HUAWEI ENTERPRISE ICT SOLUTIONS A BETTER WAY

FN Access Technology Introduction and Comparison

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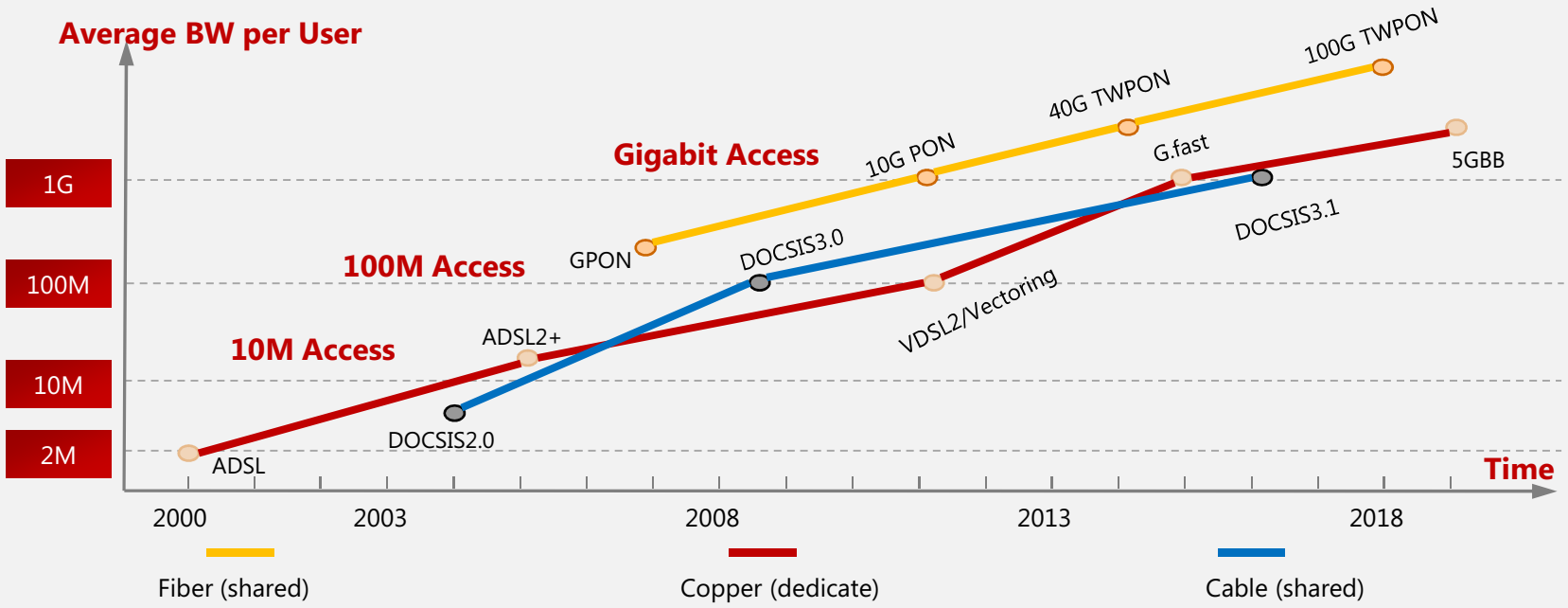
Fixed Line Network Access Technologies Evolution



- Access media (Copper, Cable, Fiber) has its own evolution way
- New technologies (G.fast, DOCSIS3.1, NG PON, …) drive access from 100M to 1G

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Huawei Innovations in Access Domain

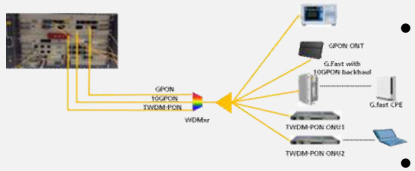
Superfast Copper: Vectoring

1st Vectoring Engine chipset

- Largest Vectoring : 768 ports
- HiSillicon Vectoring Engine chipset and line card chipset
- Launch SuperVector in Nov 2014

Smart Fiber: NG PON / iODN

1st TWDM PON module



- 1st TWDM PON line card
- 10GPON trial in Etislata, Bahrain, BT, China Telecom, etc.
- 1st AODF demo in BBWF

Superfast Copper: G.fast

1st G.fast trial with BT

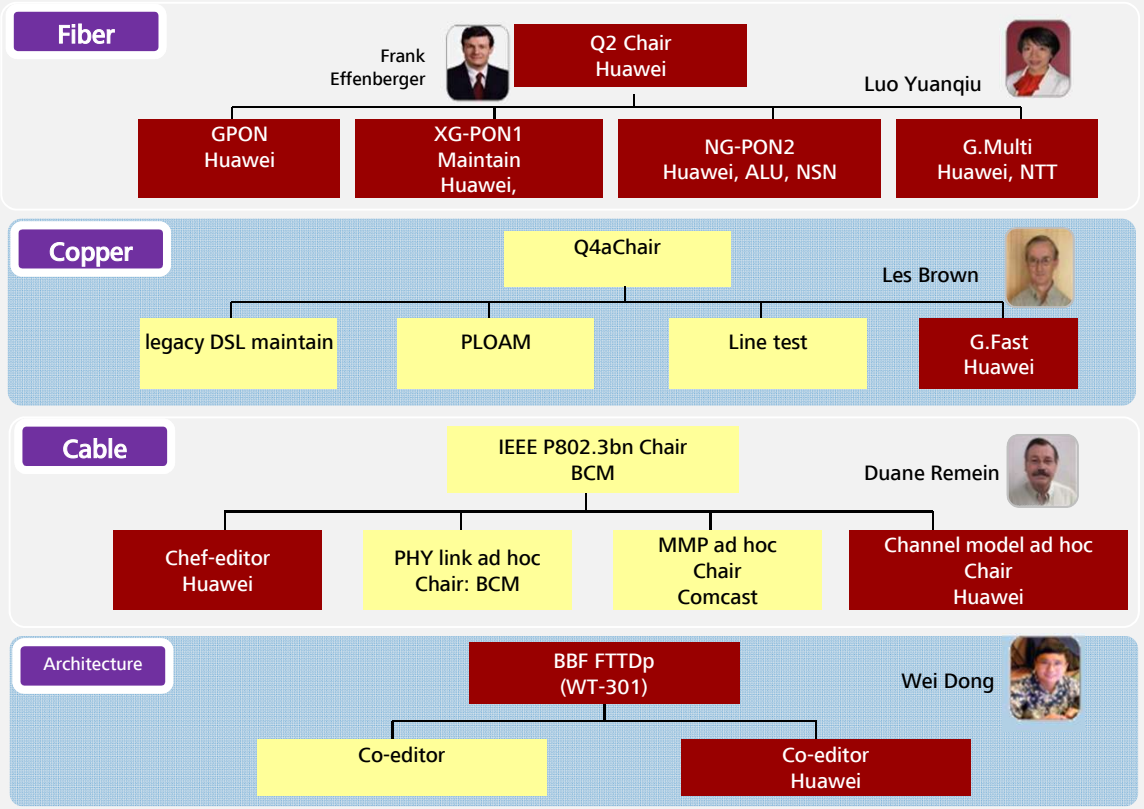
- G.fast trial with 1Gbps in BT
- G.fast trial co-exist with ADSL/VDSL2 in TeliaSonera
- Tested in Swisscom, DT, FT, etc.

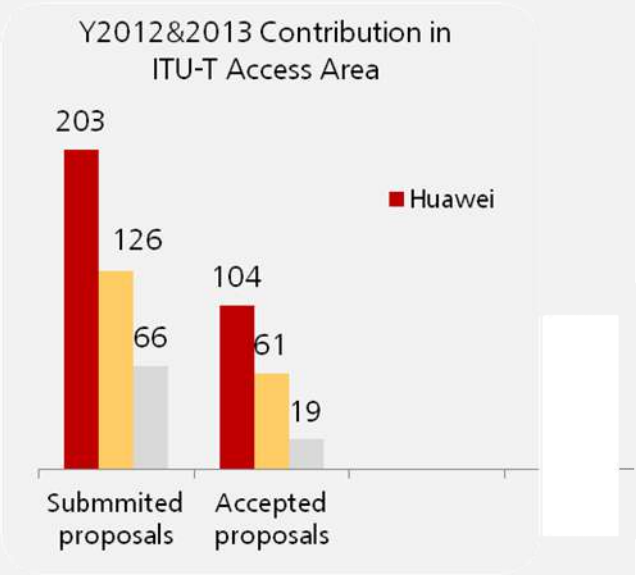
Converged Cable: D-CCAP

D-CCAP Solution

- 1st Docsis3.1 product
- 1st Cable based Mobile backhaul solution with D-CCAP

Leading in Standards Contribution





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Leading in Global FBB Market

Western Europe
43 Operators

TdE	GPON+VDSL2
FT	GPON
TI	GPON+VDSL2
DT	GPON+VDSL2
BT	GPON+VDSL2
PT	GPON

Asia & Pacific area
13 Operators

PCCW	GPON+VDSL2
HGC	GPON
TTT	GPON
BSNL	GPON
PLDT	GPON+VDSL2
Starhub	GPON
TM	GPON
…	…

Latin America
11 Operators

Telemar	GPON
Telefonica	GPON+ODN
Telesp	GPON
…	…

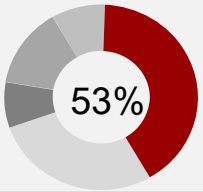
BT

The whole project
BT FTTC

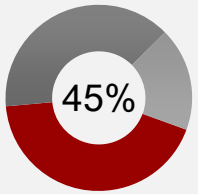
etisalat

The world's largest FTTH network

Global PON Market



Global Broadband Access Market



TELUS
the future is friendly

A breakthrough in North America

中国电信 CHINA TELECOM

The world's largest FTTB network

From Infonetics 2014 Q4

- Huawei — 30 years' experience in ICT
- World's most diversified E2E communications provider
- Serves 45 of the top 50 global telecom operators and 1/3 more global broadband users than competitors

