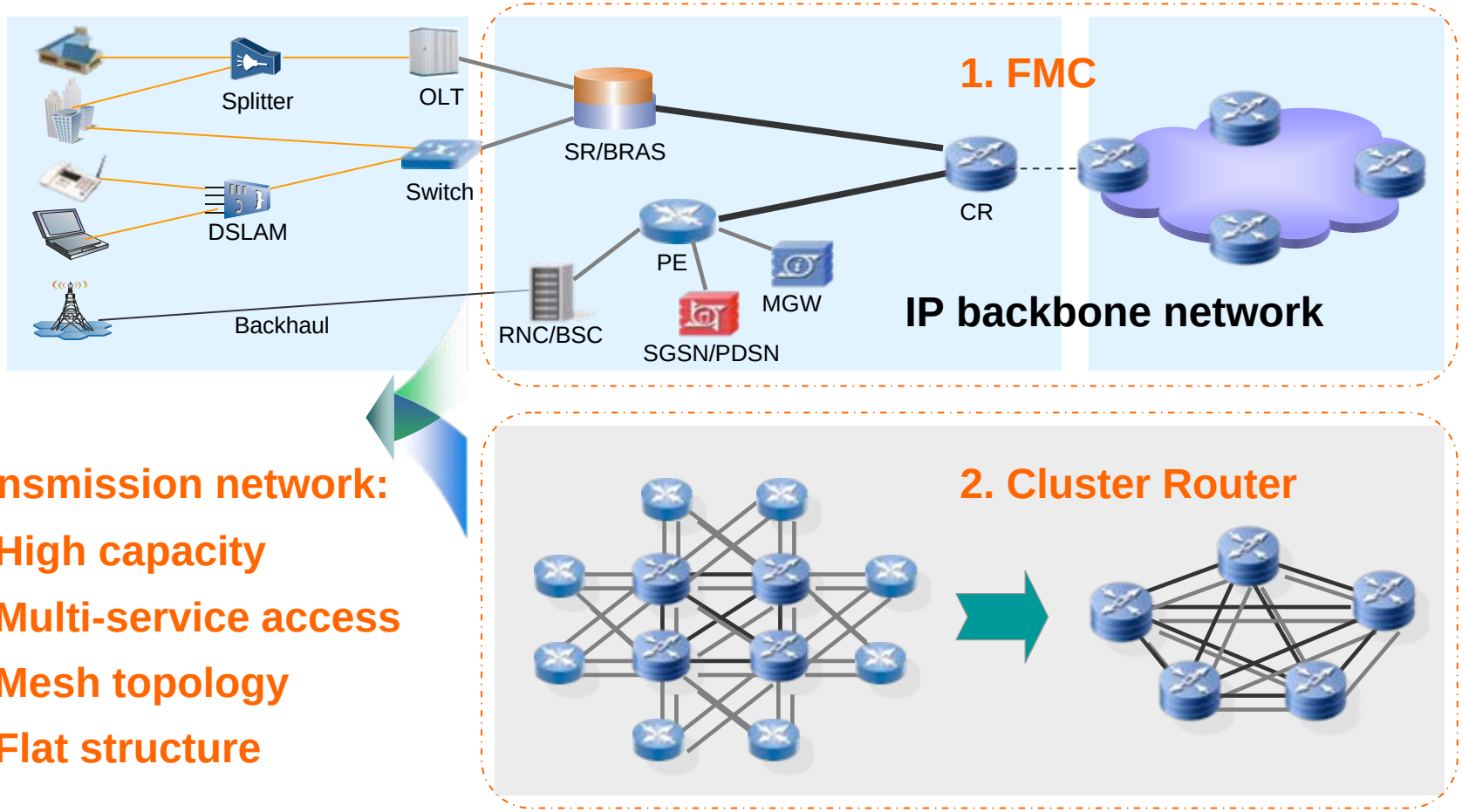
Next Generation Optical Transport Network Technology

