BT and The Developing Optical Access Network

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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

Performance	
Total bit rate	2 Mbit/s
Format	30 ISDN B channels
Max. No. customers per PON	28
Split	32 (1 or 2 level)
Topology	Ring or spine

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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**

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FTTP in the Near Past – BPON: 2004 Trial

- BPON
  - ECI technology
- Customers
  - Business
    - VPN
  - Domestic/SOHO
- Reconfigurable to customer requirements
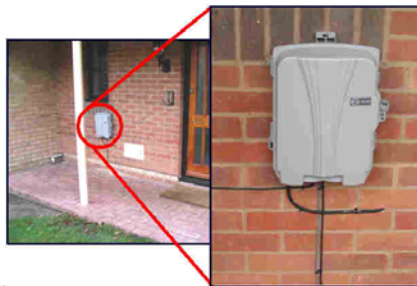
Performance	
Total bit rate	622 Mbit/s down 155 Mbit/s up
Format (ATM)	Residential: 2 → 10 Mbit/s asym. 1 x POTS Business: 2 Mbit/s sym. 4 x POTS
Max. No. customers per PON	≥ 28
Split	32 (1 or 2 level)
Topology	Spine

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

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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

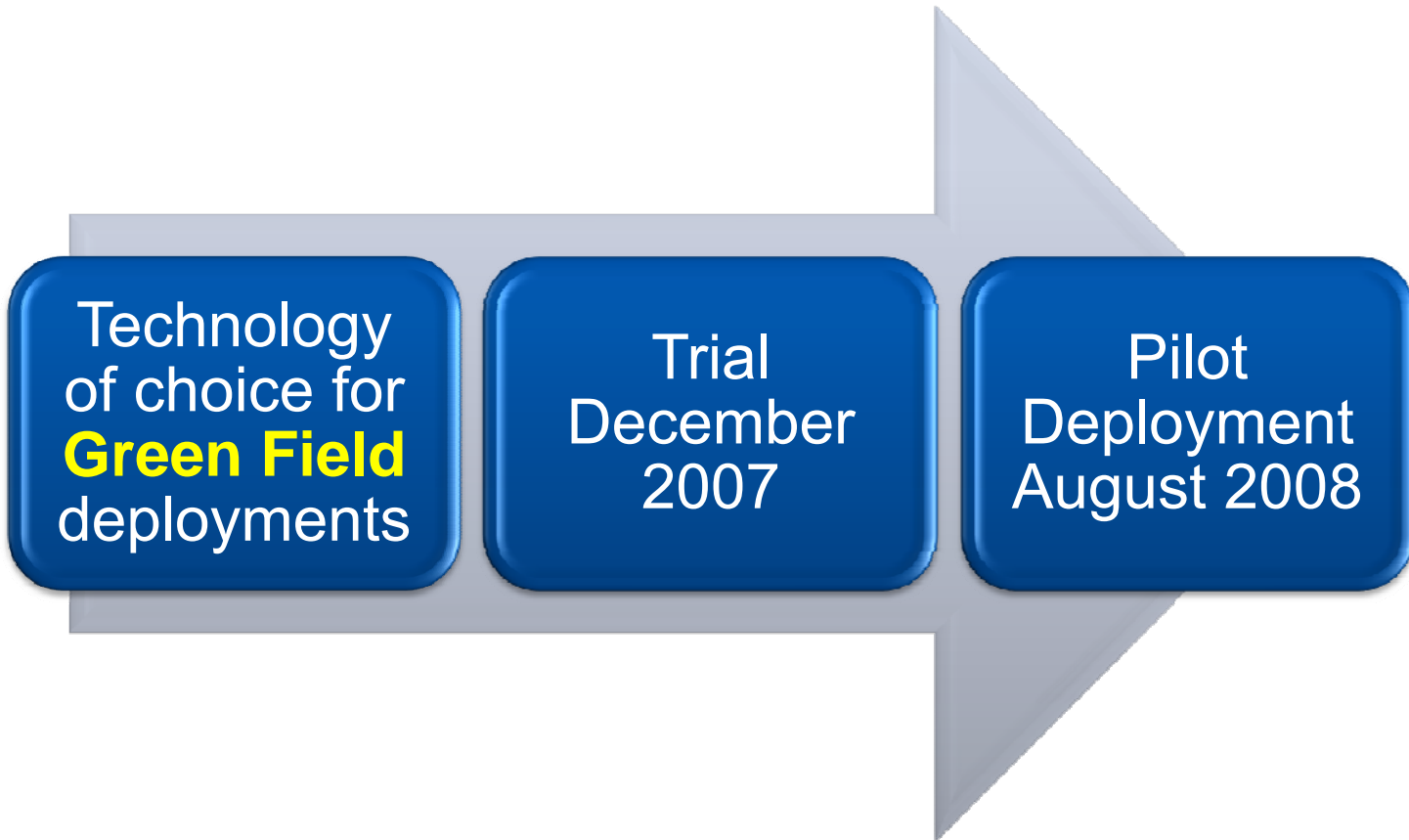| **GPON systems attractive for FTTH:**	• Large scale telco deployments announced in the last year • Class B+ budget = 28 dB • 32 customers can be served up to 20 km from CO • Class C+ budget extension to 32 dB (x32 29 km or x64 20 km)
GPON Transmission Convergence (TC) layer allows:	• Up to 60 km 'reach' • 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