Eastern Europe
6 Operators

Ukraine	GPON+VDSL2
Russia	GPON
…	…

North America
Telus

Telus	GPON+VDSL2

China
3 Main Operators

China Telecom	EPON/GPON
China Mobile	GPON
China Unicom	EPON/GPON

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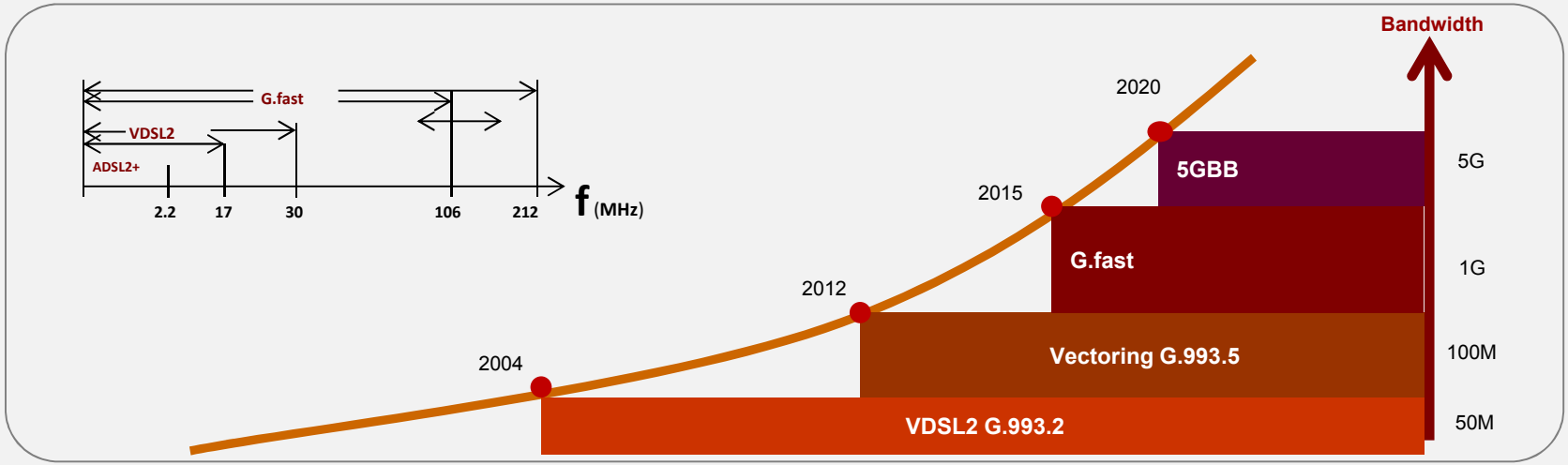
Evolution of copper access technology



VDSL2

- Speed: 30-50M
- Distance: ~1000m
- Typical FTTC/B
- Mature

Vectoring

- Speed: 50M-100M
- Distance: ~1000m
- Typical FTTC/B
- Mature

G.fast

- Speed: 500M-1G
- Distance: ~200m
- Typical FTTB/D
- ~Year 2015

5GBB

- Speed: 2G~5G
- Frequency:~800MHz
- Distance: ~50m
- Typical FTTD
- ~ Year 2020

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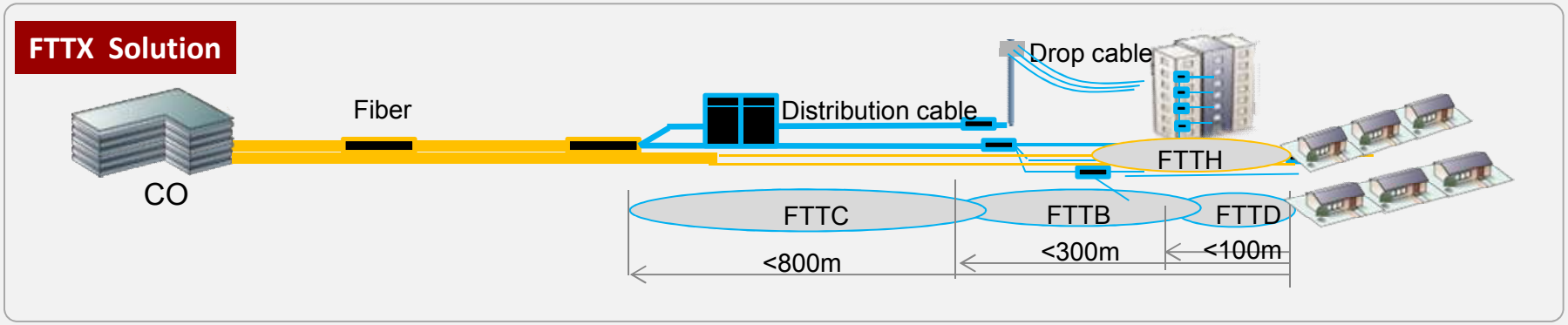
Integrated Optical-Copper Solution is FBB access trend



FTTH

- Large Bandwidth
- High investment
- Long engineering period
- Difficult drop cable routing

FTTC/FTTB/FTTD

- Copper lines provide higher rates through utilization of new technologies
- Shorter engineering periods and reduces the cost of investments

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What`s Vectoring

Crosstalk is the dominant source of noise in VDSL2

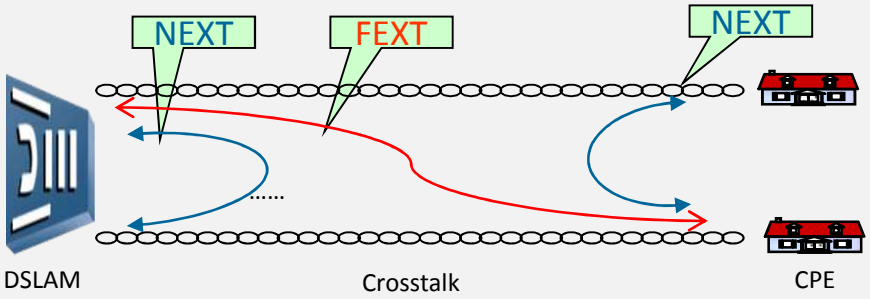
FEXT(Far End Crosstalk) severely reduces performance

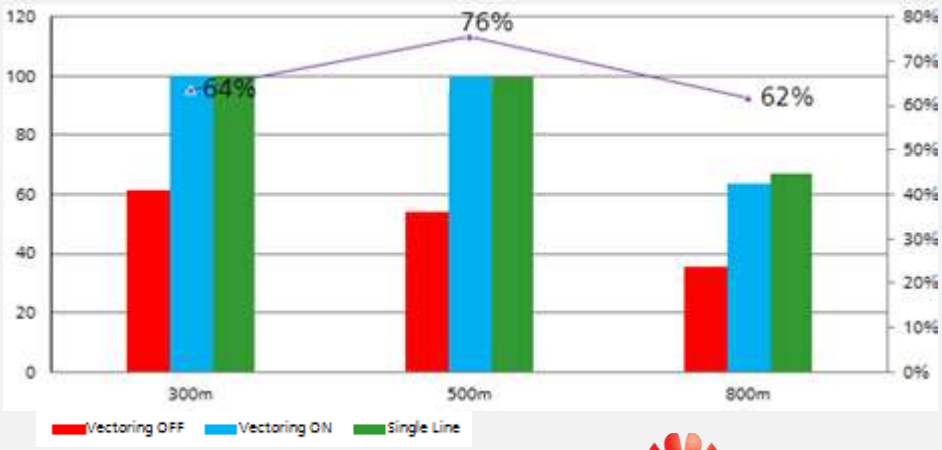
Vectoring is developed for FEXT Cancellation

Reduce crosstalk-free for one bundle of copper cable

Improve bandwidth **to 100Mbps** within 500m

FEXT :crosstalk between upstream and downstream, FEXT signal has the same frequency band as normal signal





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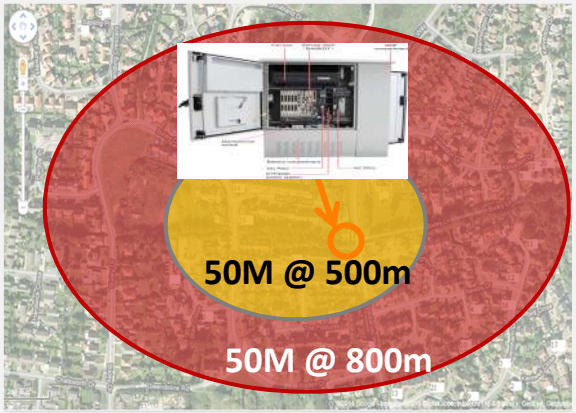
Vectoring Performance –Increase BW and extend coverage

Copper Line Distance (0.5mm)	Vectoring DS rate	VDSL2 DS rate
300m	100M	75M
500m	100M	60M
800m	60M	38M

Source： Huawei Vectoring Lab Test



- Vectoring is focus on crosstalk cancelation, which has no effect on attenuation and external noise
- FEXT can decrease VDSL's rate by 40%～60%, Vectoring can increase the rate by 50%～90%, up to 90%～95% of VDSL2 single pair rate
- Vectoring's effective distance is in 1500m
- **Best performance distance is 300～500m to provide 100M bandwidth in one pair of copper**

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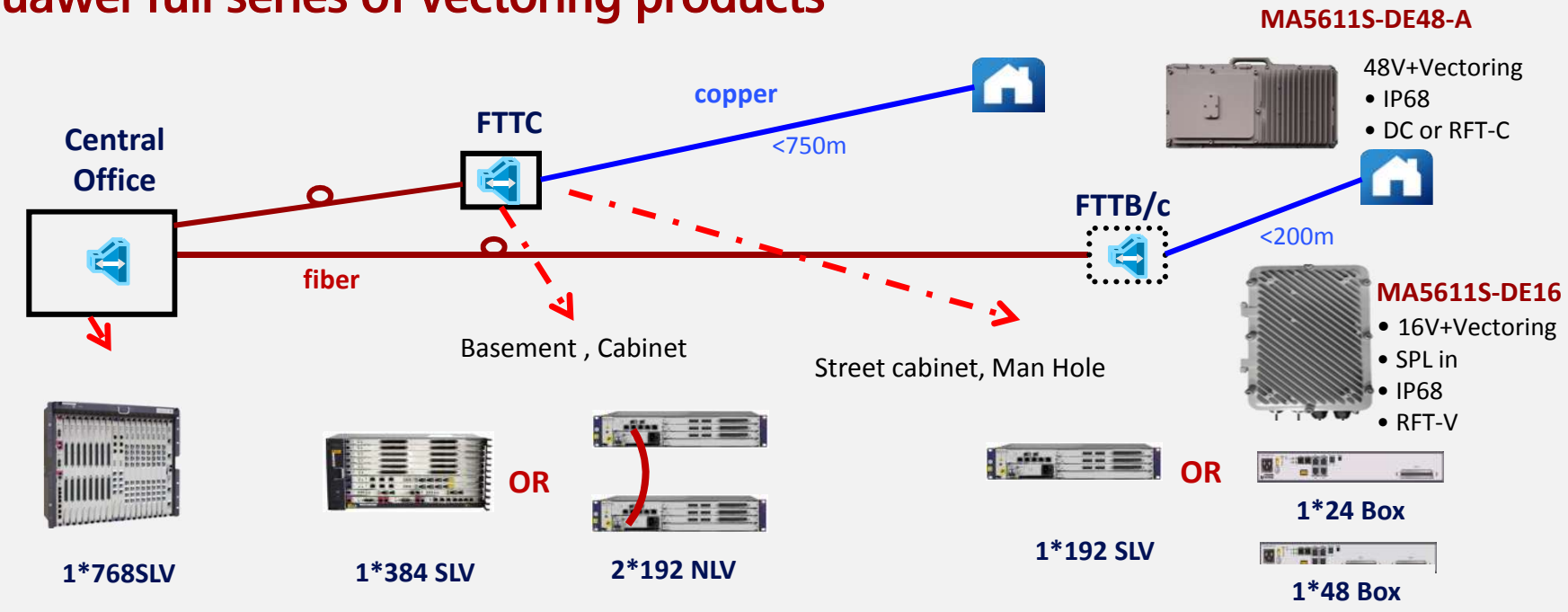
Huawei full series of vectoring products



Series of capacity: Large(768)-Medium(384,192)-Small(16/48)

