the operators
  - Backward compatibility with deployed ODNs
  - Wavelength plan
- Other requirements are
  - ODN power budget, e.g. Class B+
  - splitting ratio
  - capacity
  - distance (reach extension)
  - Reduced emissions
- For future systems target services to be accommodated should be clarified
- Power consumption
  - To limit and reduce emissions in a growing broadband market
- Reciprocal non-interfering of technologies
  - Silent start modes for P2P and PON
- Operation and Management
  - E.g. reach extension devices (to G.984.6)

G.984.5
Enhancement band for Gigabit Capable Optical Access Networks

- **Rationale**

  Optical Distribution Network (ODN) has a service life of several decades

  Optical Systems have a service life of one or two decades

  How can we upgrade the optical system without disturbing service to customers?

- **Options**

  Install another fibre for the next system

  Costly, but less so if part of 'day 1' ODN plan

  Not practical for all operator situations (when fibre is already present/lean)
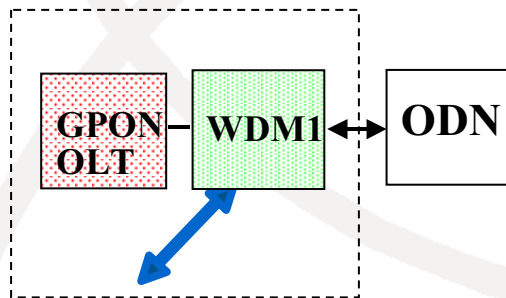
  Use WDM

  Enables reuse of ODN with migration of services to new system (Next Generation Access-NGA) as demand grows

  Key components are

  - NGA blocking filter at the user end
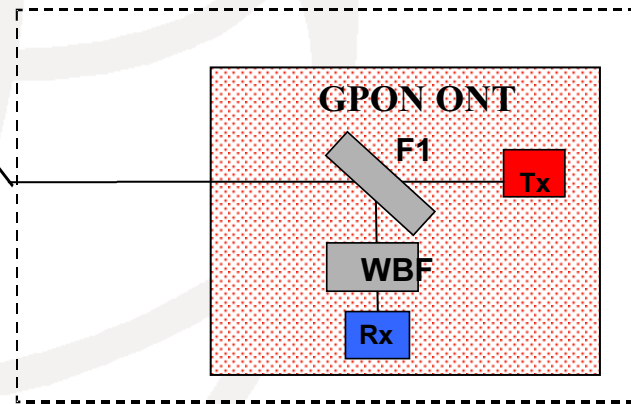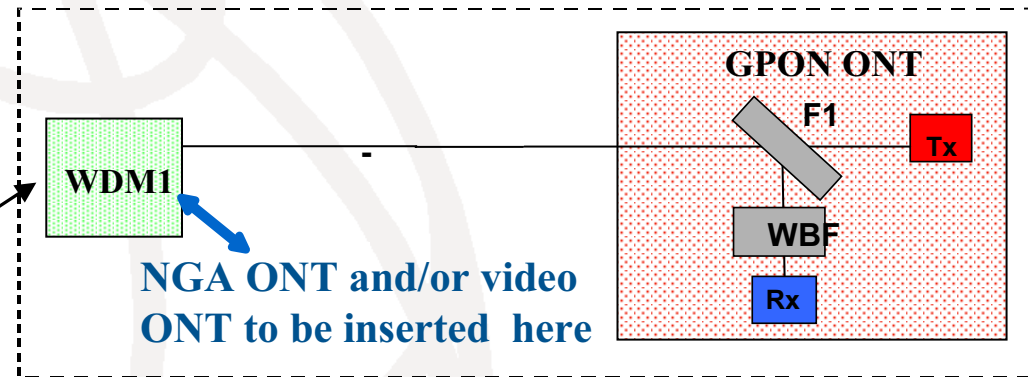 - WDM at network provider end

System Architecture

Business customer or video overlay customer

Local Exchange Central Office

WDM1

GPON OLT — WDM1 ↔ ODN

NGA ONT and/or video ONT to be inserted here

GPON ONT
F1
Tx
WBF
Rx

- **NGA OLT and/or video overlay OLT to be inserted here**

GPON ONT
F1
Tx
WBF
Rx

Residential customer (no video overlay)

NGA and G.984.5

- The purpose of G.984.5 is therefore to define Enhancement bands for NGA to be overlaid via WDM in future G-PON to maximize the value of optical distribution networks (ODNs) installed for PON

- NGA likely to be some combination of
  - 10 Gbit/s and/or
  - WDM and/or
  - Extended reach and/or split

- Full-scale development of NGA standard(s) will be held in the next ITU-T study period from 2009 to 2012.

