Maximize your network value

The Requirements and Evolution to Next Generation Optical Access Network

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HUAWEI TECHNOLOGIES CO., LTD.

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- Optical access status

- Next generation PON technologies

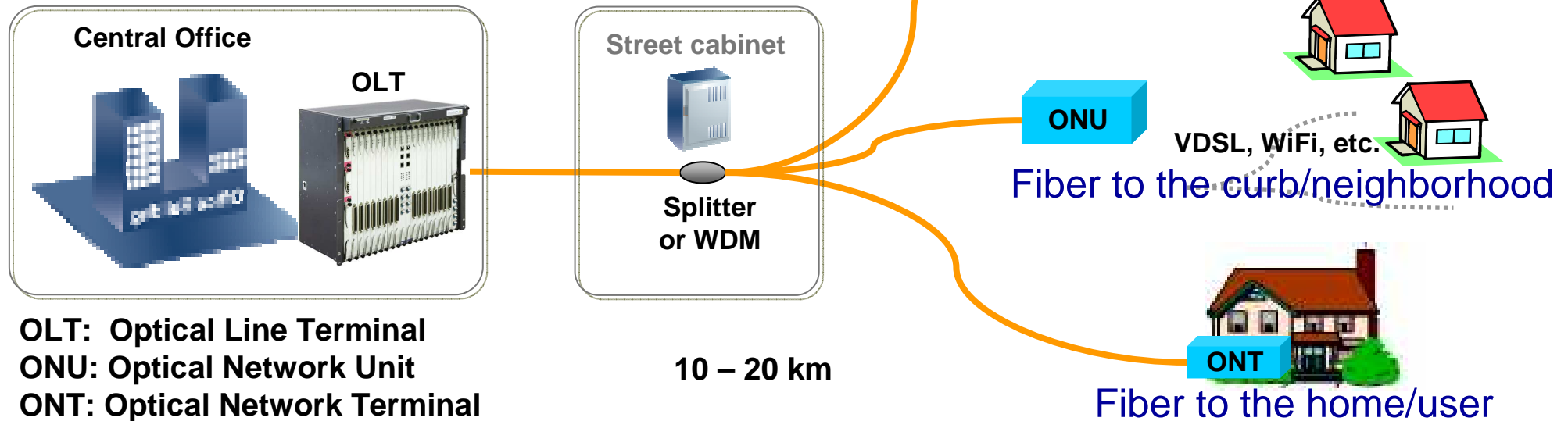# Broadband Optical Access

- **Network Architecture**

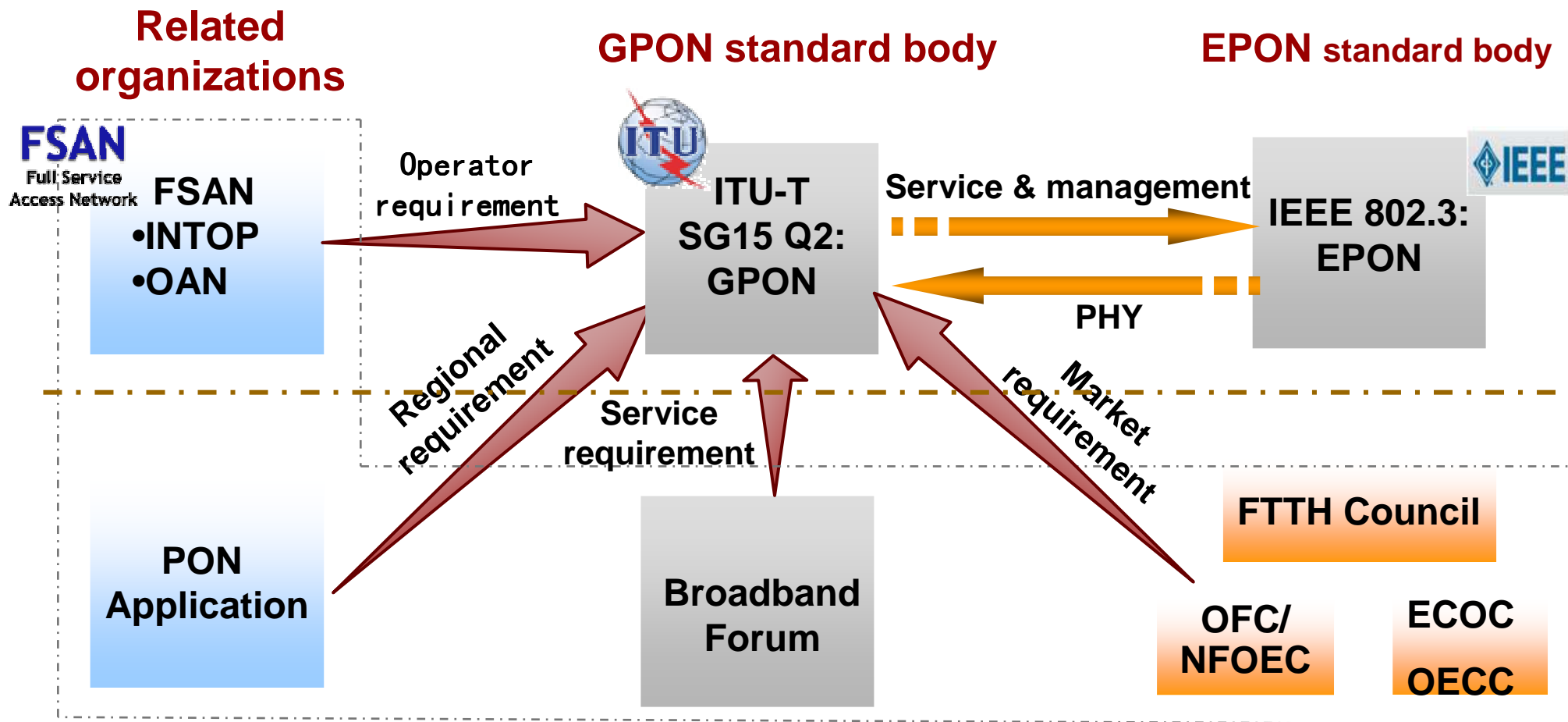   - Point-to-point: Active Ethernet

    - Point-to-multipoint: tree topology

        High-bandwidth and low cost per bit

        High reliability and easy maintenance

- **Access schemes**

    - TDM   • SCM/OFDM

    - WDM   • OCDMA

FTTx for Broadband Access

ONU

Fiber to the office/business

Central Office

OLT

Street cabinet

ONU

VDSL, WiFi, etc.