Talking to the future

Future IP Bearer Network

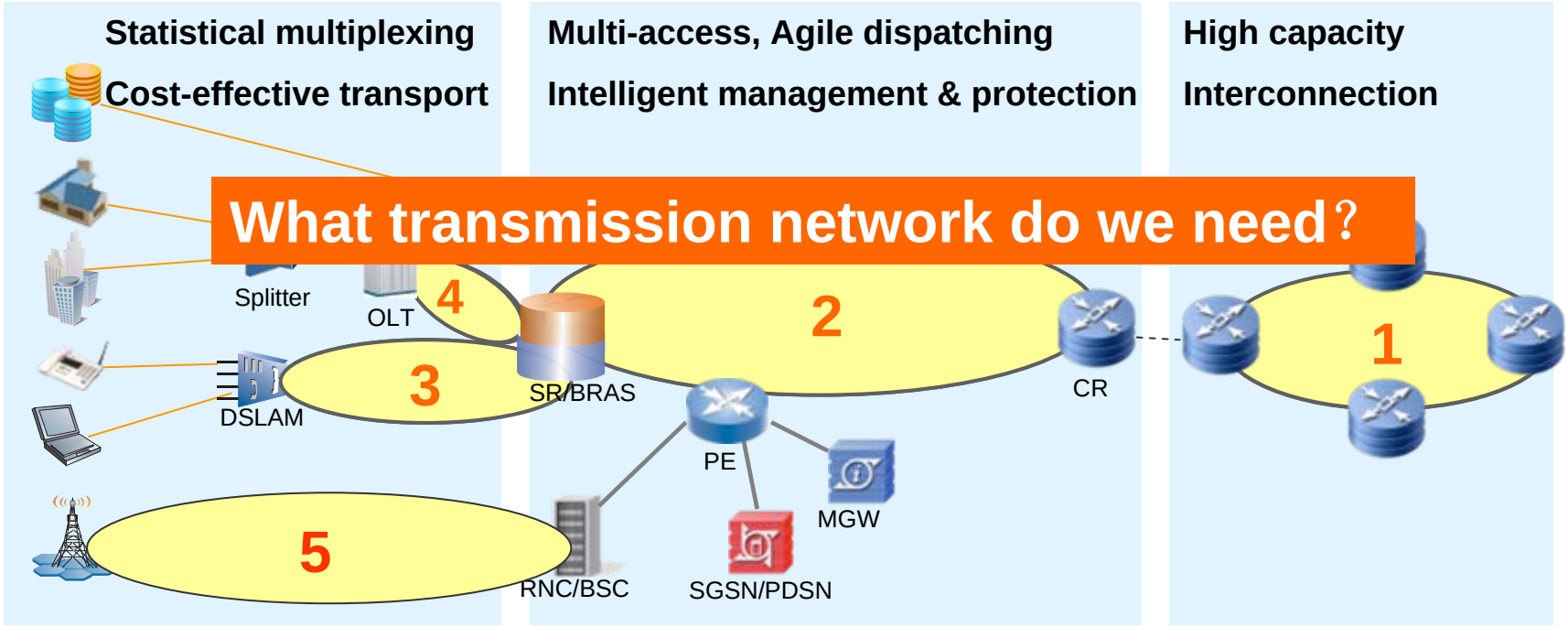


Transmission network:

- ✓ **High capacity**
- ✓ **Multi-service access**
- ✓ **Mesh topology**
- ✓ **Flat structure**

- Driven by FMC trend, the fixed and mobile network are carried on the unified IP network so that the future network is combined and flat.
- The deployment of cluster routers helps reduce layers of IP network, and turn it into higher capacity and mesh topology.

Challenges to Future Transmission Network

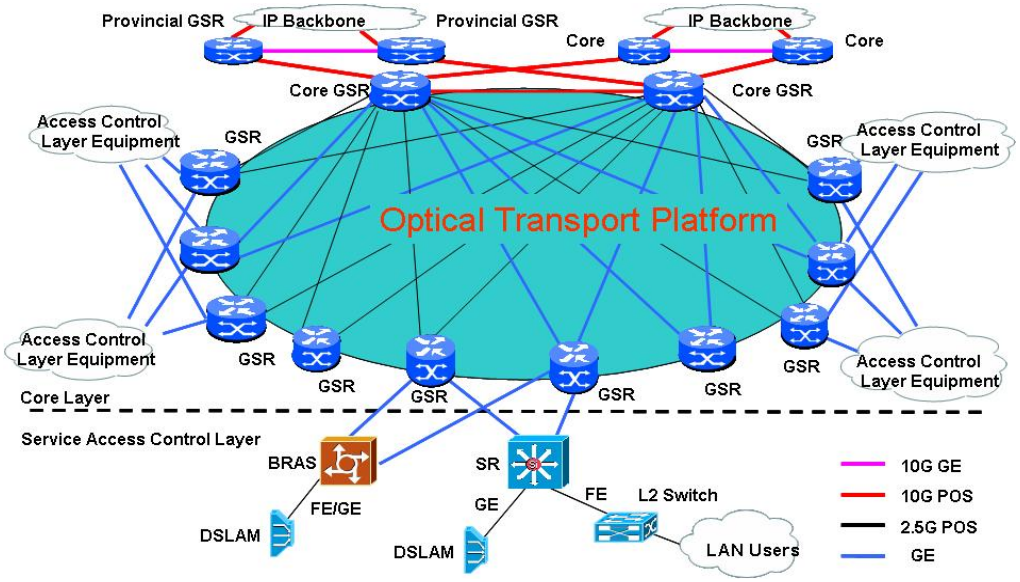


■**Backbone**：1. How to carry the core routers? How to realize the interconnection between different vendors?

■**Metro core**：2. How to access multi-service of fixed and mobile network? How to dispatch them agilely? How to realize the intelligent management and multi-failure protection?

■**Metro edge**：3. How to transport efficiently between DSLAM and BRAS? 4. What's the cost-effective solution to OLT's uplink service? 5. What's the better solution to backhaul network with large capacity?

Requirements of Core & Backbone (IP over OTN)

