



فیبر نوری

رضا قادر

الکٹرونیک – مخابرات دیجیٹال – تجارت الکٹرونیک

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فهرست

- ▶ مبانی فیبر نوری
- ▶ سیستم های مخابراتی نوری
- ▶ ساختار فیبر نوری
- ▶ انواع فیبر نوری
- ▶ فناوری های فیبر نوری
- ▶ شبکه انتقال
- ▶ شبکه دسترسی
- ▶ تحولات تجربه دسترسی آنلاین
- ▶ کاربرد فناوری های فیبر نوری
- ▶ FTTH
- ▶ GPON



مطالب درسی

- سرفصل های وزارت علوم، تحقیقات و فناوری
- مستندات دانشگاه فنی و حرفه ای استان گیلان
- گروه فناوری اطلاعات و ارتباطات



دانشگاه صنعتی امیرکبیر
(پلی تکنیک تهران)

Fiber-Optic Communications Systems, Third Edition. Govind P. Agrawal
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**Fiber-Optic
Communication Systems**
Third Edition

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جلسه اول

فیبر نوری در شبکه های مخابراتی

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1.1. HISTORICAL PERSPECTIVE

3

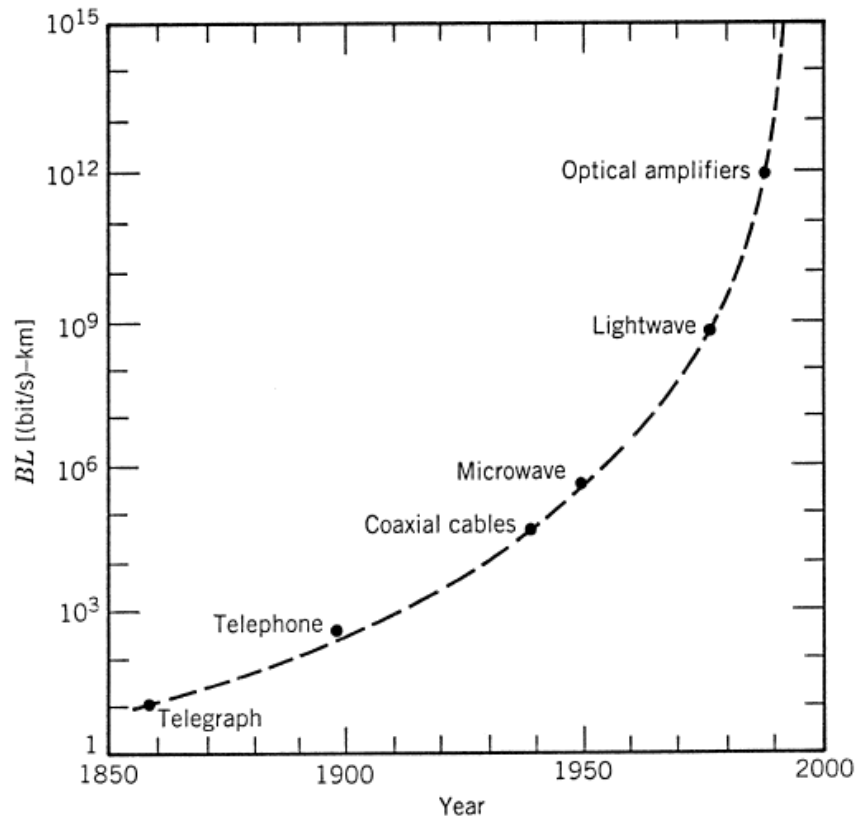


Figure 1.2: Increase in bit rate–distance product BL during the period 1850–2000. The emergence of a new technology is marked by a solid circle.

اولین تارهای کم تضعیف در سال ۱۹۷۰ تولید شدند.

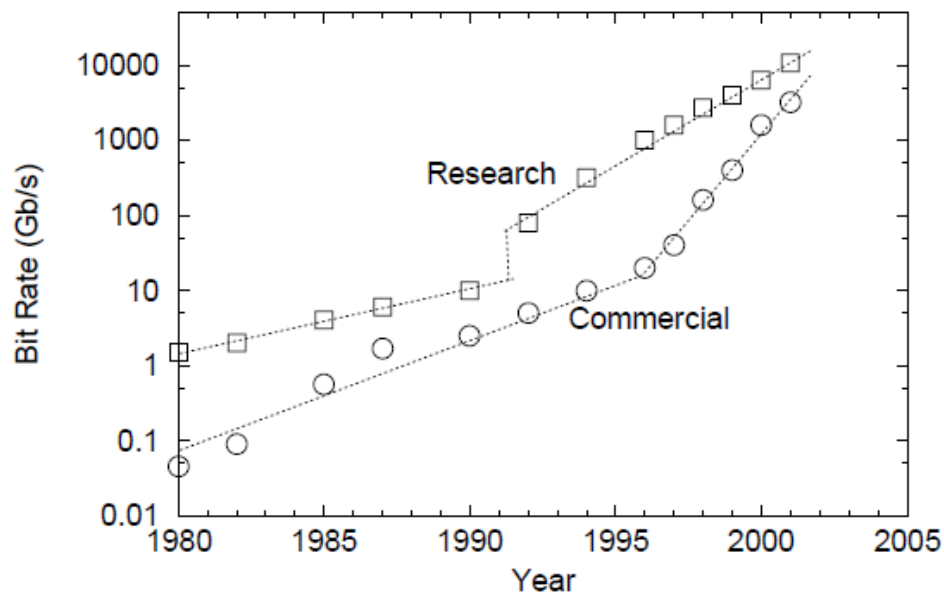


Figure 1.3: Increase in the capacity of lightwave systems realized after 1980. Commercial systems (circles) follow research demonstrations (squares) with a few-year lag. The change in the slope after 1992 is due to the advent of WDM technology.

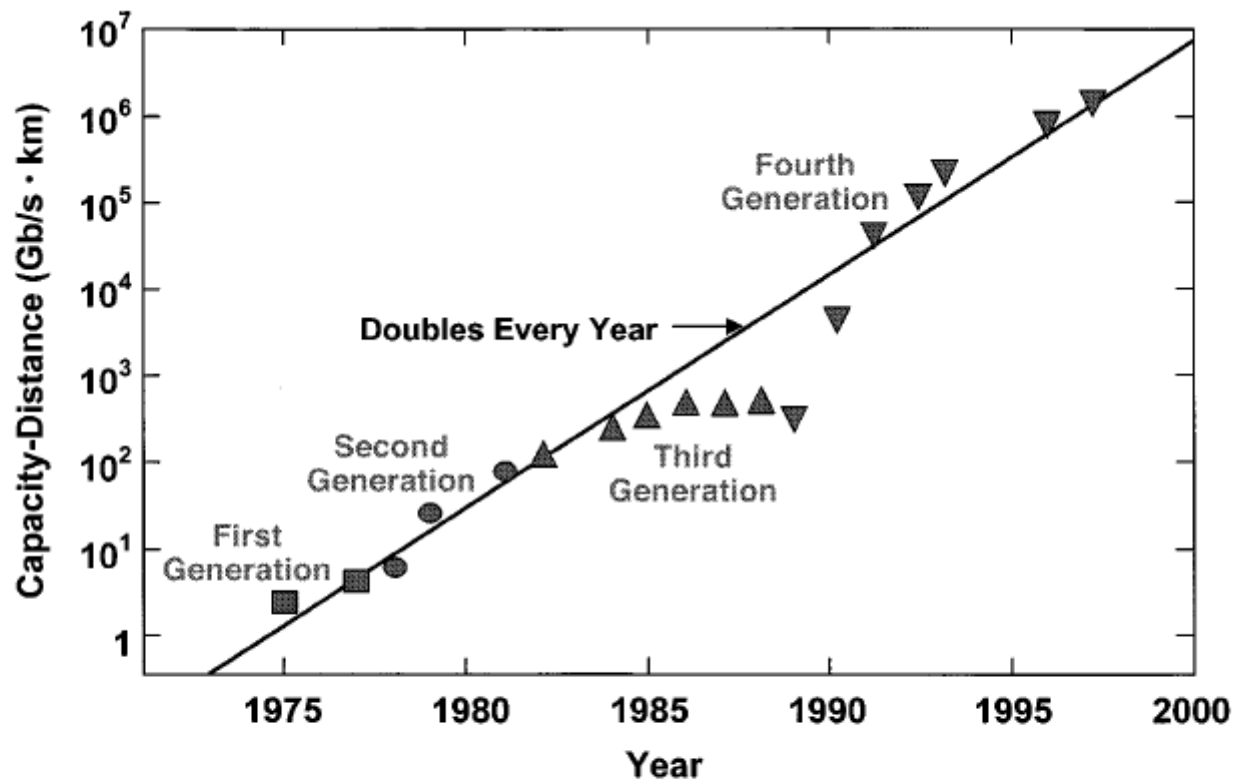


Figure 1.4: Increase in the BL product over the period 1975 to 1980 through several generations of lightwave systems. Different symbols are used for successive generations. (After Ref. [12]; ©2000 IEEE; reprinted with permission.)

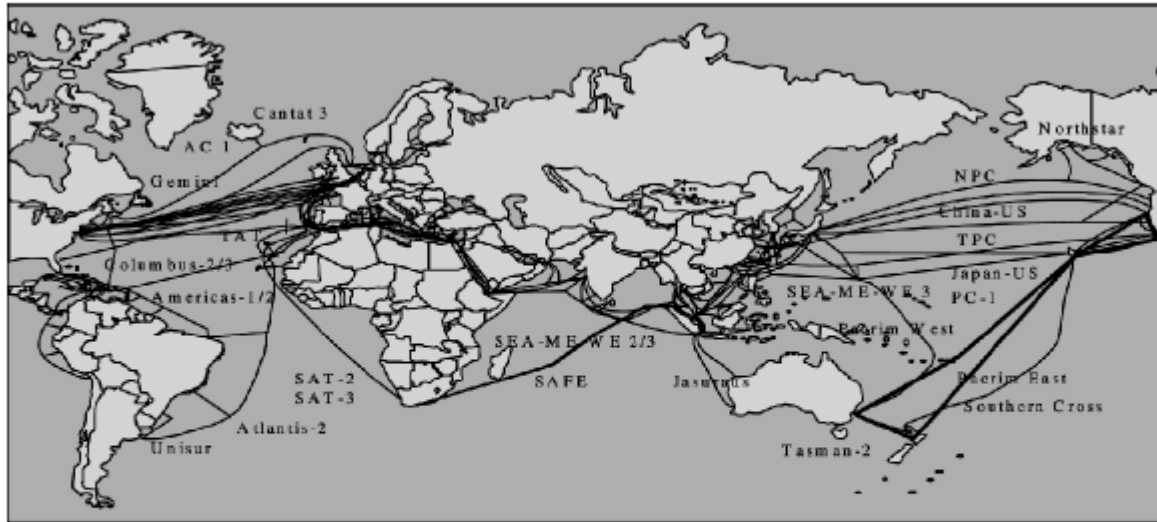


Figure 1.5: International undersea network of fiber-optic communication systems around 2000.
(After Ref. [22]; ©2000 Academic; reprinted with permission.)



جلسه دوم

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بلوک دیاگرام سیستم مخابراتی نوری

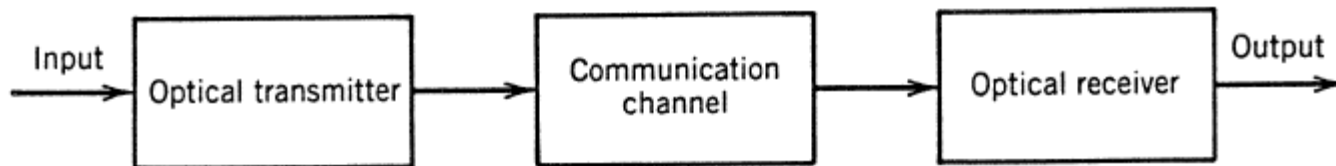


Figure 1.10: Generic optical communication system.

- ▶ در فرستنده ، خبر تولید می شود و به شکل قابل انتقال توسط کانال اطلاعات در می آید.
- ▶ اطلاعات از فرستنده به گیرنده توسط این کانال ارسال می شود.
- ▶ در گیرنده خبر از کانال دریافت می شود و به صورت نهایی آن در می آید.

اجزای یک فرستنده نوری

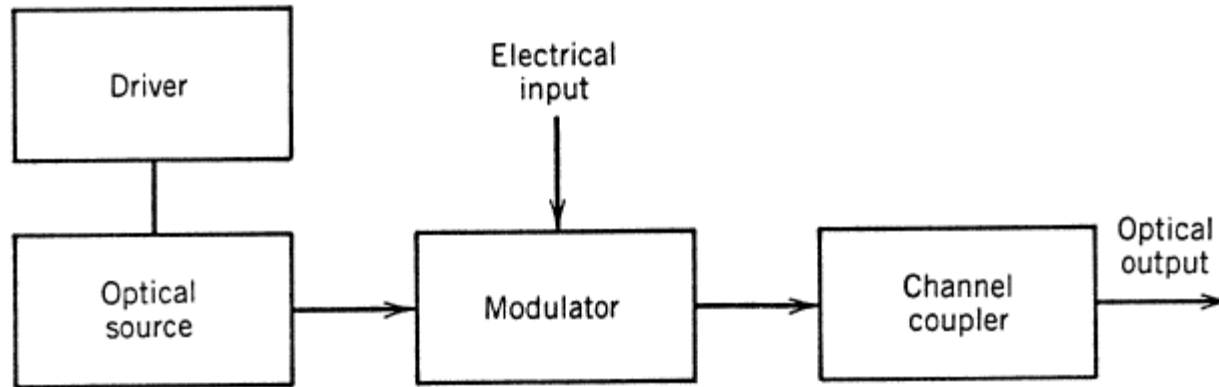


Figure 1.11: Components of an optical transmitter.

اجزای یک گیرنده نوری

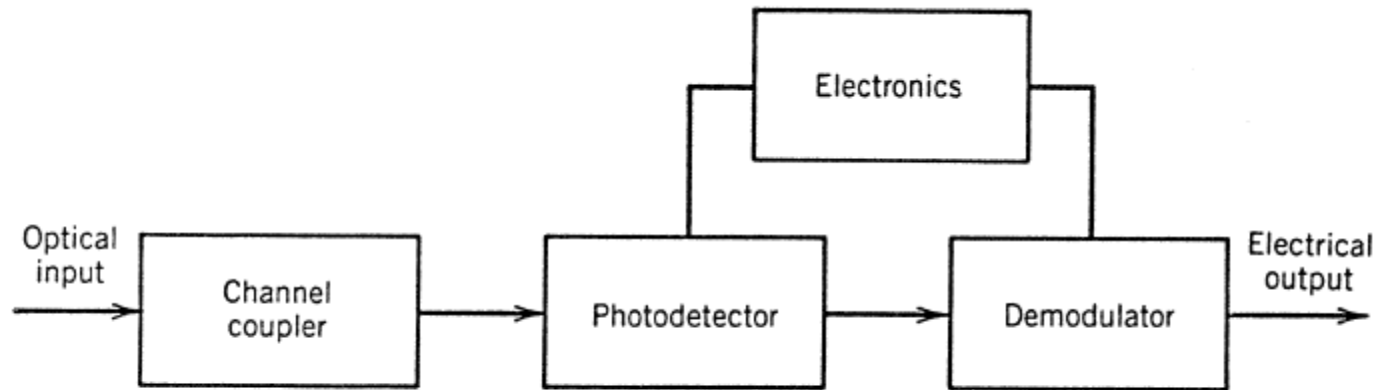


Figure 1.12: Components of an optical receiver.



جلسه سوم

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ساختار فیبر نوری

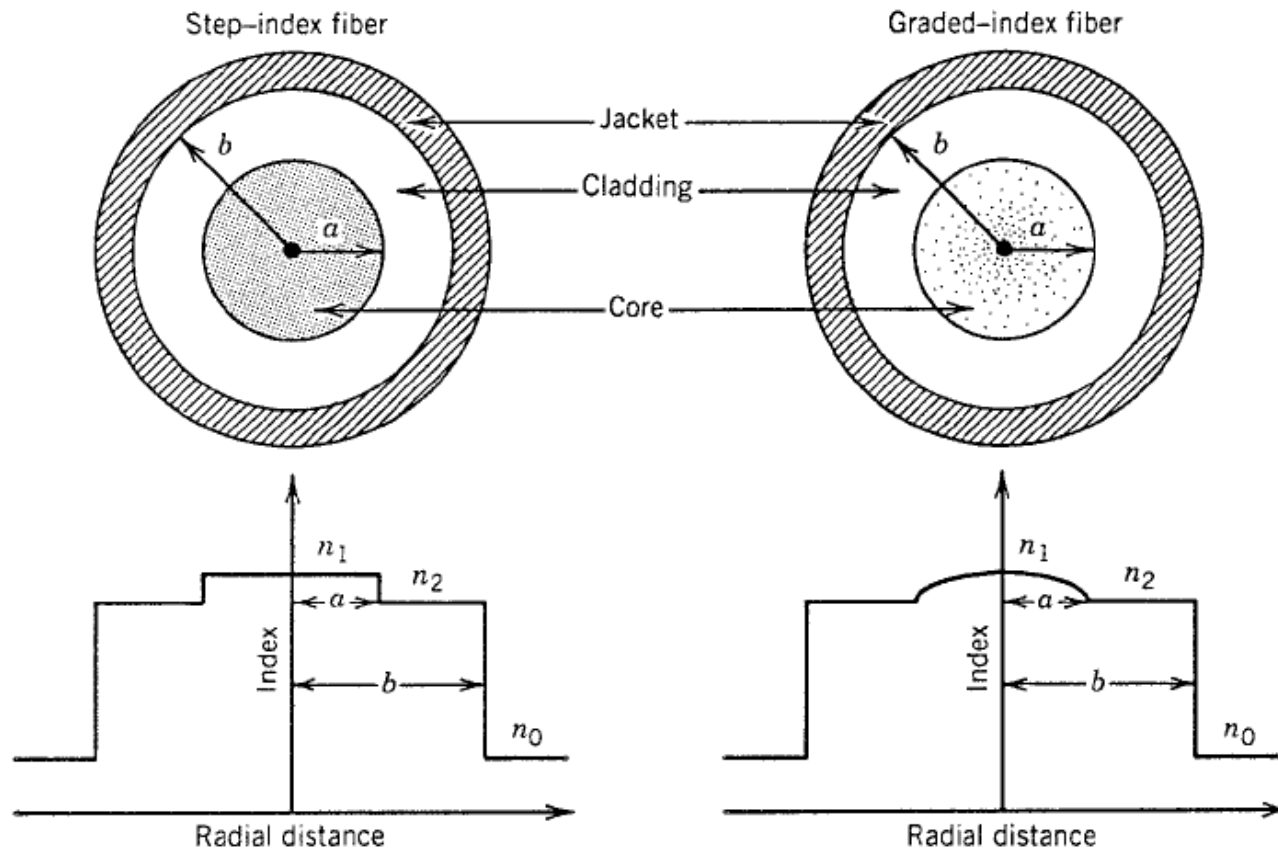


Figure 2.1: Cross section and refractive-index profile for step-index and graded-index fibers.

