BT and The Developing Optical Access Network

Malcolm Campbell
BT Design
Introduction – FTTP… Past, Present and Future

The Past
- 1990’s system
- PON versus point-to-point
- TPON ► BPON ► GPON

The Present
- BT and Openreach
- GEA products
- GPON trial and pilot deployment

The Future
- BT plans
- Optical amplification
- The all optical network
FTTP in the Past – 1990s

- Deployment – 1990’s
- Early PON
  - Proprietary technology
  - TPON based
    - ISDN
- Customers
  - Business
  - Domestic/SOHO
- Reconfigurable to customer requirements

<table>
<thead>
<tr>
<th>Performance</th>
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<tbody>
<tr>
<td>Total bit rate</td>
<td>2 Mbit/s</td>
</tr>
<tr>
<td>Format</td>
<td>30 ISDN B channels</td>
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<tr>
<td>Max. No. customers per PON</td>
<td>28</td>
</tr>
<tr>
<td>Split</td>
<td>32 (1 or 2 level)</td>
</tr>
<tr>
<td>Topology</td>
<td>Ring or spine</td>
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### PON versus Point-to-Point

**Point-to-point for:**
- Demanding applications
- E.g. ISP, web hosting

**PON for:**
- Smaller enterprises
- Domestic users

**PON types:**
- **TPON**  
  - Low costs
  - High reliability
- **BPON**  
  - Low costs
  - High reliability
  - System issues
- **GPON**  
  - Low costs
  - High reliability
  - **Choice for future**
FTTP in the Near Past – BPON: 2004 Trial

- BPON
  - ECI technology
- Customers
  - Business
    - VPN
  - Domestic/SOHO
- Reconfigurable to customer requirements

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<th>Performance</th>
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<tbody>
<tr>
<td><strong>Total bit rate</strong></td>
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<tr>
<td><strong>Format (ATM)</strong></td>
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<tr>
<td><strong>Max. No. customers per PON</strong></td>
</tr>
<tr>
<td><strong>Split</strong></td>
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<td><strong>Topology</strong></td>
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BPON Trial Results – Customers

No new services introduced

Business
  • Encouraged remote working with VPNs (2 Mbit/s)
  • Improved e-communications with customers

Residential
  • Increase in browsing and file download
  • 2▸10 Mbit/s  (Only 25% noticed the difference!)
  • Some customers ▶18 Mbit/s
  • Smaller (internal) ONT
BPON Trial Results – BT

**OPEX**

- Provision costs lower (by design)
- Fault rates 25-30% those of copper
- Fault cost much larger than copper
- Overall ⅓ lower than copper

**Technology**

- GPON for future FTTP
- Higher capacity
- Better support for Ethernet and TDM

**Processes and Systems**

- Trial used manual P&S; no integration with ‘business-as-usual’
- Strategic deployment requires considerable P&S development
The Present – GPON

GPON systems attractive for FTTH:
- Large scale telco deployments announced in the last year
- Class B+ budget = 28 dB
- 32 customers can be served up to 20 km from CO
- Class C+ budget extension to 32 dB (x32 29 km or x64 20 km)

GPON Transmission Convergence (TC) layer allows:
- Up to 60 km ‘reach’
- Up to 128 addressable customer ONTs

Operators would like to take full advantage of TC:
- Requires additional optical ‘reach’
  - Development of ‘Extender Box’ (OEO or optical amplifier)
  - Extender Box Recommendation in development
GPON Technology

Technology of choice for Green Field deployments

Trial December 2007

Pilot Deployment August 2008
Non-Green Field Sites – 1

FTTP/GPON good for Green Field

- But…
  - Existing copper users also require extra bandwidth
  - xDSL performance is reach dependent
  - VDSL2 is capable of 50 Mbit/s over <1km

1999 Concept: VDSL brick

- Similar to active cabinet (2006 BT IWCS paper)
- But..
  - Buried… and more secure
  - Simpler OSS… through fibre (GPON fed)
  - Small remote nodes scaled to market demand
Non-Green Field Sites – 2

Conversion
- Copper to fibre
- No plans at present
- Under investigation

Issues
- Copper recovery versus over-build
- Gradual take-up of services
- Cost of civil works
BT Structure – Openreach

Responsible for BT’s access network

Allows BT to be compliant with UK regulator (Ofcom)

“Final Statements on the Strategic Review of Telecommunications, and Undertakings…” (September 2005)

- Same product or service to all CPs
  - “Equivalence of input”
- LLU (full or shared) for copper
- Bitstream products proposed for fibre
  - Generic Ethernet Access (GEA)……

Customers are Communications Providers

Telephony and Internet

E.g. Easynet, Carphone Warehouse, BT Retail, Virgin Media
GEA Products and Unbundling

GEA Products
Data, Voice, Ethernet

Allow unbundling

PON at the service level

To multiple Communications Providers
FTTP GEA Architecture

CP1 Outside BT building
- CP HO Frame
- CP HO Frame
- CP HO Frame
- CP HO Frame
- CP HO Frame
- CP HO Frame
- CP Interconnect (Central Office)
- External Network (Shared bandwidth)
- Optical interfaces (1 or 10 Gbit/s)
- GPON OLT
- Layer 2 Switch (if required)
- ONT 1
- ONT 32
- End User
- Port 1
- Port 4
- Port 1
- Port 4
- End User Interface:
  - 10 Mbit/s
  - 100 Mbit/s
  - 1 Gbit/s
  - Ethernet

Openreach GEA Products
- Data
- Voice enablement
- CP Gig Ethernet port

Hand-over Point
Existing Products

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Systems Issues - Dependencies

- Reliability
  - Fibre and cable
  - Electronics
  - Optical components

- OPEX
  - Fault rates
  - Fault costs
  - OSS tools
  - Power issues
  - High up-front
  - Uncertain take-up
  - Uncertain revenues

- CAPEX
  - Plan and build
  - Service fulfilment
  - Service assurance
  - New skills and activities

- Testing and Diagnostics
  - Connectivity
  - In-service performance
  - Supervisory

- OSS
  - Connect the dots with reliability

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The Future – Long Reach

ITU-T G.984.2

- Class B 25 dB ~ 14 fibre km
- Class B+ 28 dB ~ 20 fibre km
- Class C+ 32 dB ~ 29 fibre km

Beyond 29 km

- Extender Box
- (With additional 1x4 split)

GPON OLT 1480 – 1500 nm 1260 – 1360 nm GPON OLT

WDM1

EB

PON

ONT Blocking Filter

NGA OLT 1524 – 1620 nm

NGA OLT

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Compliance

ITU-T G.984

- GPON extended reach systems
- Architecture and interface parameters

GPON OLT

NGA OLT

1260 – 1360 nm

WDM

EB

PON

ONT Blocking Filter

1480 – 1500 nm

1524 – 1620 nm

1524 – 1620 nm

GPON ONT

NGA ONT

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The Possible Future – Removal of Exchanges
The Future – The (near) All Optical Network?

Long reach access – 100 km

Non-FTTP

Large Business

Splitter Node

FTTP

10 Gbit/s

2.5/5 Gbit/s

Active Street Node

DSL

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Summary

The Past…
• Pre-DSL
• Early PON deployment (1990’s) ~1 Mbit/s

The Present…
• DSL
• FTTP/PON trials ~2 ➤ 20 Mbit/s

The Future…
• All optical
• Long reach ~100 Mbit/s to 1 Gbit/s