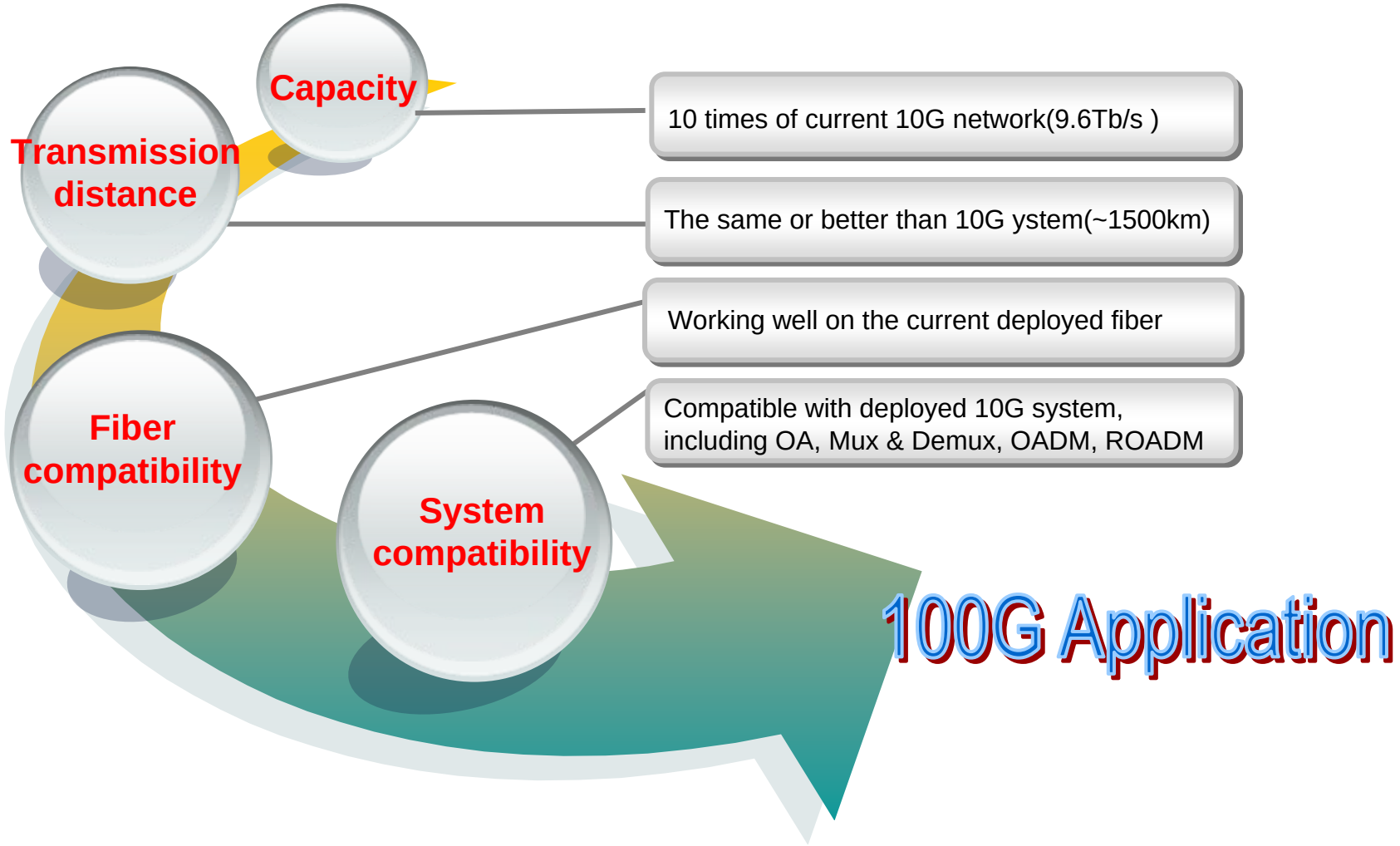


- New services are all based on IP technology
- Core transport network selects WDM/OTN platform

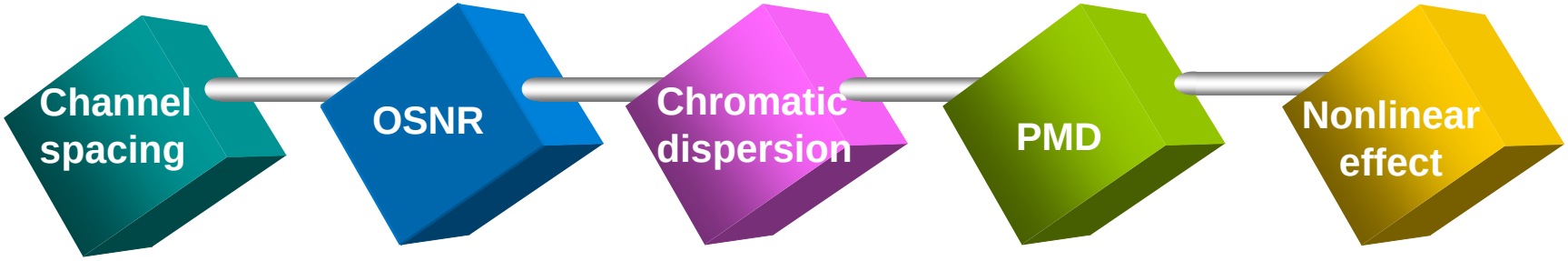
Requirements of DWDM technology

- **Service Type:** TDM → TDM/IP → IP
- **Service Level:** 10G → 40G → 100G
- **Transport Capacity:** 800/960G → 3.2/3.84T → ~10T
- **Transport Distance:** 2000~3000km LH/ULH transport
- **Topology:** Multiple rings → Mesh
- **Flexibility:** Static connection → Dynamic switch
- **Reliability:** Protection/restoration of mesh network
- **OAM:** End-end OAM capability based on service level

Targets of 100G Network



The Challenges of 100Gb/s

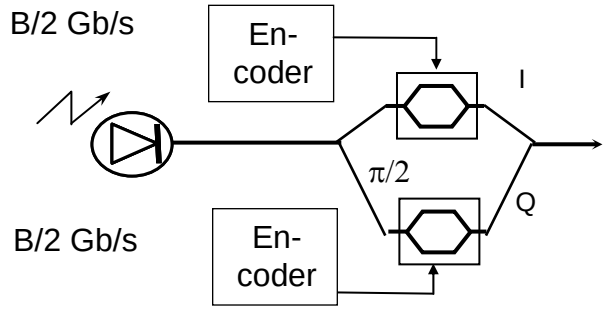


■Traditional NRZ modulation can't support 50G Hz Spacing	■OSNR is higher than traditional 10G system about 10dB theoretically	■CD tolerance is only 1/100 of traditional 10G system	■PMD tolerance is only 1/10 of traditional 10G system	■Nonlinear effect is more serious, IFWM and IXPM.