Splitter
or WDM

Fiber to the curb/neighborhood

OLT: Optical Line Terminal
ONU: Optical Network Unit
ONT: Optical Network Terminal

10 – 20 km

ONT

Fiber to the home/user

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Standard Bodies and Related Organizations

Related organizations

GPON standard body

EPON standard body

FSAN
- INTOP
- OAN

Operator requirement

ITU-T SG15 Q2: GPON

Service & management

IEEE 802.3: EPON

PHY

Regional requirement

PON Application

Service requirement

Broadband Forum

Market requirement
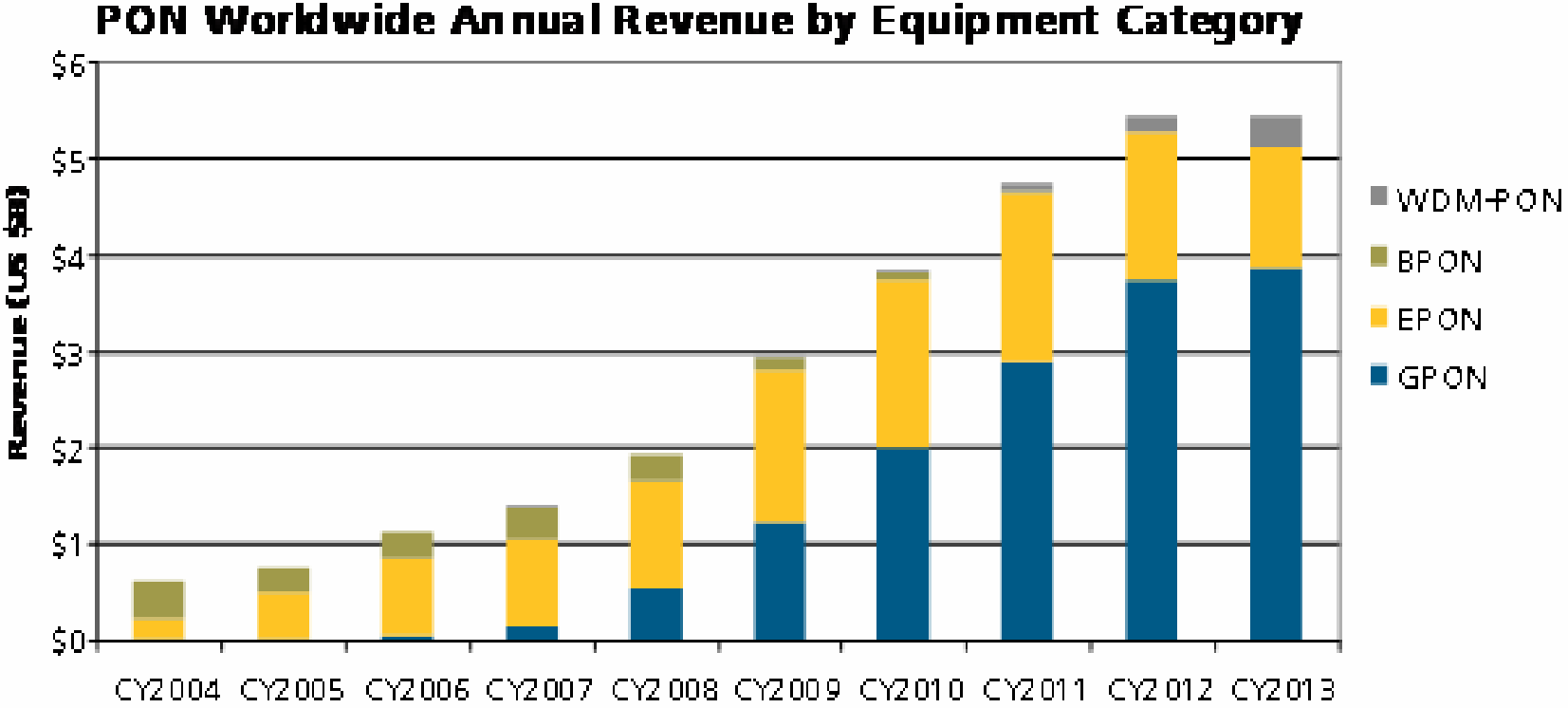
FTTH Council

OFC/ NFOEC

ECOC OECC

■ **Standard bodies and related organizations work together to promote optical access technologies and standards.**

FSAN and ITU-T Working Flow
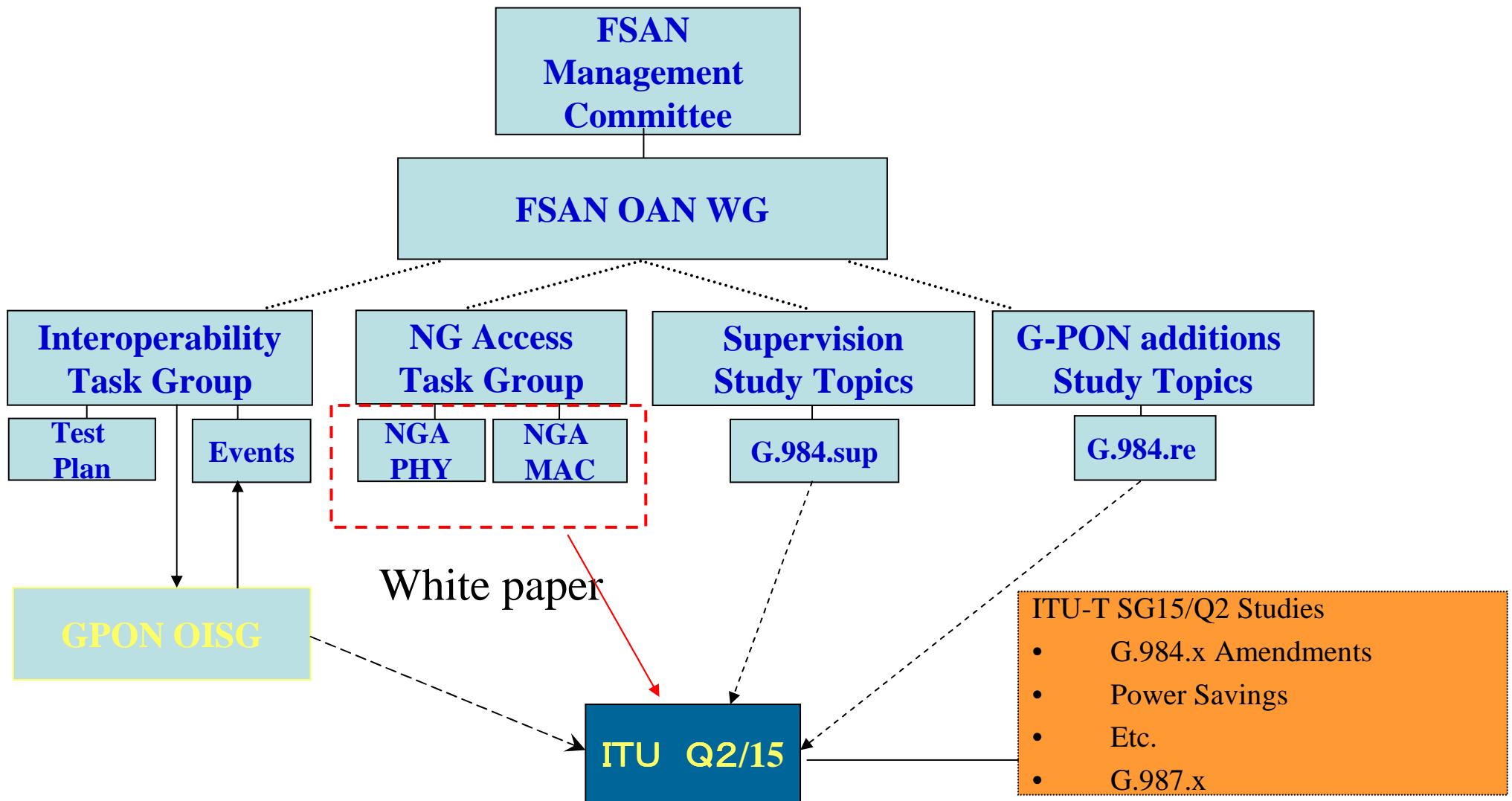
FSAN summarizes the requirements of operator and technical whitepaper as input of ITU_T.