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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

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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

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BT Structure – Openreach

Responsible for BT's access network
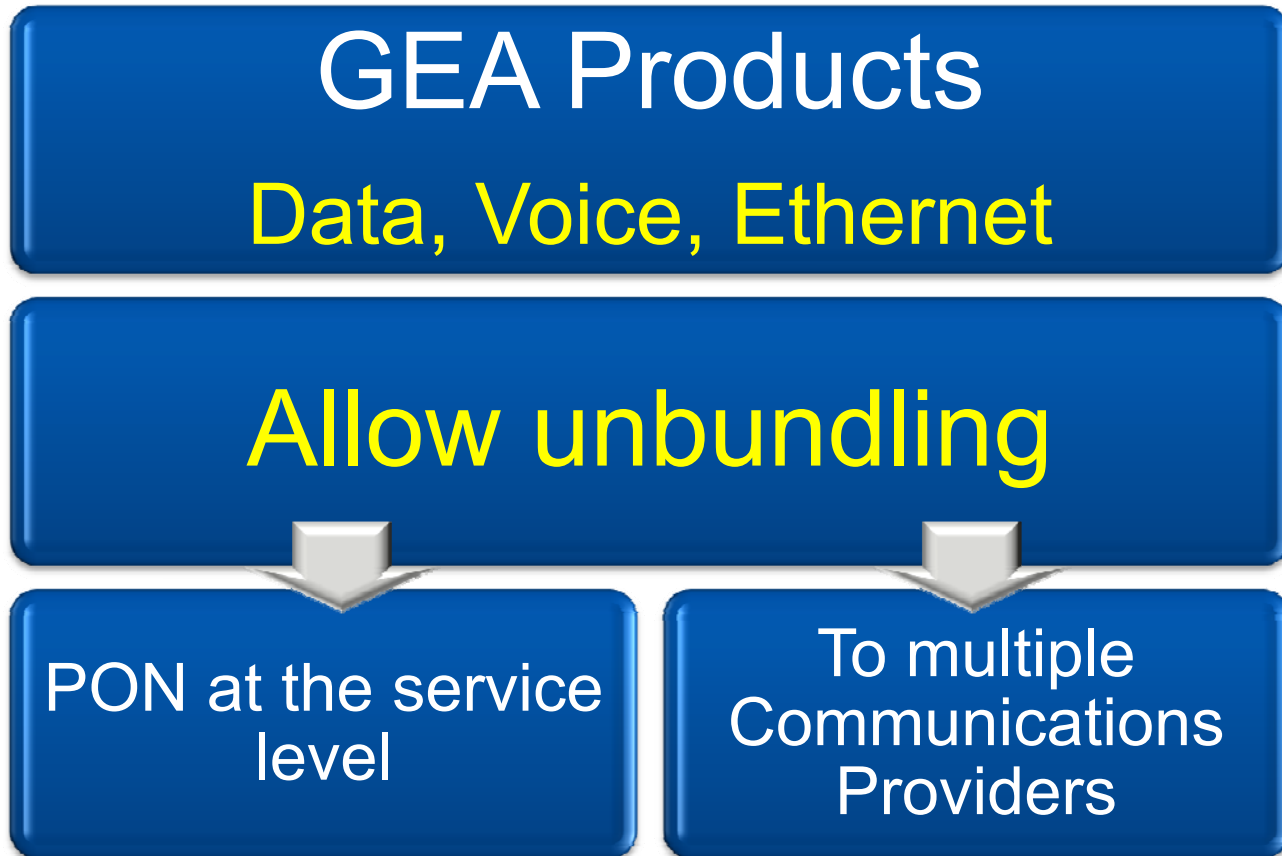
Allows BT to be compliant with UK regulator (Ofcom)