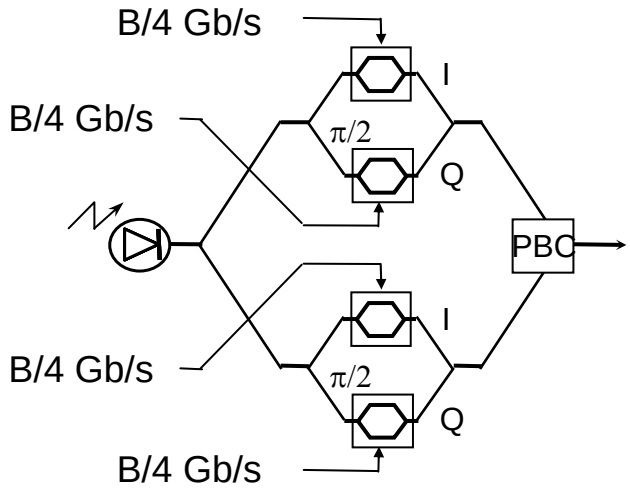
100G Key Techniques

Modulation Schemes

(RZ-)DQPSK



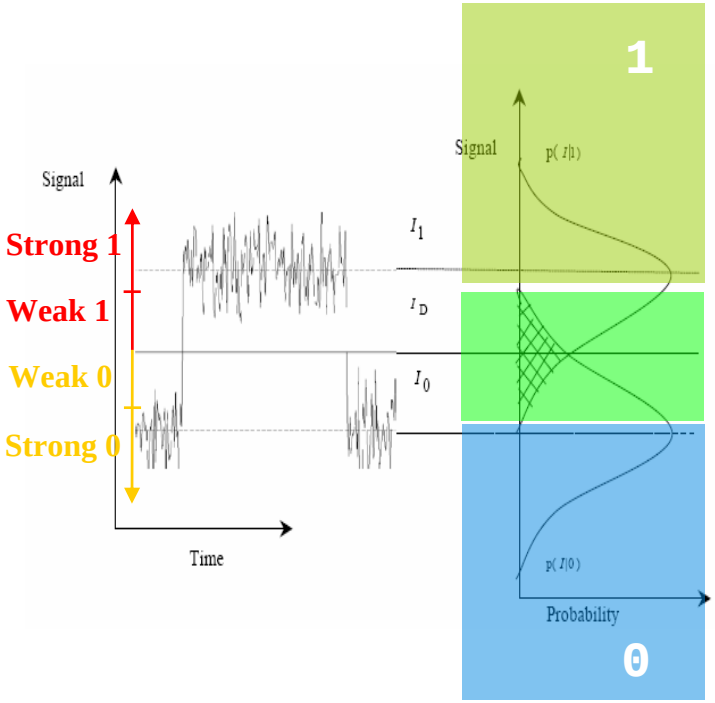
PM-(D)QPSK



Less kind of Modulation Schemes

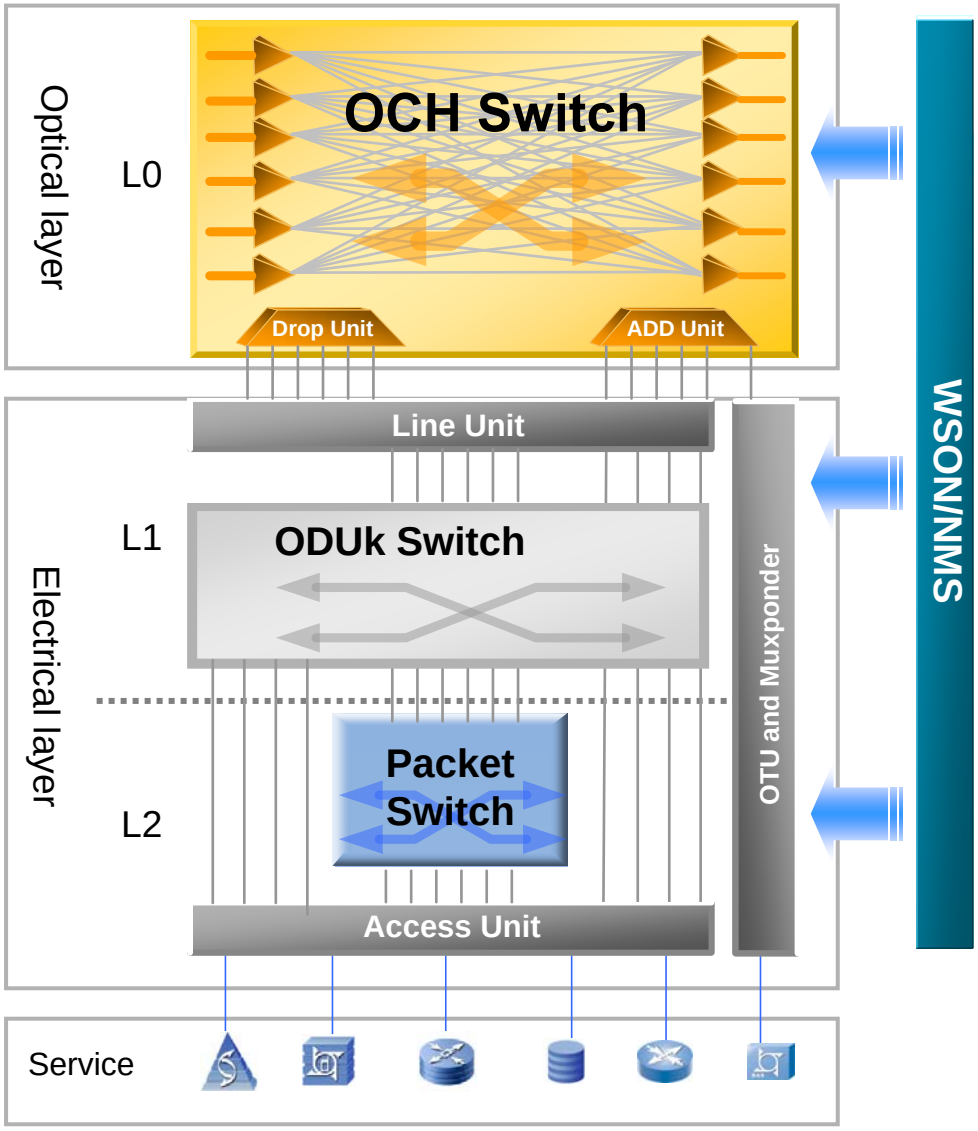
Improved OSNR

SD
Soft decision



LDPC
Low density Parity check

Dynamic Switch --Structure

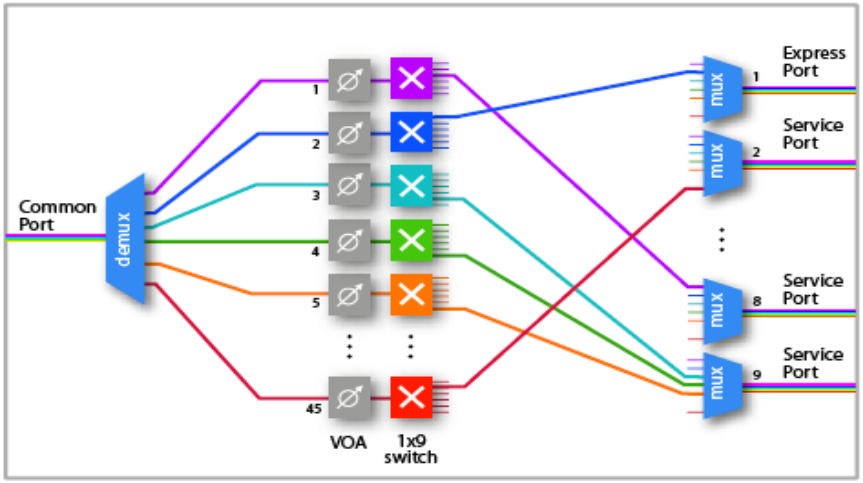


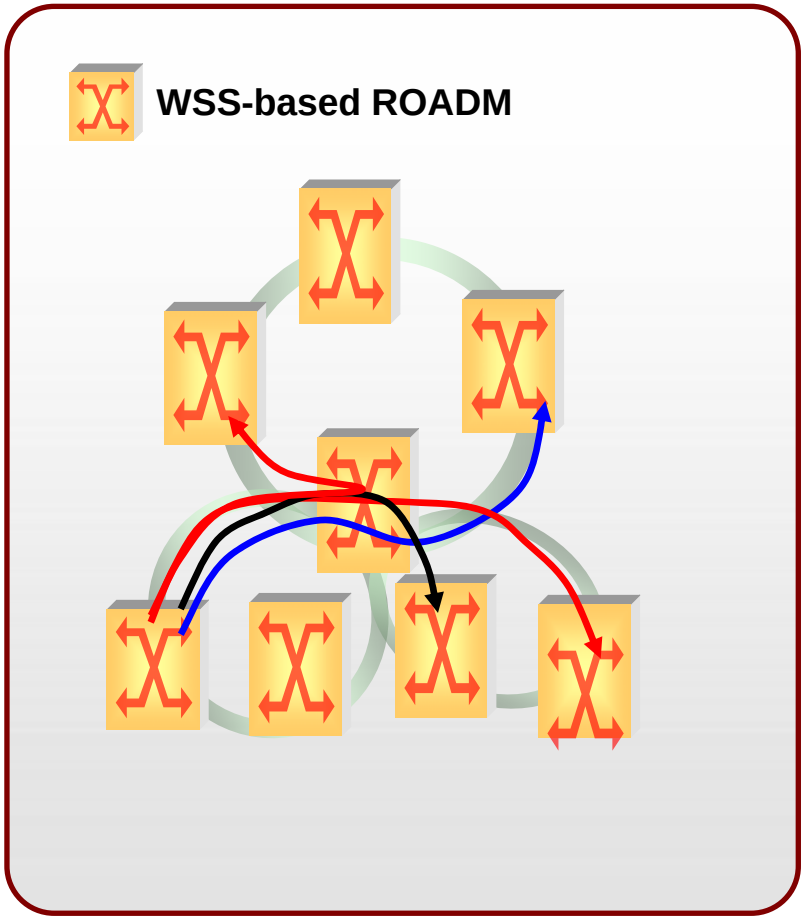
Optical level
ROAMD