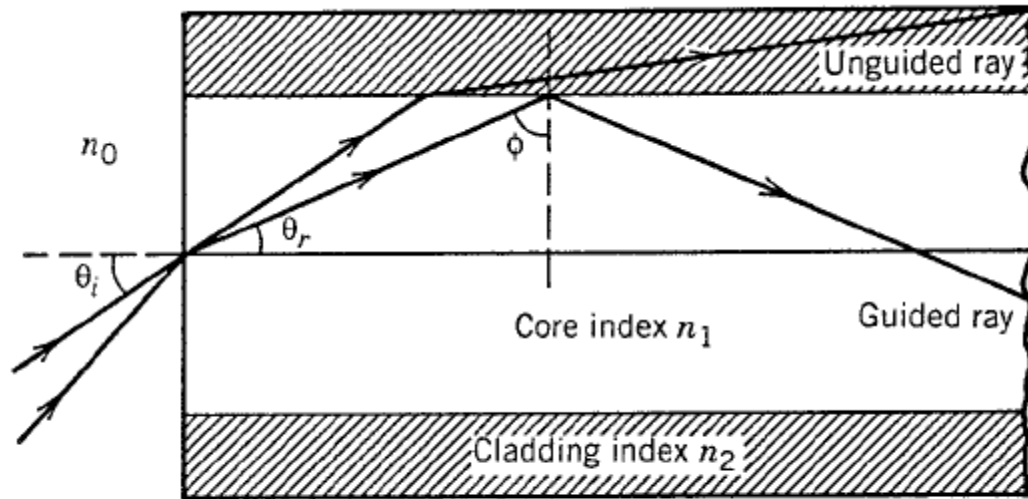


Figure 2.2: Light confinement through total internal reflection in step-index fibers. Rays for which $\phi < \phi_c$ are refracted out of the core.



جلسه چهارم

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انواع فیبر نوری



جلسه پنجم

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فناوری های ارسال و دریافت اطلاعات
به وسیله فیبر نوری

□ شبکه انتقال

Transmission Network

□ شبکه دسترسی

Access Network



جلسه ششم

فیبر نوری در شبکه های مخابراتی

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فناوری های ارسال و دریافت اطلاعات

□ شبکه انتقال

Transmission Network



جلسه هفتم

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فناوری های ارسال و دریافت اطلاعات

□ شبکه دسترسی

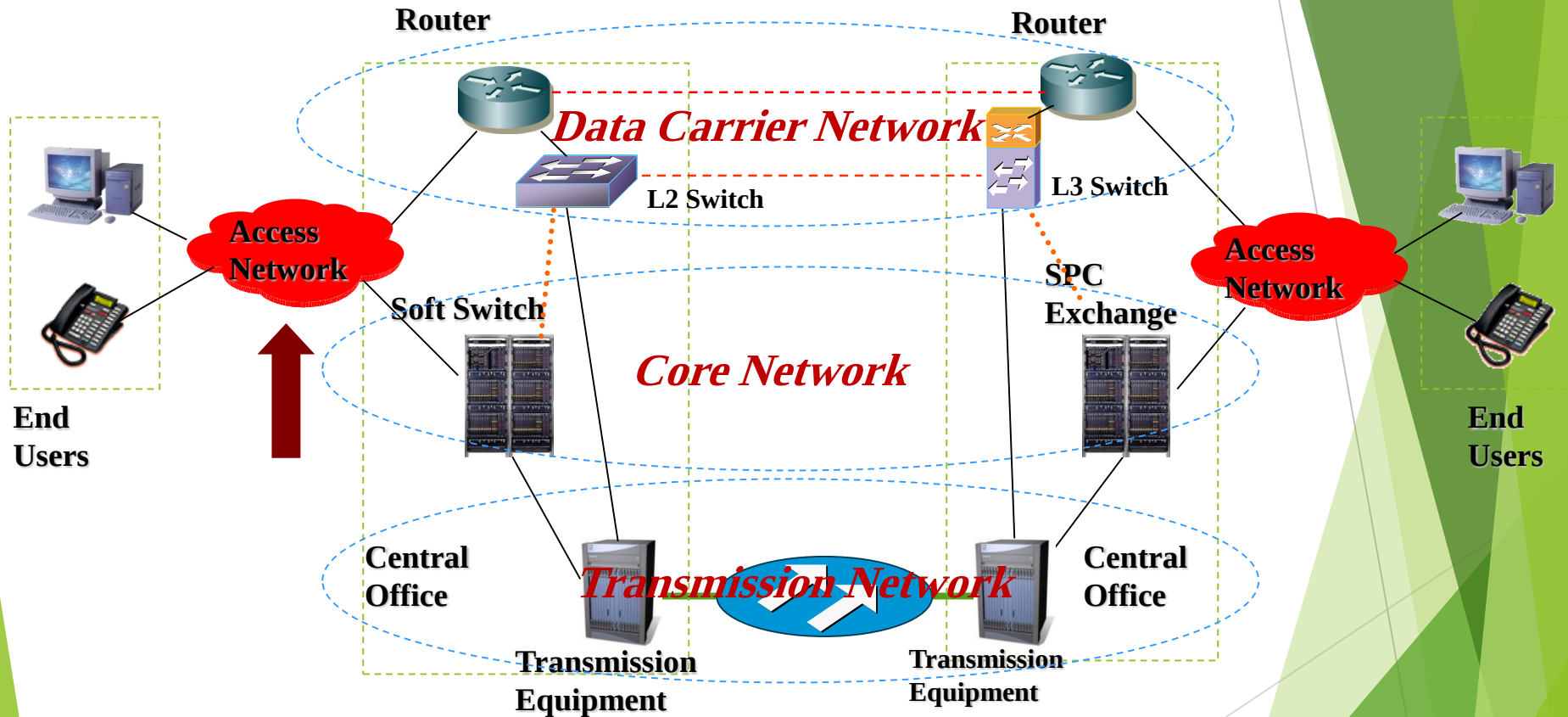
Access Network

مفهوم شبکه دسترسی نوری



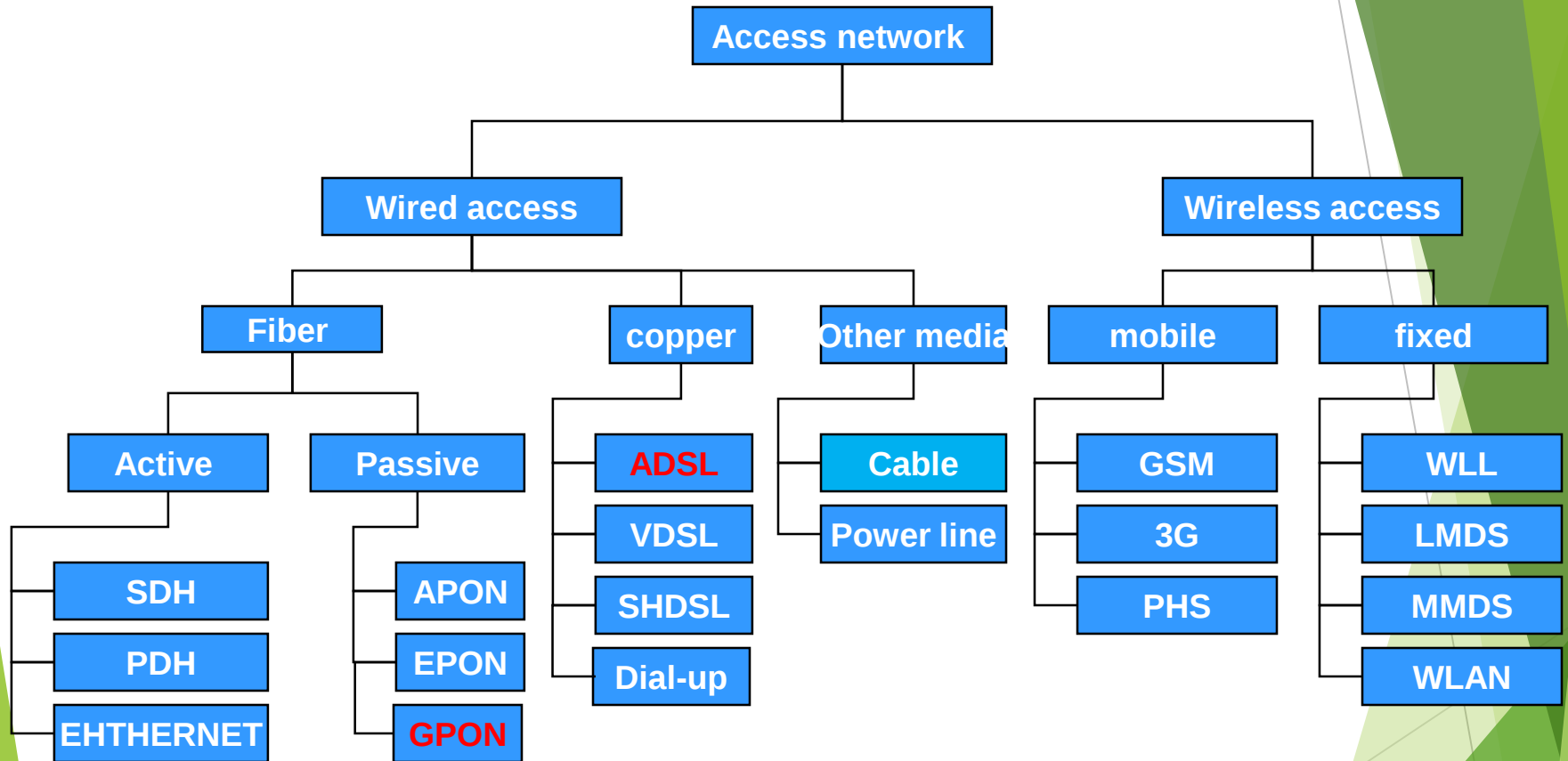
What's optical access network

Access Network



Access Network is between the end users and the exchange networks, provide channels for the end users connect to the core network.

Catalogue of access network



ADSL is the most commonly technology in copper access network, and GPON is the most commonly technology in fiber access network.



جلسه هشتم

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تحولات تجربه دسترسی آنلاین

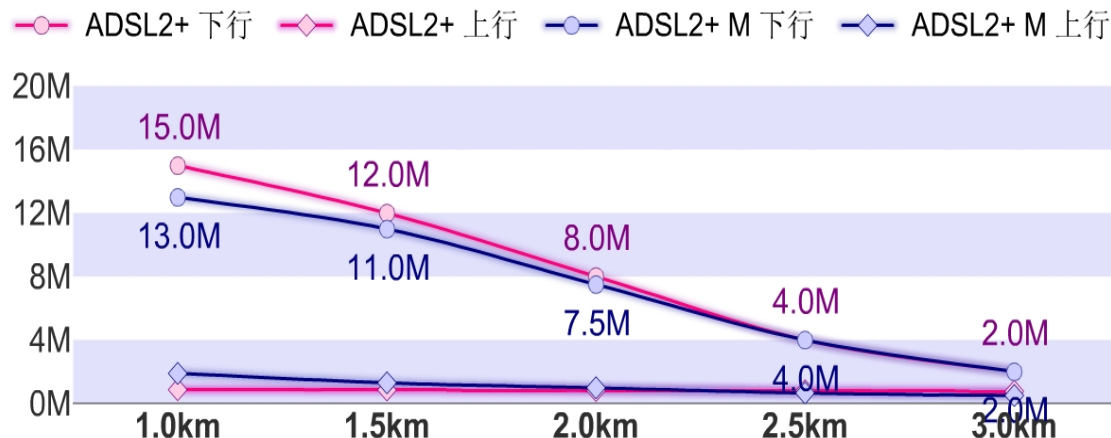
Online Experience Evolution



Bandwidth Demand

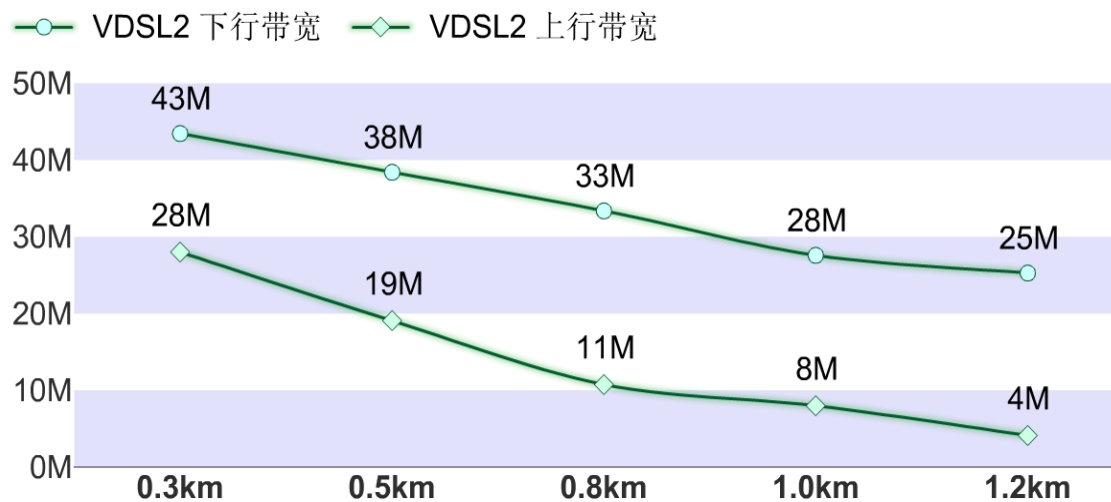
services		Bandwidth
Data Download		10Mbps
VoIP and videoconference		1Mbps
Music ,multimedia contents		2Mbps
On-line gaming		1Mbps
SD Digital TV		3Mbps
HD Digital TV, Additional TV channels		8Mbps

ADSL2+ 速率与铜缆长度的关系



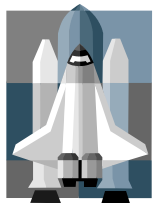
➤ **ADSL2+ can provide 15M bandwidth within 1km and 12M within 1.5km.**

VDSL2 速率与铜缆长度的关系 (实验室模拟测试结果)



➤ **With the experiment test conditions, VDSL2 can provide more than 25 M bandwidth within 1 km distance.**

Distance and Bandwidth



Transport Technology

How to solve
the problems
for 'Distance'
and
'Bandwidth'?

xDSL Technology

ISDN

HDSL

ADSL

ADSL2+

VDSL2

.....

???



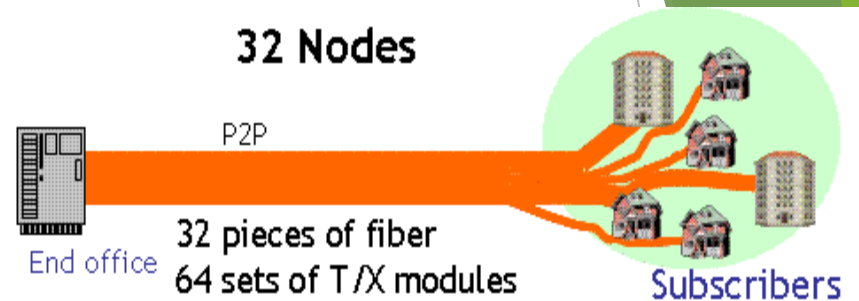
Q:
How to do?

A:
Optical Access
Network

Solutions for Optical Access Network

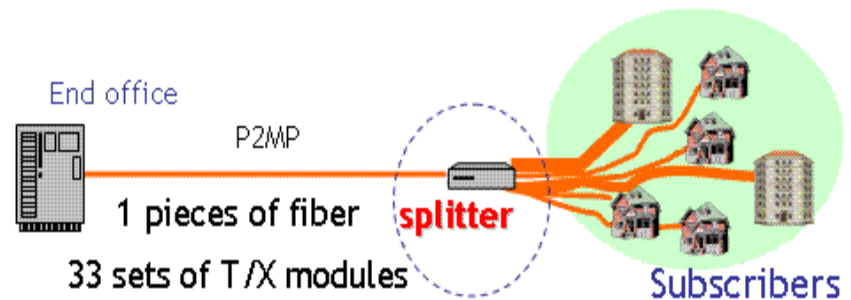
► P2P Method--ETTH

- N pieces of fiber, 2N sets of optical T/X modules
- Each channel is respectively manageable
- Suitable for non dense area or gray field.