"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

CP Interconnect
(Central Office)

External Network
(Shared bandwidth)

End User

CP1 Outside BT building
CP HO Frame

In-span Hand-over

CP2 in same BT building
CP HO Frame

In-building Hand-over

Optical interfaces (1 or 10 Gbit/s)

CP3 Remote different BT building
CP HO Frame

ONBS

CP3 Remote different BT building
CP HO Frame

ONBS

T

R

Layer 2 Switch (if required)

GPON OLT

GPON OLT

2.5 Gbit/s

1.2 Gbit/s

32-way split

32-way split

28 dB Max.

ONT 1

ONT 32

Port 1

Port 4

Port 1

Port 4

S

End User Interface:

10 Mbit/s
100 Mbit/s
1 Gbit/s

Ethernet

Hand-over Point

Existing Products

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

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Systems Issues - Dependencies

- Fibre and cable
- Electronics
- Optical components

Reliability

- Fault rates
- Fault costs
- OSS tools
- Power issues

OPEX

Testing and Diagnostics

- Connectivity
- In-service performance
- Supervisory

- High up-front
- Uncertain take-up
- Uncertain revenues

CAPEX

OSS

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

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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) |

ONT Blocking Filter

GPON OLT — 1480 –1500 nm → WDM1 — EB ⇄ — PON — ← 1260 –1360 nm — GPON ONT

NGA OLT

NGA ONT

1524 –1620 nm

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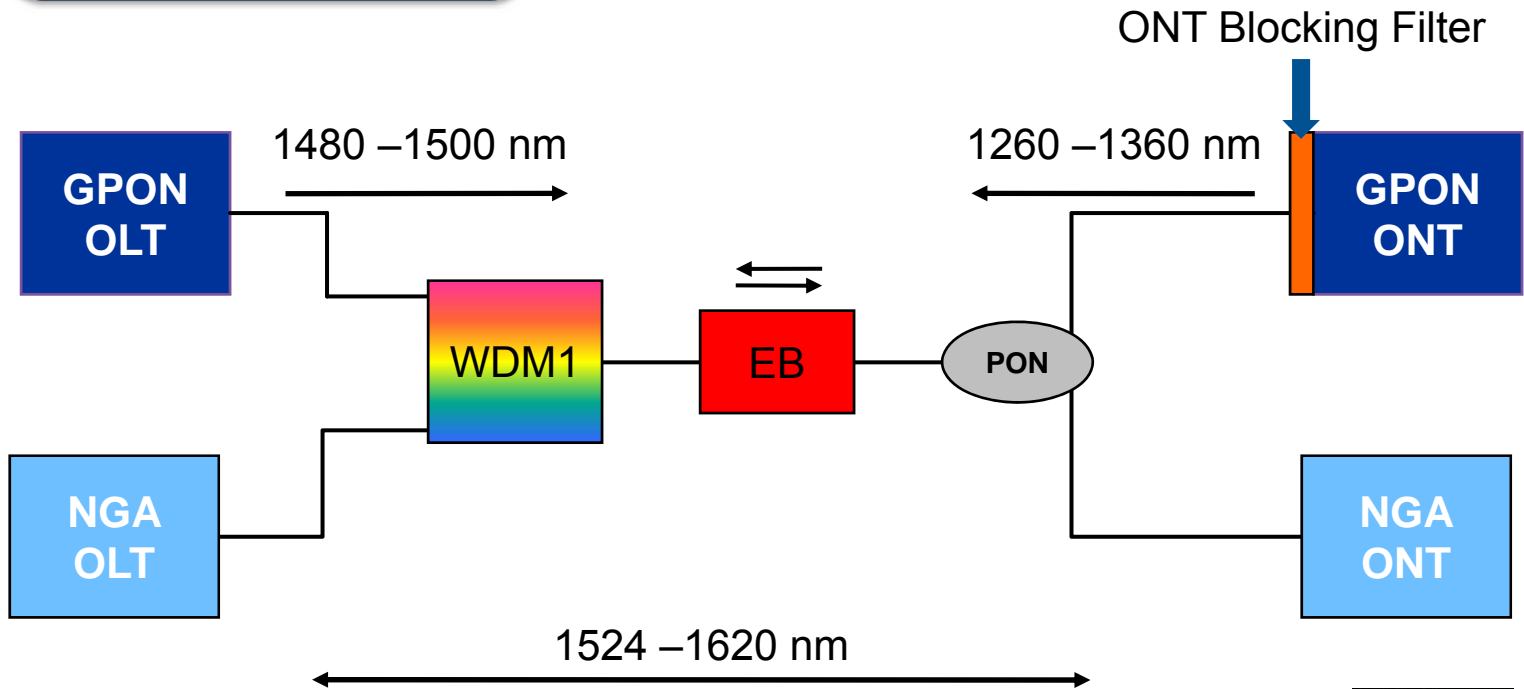
Compliance

| ITU-T G.984 | • GPON extended reach systems
• Architecture and interface parameters |