Trends of XPON Market Share

PON Worldwide Annual Revenue by Equipment Category

Legend:
- WDM-PON
- BPON
- EPON
- GPON

X-axis: CY2004, CY2005, CY2006, CY2007, CY2008, CY2009, CY2010, CY2011, CY2012, CY2013

Y-axis: Revenue (US $b)

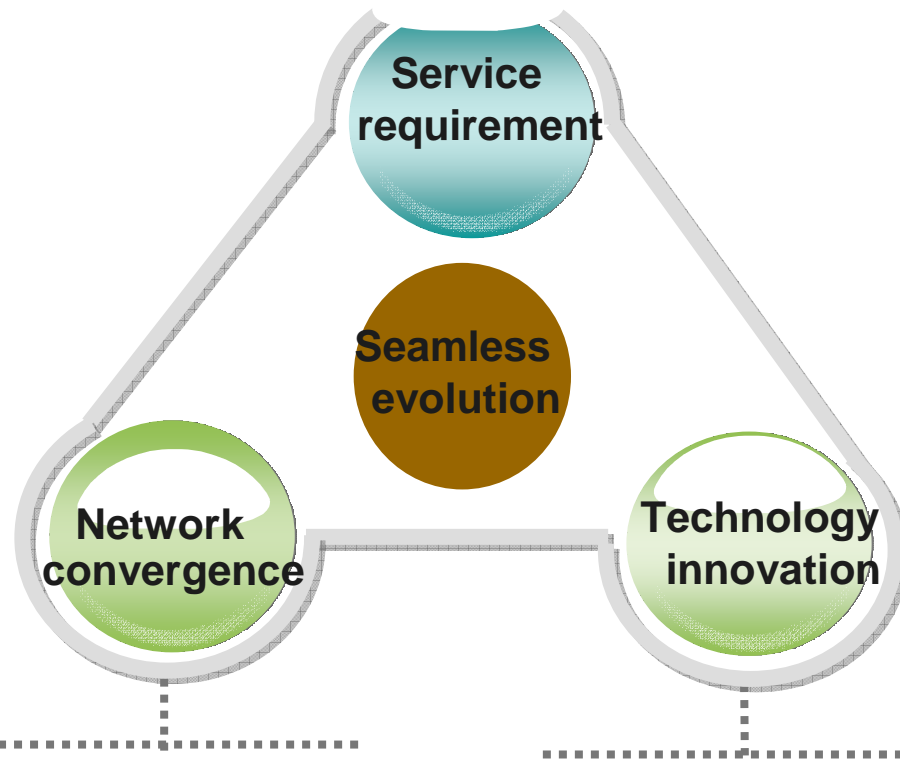*Source: infonetics,2009*

Trends of xPON market share

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- Optical access status

- Next generation PON technologies

Three Driving Forces for NG PON

- **higher service requirements**

Service requirement

Seamless evolution

Network convergence

Technology innovation

- **network structure changes**
- **carrier network converges**

- **new technology achievement**

- **Seamless Evolution helps to saving the system investments**

- **ODN compatibility and smooth upgrade – helps to saving the construction investment**