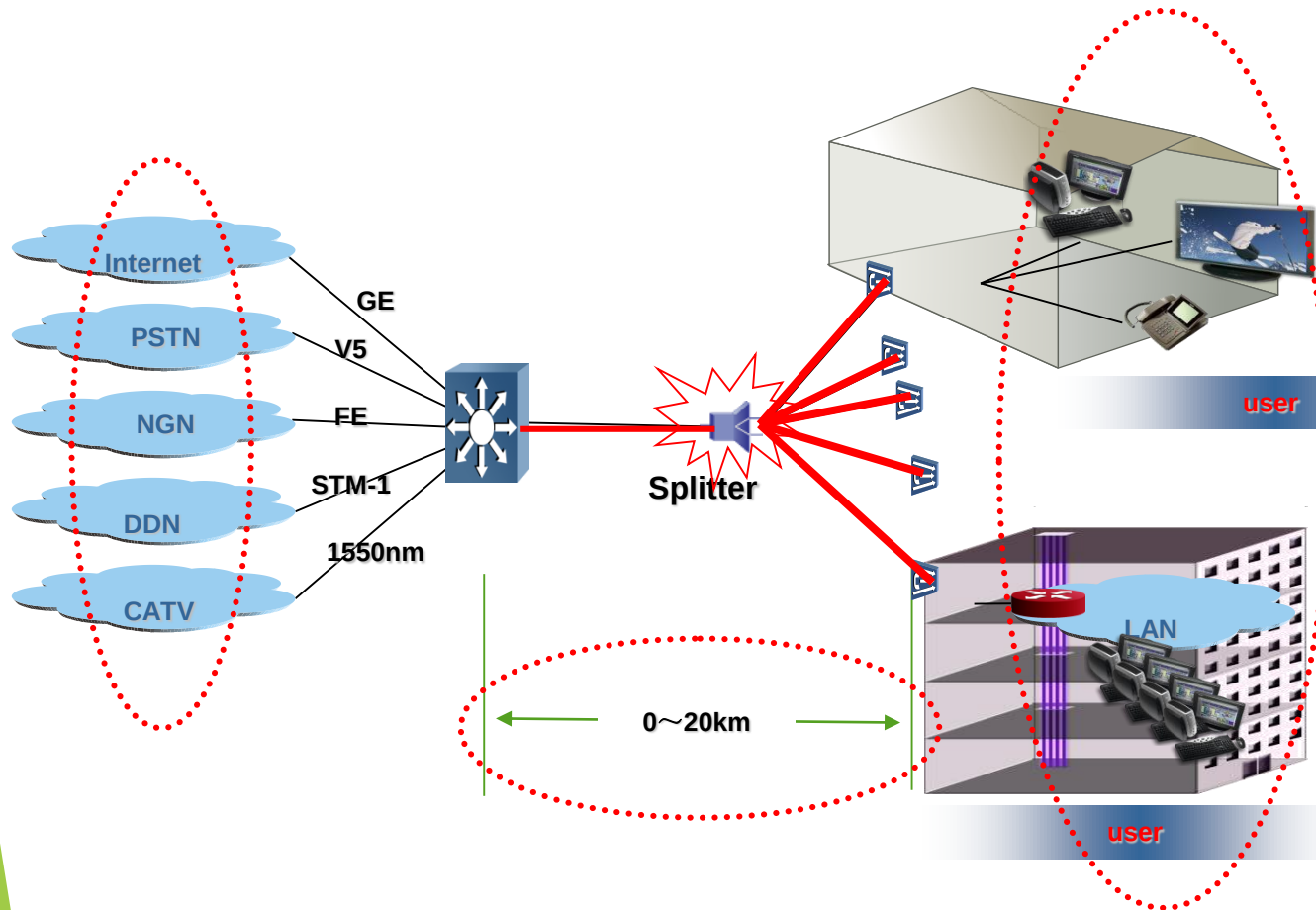


► PON Method--FTTH

- One or two backbone fiber to district
- N+1 sets of optical T/X modules
- Save Exchange Office space
- No active devices between end office and subscribers
- Ease manageable
- Suitable for dense area or green field, especially good solution for large broadband access deployment



The advantage of PON technology



1. Bandwidth

2. Low CAPEX

3. Manageable

4. Full service

5. Low OPEX

PON Network Service Operators' Philosophy



جلسه نهم

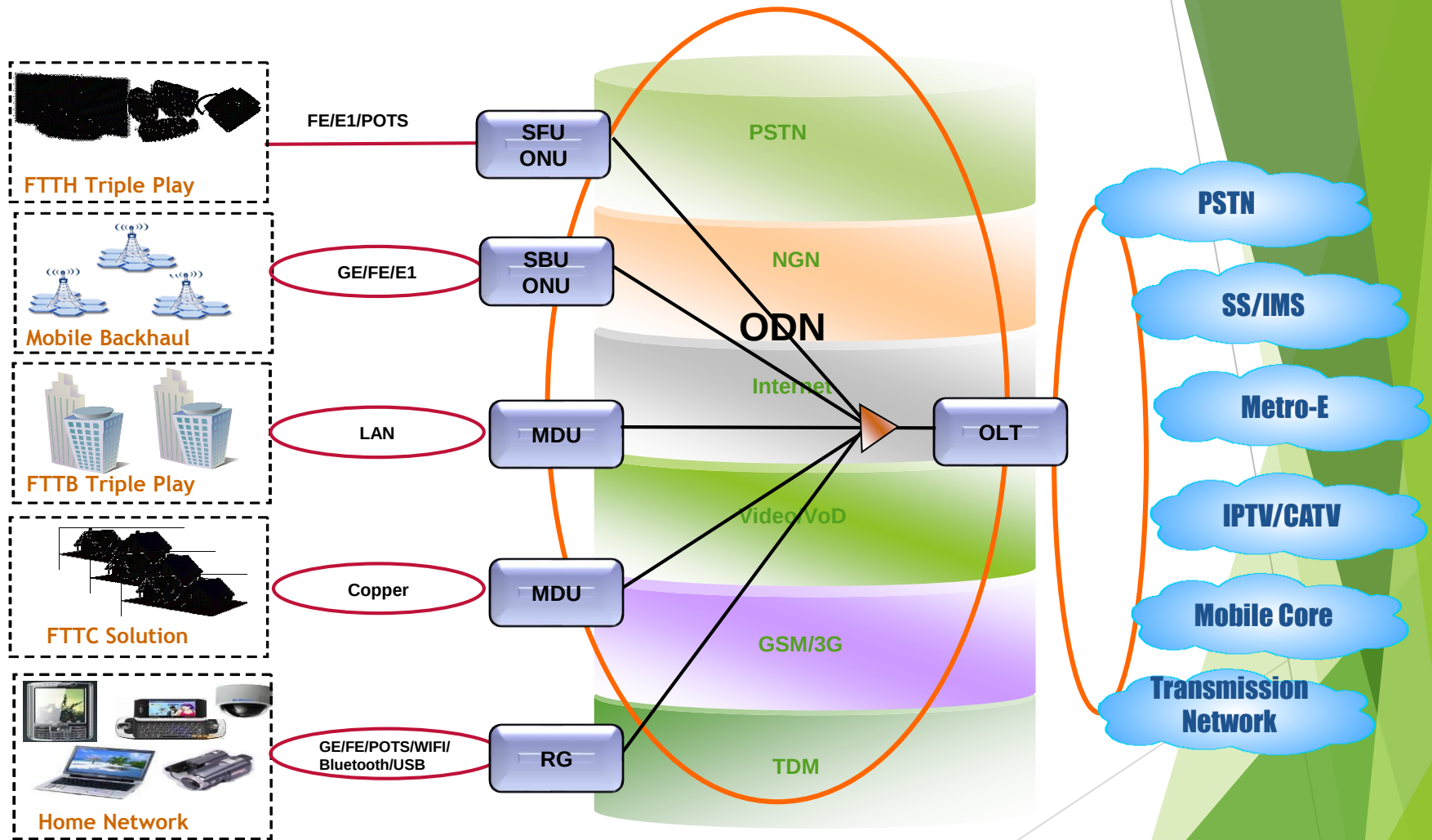
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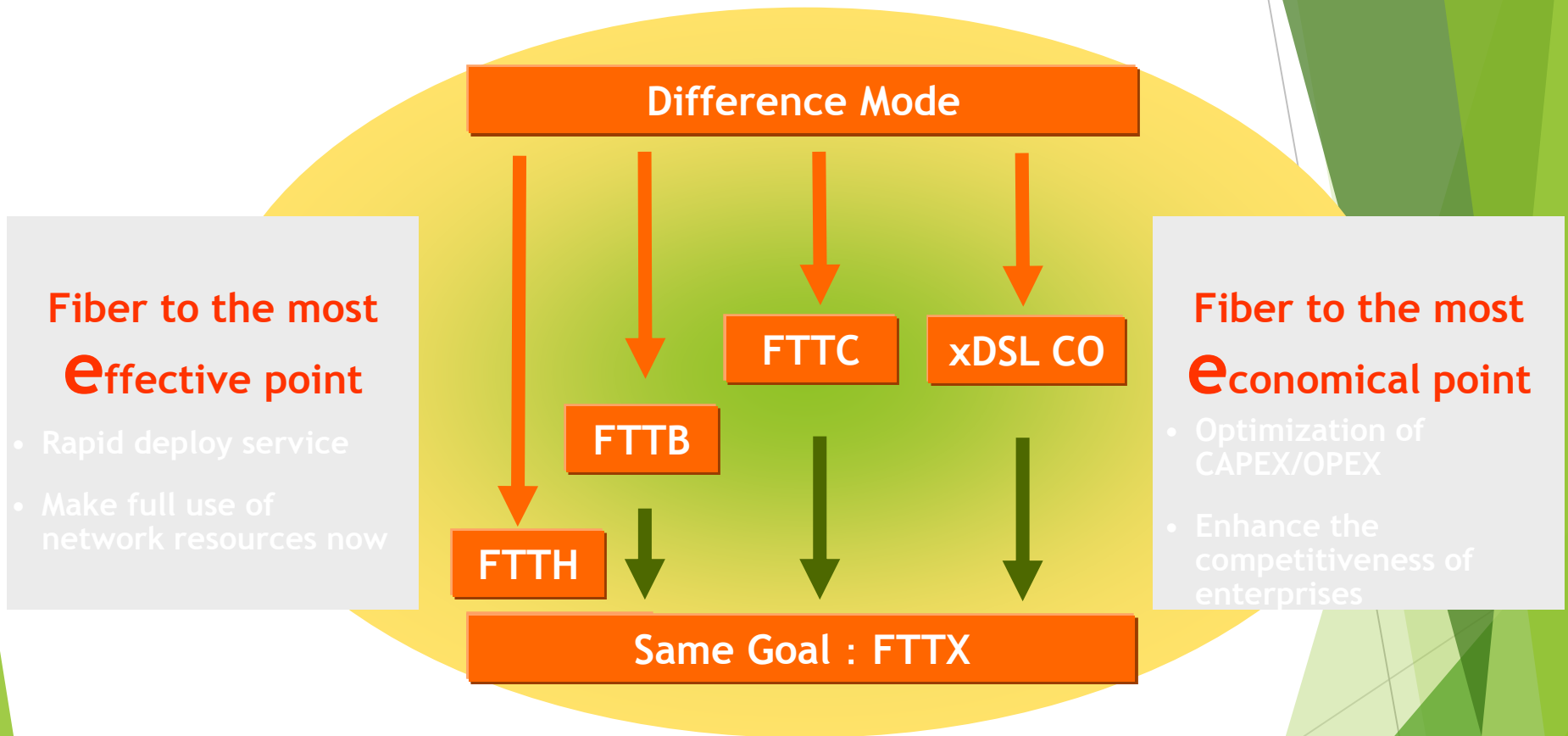
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کاربرد فناوری های PON

Moving to Full Service Providers Using PON



FTT e^2 : Optics access networks pushed into the most economical
the most effective place



According to the actual situation of FTTX deployment



جلسه دهم

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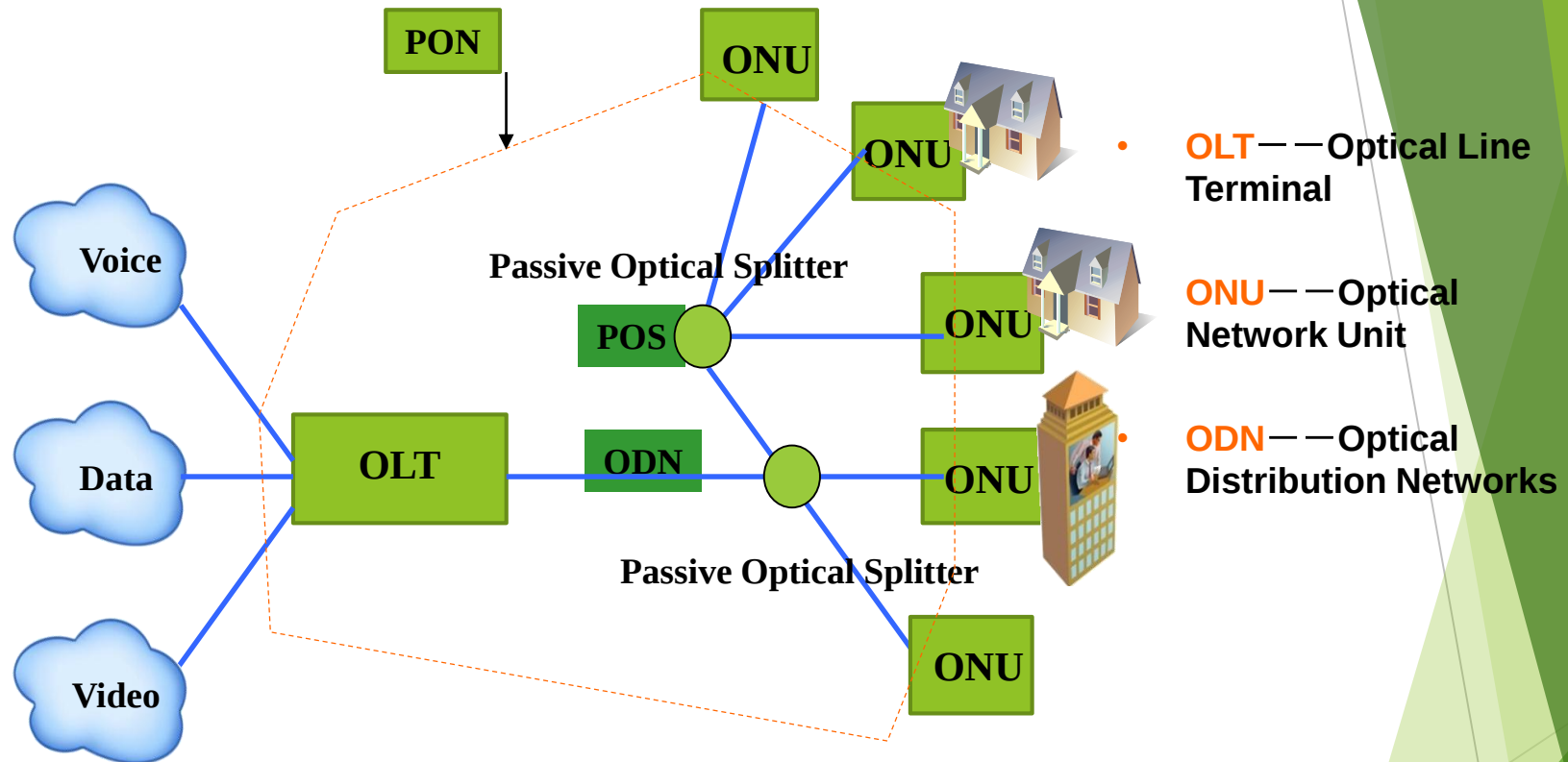
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مفہوم فٹاوری GPON



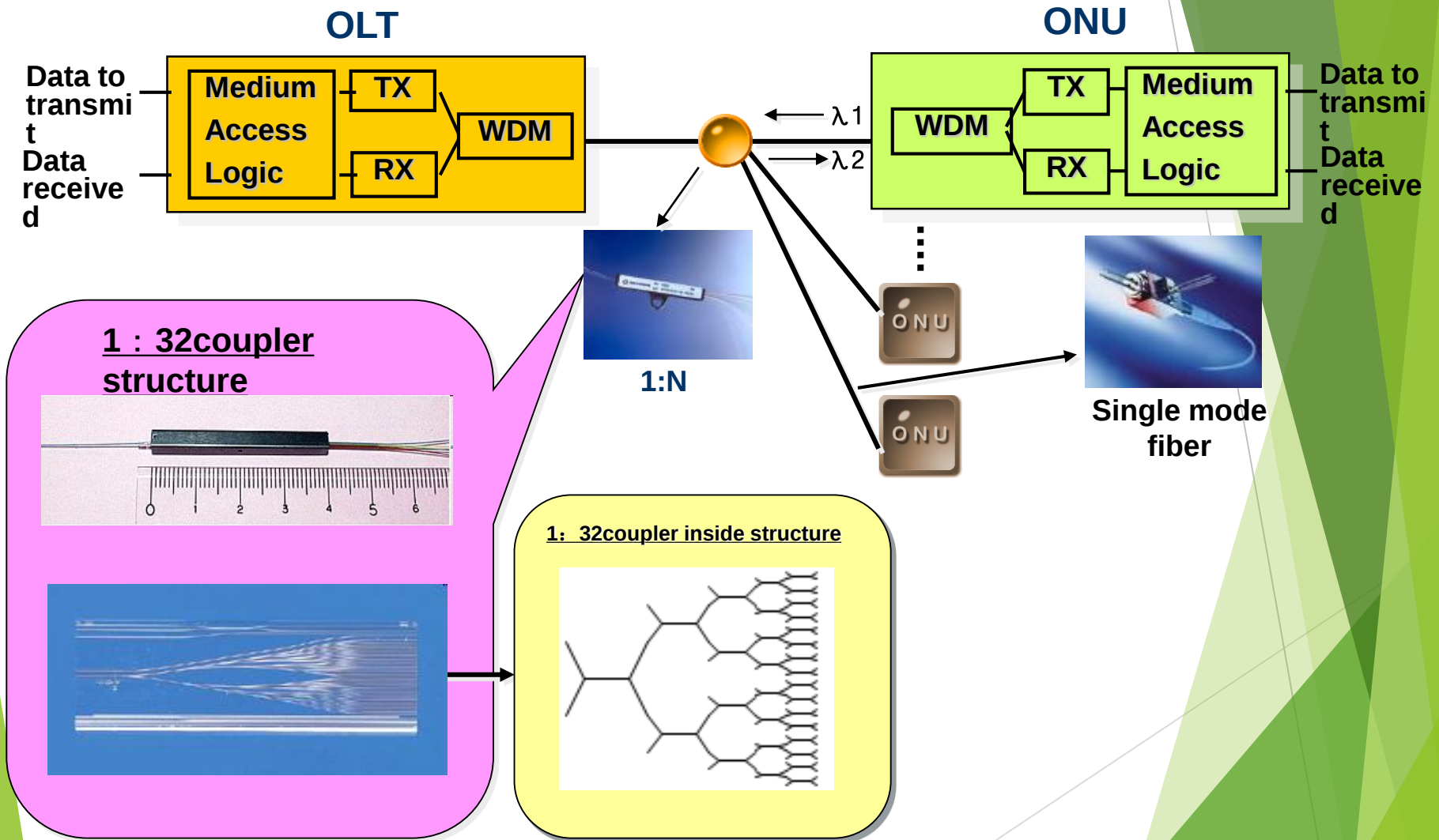
Concept of GPON

The composition of the PON network



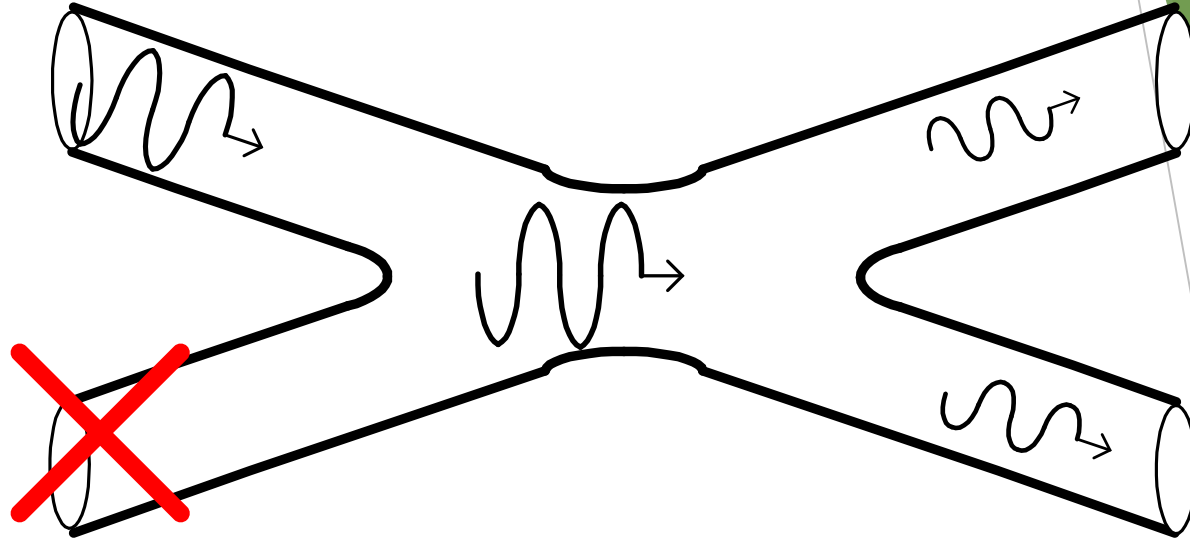
- PON network is a P2MP Passive Optical Network
- PON network comprised by OLT,ODN,ONU. Network structure is very clear and simple.