ONT Blocking Filter

GPON OLT   1480 – 1500 nm →   1260 – 1360 nm ←   **GPON ONT**

WDM — EB — PON

NGA OLT   1524 – 1620 nm   **NGA ONT**
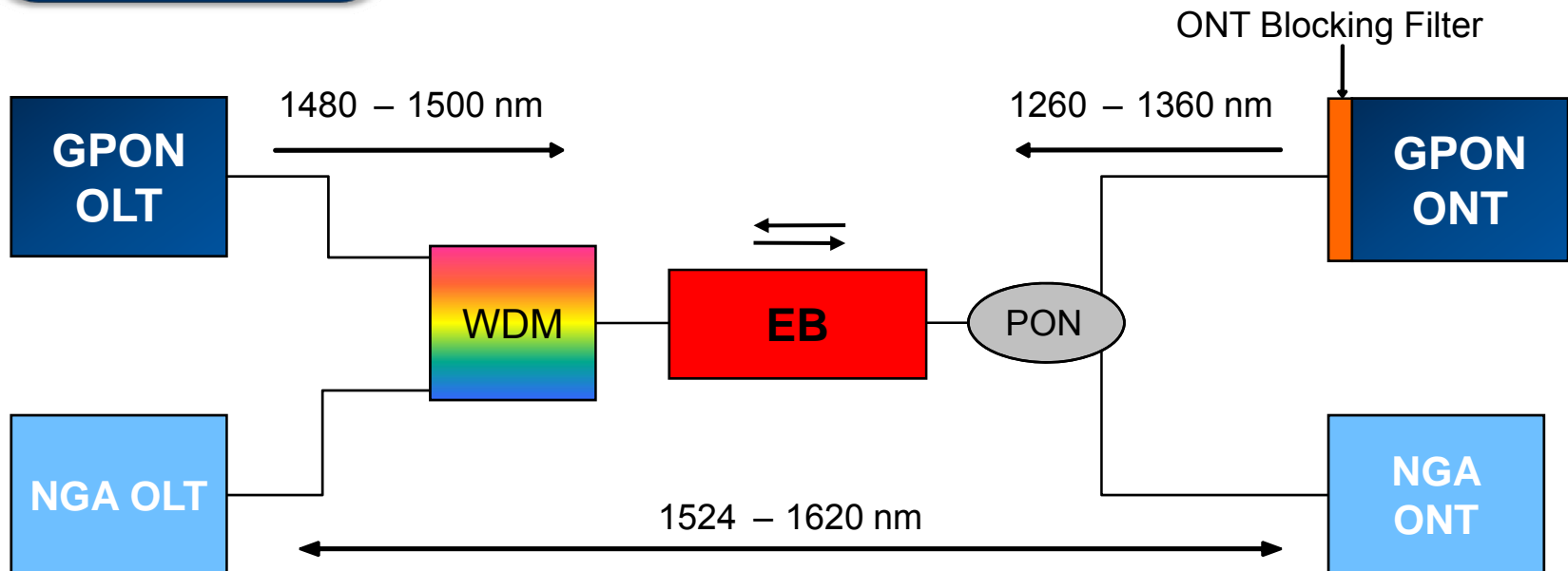
The Possible Future – Removal of Exchanges
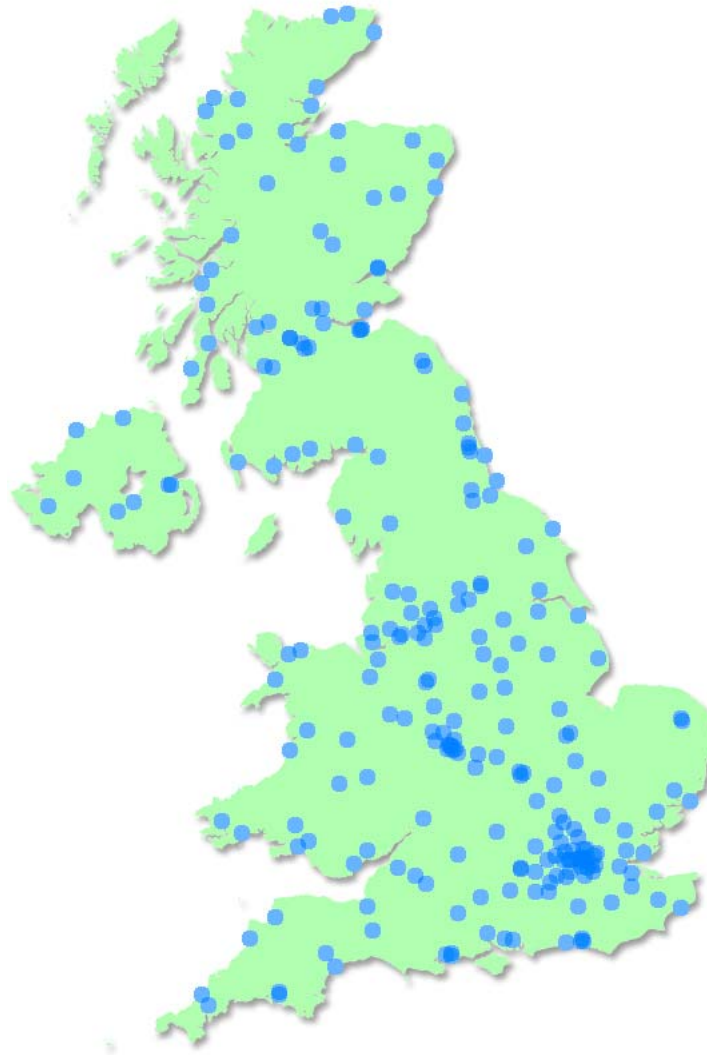
The Future – The (near) All Optical Network?