Electrical level
ODUk

Connect-oriented
packet switch

Dynamic Switch –Optical Level





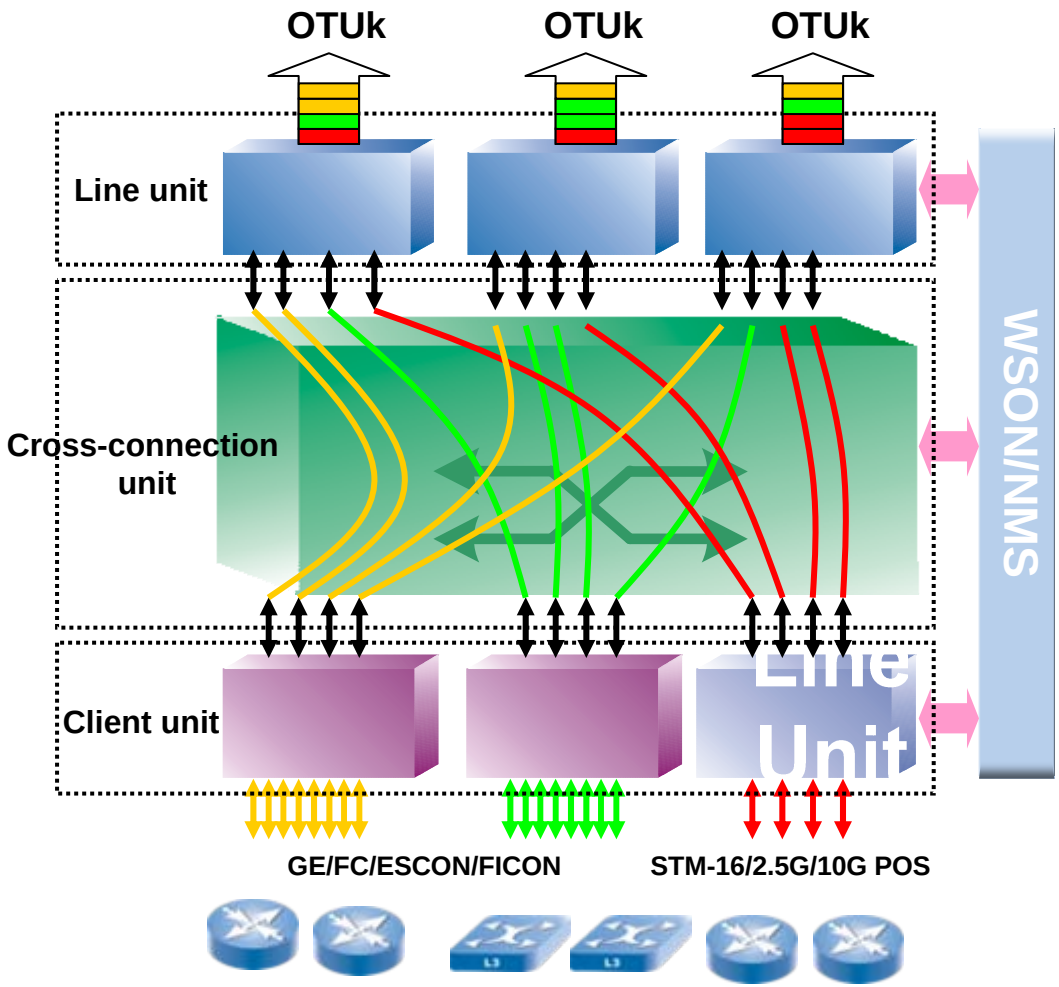
Realized:

- Wavelength level dispatching
- Directionless
- Colorless---any lambda to any port;
- Multi-direction

To be resolved:

- Physical limitations - Dynamic dispersion Compensation
- Wavelength Block - complex structure
- Optical layer overhead
- Compactness, more ports
- Higher cost.