Optical split technology



Working principle of POS

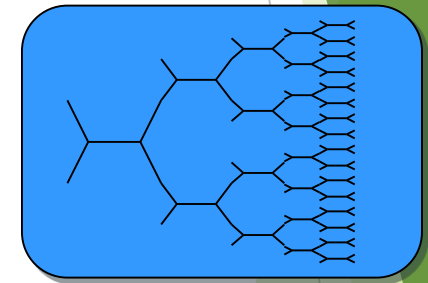
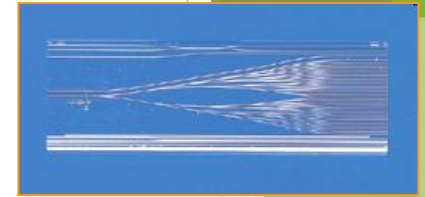
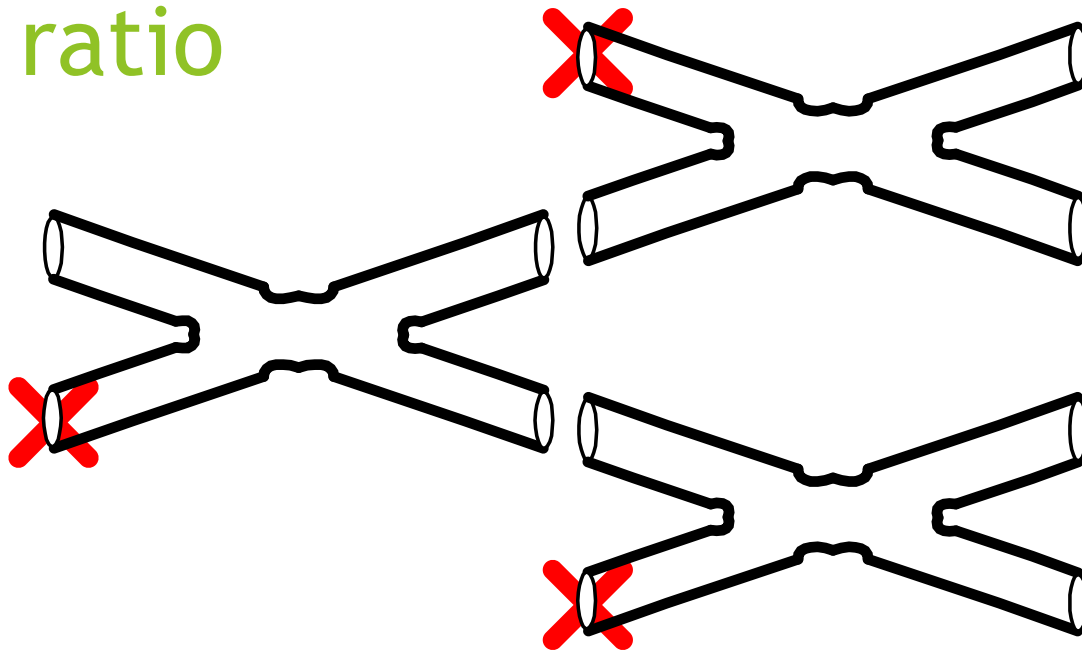
We take two fiber close and heating a point ,the two fiber will fuse together. The light from a branch into fusion point, is divided into two parts, carefully,it is light power, and not be signal



Manufacturing method



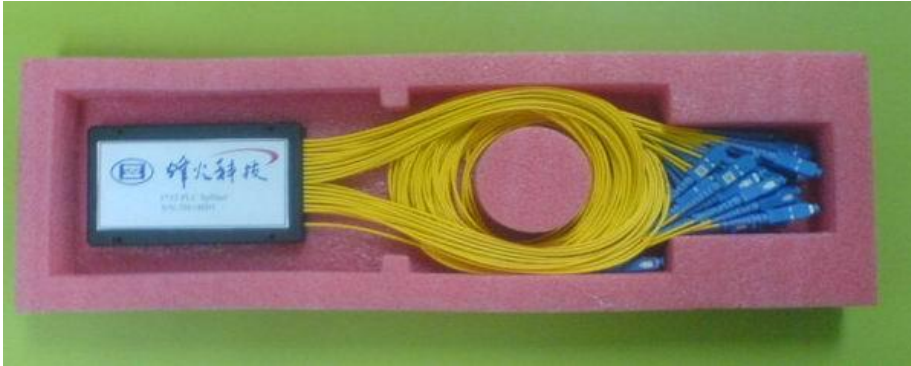
How to make different split ratio



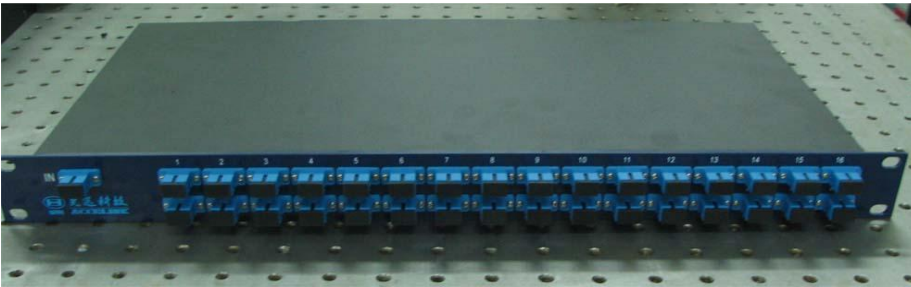
◆ We can cascade this kind of “x” type fusion point, We can get 1:2, 1:4, 1:8, 1:16, 1:32 split ratio POS...

◆ If we do not blocked the other input port, we can get 2:N splitter, so 1:N and 2:N splitter have the same structure.

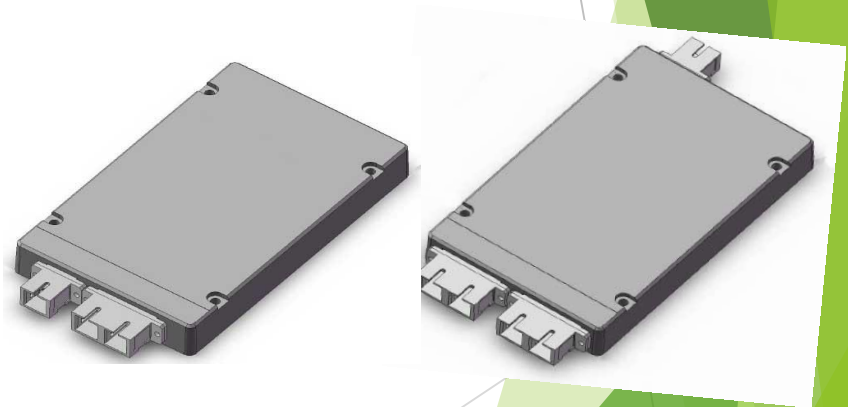
Real splitter example



size : 128×78×15mm



size : 482mm x 160mm x 43.5mm





جلسه یازدهم

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GPON Standards

ITU-T G.984.1

- Parameter description of GPON network
- Requirements of protection switch-over networking

ITU-T G.984.2

- Specifications of ODN parameters
- Specifications of 2.488Gbps downstream optical port
- Specifications of 1.244Gbps upstream optical port
- Overhead allocation at physical layer



ITU-T G.984.3

- Specifications of TC layer in the GPON system
- GTC multiplexing architecture and protocol stack
- GTC frame
- ONU registration and activation
- DBA specifications
- Alarms and performance

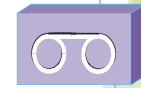


Simple development process
Powerful compatibility

ITU-T G-984.1/2/3/4

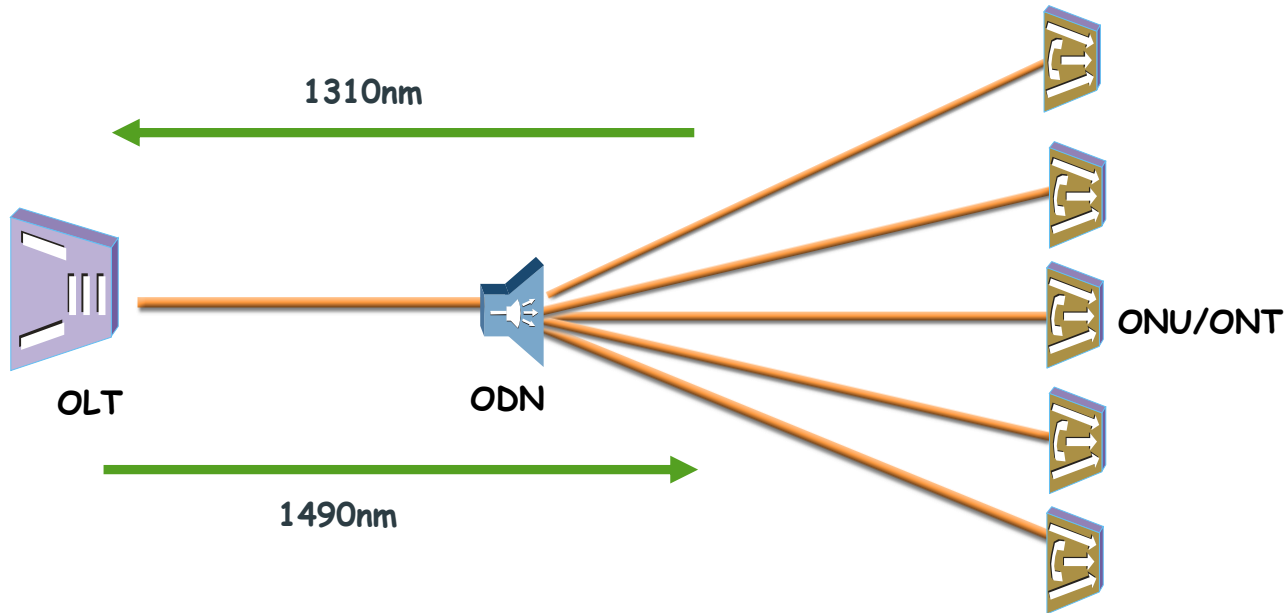
ITU-T G.984.4

- OMCI message format
- OMCI device management frame
- OMCI working principle



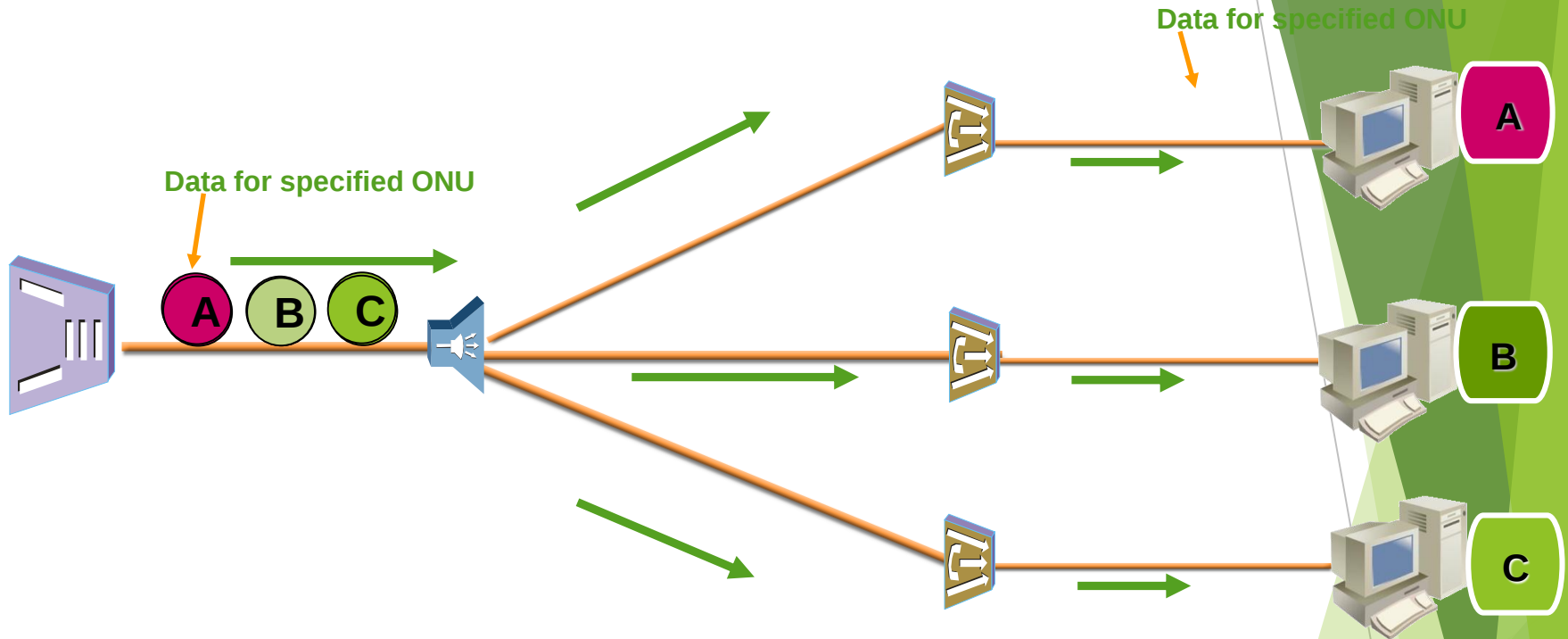
GPON Principle---Data Multiplexing

- GPON adopts Wavelength Division Multiplexing (WDM) technology, facilitating bi-direction communication over a single fiber.



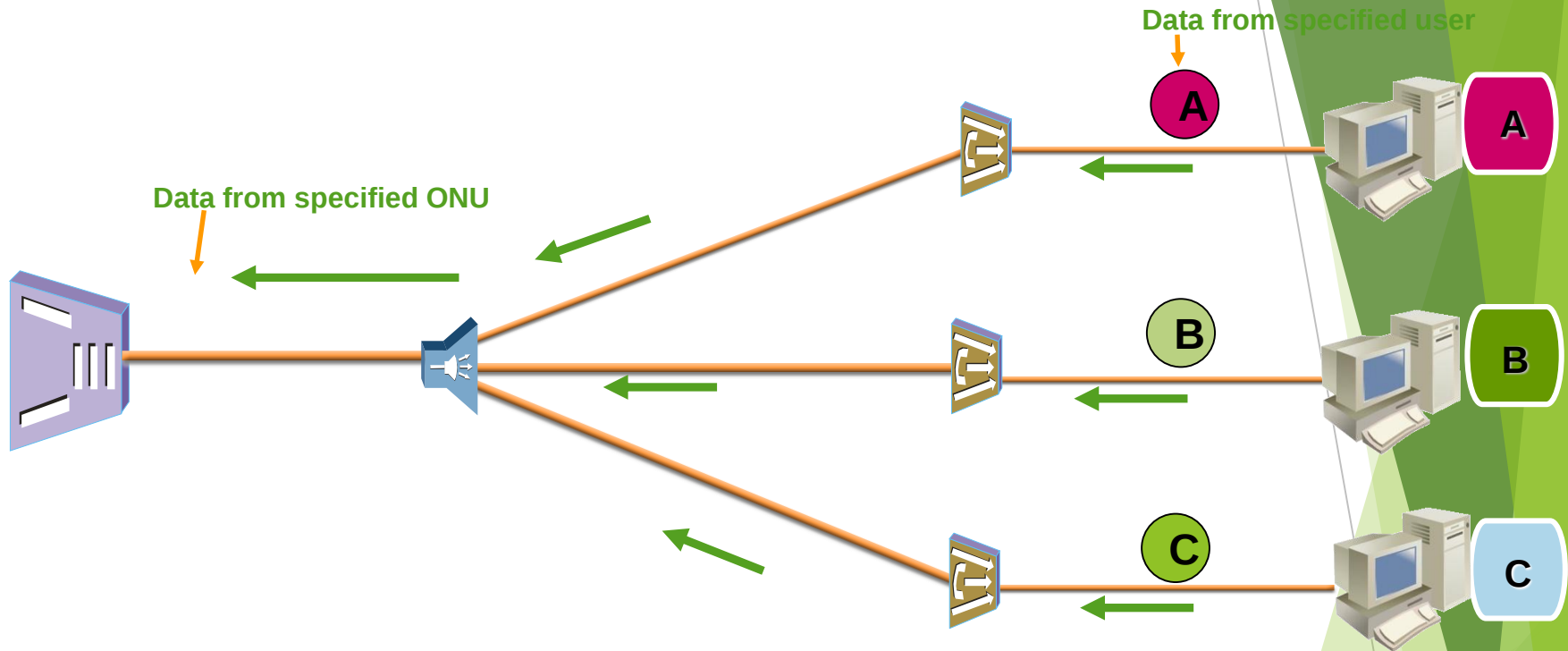
- To separate upstream/downstream signals of multiple users over a single fiber, GPON adopts two multiplexing mechanisms:
 - In downstream direction, data packets are transmitted in a broadcast manner;
 - In upstream direction, data packets are transmitted in a TDMA manner