GPON upstream

Enhancement band

GPON down-stream

Video overlay

1550 1560

Enhancement band

1260   1360 1400*   1450 1480 1500   1530   1625*
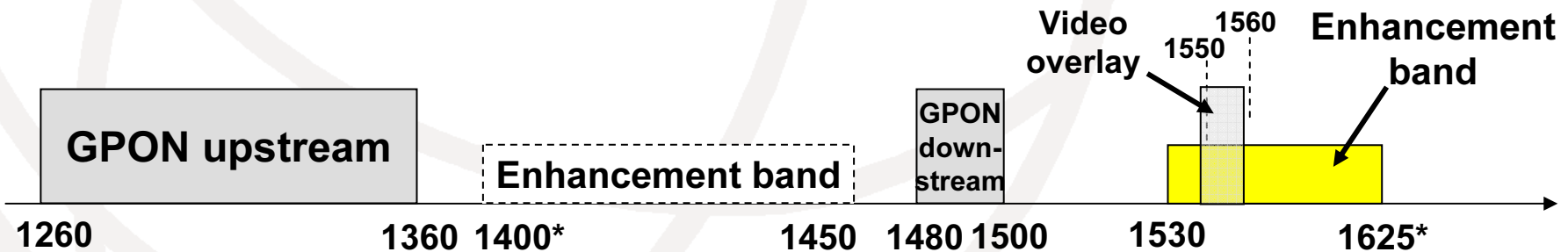
* Other options exist in G.984.5

How do we decide what NGA will be?

- Gather service and system requirements from members
- Set future targets based upon feasibility analysis of the optical components and key devices. Such as
  - How to gain 10 Gbit/s PON upstream and when will it be feasible?
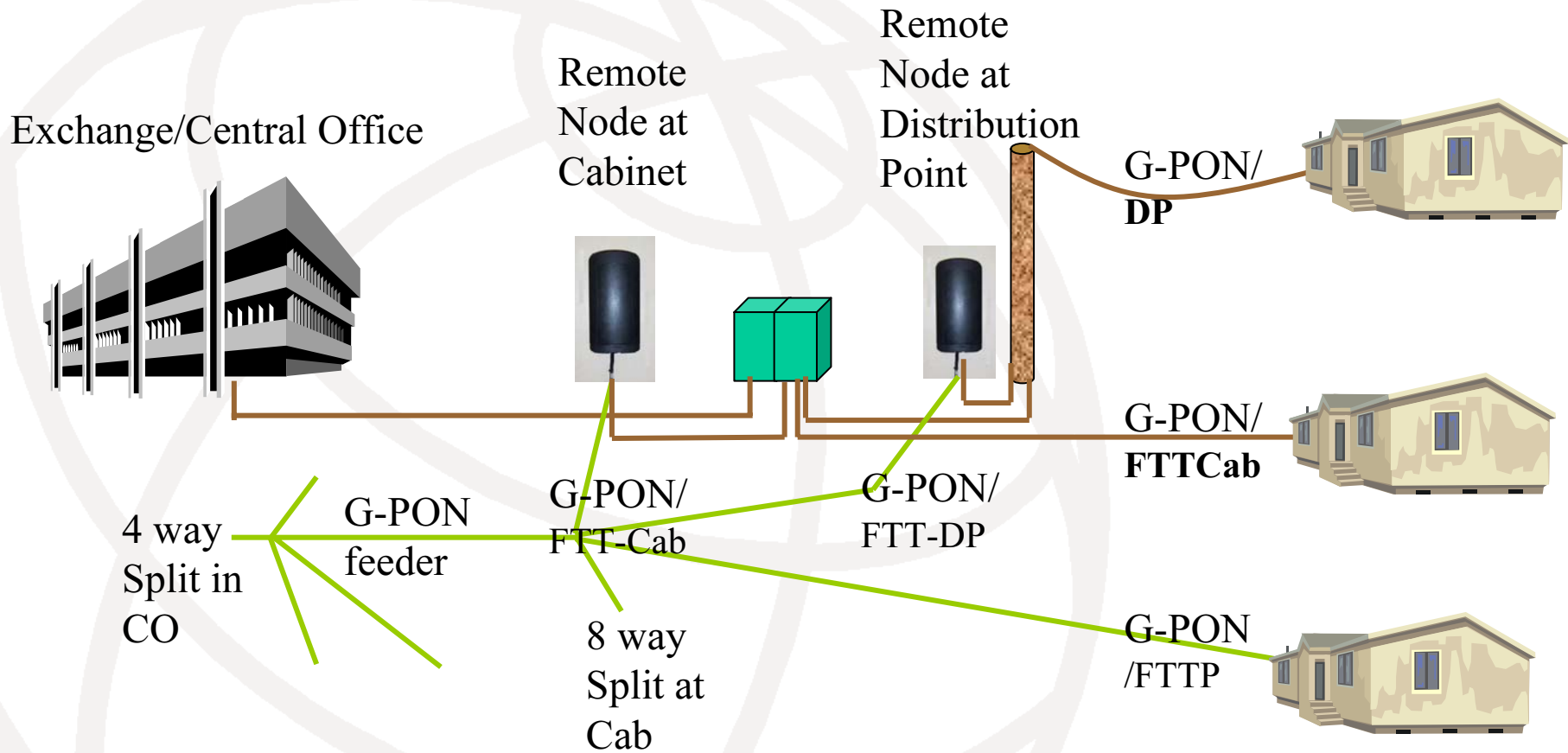 - How to upgrade the existing systems to the future ones?