Dynamic Switch –ODUk Level



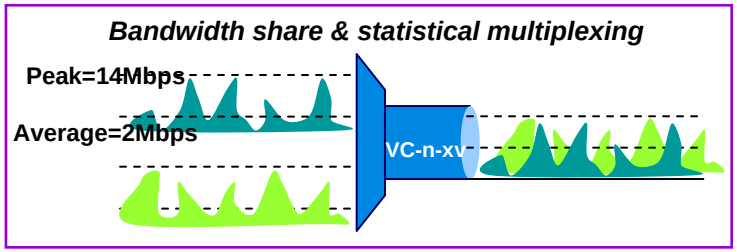
Realized:

- Wavelength level dispatching
- Line side and client side separated
- Several hundred G bits cross-connect for X-ADM function
- Good OSNR performance

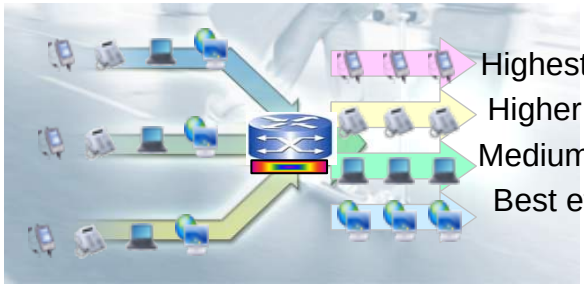
To be resolved:

- T bits cross-connect capacity
- High reliability
- ODU0 definition

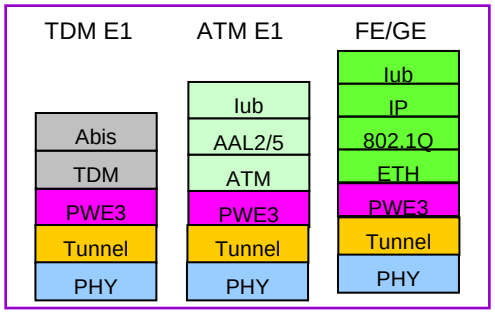
Dynamic Switch –Packet Level



① Efficient Use of Bandwidth



② Service awareness & Differentiated QoS



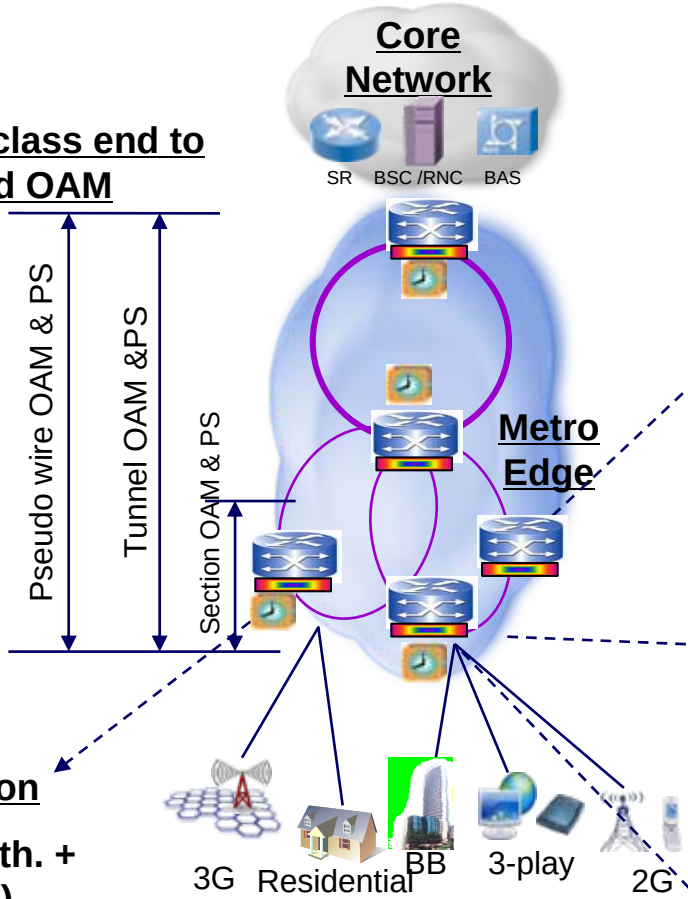
③ Multi service emulation-pseudo wire

④ Carrier class end to end OAM

⑤ Carrier class protection

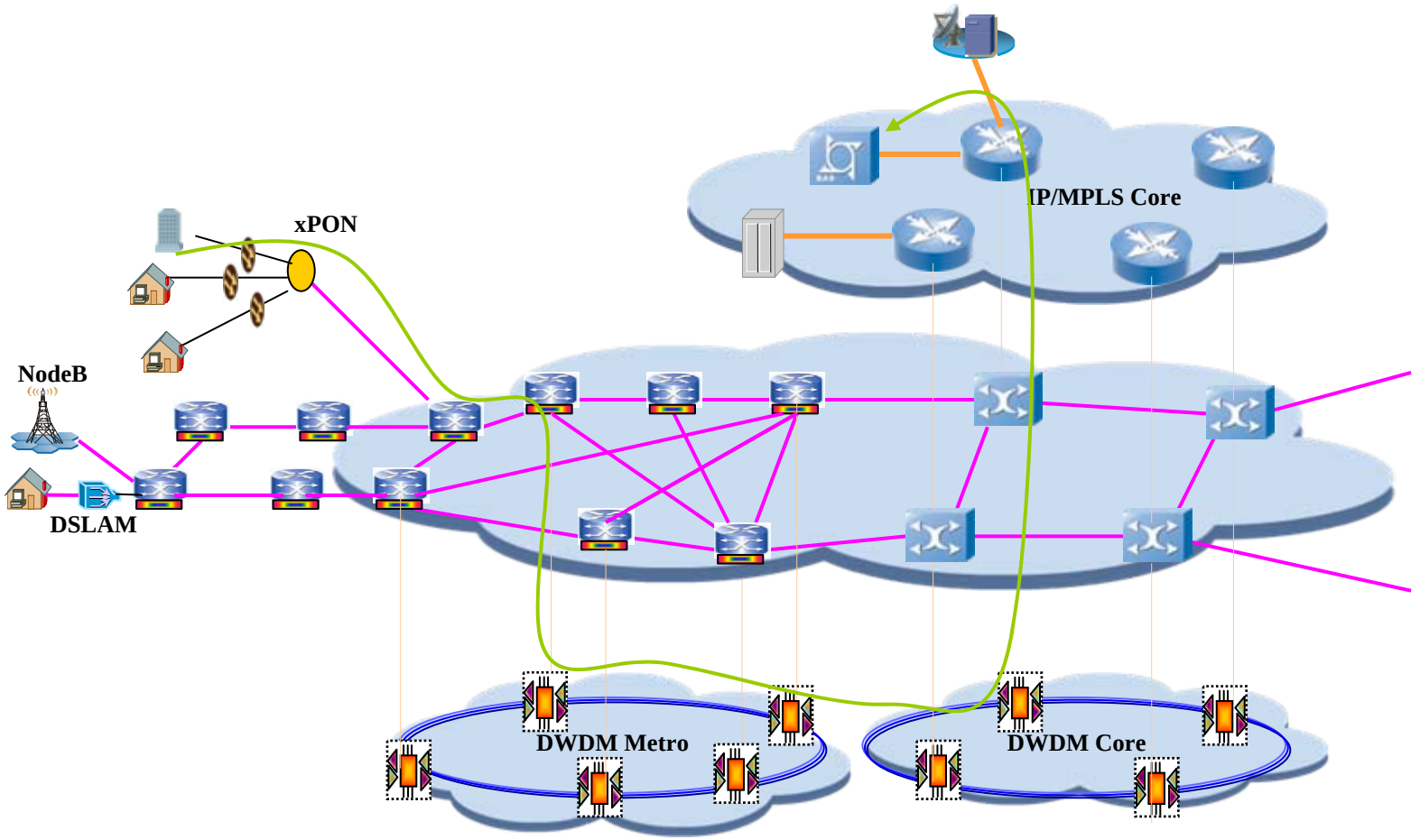
⑥ Clock Synchronization

(Synchronous Eth. + IEEE1588 V2)



Benefits of connect-oriented packet switch

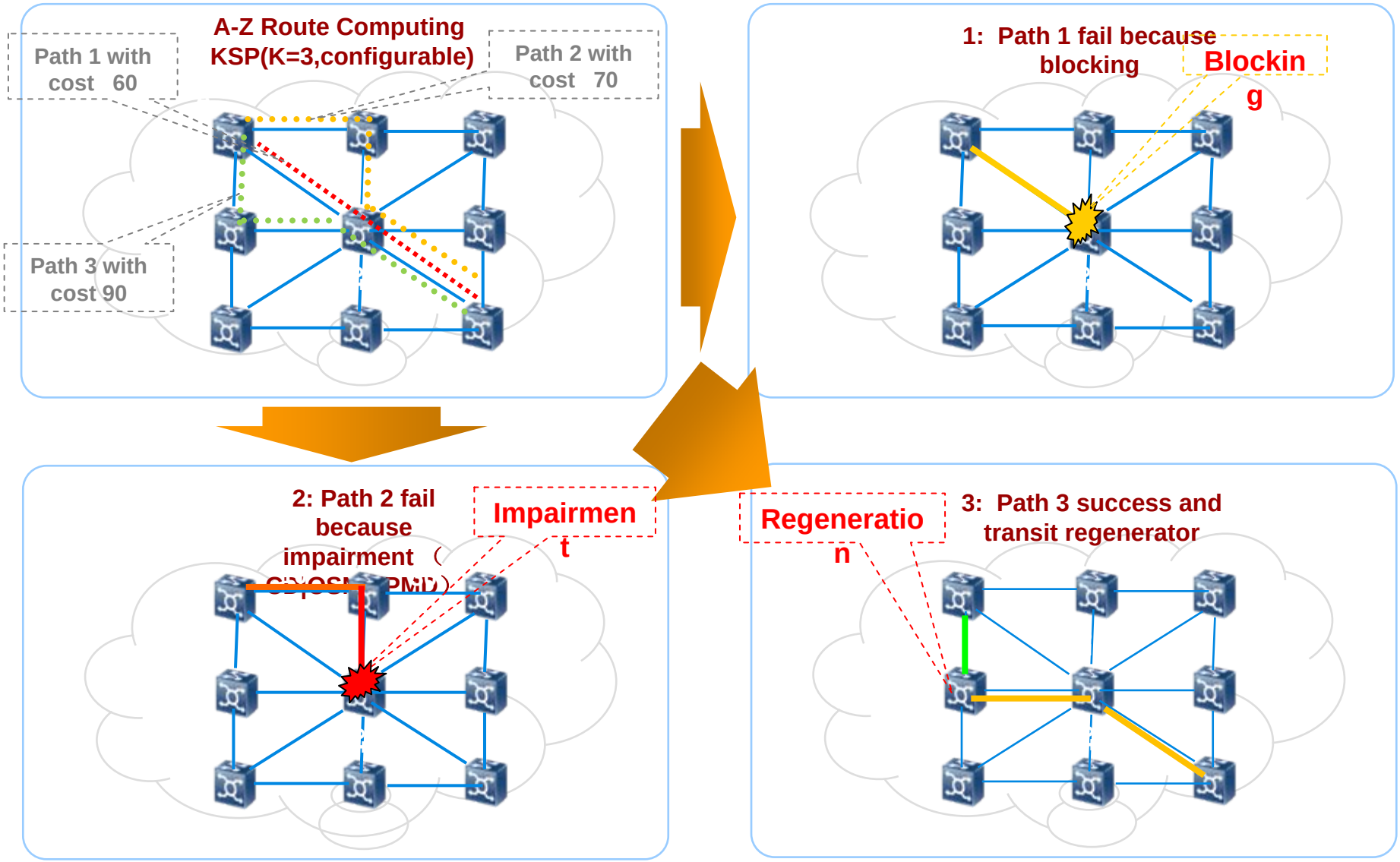
Dynamic Switch –Packet Level



Network pattern changes optical transport network pattern

- Flexible network expansion
- Simplify Services provisioning.