GPON Principle----Downstream



- ▶ Broadcast mode
 - ▶ $38880\text{bit/s} \times 8000 = 2.48832\text{Gbit/s}$

GPON Principle----Upstream



- ▶ TDMA (Time Division Multiple Access) mode



جلسه دوازدهم

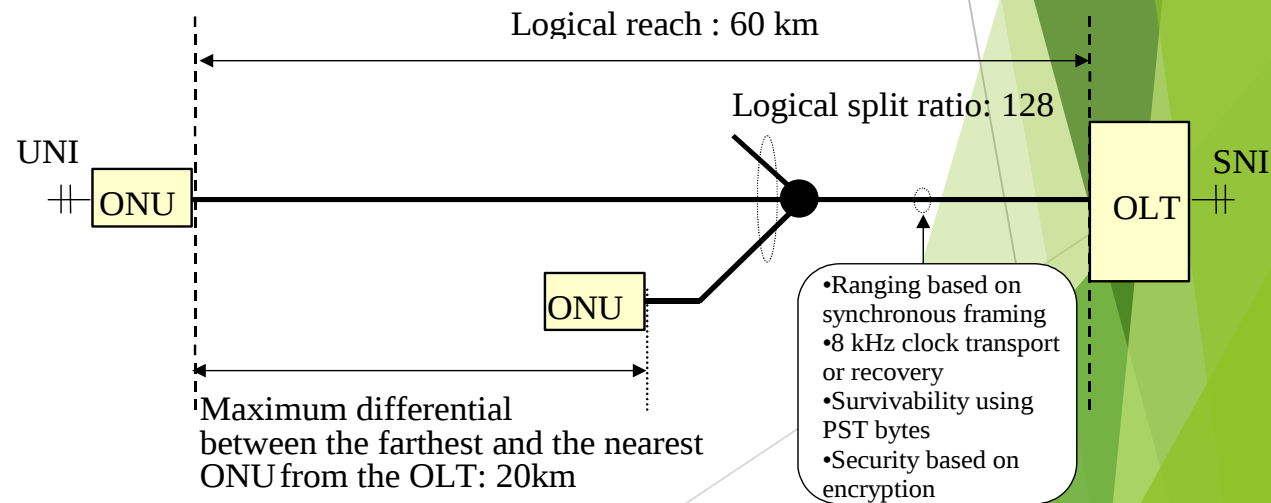
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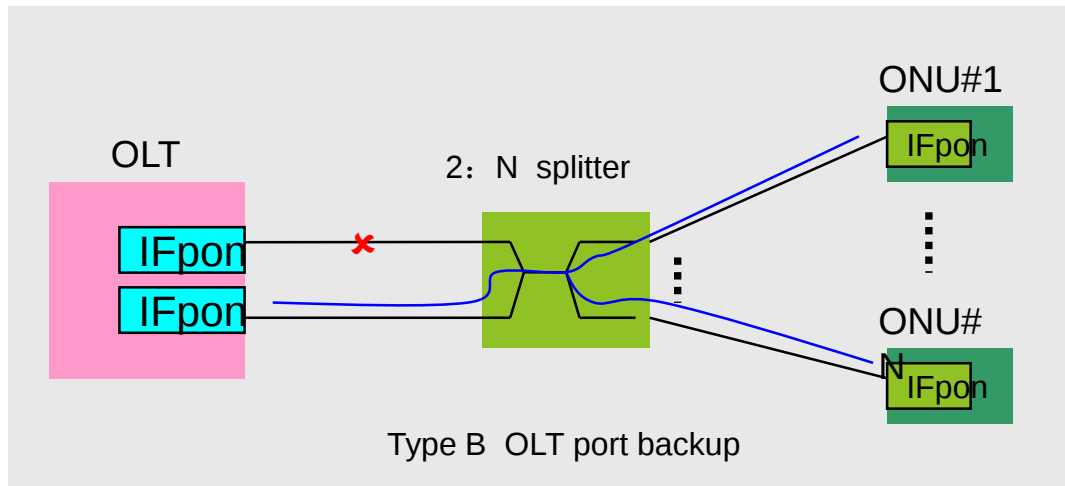
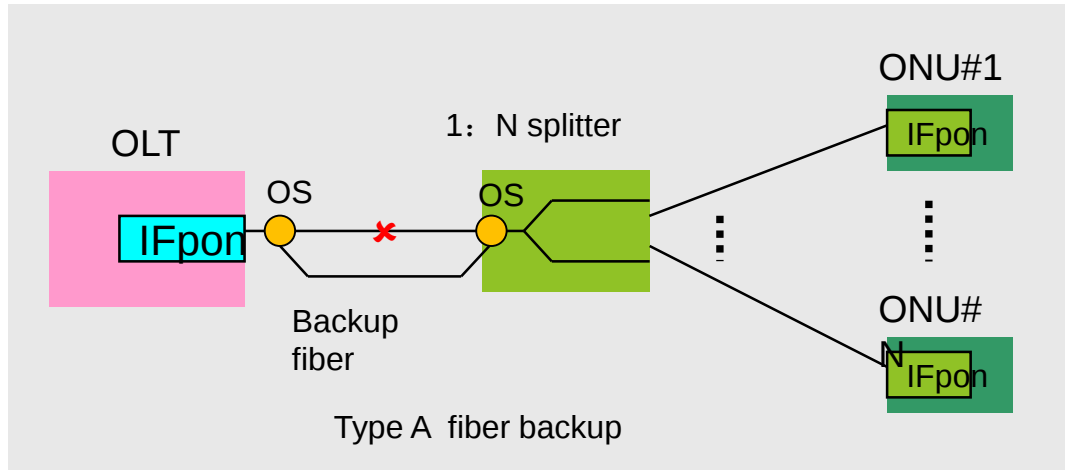
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Basic parameters of GPON

- GPON rates :
1.24416 Gbit/s up, 2.48832 Gbit/s down (most used)
- max logic distance: 60km
- max phy distance: 20km(The coverage of G.984 recommended with 1:64 splitting ratio)
- max differential distance: 20km
- splitting ratio 1: 64, support upgrade to 1: 128

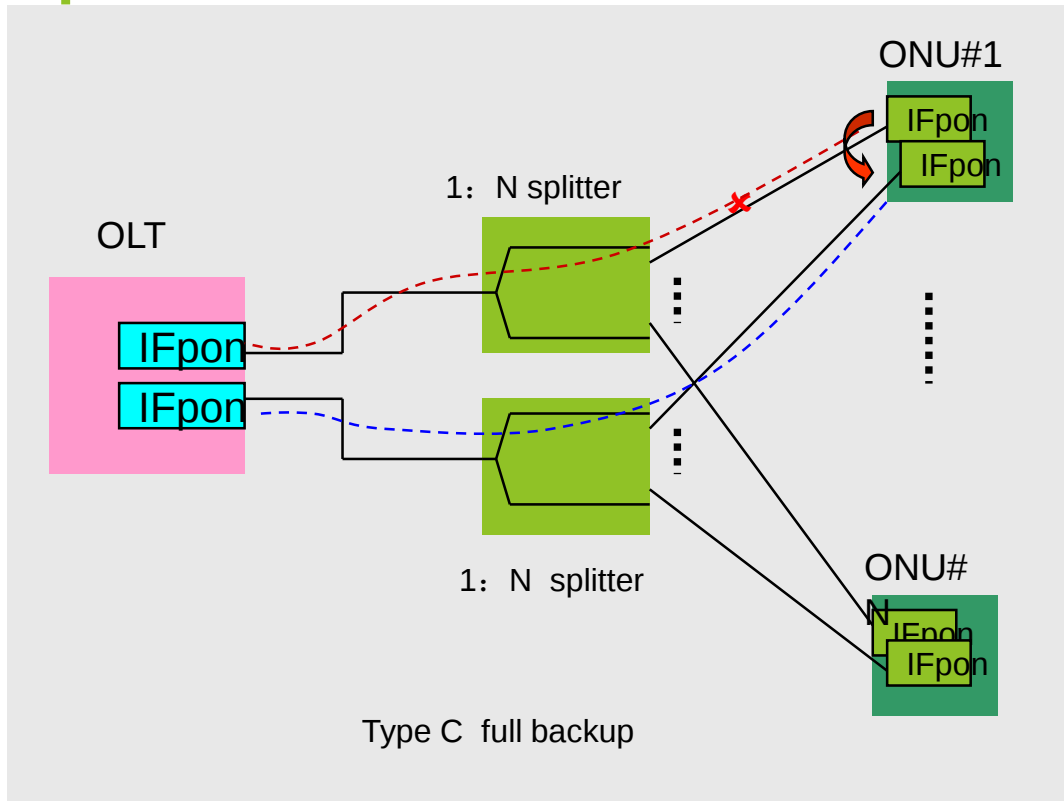


PON protection



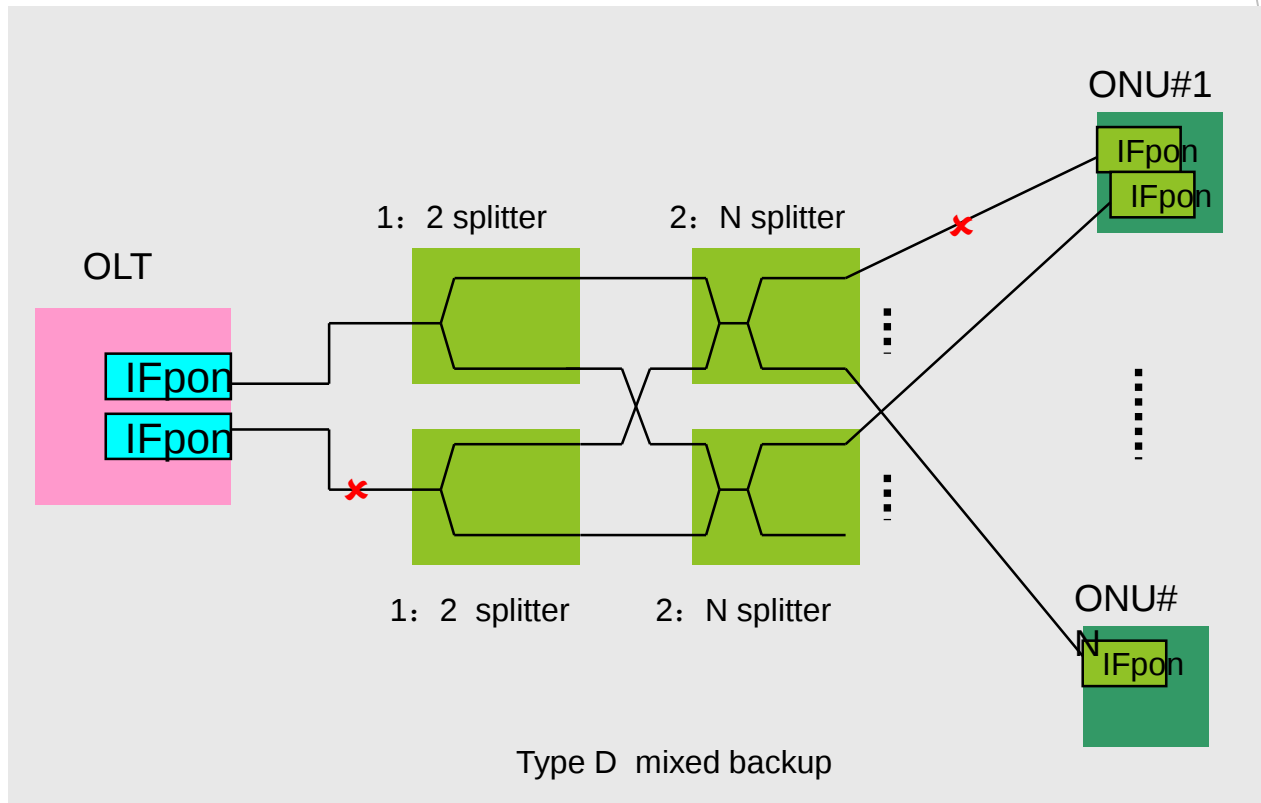
- **Type A protection protected backbone fiber**
- **Type B protection can provide backbone fiber and OLT PON port both have backup one.**

PON protection



- **Type C protection is full protection, OLT ,backbone fiber, splitter, branch fiber and ONU PON port, all can be protected. But we must construct double ODN.**

PON protection



- Type D protection can avoid two faults as follow in the same time, backbone , branch fiber and splitter ,any two point fault ,the PON network can still work. But we must construct double ODN than type C.



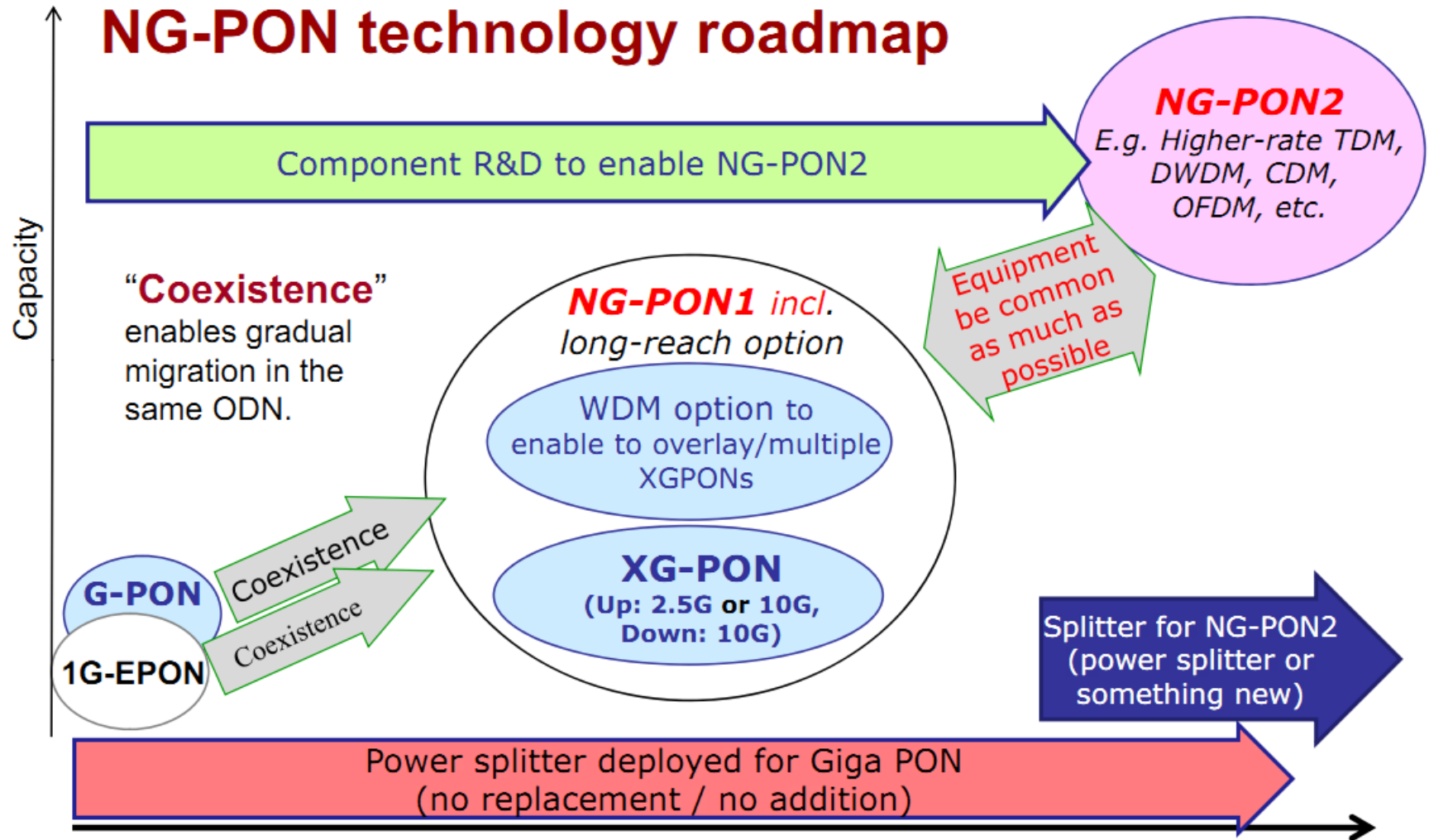
جلسه سیزدهم

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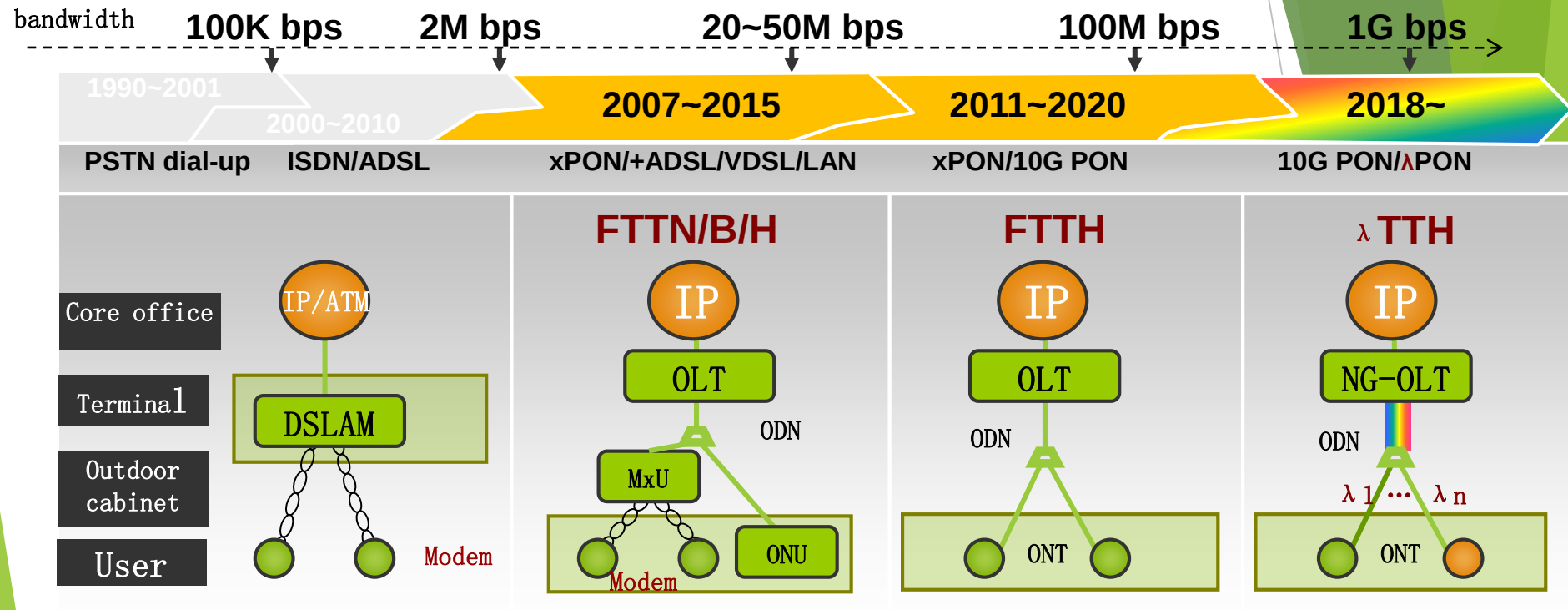
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PON develop roadmap