Series of Vectoring Level: NLV-SLV-Box

Series of service type: Combo- Vectoring with SPL- Vectoring Without SPL

NLV Support Smooth Expansion

MA5616+MA5616

Step1

- 0 < user number < 192 lines
- 100M broadband bandwidth
- Deploy 1nd MA5616(SLV)

Step2

- User number growing up(>192 lines)
- 100M broadband bandwidth
- Add 2nd MA5616, expand from SLV to NLV smoothly

Note:
SLV: System level vectoring; NLV: Node level vectoring

eircom

Solutions:

- Use BT's proved vendor and solution will shorten the decision making and deployment time
- Plan all sites Vectoring and big sites Node Level Vectoring
- NLV keep all cabinets the same in day 1 and quickly roll out
- The 2nd MA5616 with NLV will be added in day 2 when user number growing up

Benefits

- Till 2014Q1, 4000 FTTC cabinets deployed and whole network Vectoring enabling is on going,
- All sites Vectoring to compete with Cable operator
- Node Level Vectoring for large site

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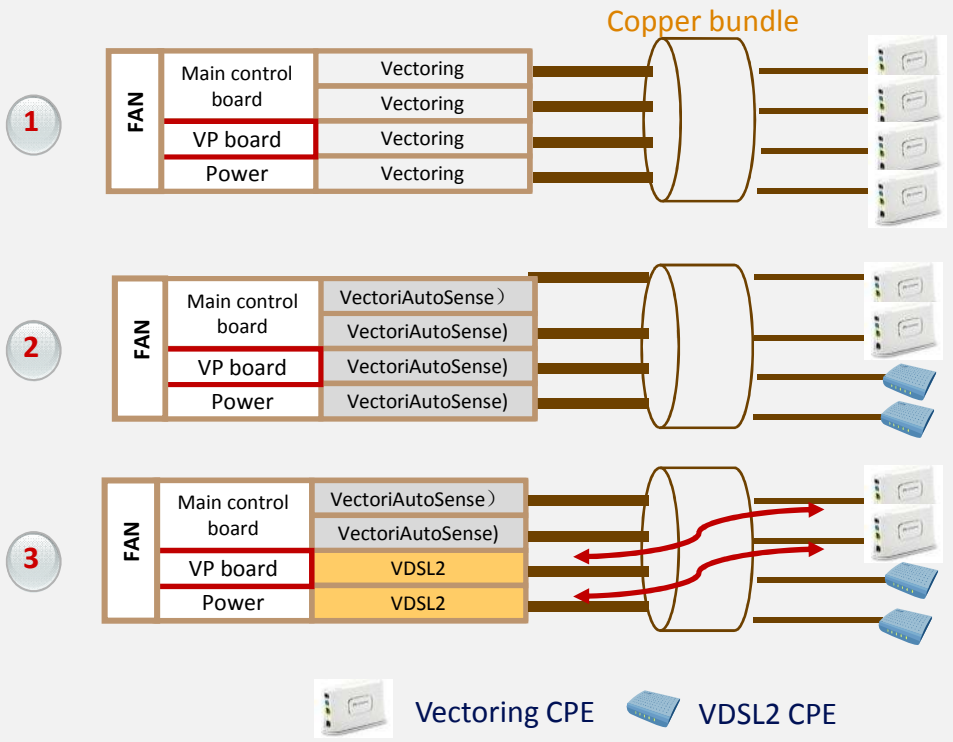
Vectoring Deployment Request



- The service board and the CPE all support Vectoring, the bandwidth improve a lot

- Vectoring service board support **AutoSense**
- Vectoring user bandwidth improved and the VDSL2 bandwidth not be affected

- Vectoring service board and VDSL2 service board mixed in the frame
- Crosstalk can not cancelled, affect the user bandwidth

Autosense solution automatic detect CPE's capability and automatic apply suitable coexistence policy to CPEs !!!

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Huawei Vectoring footprint in the world

Large Vectoring Shipment

- BT, eircom, Swisscom, China Telecom, China Unicom, PCCW, etc. **continued increase**
- China Telecom Yuxi & Jiangmeng, China Unicom Qingdao **start Vectoring trials**
- More than **5.8 million** Vectoring lines shipped by end of Q4 2014

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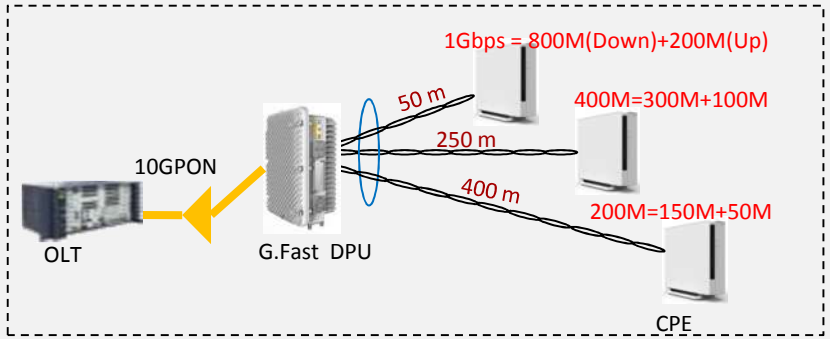
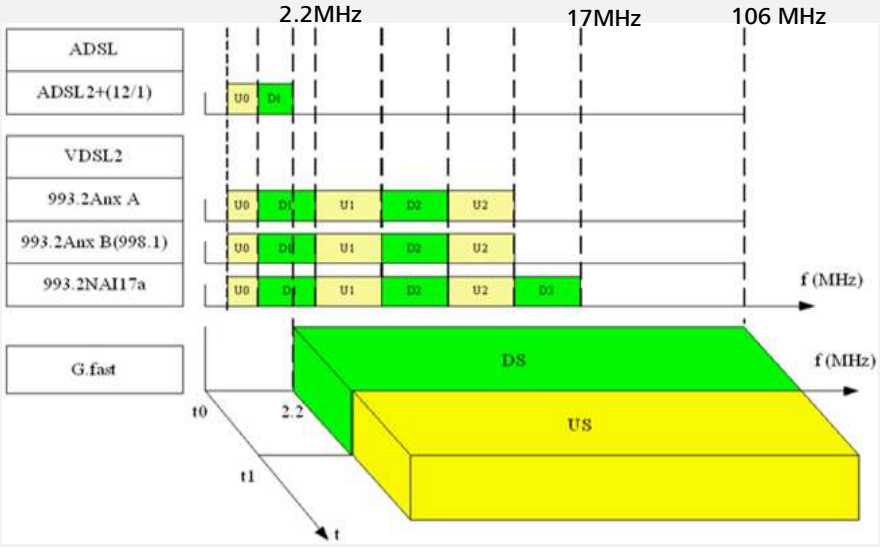
FTTB/D+ G.Fast





Features

◆ G.Fast is used in FTTB/D scenarios, provide 400M-1G bandwidth with 250 meters

◆High Frequency band: 106MHz (212MHz in future)

◆G.Fast is adopted OFDM+TDD， The data is transmitted in the whole band without distinguishing between the upstream and the downstream frequency bands

◆TDD flexible ratio (up:down = 1:1 to 1:9)

◆Compatible with AD/VD2/Vectoring

Equipment

MA5811S （DPU） -- 2015.9 GA

- 16p G.fast with vectoring
- IP68
- 2*GE/2*10GE uplink

Leading in G.fast Trial & Test

Leading in Test & Trial with 10+ operators

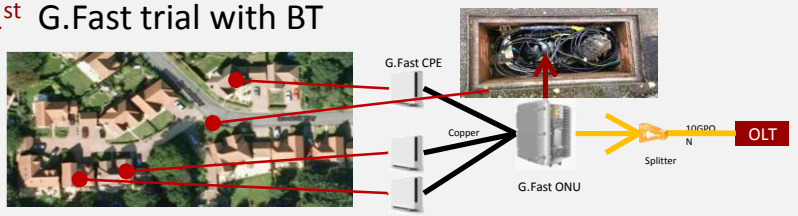
8-port G.Fast DPU

G.Fast CPE

Bell, BT, vodafone, eircom, TELUS, M-net Mein Netz, TURK TELEKOM, orange, TeliaSonera, STC, france telecom, FASTWEB, swisscom, Deutsche Telekom

- Huawei has done G.fast test with 15 operators
- Huawei has done field trial with 4 operators
- Huawei has signed industry first commercial contract

1st G.Fast trial with BT



G.fast trials:
BT, TeliaSonera,
Swisscom, eircom

1st Co-exist with DSL G.Fast trial with TeliaSonera

swisscom HUAWEI

1st G.fast commercial contract with Swisscom

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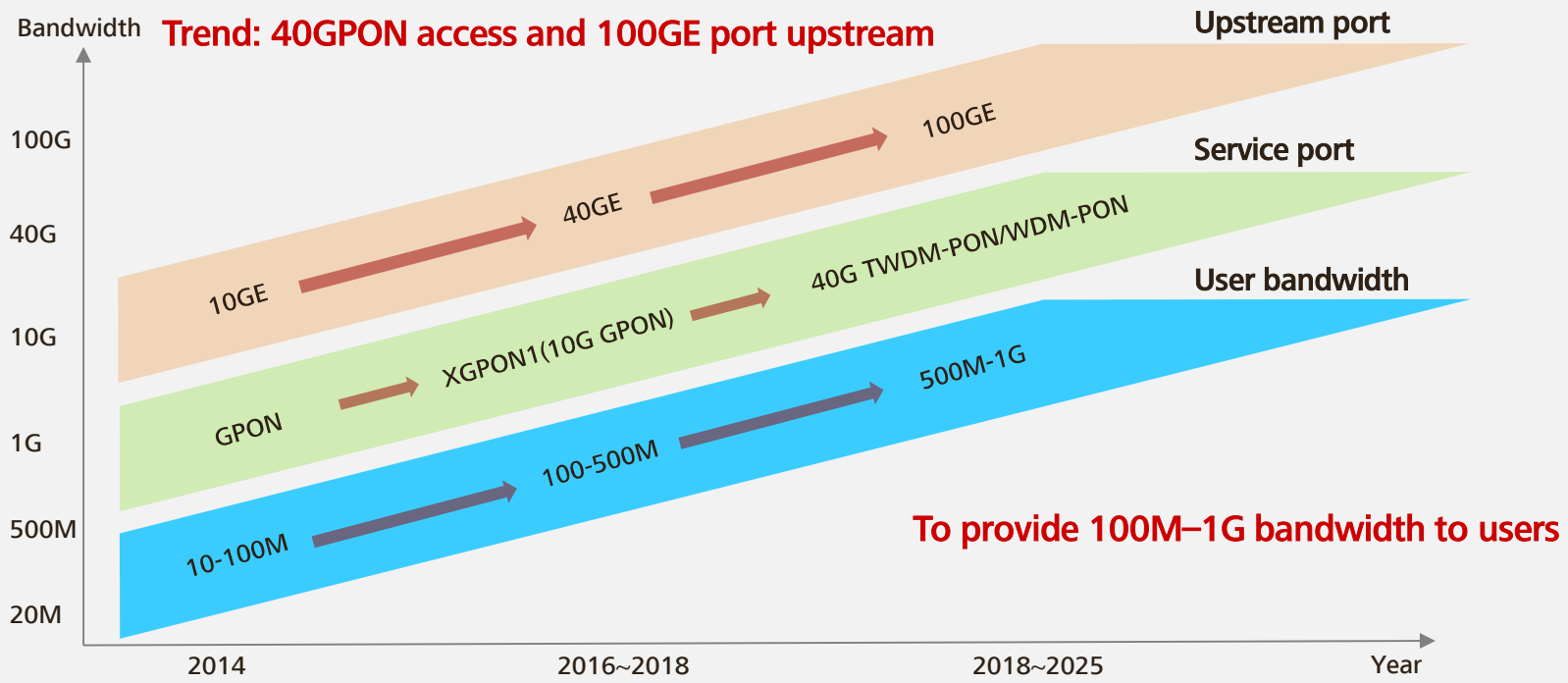
Smooth Evolution of PON Access in Next 10 Years