- **more users, higher density**
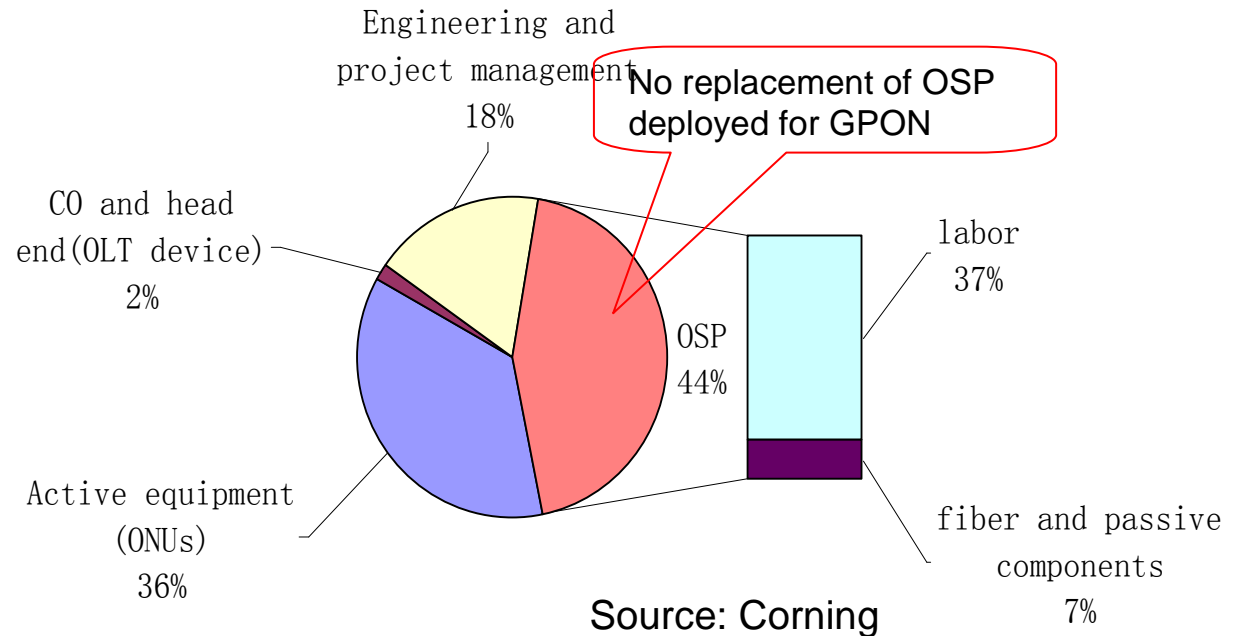
- **higher rate, larger bandwidth**
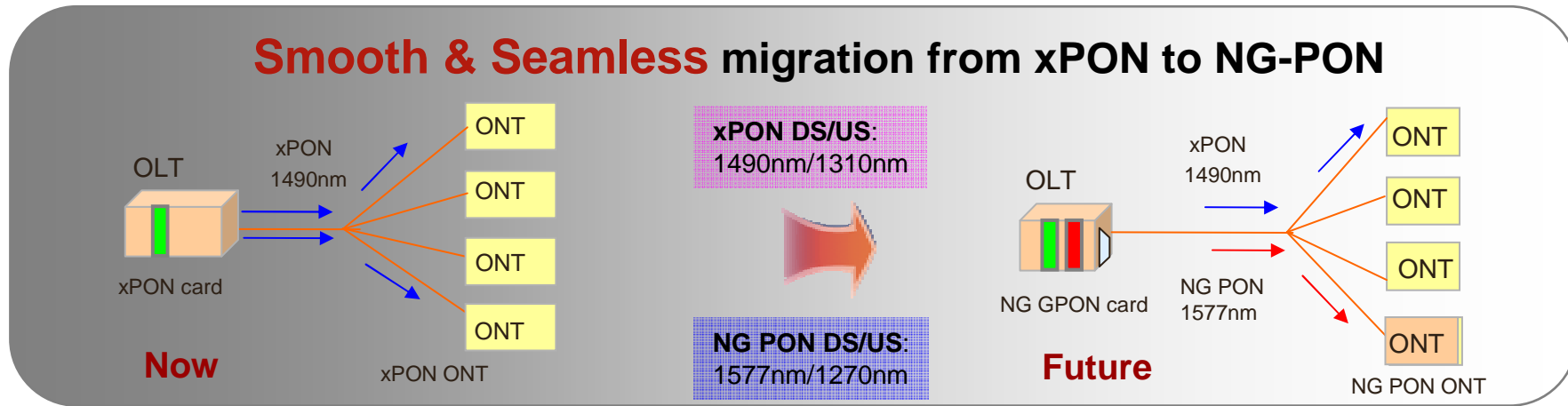
With Evolution, What Stays?

- **In a word, the outside plant**

  - Huge investments have been made in OSP

  - Purported life of this investment is >30 years

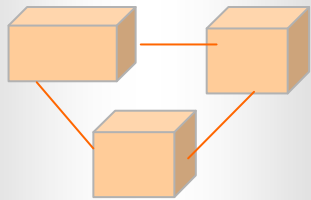 - To ask for its replacement in 10 years would be suicide

- **For the next 15 years, we must use this ODN network**

Engineering and project management 18%

CO and head end(OLT device) 2%

No replacement of OSP deployed for GPON

OSP 44%

Active equipment (ONUs) 36%

labor 37%

fiber and passive components 7%

Source: Corning

Four Key Issues for Seamless Migration

Smooth & Seamless migration from xPON to NG-PON

Now

OLT
xPON 1490nm
xPON card

ONT
ONT
ONT
ONT

xPON ONT

xPON DS/US: 1490nm/1310nm

NG PON DS/US: 1577nm/1270nm

Future

OLT
NG GPON card

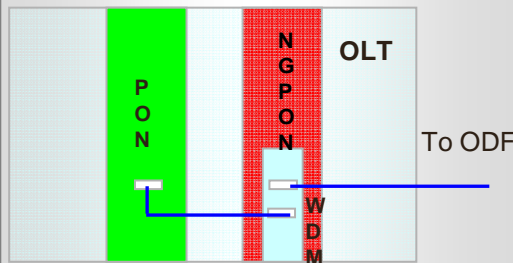xPON 1490nm
NG PON 1577nm

ONT
ONT
ONT
ONT

NG PON ONT

Unified EMS

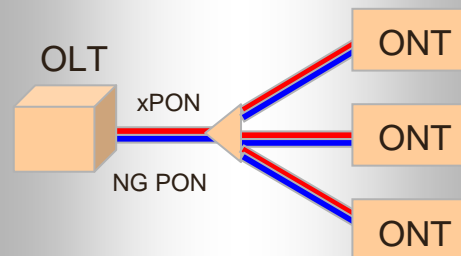- Physical adaption layer for different PON technologies
- Same OSS integration platform
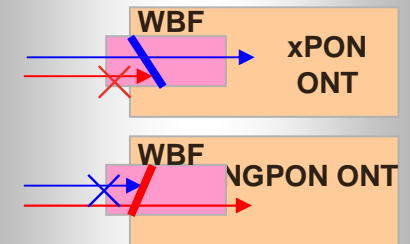
Platform Ready
Compatible with NG PON

PON
NGPON
WDM
OLT
To ODF

- 40G/slot
- NG PON Compatible chassis
- Integrated passive WDM

ODN Ready
Reusing ODN network With multiple wavelength

OLT
xPON
NG PON

ONT
ONT
ONT

- Reuse existed ODN

ONU Ready
Built-in WBF (Wavelength Block Filter)

WBF
xPON ONT

WBF
NGPON ONT

- xPON ONU integrated NG PON WBF currently
- NG PON ONU with xPON WBF in the future

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Technical Candidates for NG-PON

Higher speed TDMA-PON

   High speed Burst mode Transceiver

   10Gbps DML (Direct Modulator Laser)

   2.5G/10G TIA (Trans-Impedence Amplifier), LA (Limiting Amplifier),

   BCDR (Burst Clock and Data Recovery)