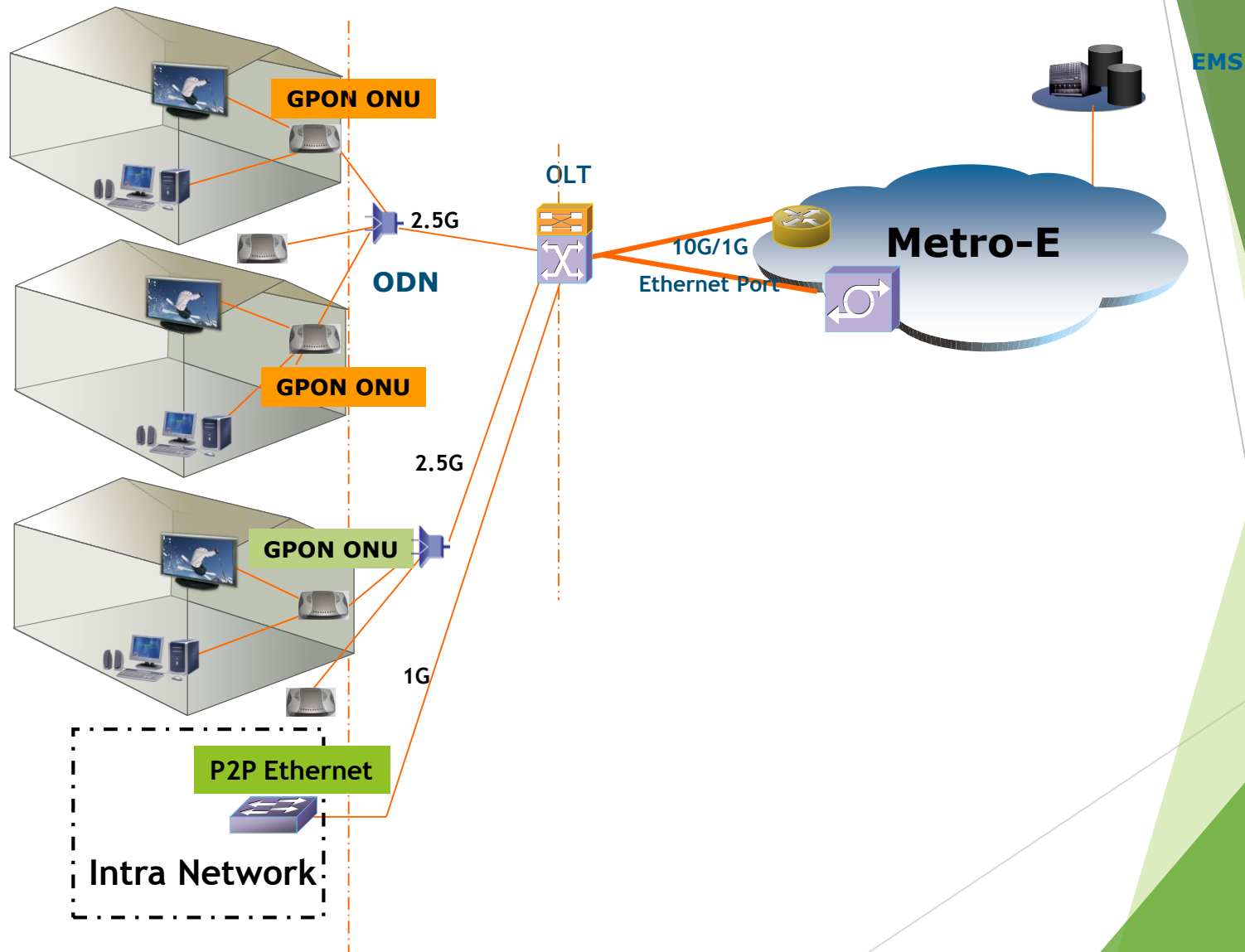


FTTX technology deployment roadmap

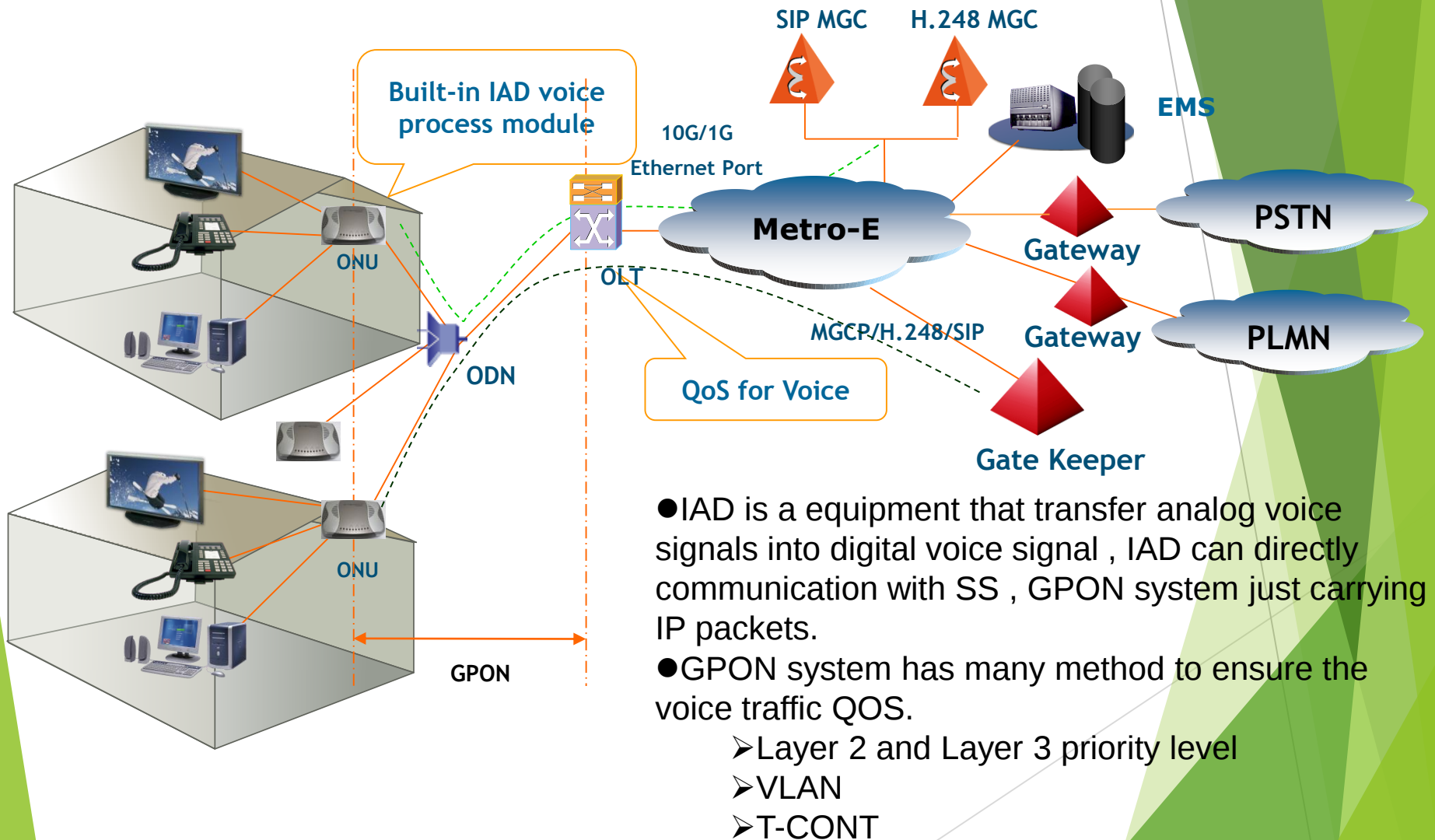


- Access Network technology develop so fast, but however the construction cost is much high, so the operator should consider the risk of their investment, make every period technology life cycle up to 10 years.
- Users and Service demand drive bandwidth increasing, fiber to the home is a trend, and wavelength to the home is ultimate goal.

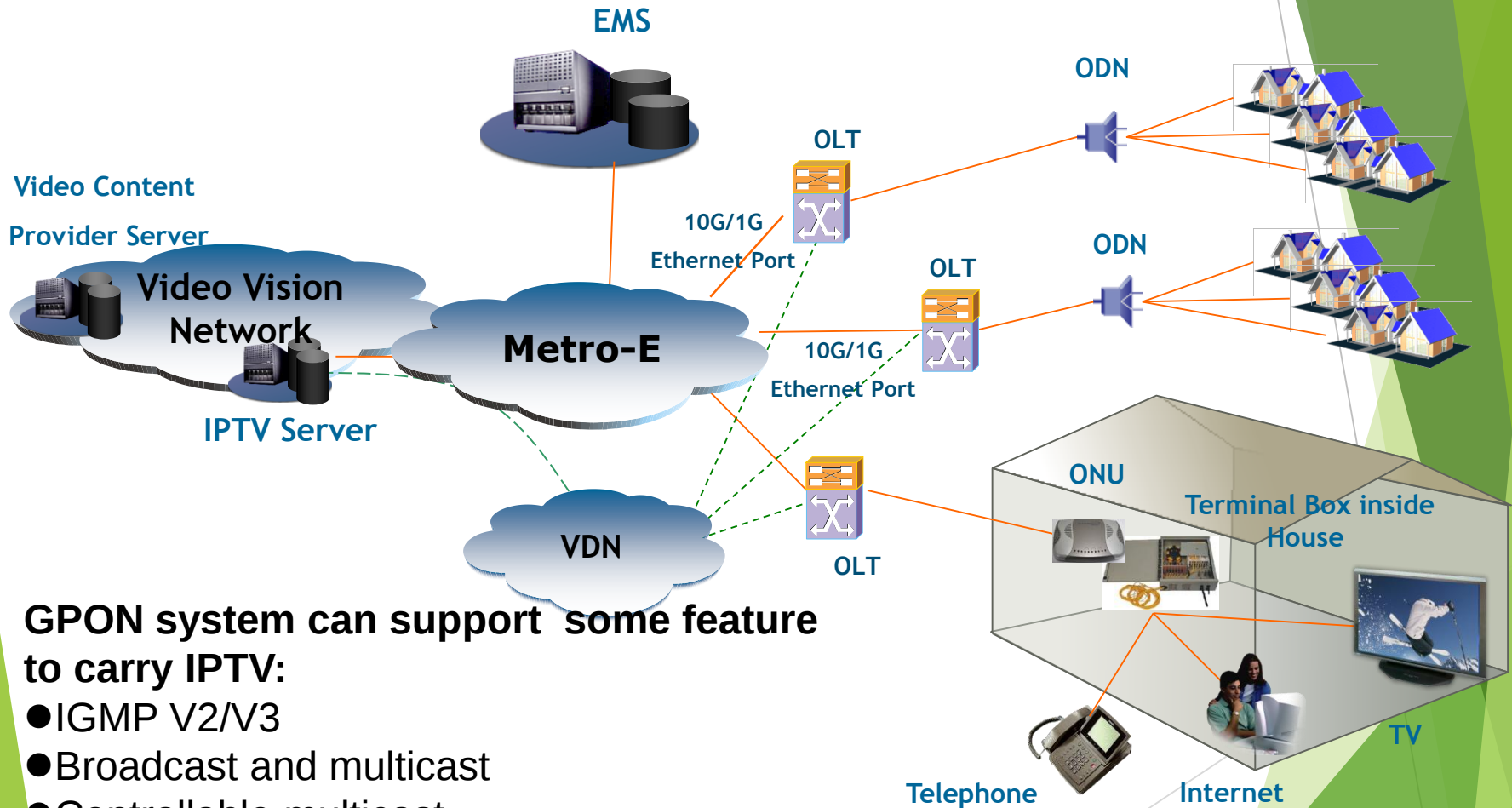
Pure Data Solution



Voice Solution



IPTV Solution

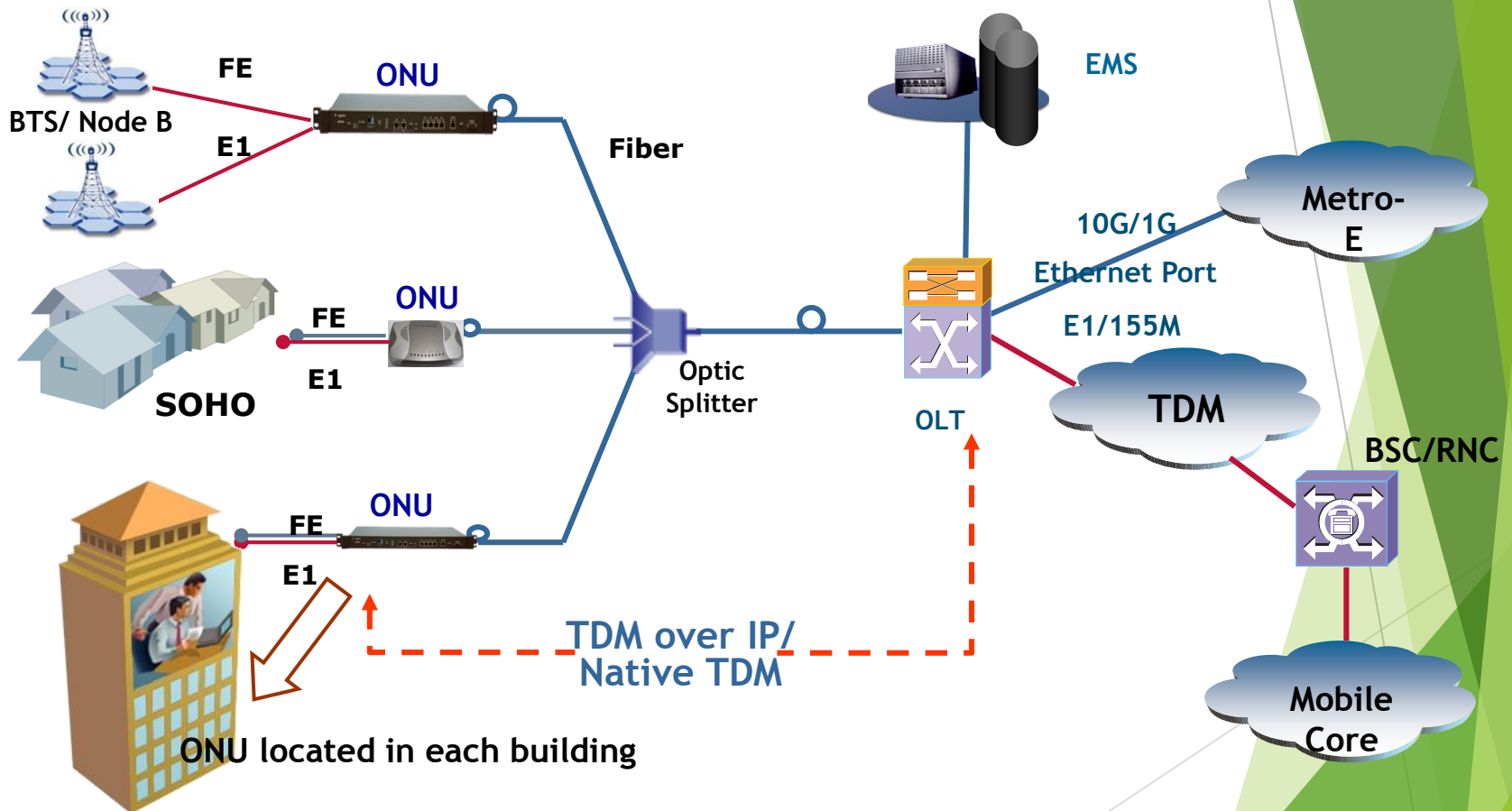


GPON system can support some feature to carry IPTV:

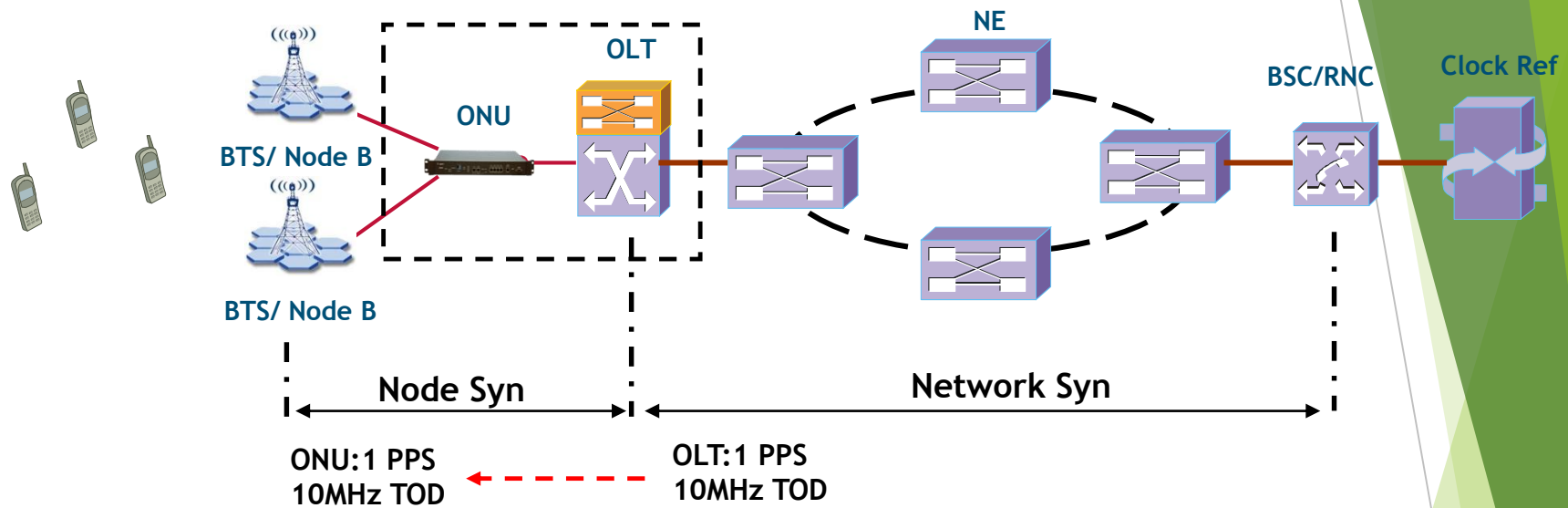
- IGMP V2/V3
- Broadcast and multicast
- Controllable multicast
- Hierarchical QOS

TDM Service Solution

GPON is a choice for Mobile backhaul!