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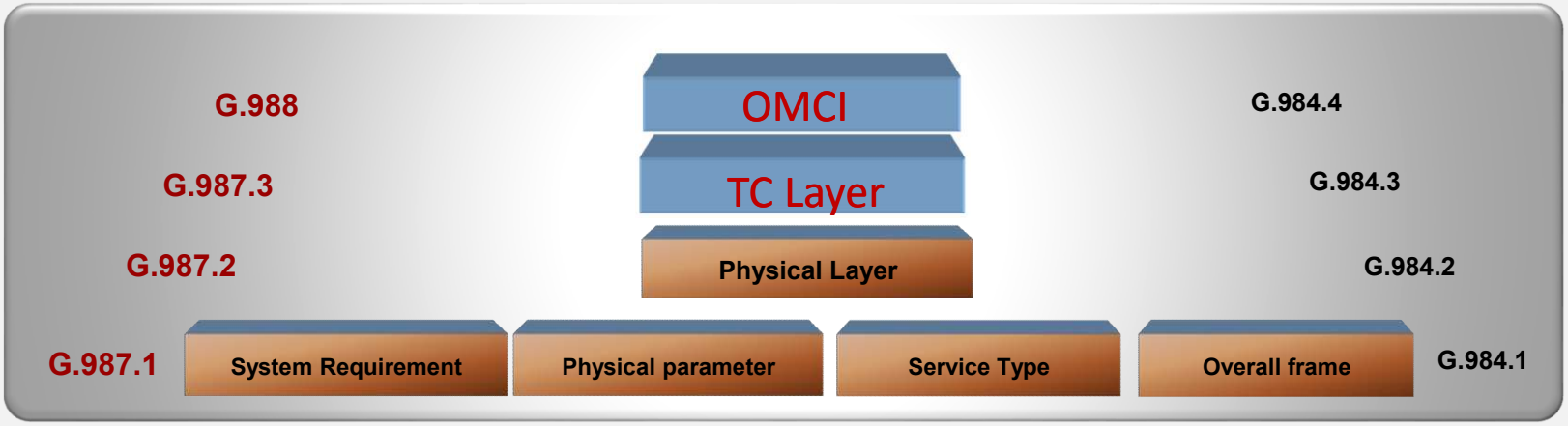
XGPON Standards Development

XG-PON1: Asymmetric 10G/2.5G (DS/US)

- XGPON1 system based on G.987.x can be co-existent with GPON system based on G.984.x on the same ODN, by using different wavelengths.
- G.987x inherits the GPON characteristic, and also supports the high quality & full service experience.
- G.987x shares the same management mechanism, and can realizes easy upgrade from the current GPON OSS system;

XG-PON2: Symmetric 10G/10G. Maybe it would be skipped and directly to NG-PON2



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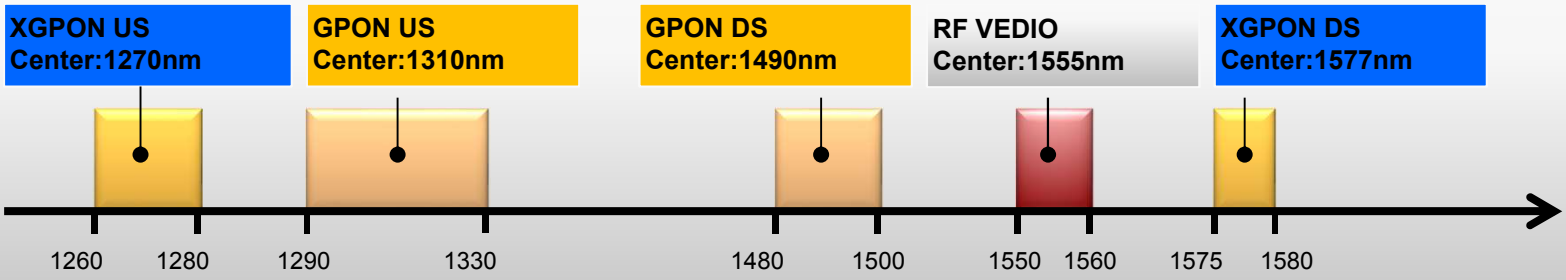
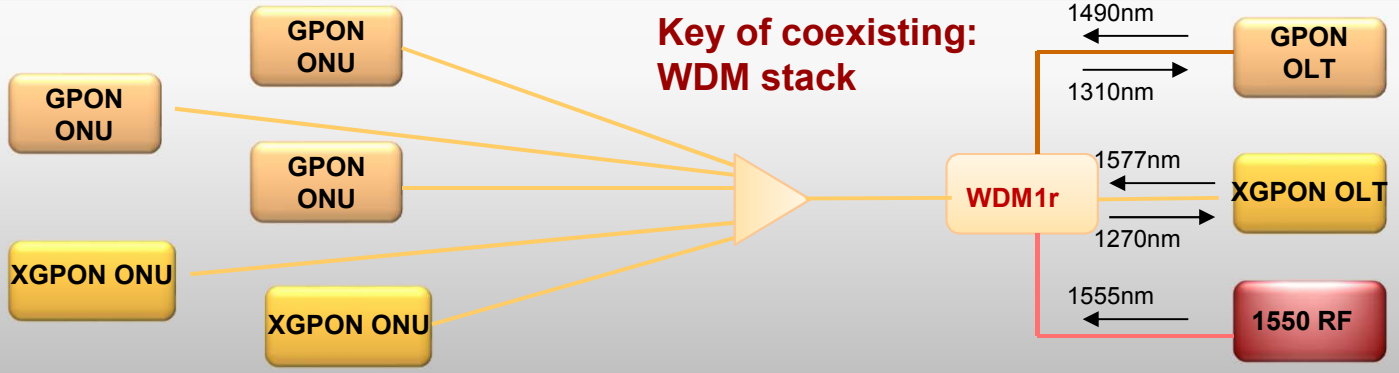
XGPON Coexists with GPON



No wavelength overlap between GPON and XGPON, they can coexist in the same ODN with WDM



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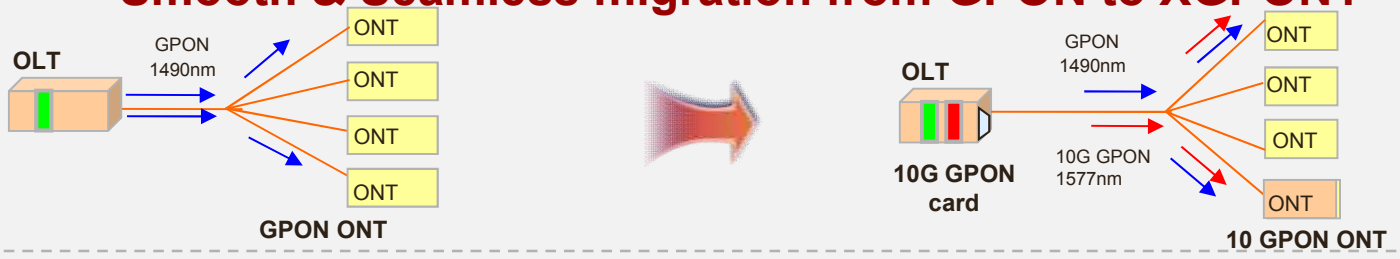
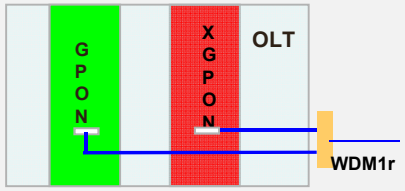
Huawei XGPON1 Solution

Smooth & Seamless migration from GPON to XGPON1

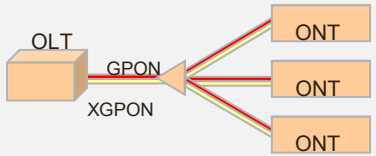


Reusing OLT platform



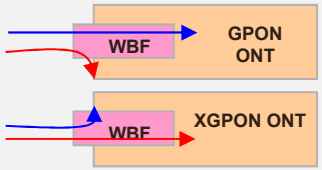
- Chassis compatible with XGPON
- Control card compatible with XGPON

Reusing ODN network



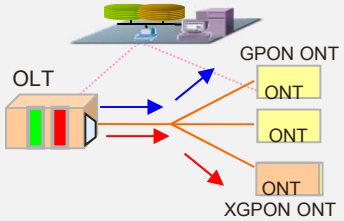
- Reuse the same ODN network
- Multiplex XGPON and GPON wavelengths

Reusing ONT



- GPON ONT with WBF to block XGPON wavelength.
- XGPON ONT with WBF to block GPON wavelength