WDM-PON

   Colorless light source for ONU – IL-FPLD, RSOA, Tunable Laser

   High power BLS (Broadband Light Source)

   Athermal AWG (Array Wave Grating)

Hybrid WDM-TDMA PON
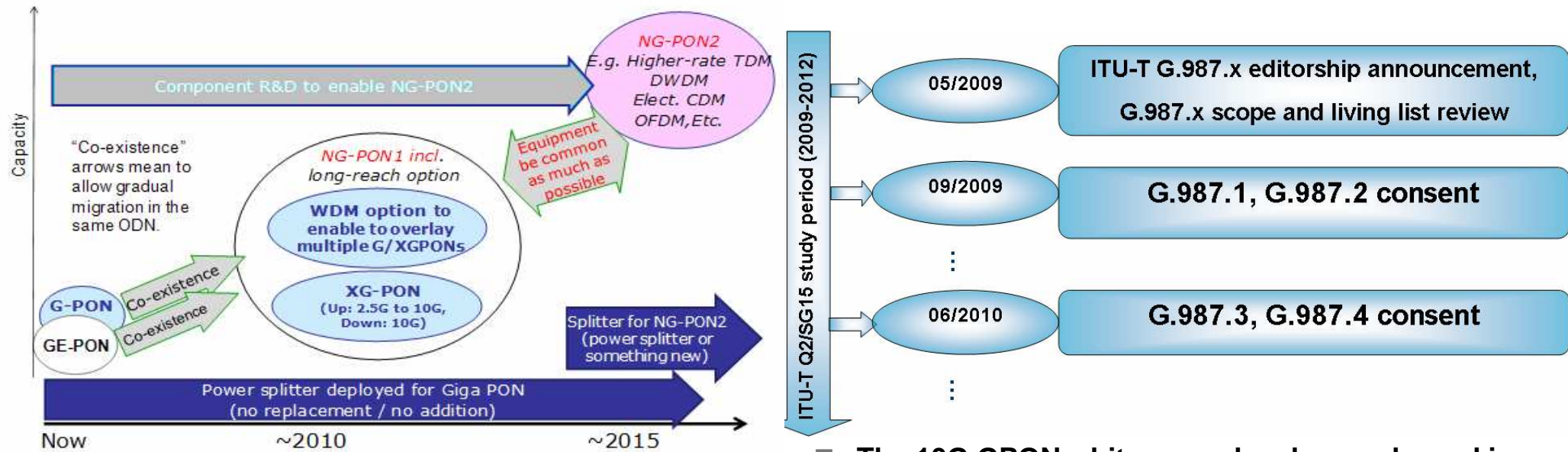
   Hybrid WDM-TDMA Components

EPON /10G EPON/10G GPON Comparison

Item	EPON	10G EPON		10G GPON	
		10G/1G EPON	10G/10G EPON	10/2.5G GPON (XG-PON1)	10G/10G GPON (XG-PON2)
Line rate	1G DS/1G US	10G DS/1G US	10G DS/10G US	10G DS / 2.5G US	10G DS/10G US
Upstream Line code (efficiency)	8B10B (75%)	8B10B (75%)	64B66B(97%)	NRZ (efficiency 100%)	TBD
Split ratio	1:32	1:16/32	1:16/32	≥1:64	≥1:64
FEC	RS(255, 239), option	RS(255,223), mandatory	RS(255,223), mandatory	TBD	TBD
Wavelength plan	1480-1500nm DS/1260-1360nm US	1575-1580nm DS/1260-1360nm US	1575-1580nm DS/1260-1280nm US	1575-1580nm DS/1260-1280nm US	1575-1580nm DS/1260-1280nm US
Max. Distance	20km	20km	20km	≥20km	≥20km
Power budget	PX 10/20	PRX 10/20/30	PR 10/20/30	Class B+, Class C+	Class B+, Class C+
MAC	MPCP	MPCP	MPCP	XGTC	XGTC
Service provisioning	Over Ethernet frame	Over Ethernet frame	Over Ethernet frame	Over GEM frame	Over GEM frame
Management	MPCP for basic management	MPCP for basic management	MPCP for basic management	OAM+PLOAM+OMCI for comprehensive Management	OAM+PLOAM+OMCI for comprehensive Management
Key challenge	1G BMT/R	1G BMT/R	10G BMT/R, 10/1G BMR	2.5G BMT/R	10G BMT/R
Cost	Low	Relatively high	High	Relatively low	High
Standard body	IEEE 802.3ah	IEEE 802.3av	IEEE 802.3av	ITU-T Q2/SG15, G.987 series	ITU-T Q2/SG15, G.987 series

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10G EPON/10G GPON WDM-PON Comparison

Item			10G GPON	10G EPON	WDM PON
Ultra-broadband		D.S. Bandwidth	10Gbps shared	10Gbps shared	1Gbps/ λ individual
		U.S. Bandwidth	2.5Gbps shared; 10Gbps shared;	1Gbps shared; 10Gbps shared;	1Gbps/ λ individual
Convergence			possible	possible	possible
Compatibility	BPON	Possibility	Yes	Yes but complex	Yes
		ODN protection	untouched	untouched	touched
		Service Interruption	No	Yes	No
	EPON	Possibility	Yes but complex	Yes	Yes
		ODN protection	untouched	untouched	touched
		Service Interruption	Yes	Yes	No
	GPON	Possibility	Yes	Yes but complex	Yes
		ODN protection	untouched	untouched	touched
		Service Interruption	No	Yes	No

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10G GPON standard is coming in Sep 2010