Non-FTTP

Long reach access – 100 km

Large Business

10 Gbit/s

2.5/5 Gbit/s

Splitter Node

FTTP

Active Street Node

DSL

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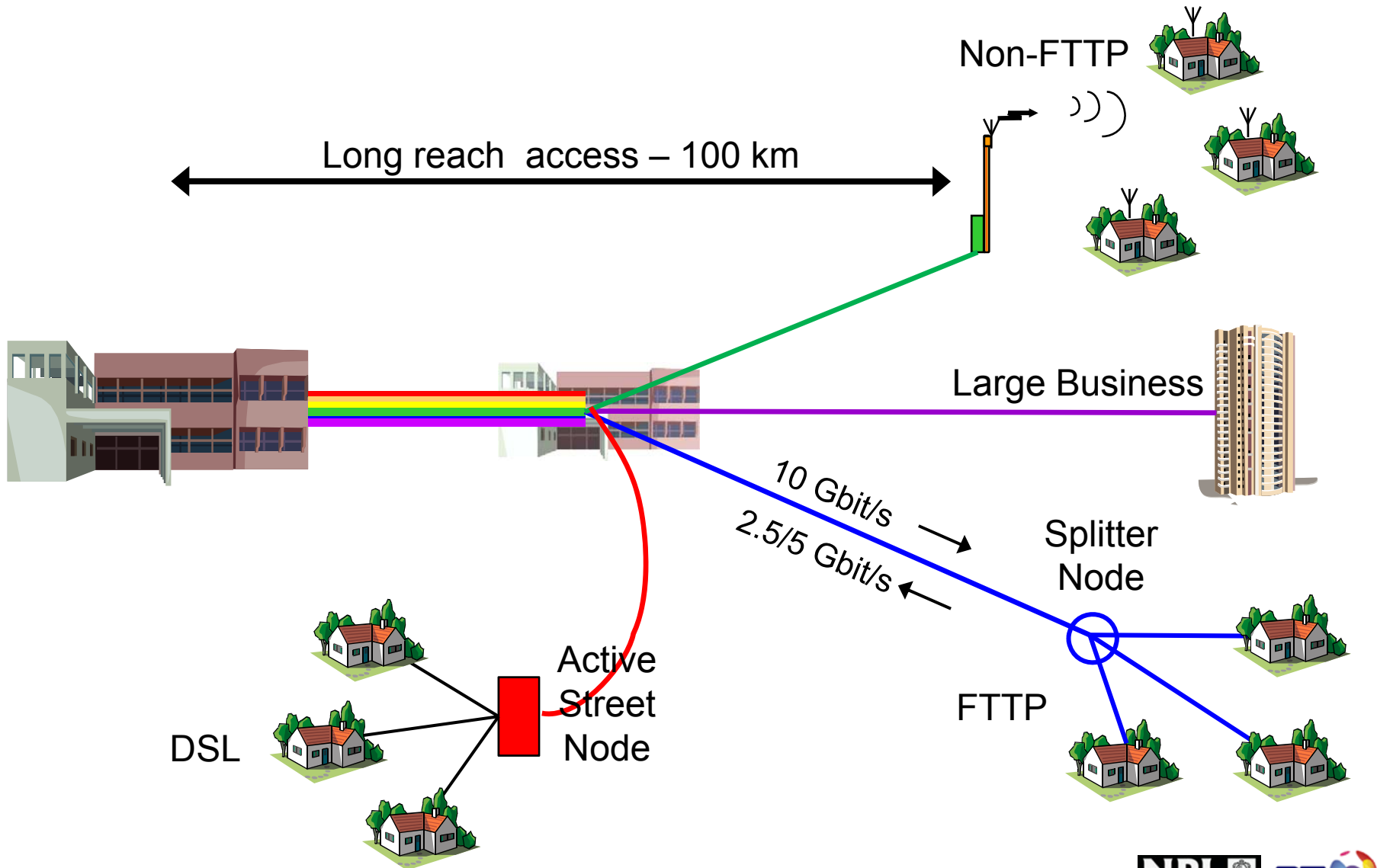
Summary

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

Bringing it all together