Reusing EMS



- Reuse the same EMS
- Minimize operational & provisioning change

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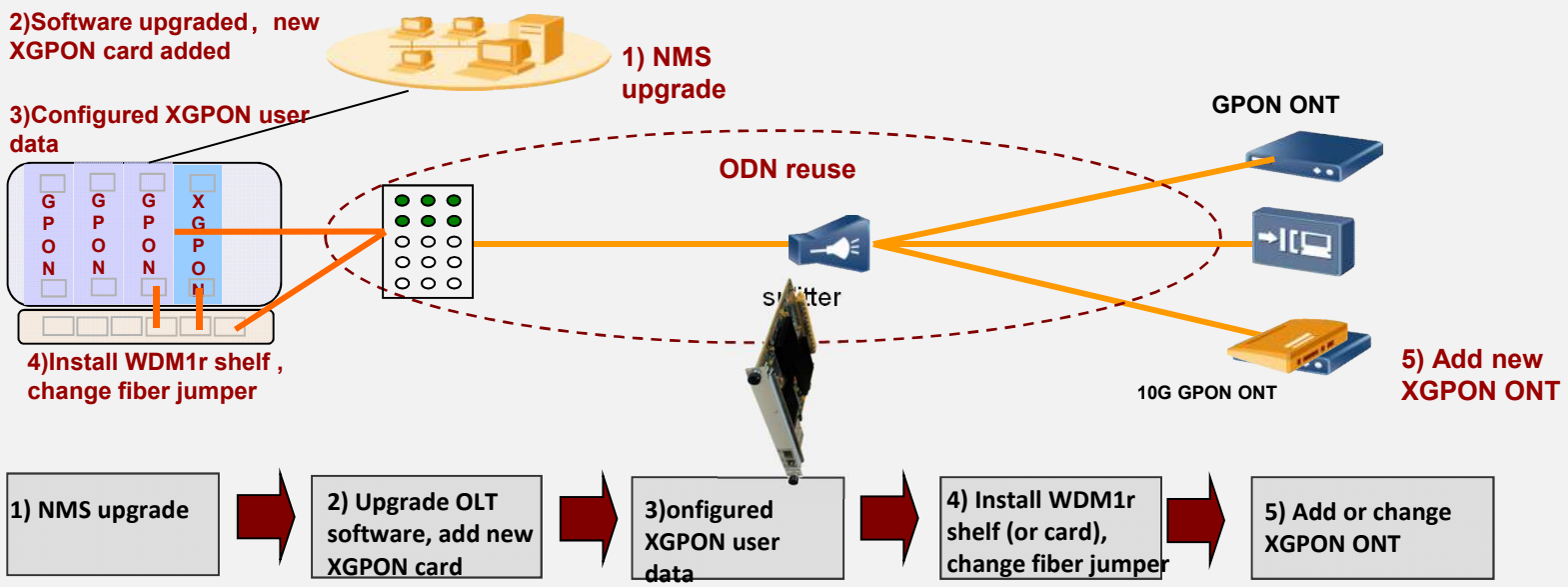
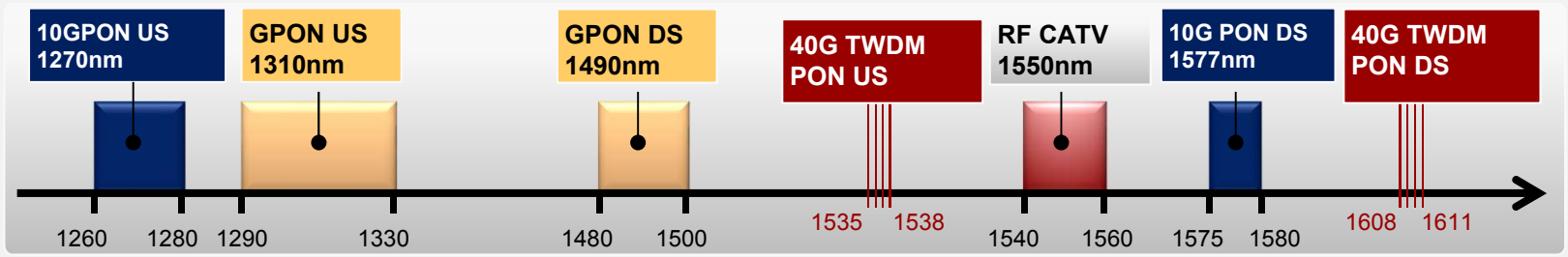
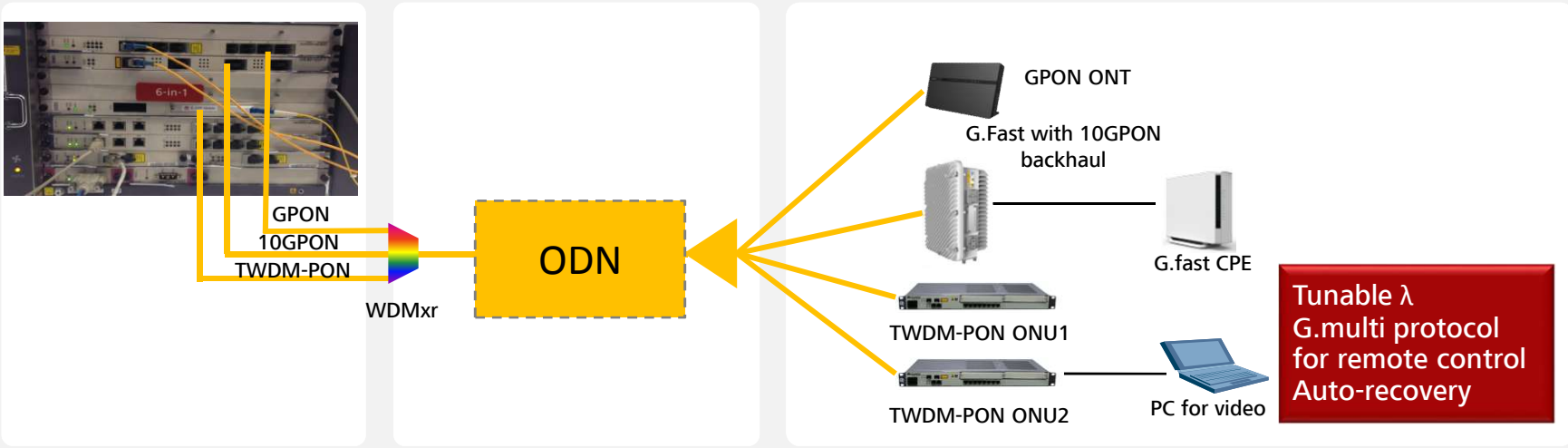
GPON Migrates to XGPON: Simple and Seamless



- Current XGPON and GPON signals can be both carried with the same ODN based on the wavelength multiplex. Easy to plan and management, because XGPON is independent from GPON.
- Only the upgraded user's profile need to be reconfigured under the GPON port when one user upgrade to XGPON.

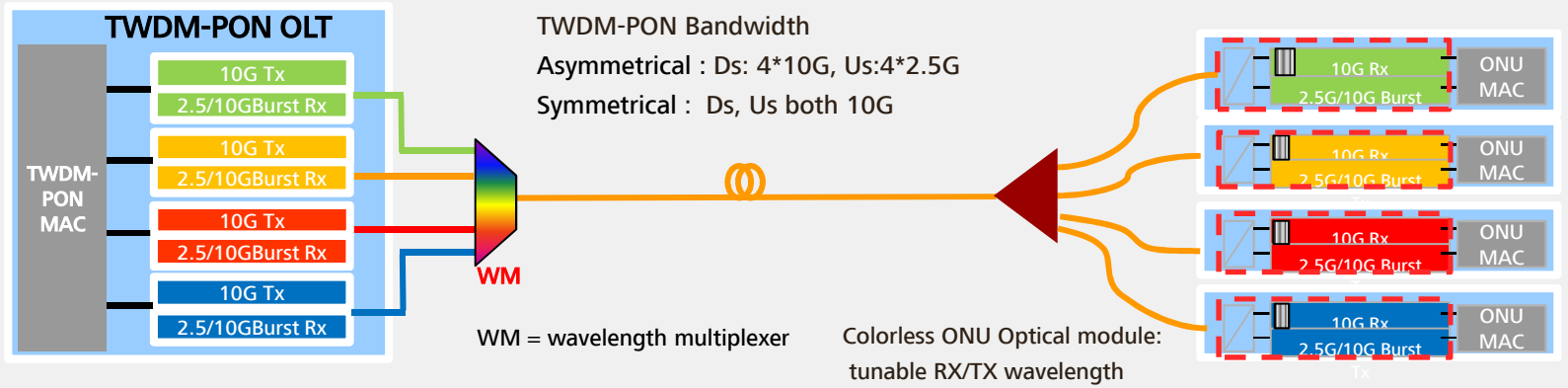
GPON, 10G PON, & 40G TWDM PON in One Network





TWDM-PON System and Key Features

TWDM-PON: hybrid TDD and WDM, just like 4*10G PON stack on the same ODN.



Allocate by wavelength, PAYG

- ✓ Isolate by wave, secure and reliable
- ✓ Buy wave as need, pay as you grow
- ✓ OpenAccess for Different ISP

DS/US Symmetrical 10G

- ✓ DS/US Symmetrical 10G per TWDM-PON ONU
- ✓ High upstream bandwidth suitable for leased line or mobile backhaul

High capacity, 40/80G per Group

- ✓ 10G per wavelength, 4 wave make up 40G, 8 wave make up 80G in future
- ✓ Suitable for VIP consumers
- ✓ Suitable for aggregation of FTTC/B/D

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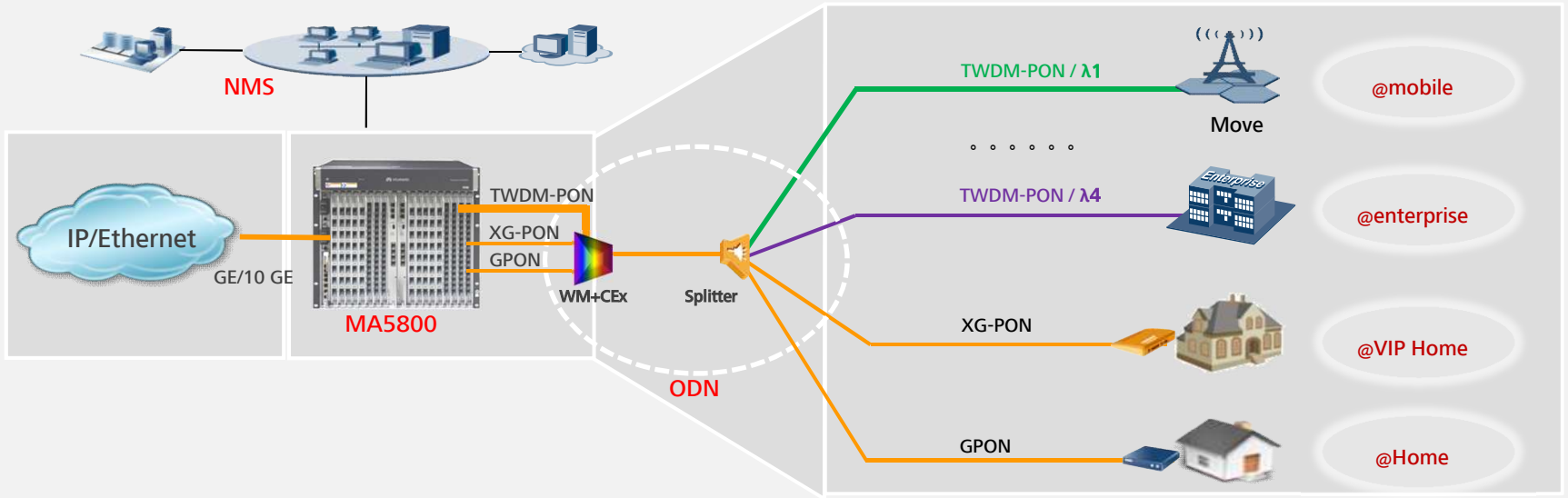
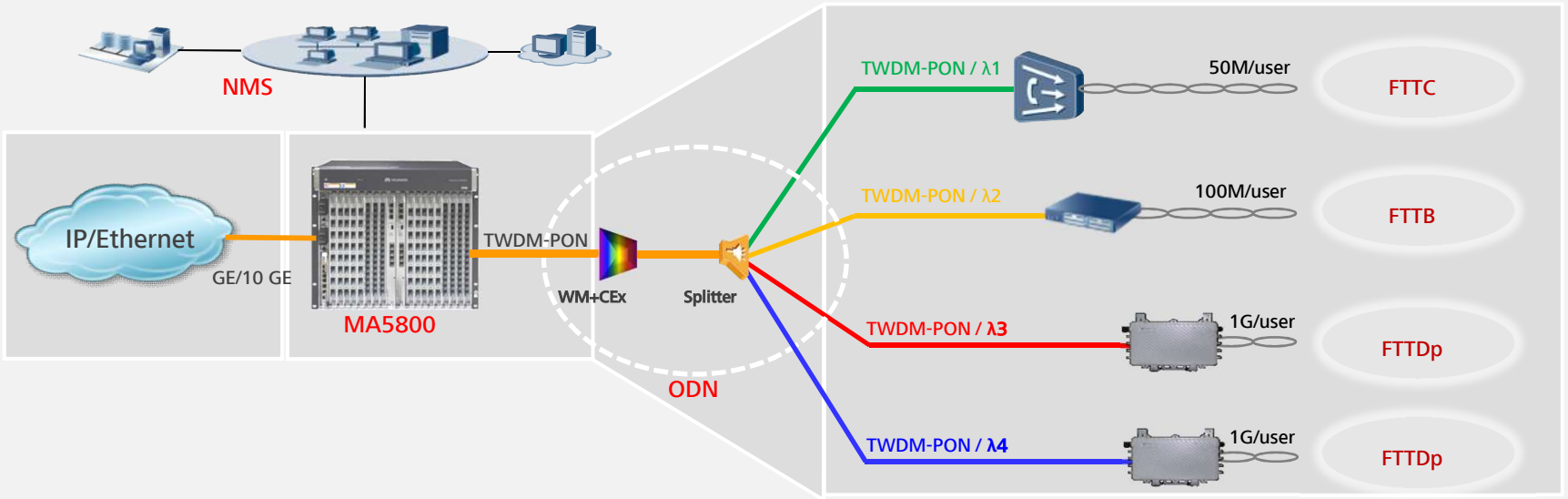
TWDM-PON Application 1: Multi-service converged networking