- **ITU-T G.987.x editorship announcement, G.987.x scope and living list review** — 05/2009
- **G.987.1, G.987.2 consent** — 09/2009
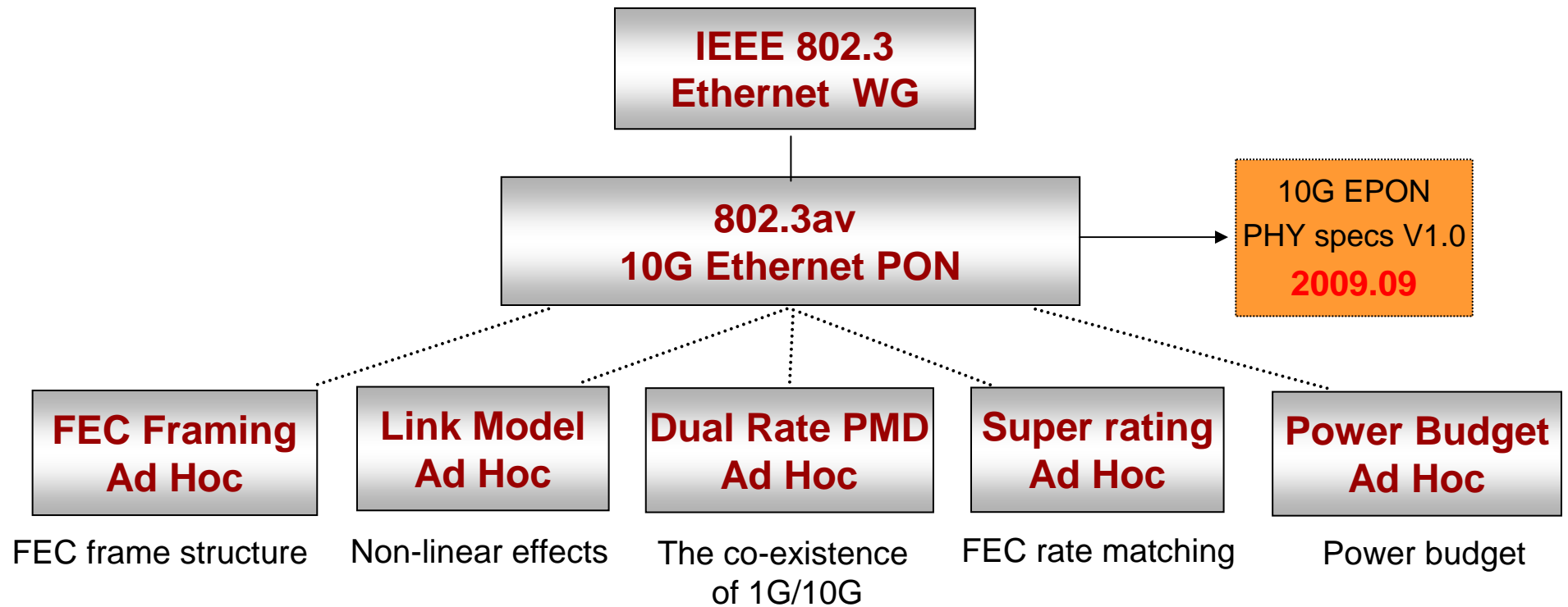- **G.987.3, G.987.4 consent** — 06/2010

■ **The 10G GPON white paper has been released in Q4 of 2008. The physical layer specifications of XGPON1 has been dealt with.**

■ **ITU-T speeds up the standardization process for 10G-GPON. G.987.1 and G.987.2 (PHY) recommendations are scheduled to be consented and then published in next SG15 plenary, in Sept., 2009, G.987.3 and .4 recommendations are scheduled to be consented and then published in the plenaries in Sep, 2010.**

10G EPON PHY standard is coming in Sept 2009

IEEE 802.3 Ethernet WG

802.3av 10G Ethernet PON

10G EPON PHY specs V1.0 **2009.09**

FEC Framing Ad Hoc	**Link Model Ad Hoc**	**Dual Rate PMD Ad Hoc**	**Super rating Ad Hoc**	**Power Budget Ad Hoc**
FEC frame structure	Non-linear effects	The co-existence of 1G/10G	FEC rate matching	Power budget

Workgroup Ballot

Sponsor Ballot

Send To RevCom

CFI, SG

PAR

D1.0

D2.0

D3.0

Std!

Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

2006   2007   2008   2009

- IEEE 802 Plenary Meeting
- IEEE 802.3 Interim Meeting
- IEEE-SA Standards Board Meeting

Last Feature

Last Technical Change

We are here

■ **IEEE 802.3av focuses on solving 10G EPON PHY issues. Its PHY specification is planned to be published in Sept., 2009.**
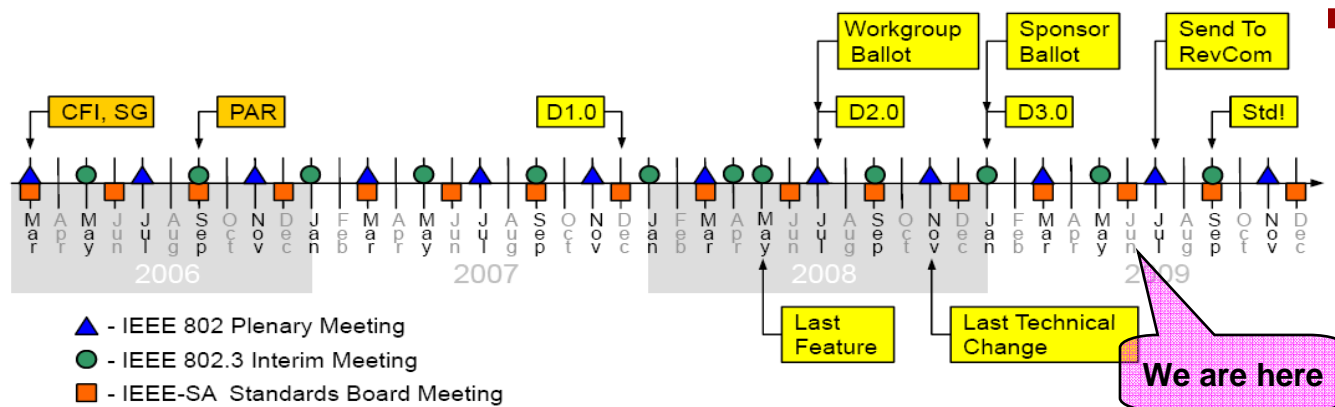
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Huawei's contributions to OAN

- **On June 3rd, 2009, Huawei released the NG PON solution**

- **Huawei plays actively in the mainstream international standard bodies**

atis	Vice chairman in NIPP-OAN Editor in NIPP-NAI (DSL)
broadband forum	Editor of T&I
IEEE	2 Chief Editors of 5 Liaisons between IEEE 802.3 and ITU SG15
ITU	Editorships of G.983, G.984, and G.987
FSAN Full Service Access Network	OISG co-chair co-editor Co-editor of NG-PON white paper

- As actively involved in ITU-T, FSAN, IEEE and some other standard organizations, Huawei has been assigned **many chairmanships and editors positions. Huawei has served as the liaison between IEEE 802.3 and ITU-T.**

- **Huawei leads a very positive position in the next generation PON research and development work. Huawei has contributed a lot in prototypes, in order to accelerate the progress of standard.**

Huawei Optical Access Footprint

- **Generation 0: Research projects a-plenty**

- **Generation 1: STM-PON**
  - ITU G.982: 50 Mb/s TDM, based on static time slots