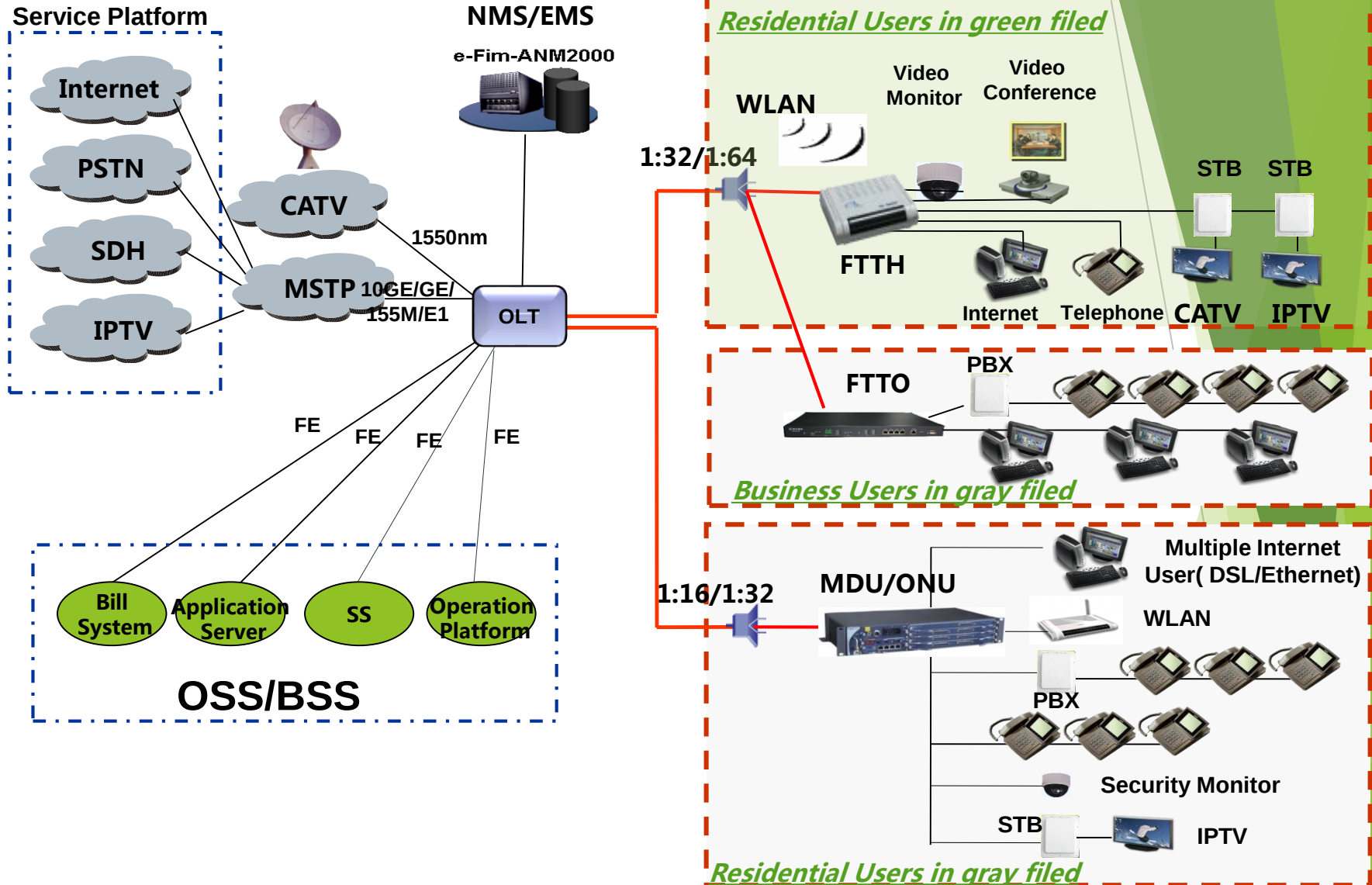


Mobile Backhaul Solution over GPON

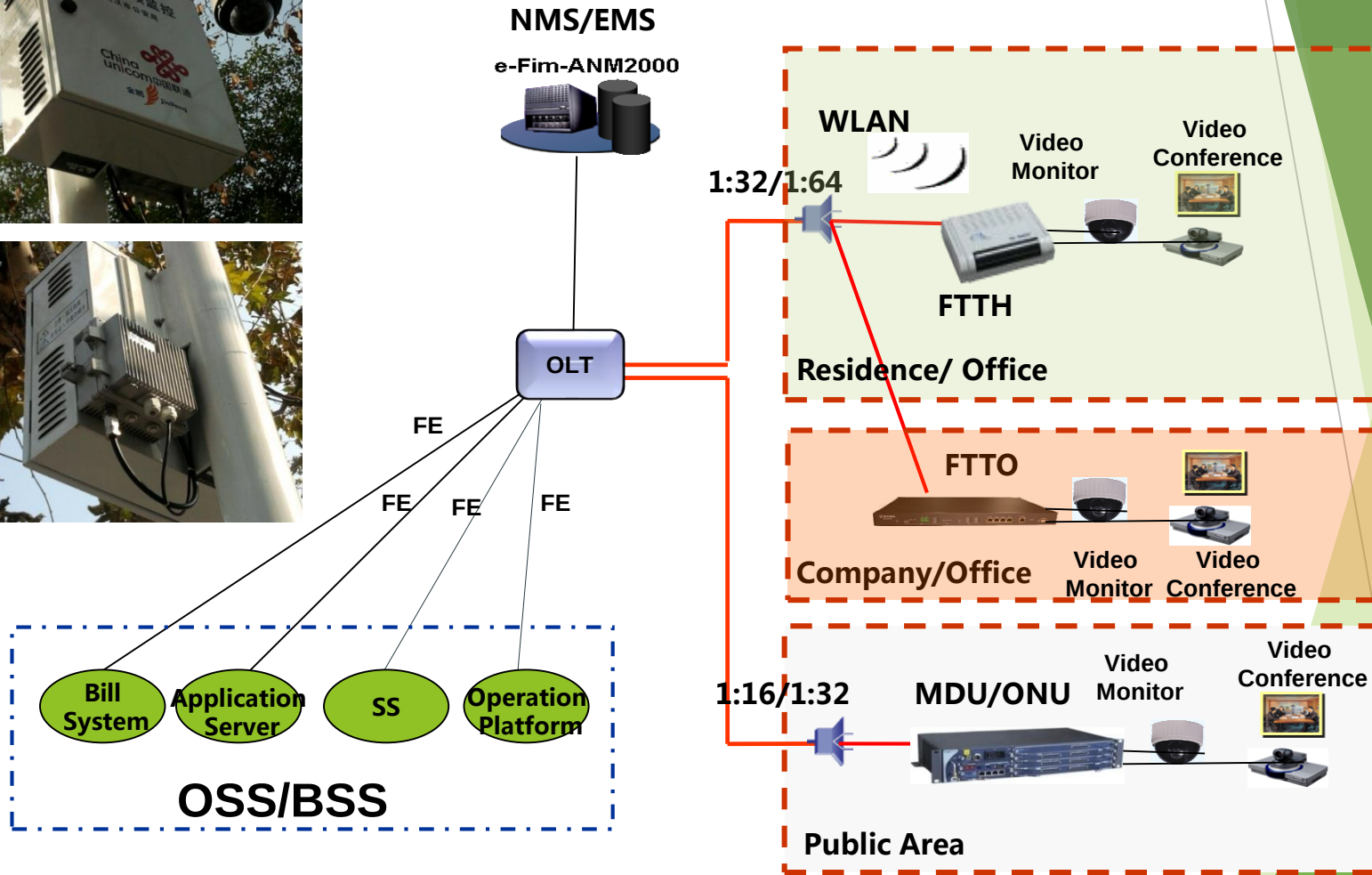


- Time transport via PON link
- BTS/Node B can also receive syn signal from local GPS ref
- Mobile backhaul solution over GPON will support smooth upgrade from 2G mobile system to 3G or NG mobile system.

Triple Play Service Solution



Value-added Service Overview





جلسه چهاردهم

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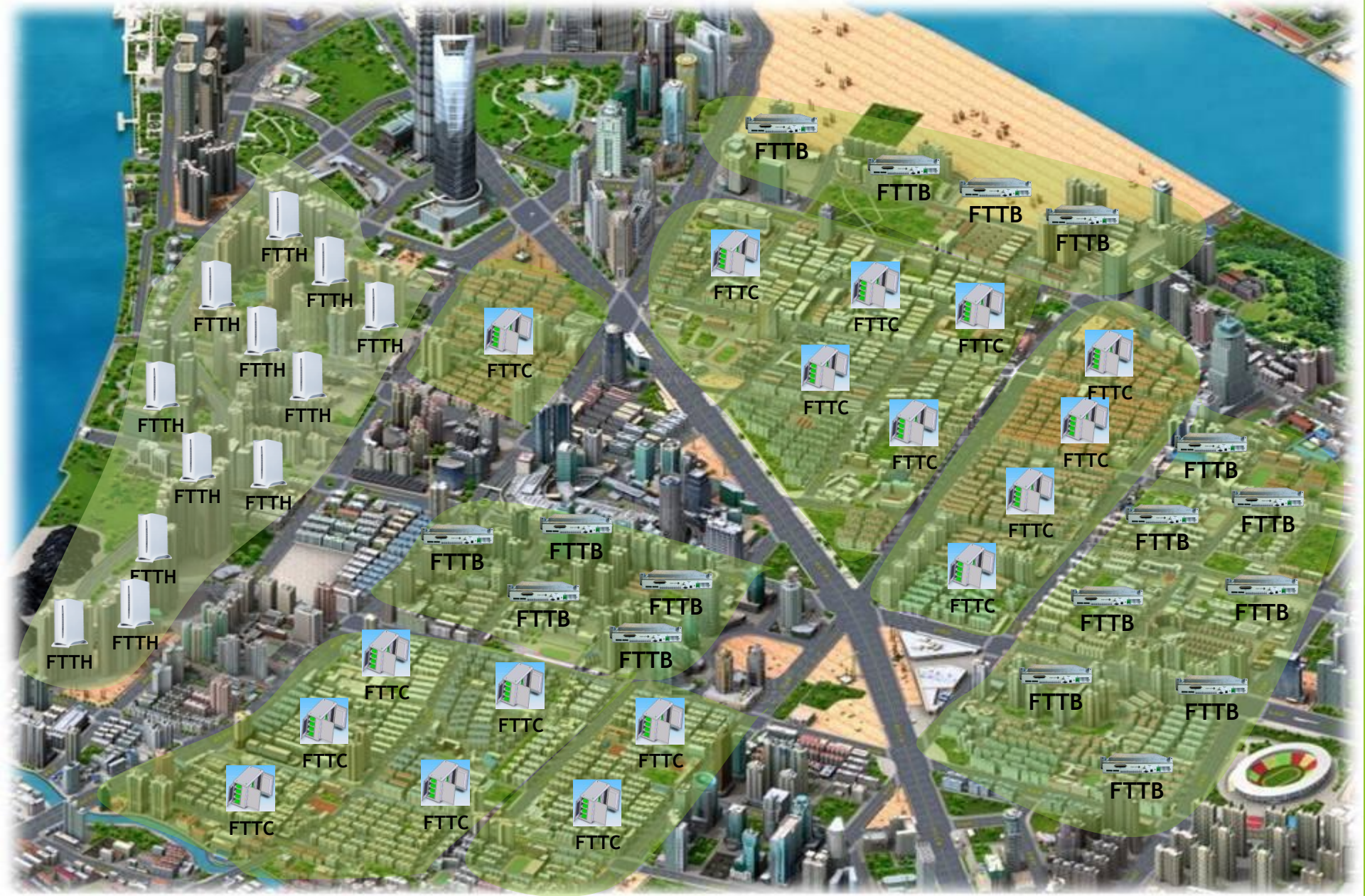
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مفهوم توسعه فناوری GPON

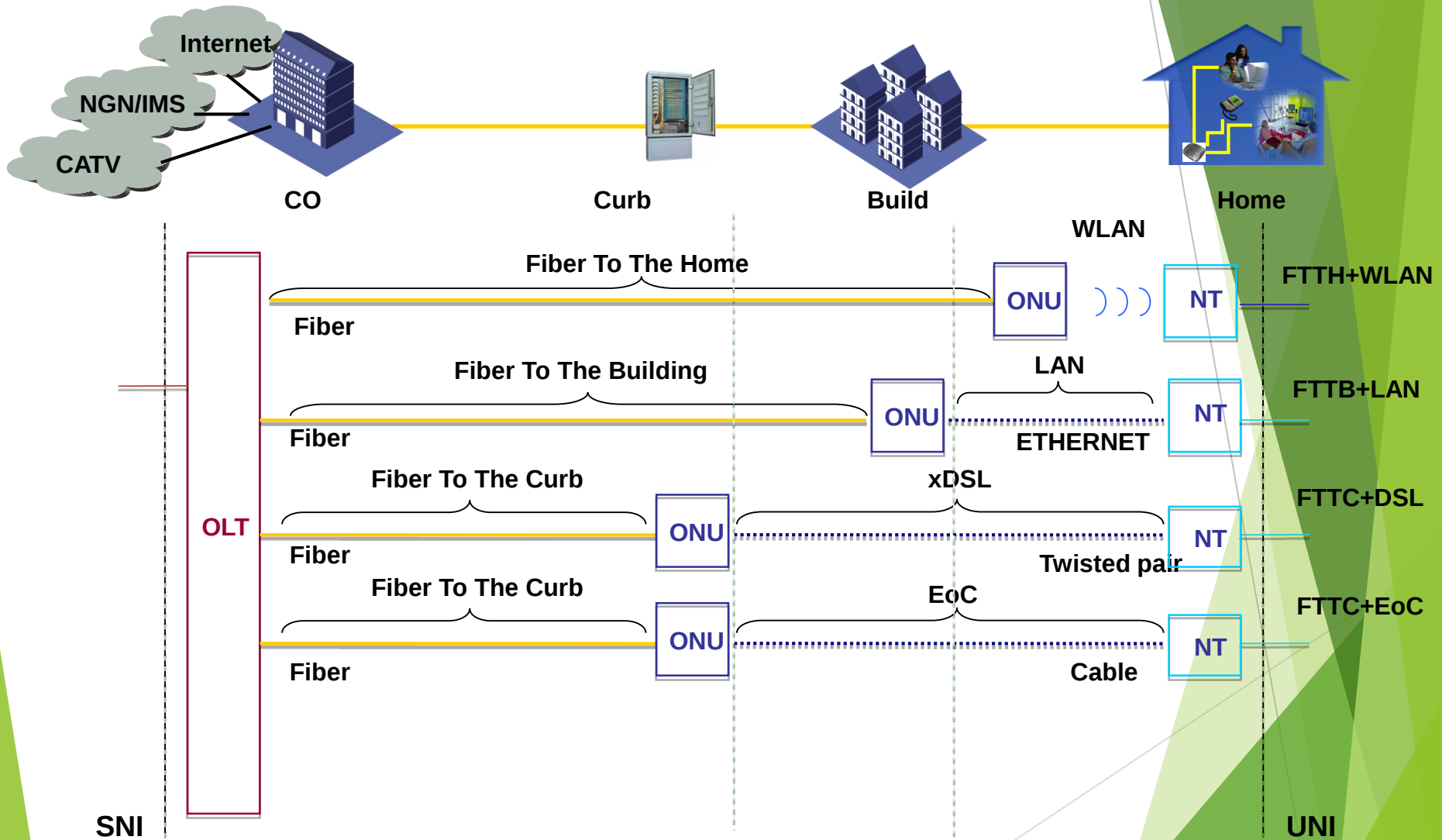
▶ Proposal of GPON deployment

Shang Hai : FTTx deployment solution depend on the different residential

Gray field	→	FTTC+ADSL2+/VDSL2
Green field	→	PON+FTTB+LAN/VDSL2
Green field/Business	→	PON+FTTH