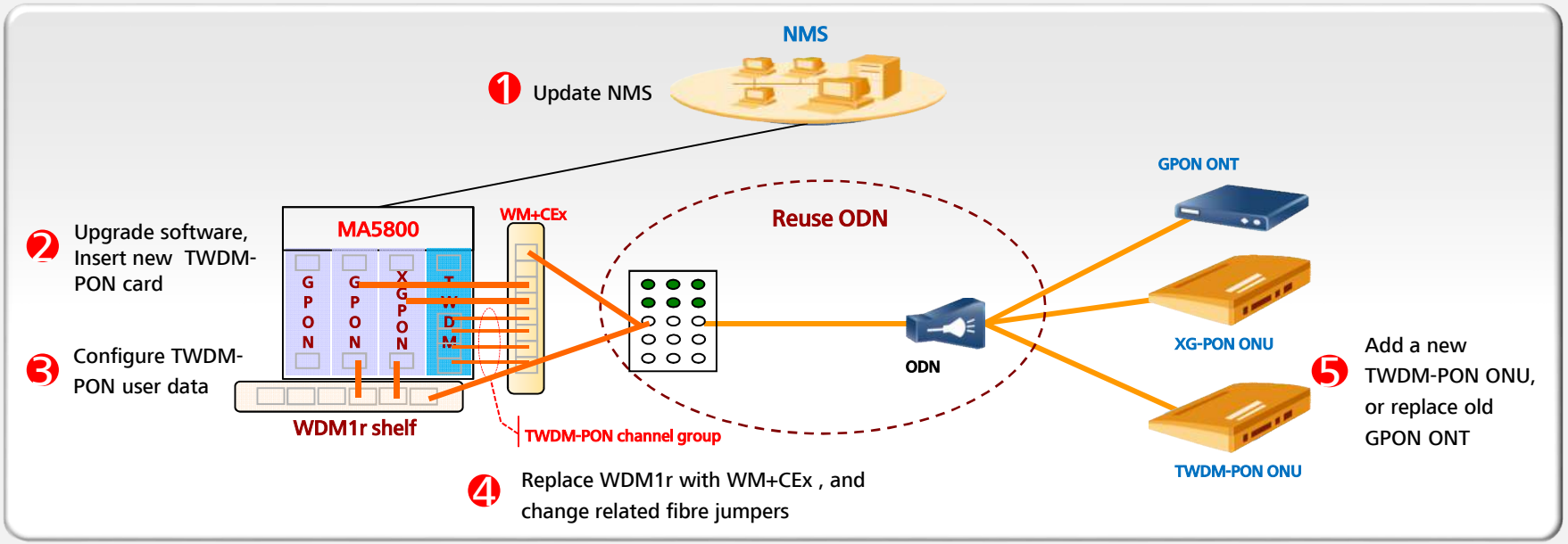
- **TWDM-PON share ODN with GPON/XG-PON , no need to change network, and supply different bandwidth according to requirements:**
  - ✓ Supply **100M** to general home user base on **GPON**.
  - ✓ Supply **1G** to vip home user base on **XG-PON** .
  - ✓ Supply service **for enterprise and mobile backhaul** base on the DS/US Symmetrical 10G of **TWDM-PON**.
- **Different types of users, such as home and enterprise user, are isolated by wavelength, keep services more reliable and safe.**

TWDM-PON Application 2: Aggregation of FTTC/B/D



- In order to increase the bandwidth of users on copper to 50~100M, Copper site should be split and sink, this requires wider bandwidth for the aggregation of FTTC/B/D
- The 40G bandwidth, P2MP mechanism of TWDM-PON , suitable for the aggregation of FTTC/B/D
  - ✓ Totally 40G , max **10G** uplink **per site**.
  - ✓ Wave-multiplexed, save trunk fiber resources , and simplify network architecture, fasten deployment.
- Share ODN with FTTH , reduce CAPEX.

Migrate from GPON/XG-PON to TWDM-PON (Simple and Seamless)



CE = Instance of co-existance element
WM = wavelength multiplexer

- Current GPON/XG-PON, TWDM-PON signals can be both carried with the same ODN based on the wavelength multiplex. Easy to plan and management.
- Only the upgraded user's profile need to be reconfigured under the GPON/XG-PON port when one user upgrade to TWDM-PON.

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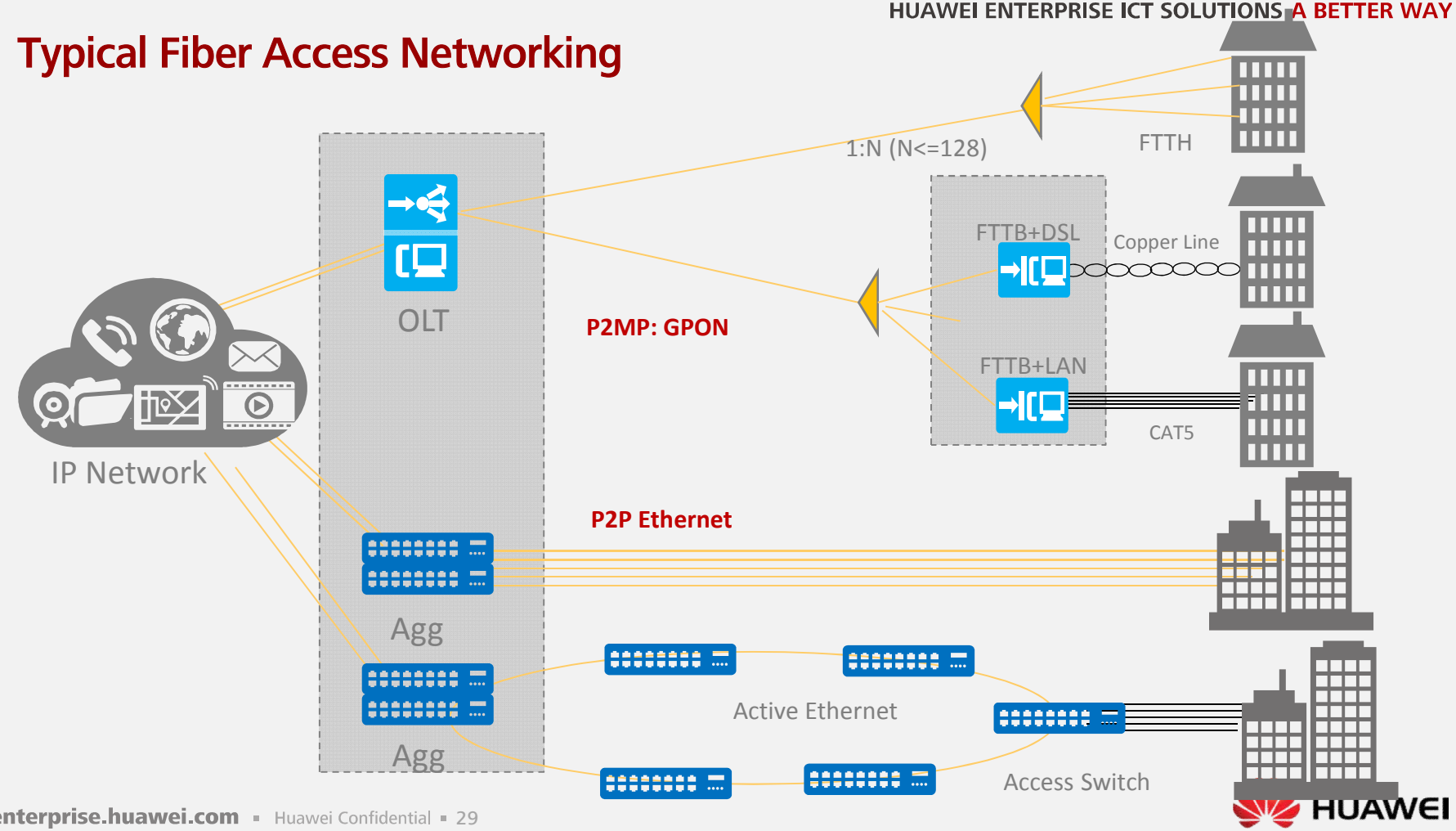
Typical Fiber Access Networking



GPON Vs. Ethernet P2P

Technologies	GPON(P2MP)	Ethernet P2P
Standard	ITU-T G.984	IEEE 802.3 ah(Most Popular) ITU-T G.985 TS-1000
Bandwidth	Downstream / upstream 2.5 Gbps; 1.25Gbps	Scalable from 100M ~ 1Gbps
Wavelength	Up(nm) 1260~1360 , Dn(nm) 1480~1500 1540~1560nm for CATV	Up(nm) 1260~1360 , Dn(nm) 1480~1580
Distance	20Km	Based on BIDI SFP
Splitting Ratio	Up to 1:128	/
Traffic Modes	ATM, Ethernet, TDM	Ethernet
Residential Services	Triple play (CATV analogue or IPTV)	Data service
TDM Service	TDM over Ethernet (CESoP / Native TDM)	TDM over Ethernet (CESoP)
Bandwidth Efficiency	93%	80% (8B10B)
OAM Protocol	ITU-T G.984 (Mature)	IEEE 802.3ah
Interoperability	Organized by FSAN/ITU-T	Easy