- **Generation 2: ATM-PON**
  - ITU G.984: 155/622 Mb/s TDM, based on ATM cell transmission
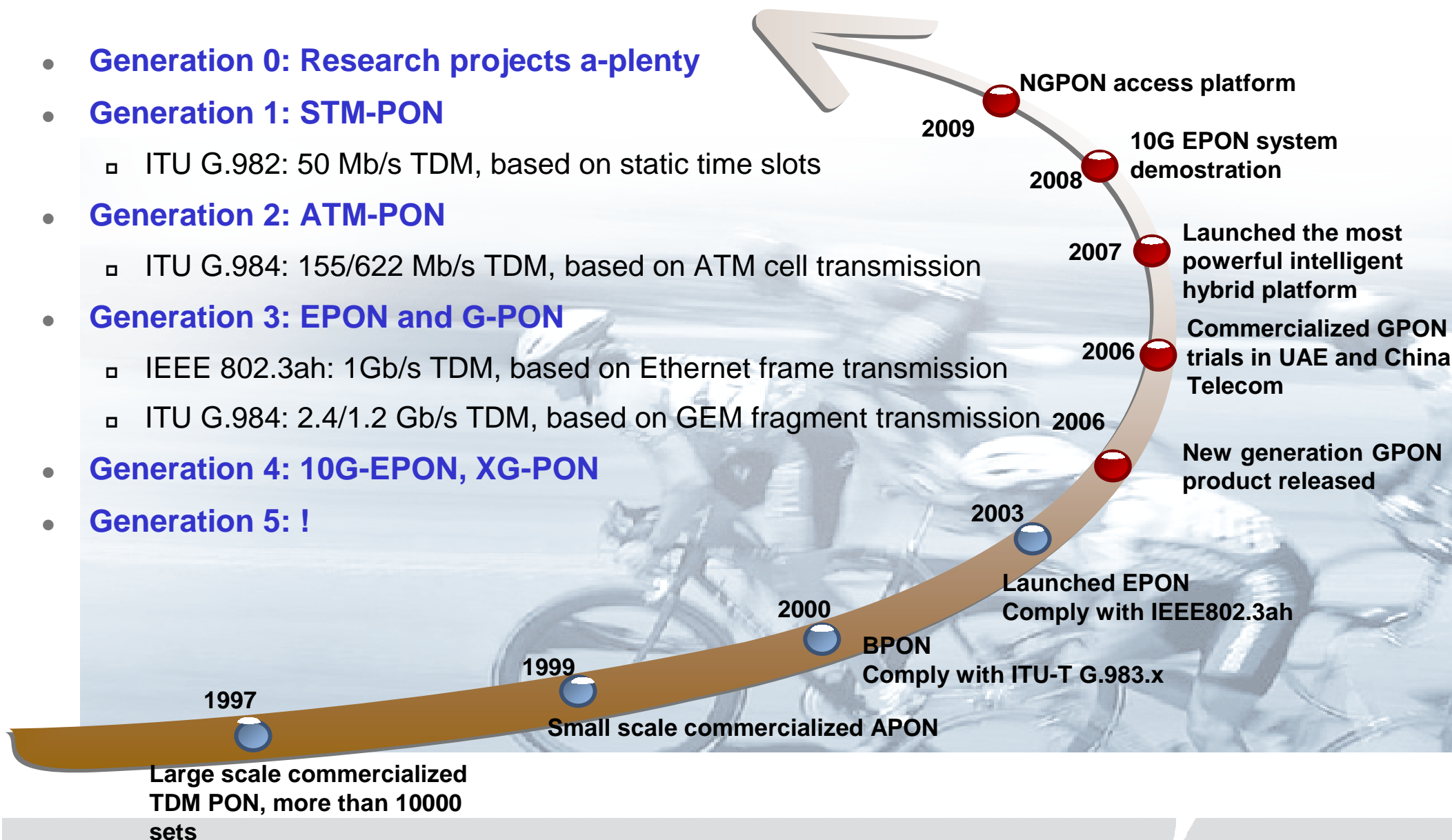
- **Generation 3: EPON and G-PON**
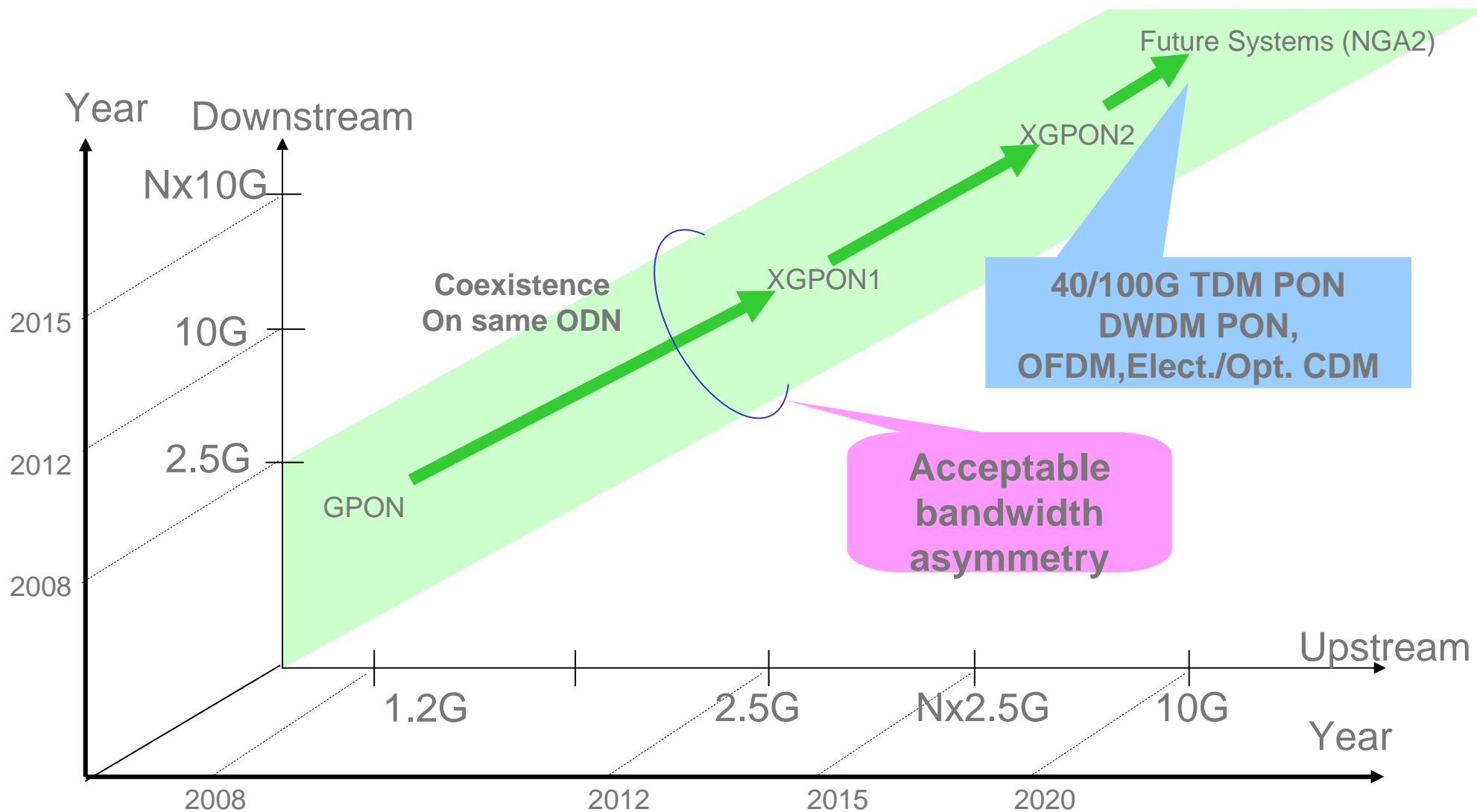 - IEEE 802.3ah: 1Gb/s TDM, based on Ethernet frame transmission
  - ITU G.984: 2.4/1.2 Gb/s TDM, based on GEM fragment transmission