GPON deployment mode





جلسه پانزدهم

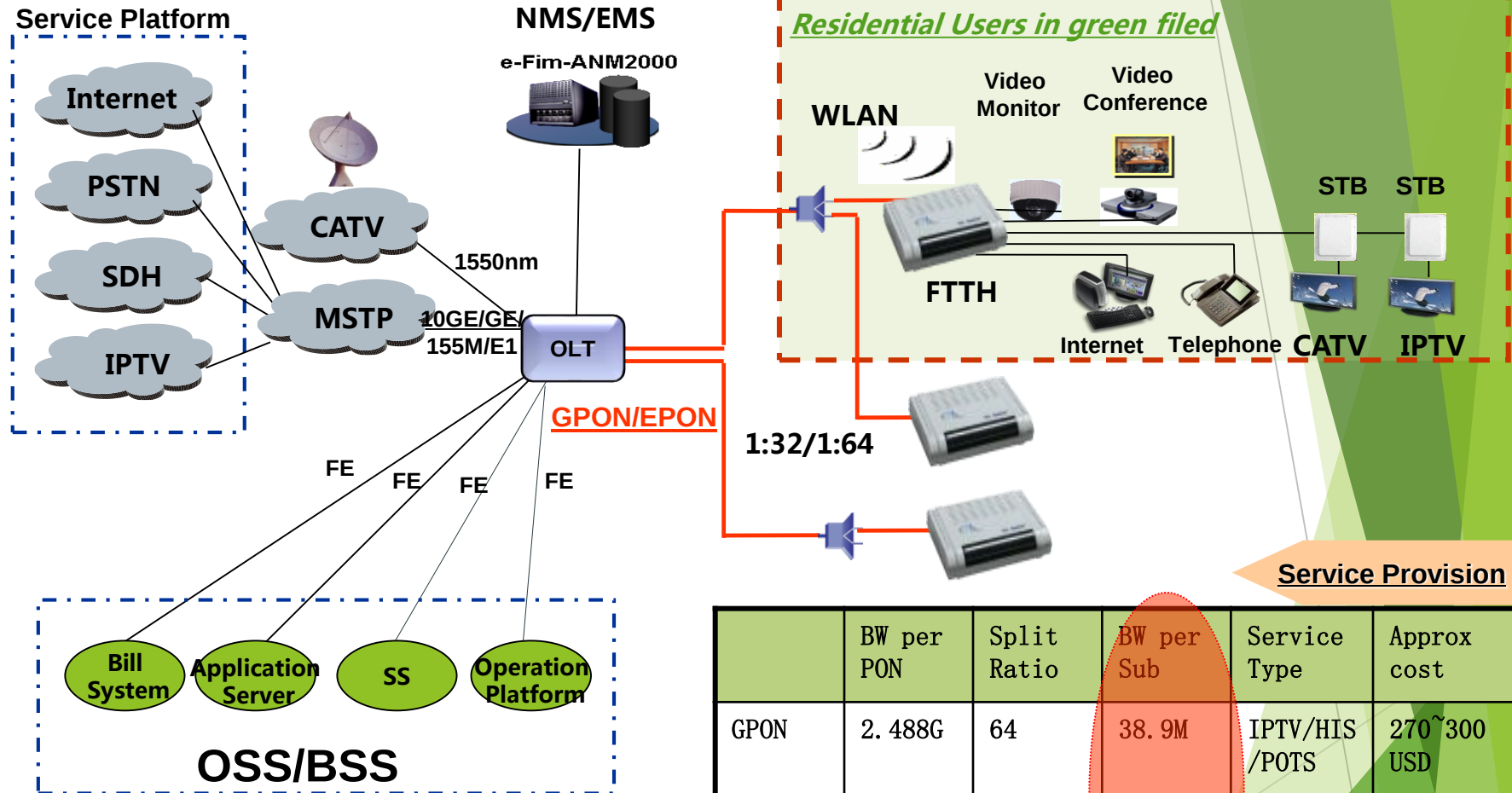
فیبر نوری در شبکه های مخابراتی

رضا قادر

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FTTX Solutions

Option I—FTTH Solution

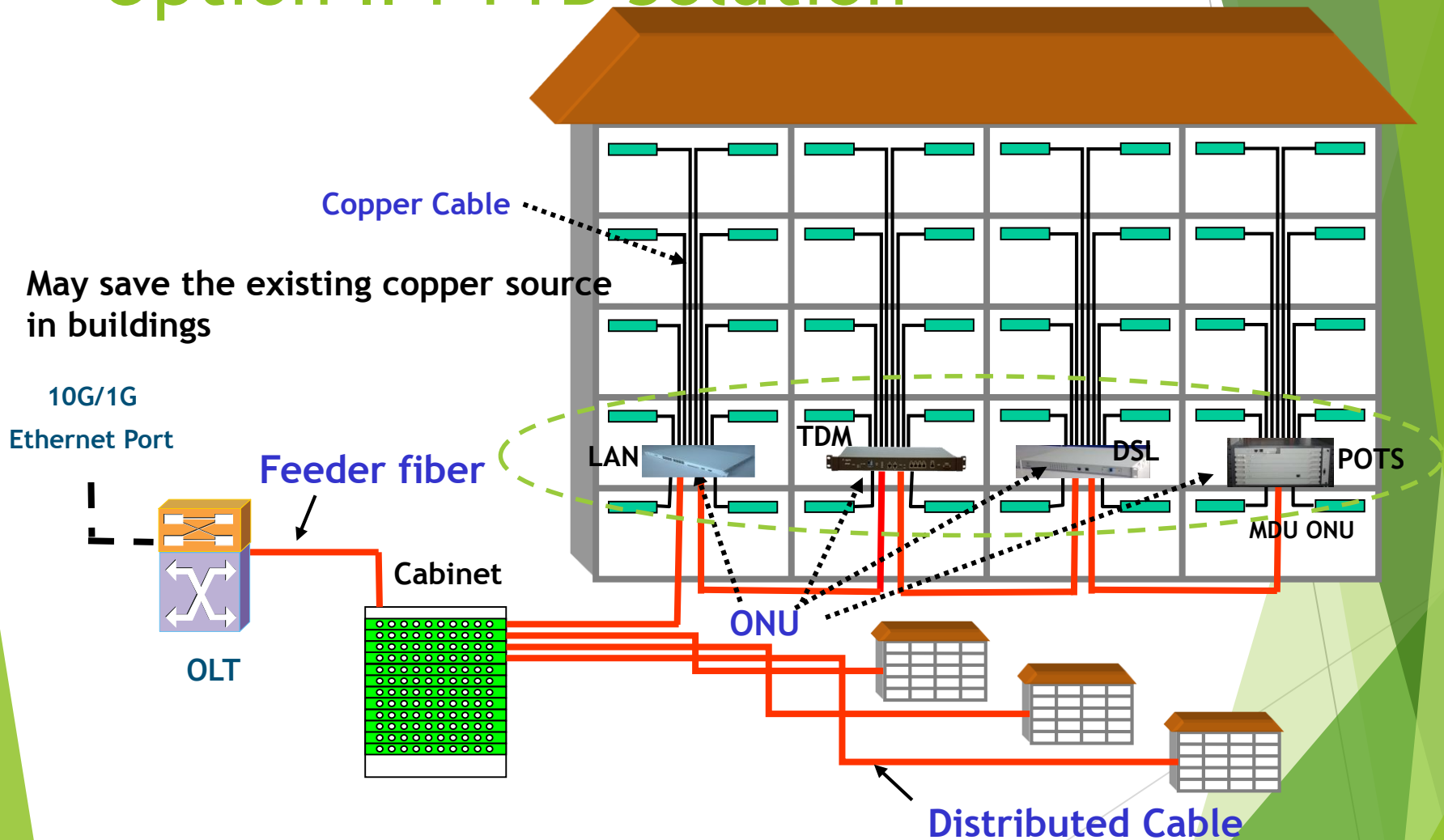


Service Provision

	BW per PON	Split Ratio	BW per Sub	Service Type	Approx cost
GPON	2.488G	64	38.9M	IPTV/HIS /POTS	270~300 USD
EPON	1.25G	32	31.25M	IPTV/HIS /POTS	260~280 USD
10G PON	10G	128	78.1M	IPTV/HIS /POTS	450~500 USD

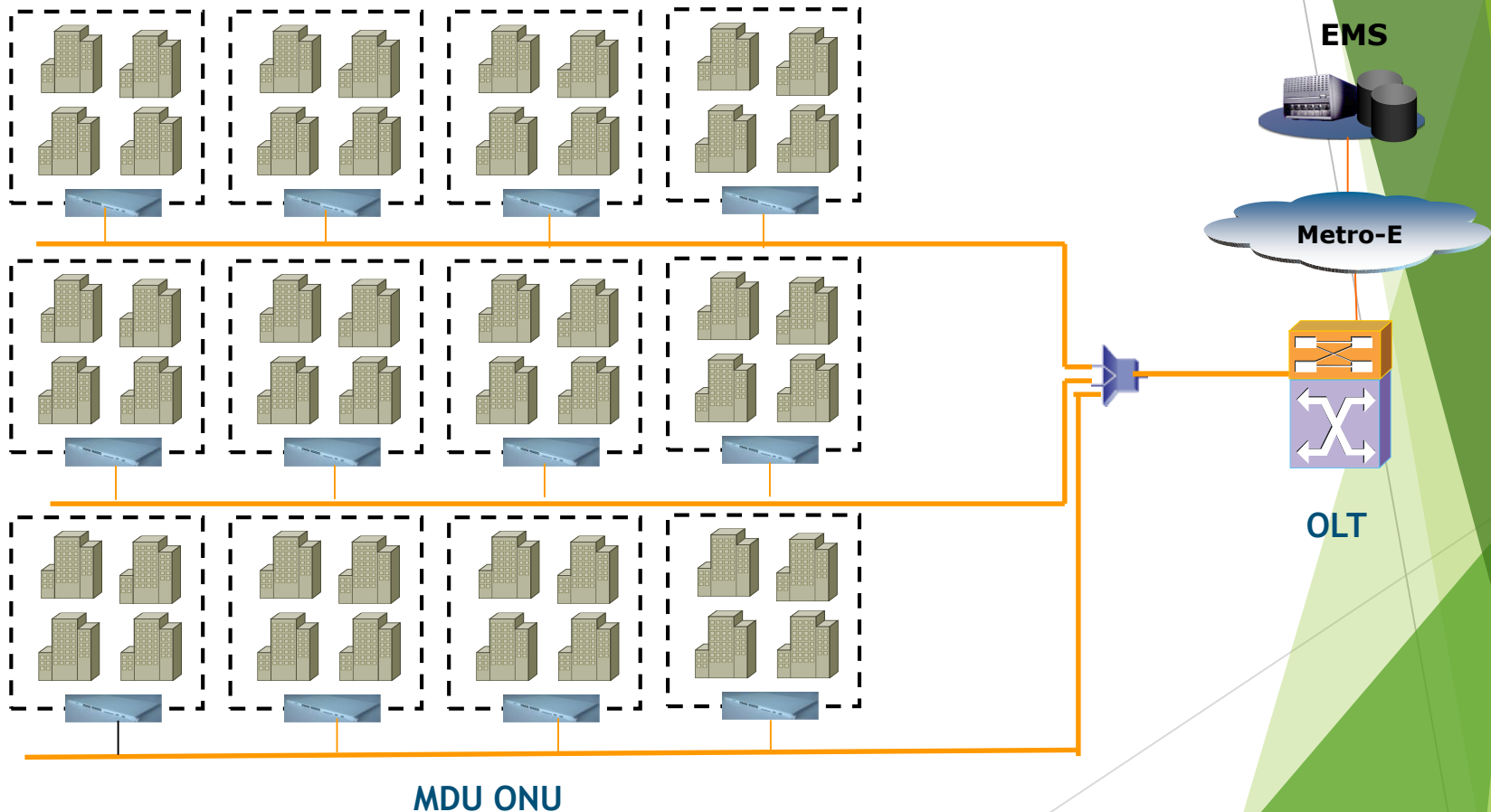
Turn to the Most Advanced but Mature Technology

Option II-FTTB Solution

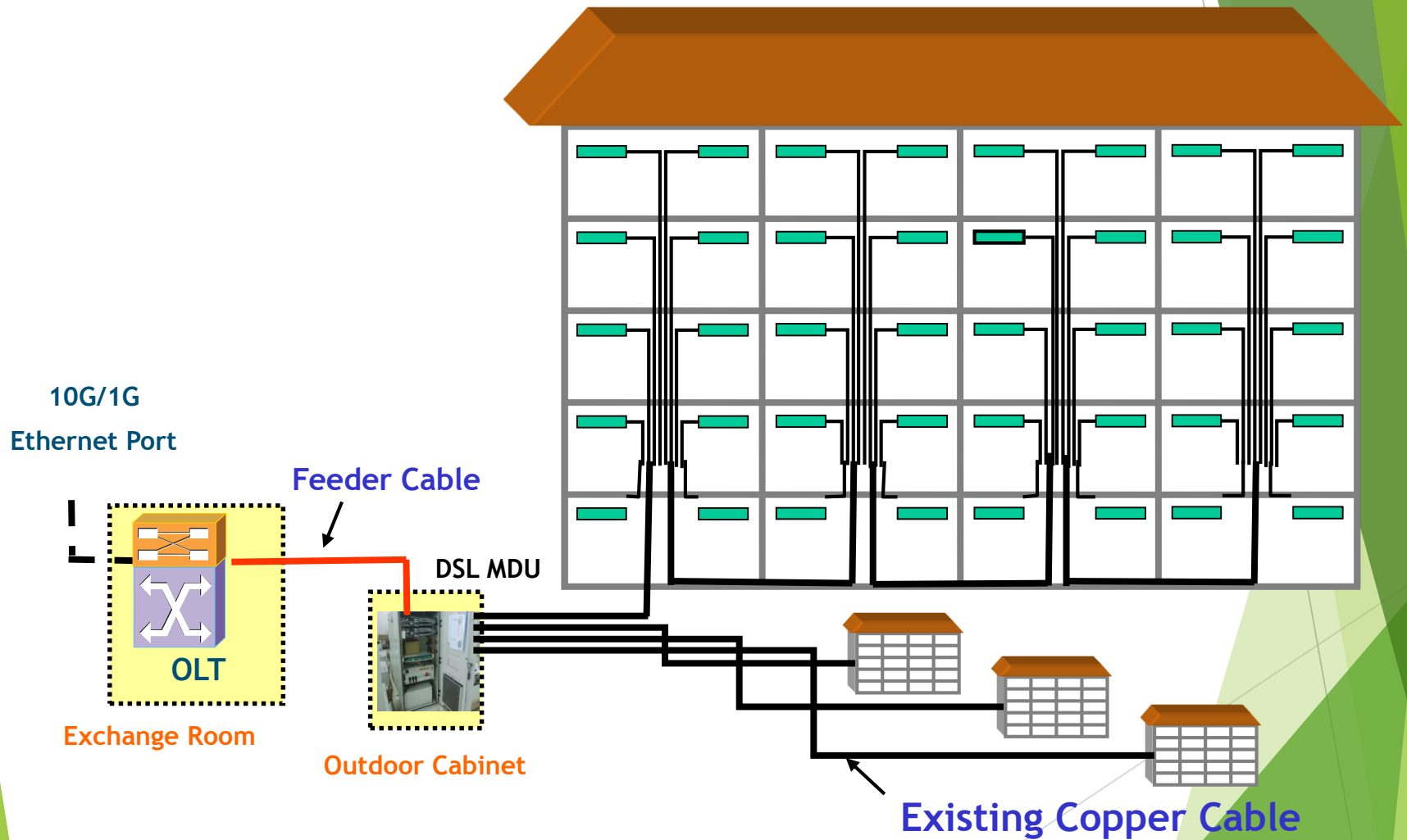


Option II-FTTB Solution--Large Scale FTTB Solution

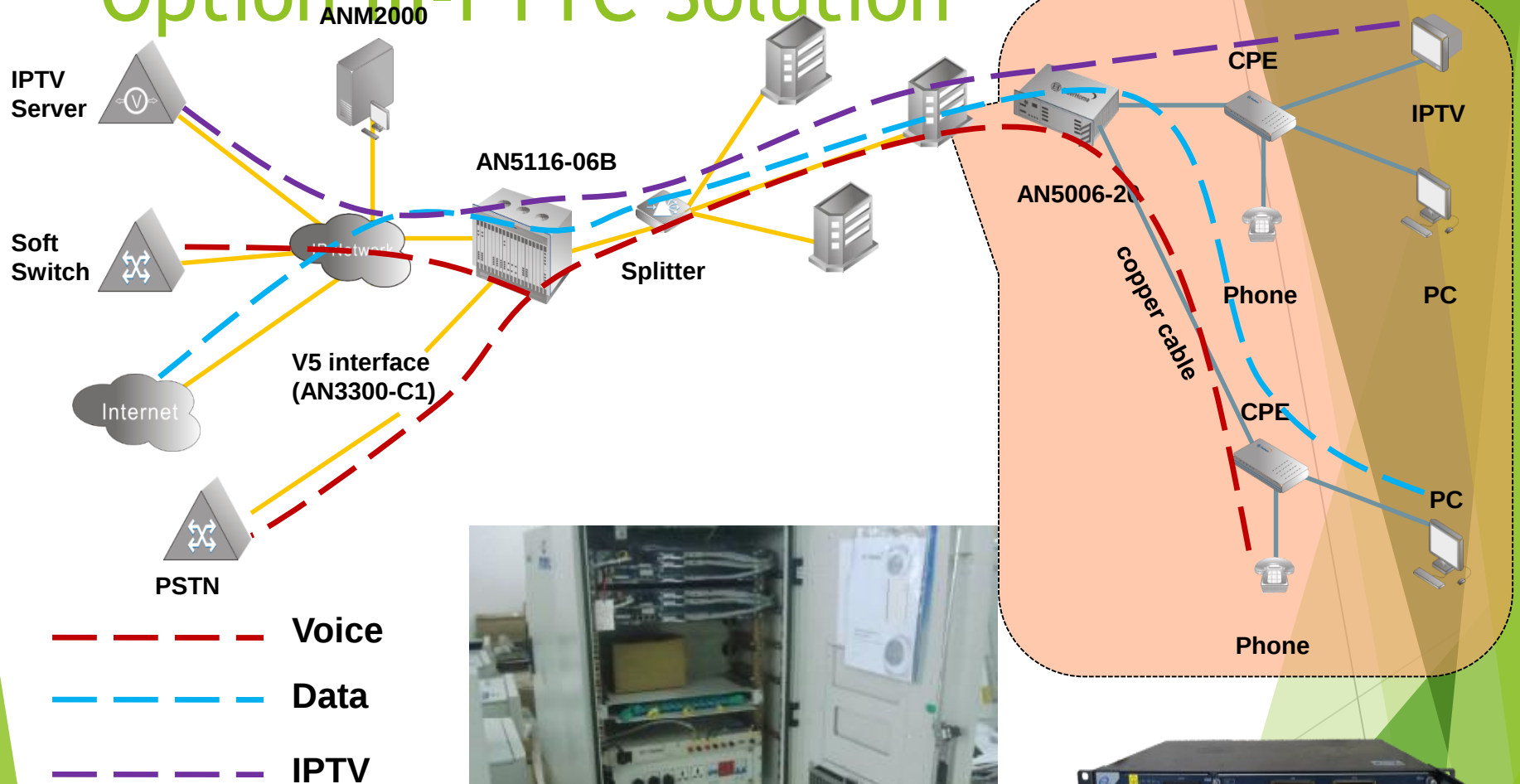
This application is used for optimizing the existing copper network architecture by providing subscribers 2M~8M bandwidth Internet services.



Option III-FTTC Solution

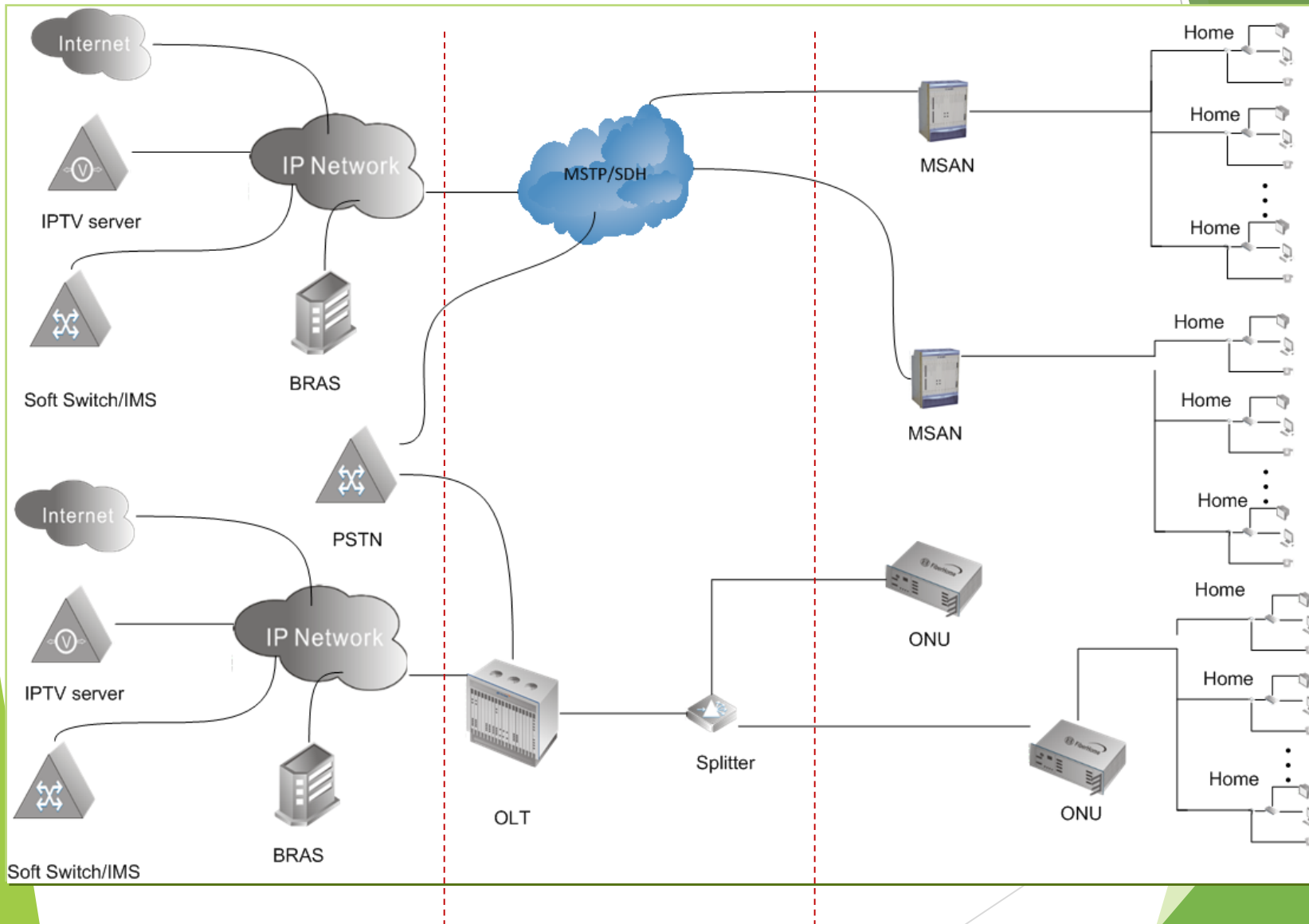


Option III-FTTC Solution



AN5006-20

FTTC Solution compare with MSAN



Two Benefits:

- Coverage;
- Capacity



جلسه شانزدهم

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موفق باشید