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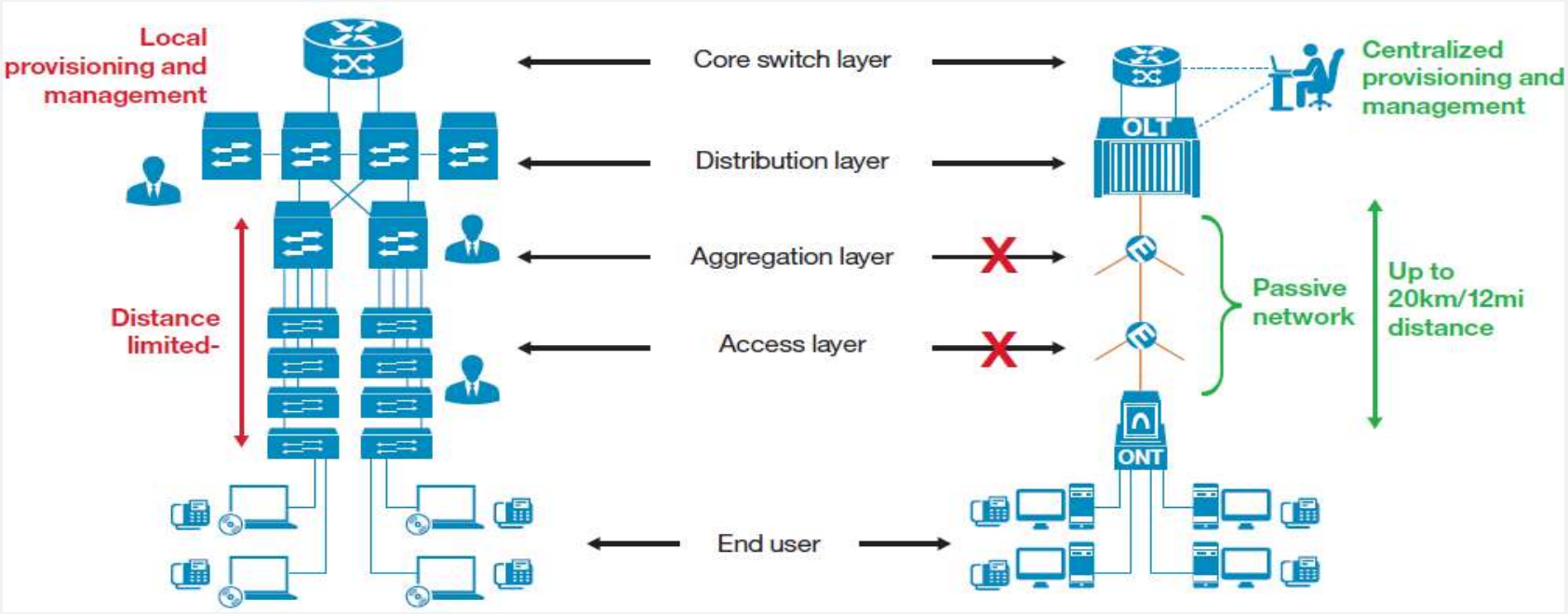
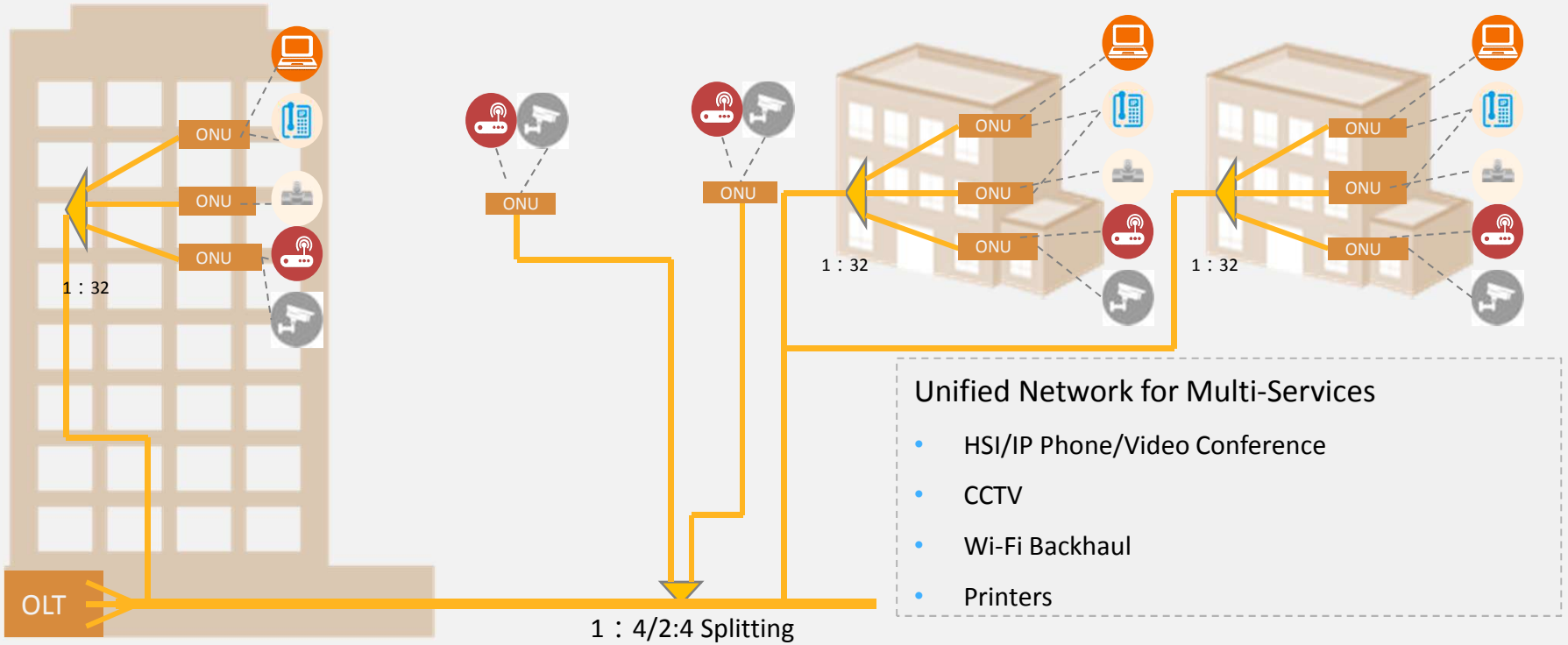
Network Topology



Ethernet P2P	Multiple Aggregation; Limited Distance; More Fiber Resource; Poor Anti-interference
GPON	Simple Network; Long Distance; Save Fiber Resource; Strong Anti-interference

GPON better serves multi-service requirement



Unified Network for Multi-Services

- HSI/IP Phone/Video Conference
- CCTV
- Wi-Fi Backhaul
- Printers

- **GPON solutions can support nearly all services in various scenarios**
- **Most switches still provide single play service**

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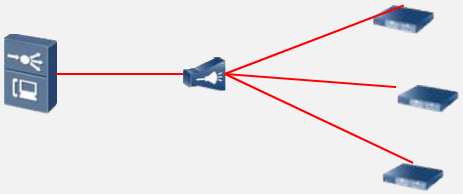
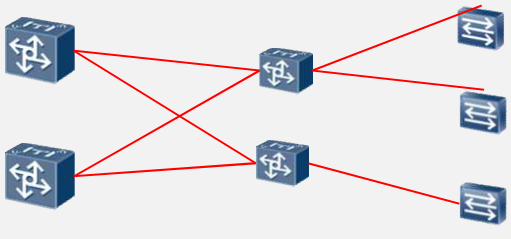
GPON O&M is easier

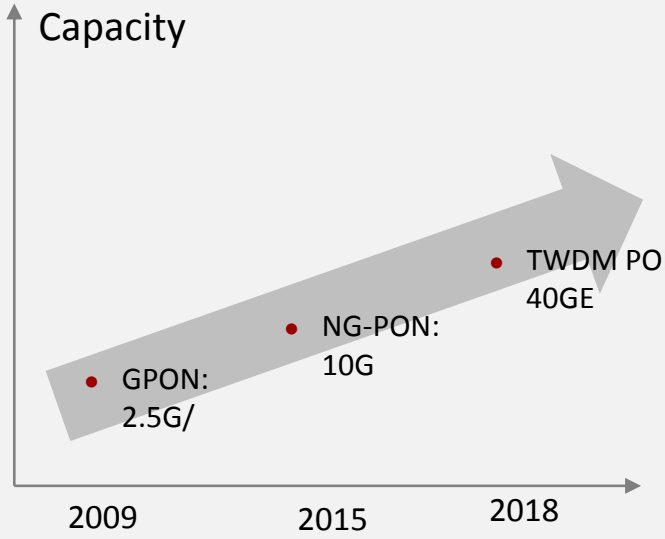




Item	GPON	Ethernet P2P
O&M	• Off-line deployment of batch ONUs, Automatic configuration delivery • Remote supervision and maintenance • iODN can realize optical network resource management , business provision automatically , accurate fault location	• Slow deployment • Low efficiency in cable routing and equipment installation • Low efficiency in fault location and monitoring
Reliability	• Strong encryption algorithm : AES-128 • Passive optical splitter ， low failure rate	• Lack of encryption algorithm generally • Massive active equipments , high failure rate

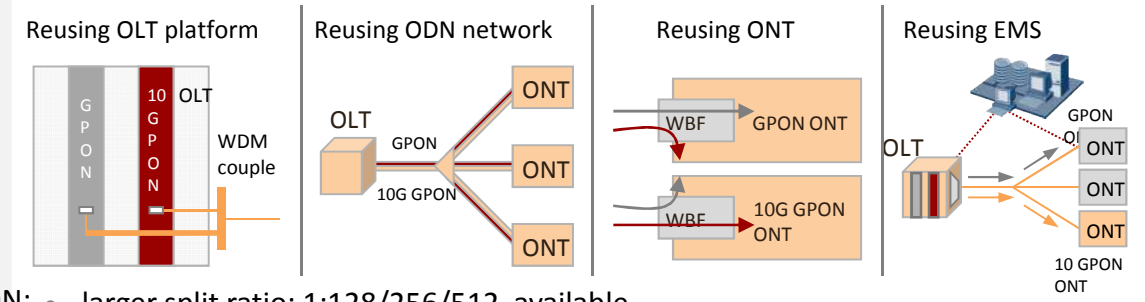
GPON supports Smooth Evolution

Fiber Technologies evolution



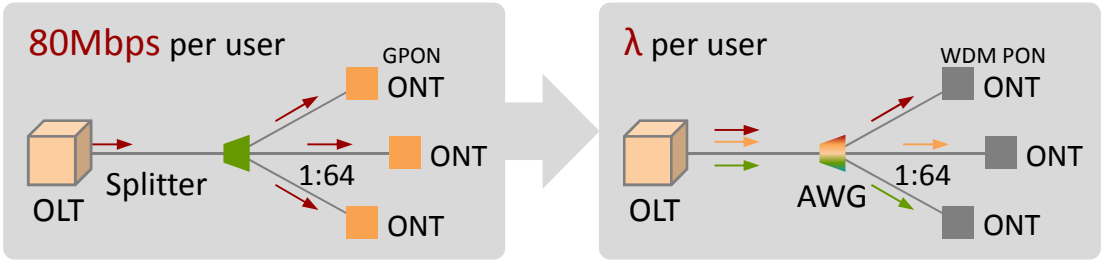
- Fiber: abundant spectrum & wavelength resource to meet endless bandwidth demand

From GPON To 10G NG-PON



- larger split ratio: 1:128/256/512 available

From NG-PON to WDM PON



- Self seeding solution Lower the cost without special laser, additional seed light