- **Generation 4: 10G-EPON, XG-PON**

- **Generation 5: !**

2009 — NGPON access platform

2008 — 10G EPON system demostration

2007 — Launched the most powerful intelligent hybrid platform

2006 — Commercialized GPON trials in UAE and China Telecom

2006 — New generation GPON product released

2003 — Launched EPON Comply with IEEE802.3ah

2000 — BPON Comply with ITU-T G.983.x

1999 — Small scale commercialized APON

1997 — Large scale commercialized TDM PON, more than 10000 sets

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Huawei: Optical Access Technology Trends

Future: Integrated Broadband Access Networks

TDM/WDM/HPON

Central Office
- OLT
- MA5600T

Cabinet
- Splitter
- AWG (λ_1, λ_2, λ_3, λ_4)
- Remote Node

ONU — residential
WiFi — Home Networks
VDSL
Digital Baseband
DSLAM
Business
P2P GE
Baseband
Cellular & WiFi/WiMax
SCM/OFDM
IF/RF
Wireless Networks
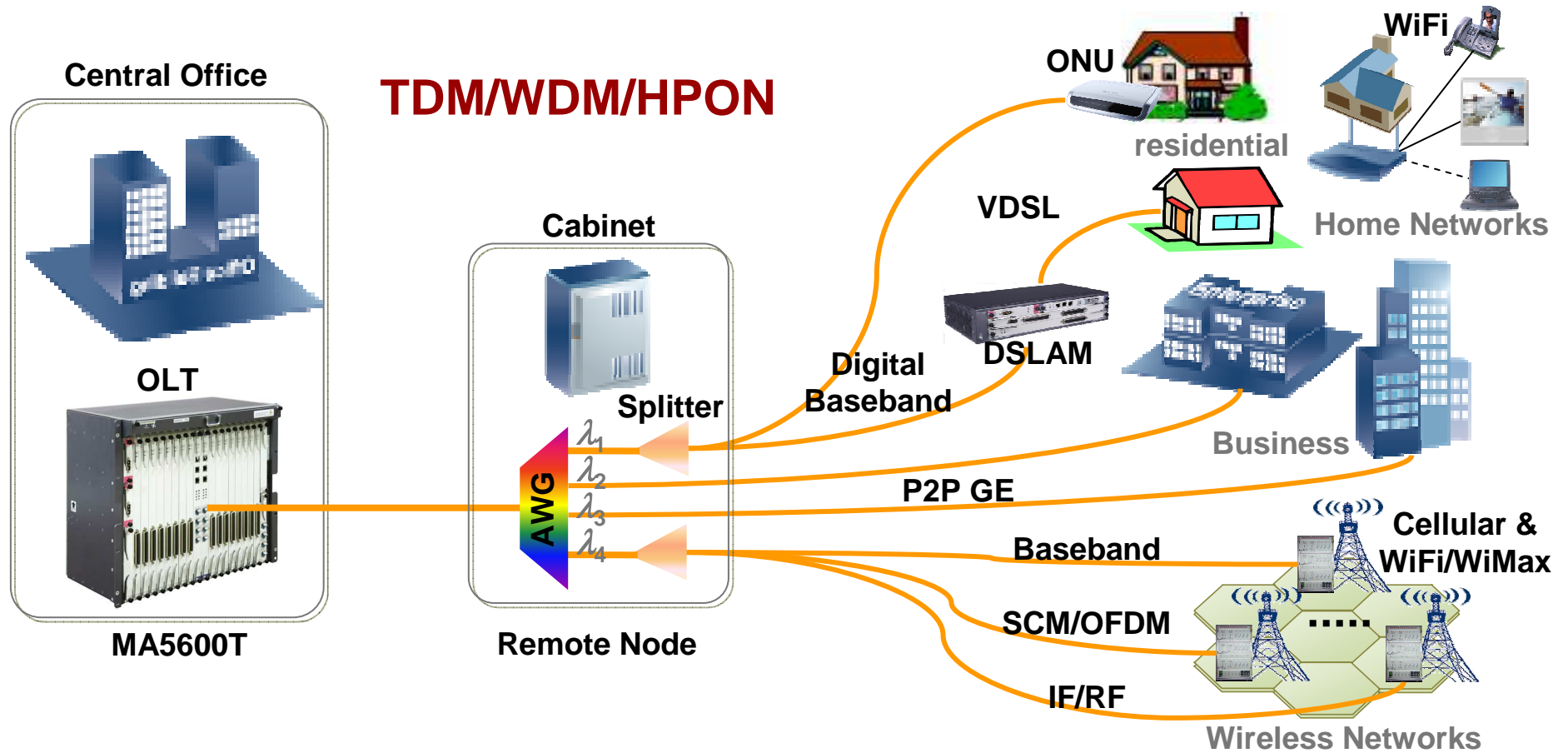
Anyone, anywhere, anytime, anymedia communications

Thank You

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