Opportunities for ITU and IEEE Cooperation

- Agree a common ODN
  - To minimise risk of 'stranded' assets
  - We need a wavelength plan for upgrades including power levels for coexistence of systems

- Common optics requirements will focus market
  - E.g. wavelength, power, isolation
  - As was achieved for B-PON, G-PON and E-PON duplexing on a single fibre ODN

- A common line rate and wavelength plan for higher speed PON is a further goal for discussion
  - To focus further the market for NGA components

Bandwidth-Intensive Applications for NGA

- ■ As a video distribution network

    Either as part of baseband payload

    Or via RF overlays (carrying off-air type signals)

- ■ As feeder system for a hybrid Fibre/copper remote node

- ■ As a feeder system for wireless base stations

PON/xDSL Overlay
to re-use existing infrastructure

Exchange/Central Office

Remote Node at Cabinet

Remote Node at Distribution Point

G-PON/ **DP**

G-PON/ **FTTCab**

4 way Split in CO

G-PON feeder

G-PON/ FTT-Cab

G-PON/ FTT-DP

G-PON /FTTP

8 way Split at Cab

G-PON: Gigabit/s Passive Optical Network
DSL: Digital Subscriber Line

Fibre

Copper

PON as a Feeder System for Mobile/Wireless Access

- The P-MP topology and high capacity makes G-PON attractive as a feeder system for wireless base stations

- Capacity can be

  'nailed up' and guaranteed

  or dynamically allocated to the base station according to traffic demand

G-PON Protection

- **Dual homing added to allow backup of PON feeder from two COs**

- **A 1:n protection scheme has been included in G.984.1 (Revised) for G-PON**

  (In addition to existing schemes such as 1:1)

  - The external network (may be wireless etc) to provide a low-cost alternative path to G-PON
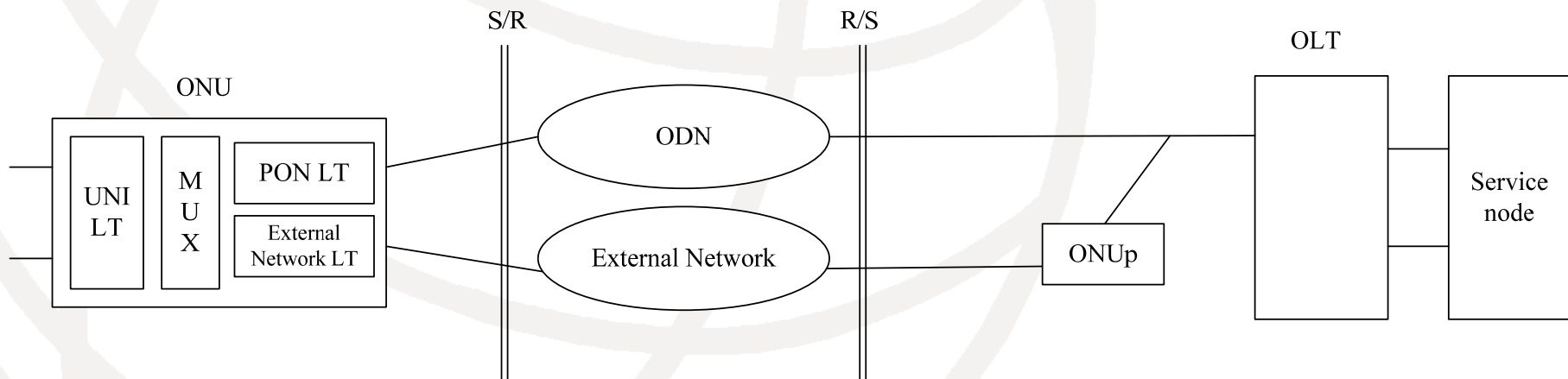
Opportunities for energy saving

- Longer reach to bypass Central Offices
  - Closure of offices saves power
- Reduce the number of service platforms
  - For POTS, data and video
  - Turn off old ones
- Reduce power consumption of ONT and ONU
  - Turning off unused devices/interfaces
  - More efficient design and integration of devices
  - Standby modes-when traffic is light
- Reduce the number of faults
  - Fewer despatches

Conclusion

- G-PON now a mature technology
    - Suppliers announced by Verizon, AT&T, France Telecom, British Telecom (pilot) and Telenor
    - Deployment in significant numbers expected in 2008

- Additional applications being considered for G-PON
    - Feeder system for a hybrid Fibre/copper remote node
    - Feeder system for wireless base stations
    - Multicast video network

- Next Generation Access topics for next ITU-T study period
    - How to gain 10 Gbit/s PON upstream and when will it be feasible?
    - How to upgrade the existing systems to the future ones (e.g. WDM)?
    - How to implement next generation systems with at least a 50% reduction in power over G-PON?