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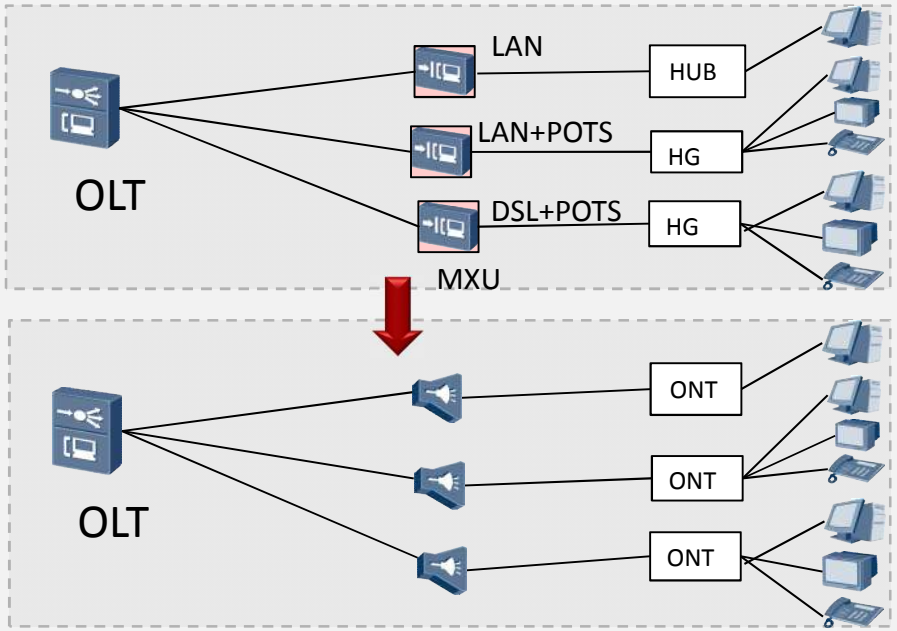
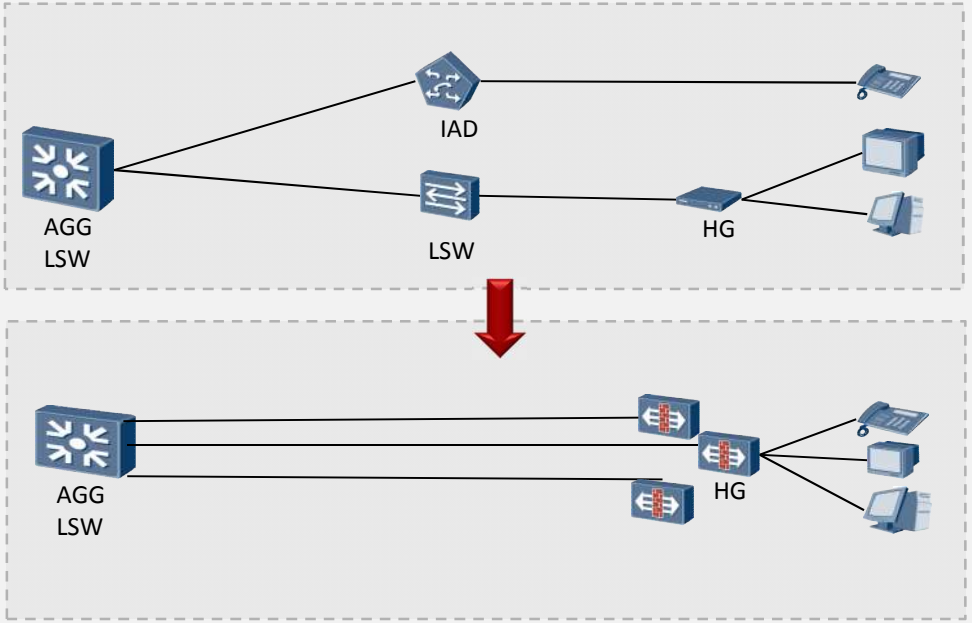
Evolution Comparison

Evolution from FTTB to FTTH



Evolution from ETTB to ETTH



- Only need replace MxU with SPL when evolves from GPON FTTB to FTTH
- ETTB evolves to ETTH also need more fibers compare with GPON FTTH solution

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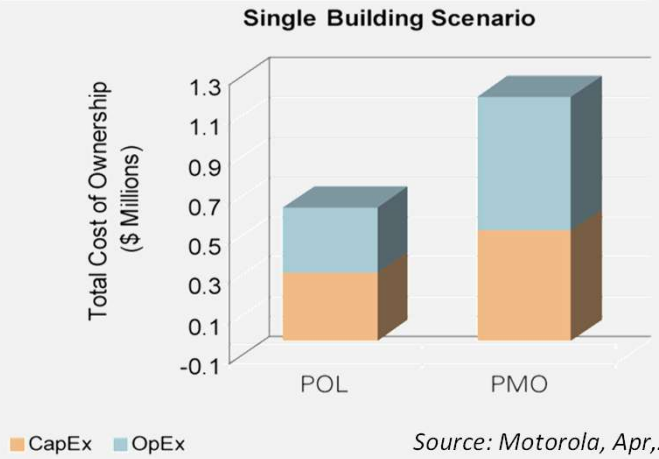
PON saves More than 25% TCO

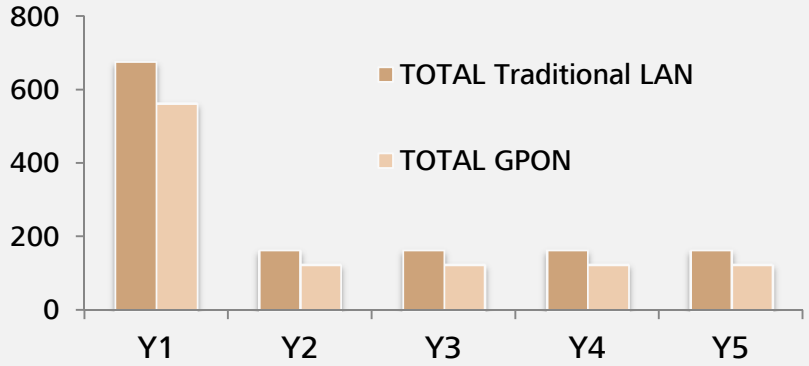
45% savings in a 5-year TCO for Single building



Source: Motorola, Apr,2012

- About 45% savings comparing with present LAN for a 5-year TCO
- CAPEX saving would be about 15 ~ 20% , major coming from the riser closet equipments and lateral cabling differences
- Energy saving, riser closet room saving are the major contribution of OPEX saving

At least 25% to 30% saving with Huawei analysis



Source: Huawei Analysis

- About 20% savings between PON and P2P considering CAPEX and energy saving
- Additional savings from cooling equipment, UPS and room reservation in each floor, 30% total saving can be guaranteed

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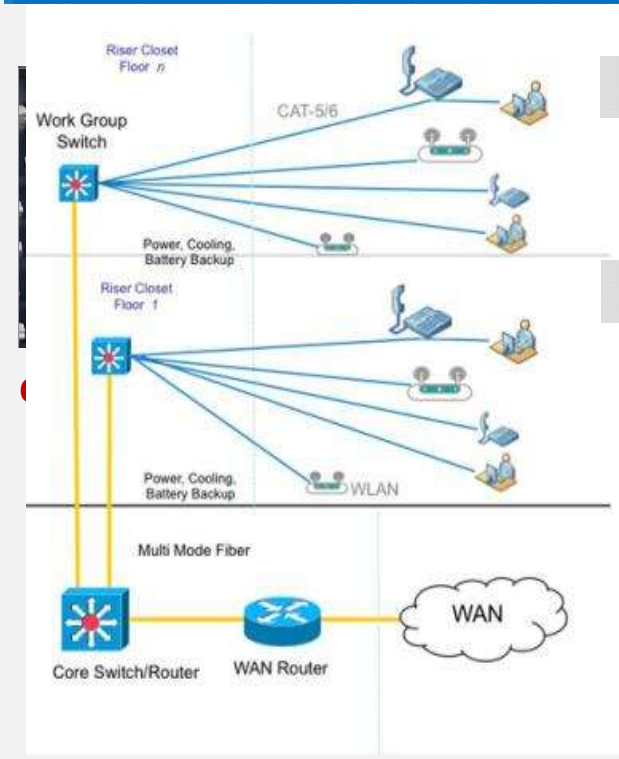
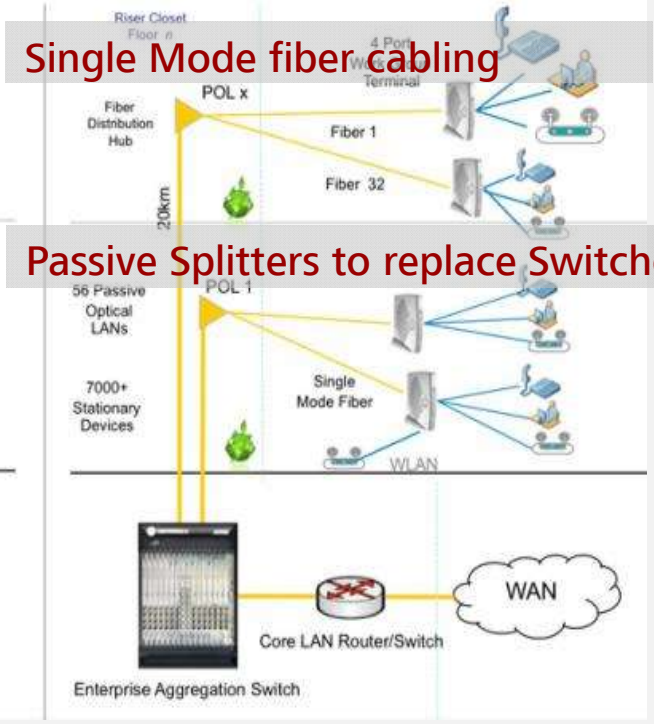
PON is Greener

Ethernet P2P



PON



Single Mode fiber cabling

Passive Splitters to replace Switches

Fiber Eth Cable

- Energy saving
- Cabling materials saving
- Maintenance saving

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Applications

	GPON		Ethernet/P2P
Carriers			Not well-known Small operators
	Tie 1 or 2 operators	Vs.	Municipal or Tier3 operators
Providers			
	Carrier-focused	Vs.	Enterprise-focused
Organizations			No international organization to support standard protocols for service provision and management on this technology
	Strong International teamwork	Vs.	Weak teamwork

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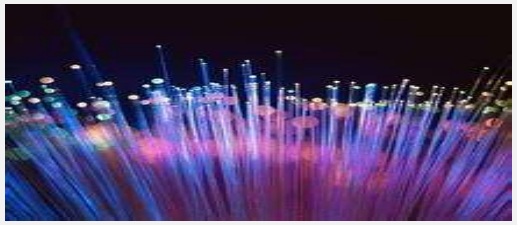
Summary: PON vs Ethernet

Lower TCO
Cost Effective

Flattened Network
Easy O&M



Smooth Evolution
Wide Application

Multi-service Support
High Reliability

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HUAWEI ENTERPRISE ICT SOLUTIONS A BETTER WAY