One RWA Model With Optical Impairment



Unified Control Plane

Benefit of WSON

Flat and complicated mesh network

Fast service provision

Simplified OAM

WSON/GMPLS

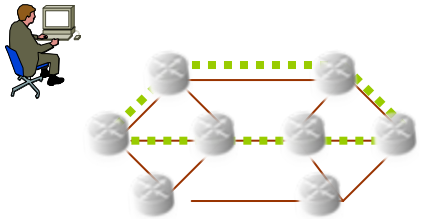
Rapid Protection & Restoration

BoD, OVPN, O-SLA,

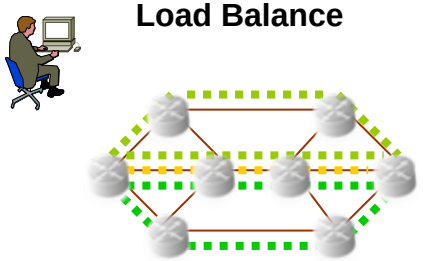
BoD GE/FE OVPN FC

Traffic engineering

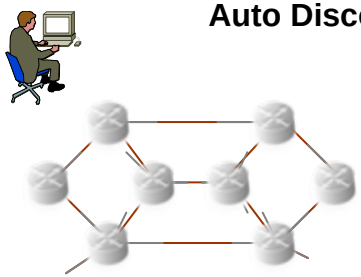
Path Optimization



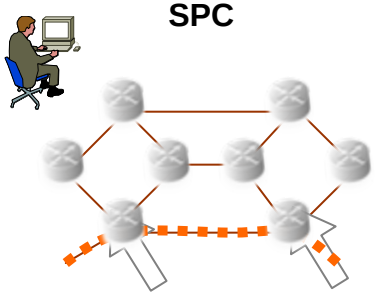
Load Balance



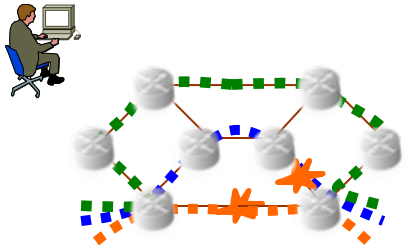
Auto Discovery



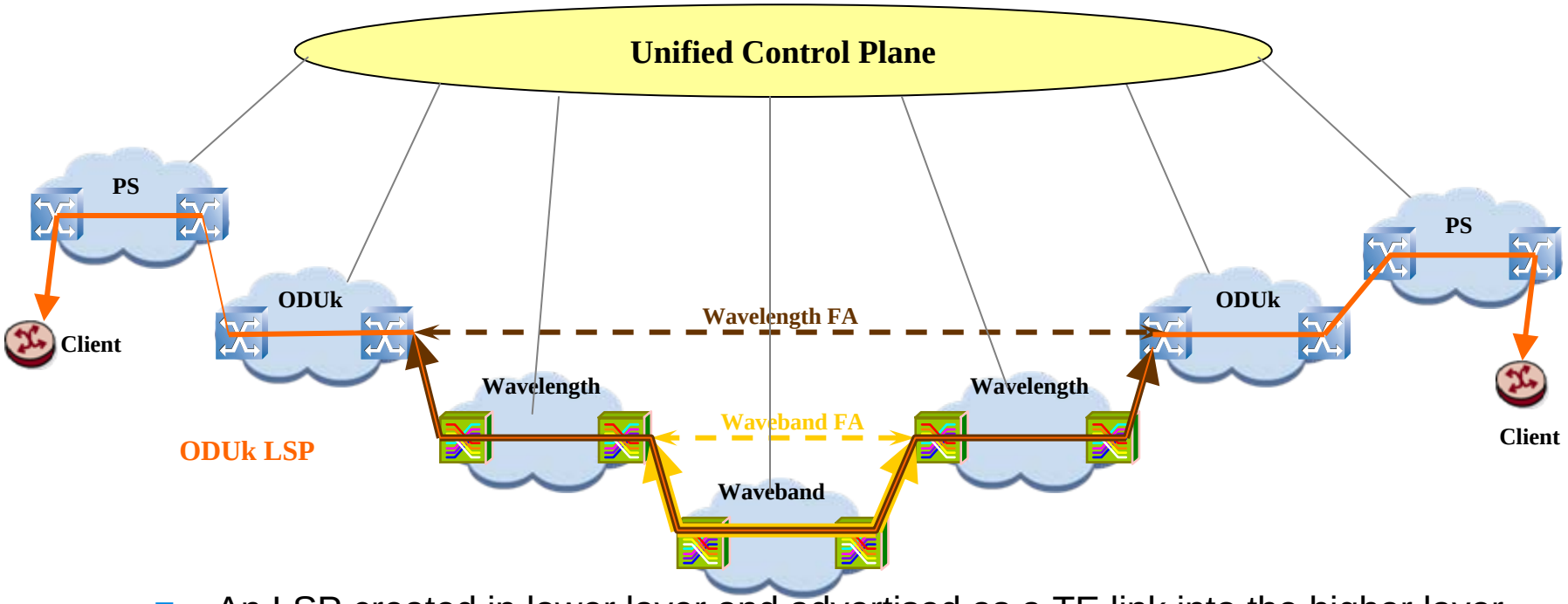
SPC



1+1Protection / Restoration

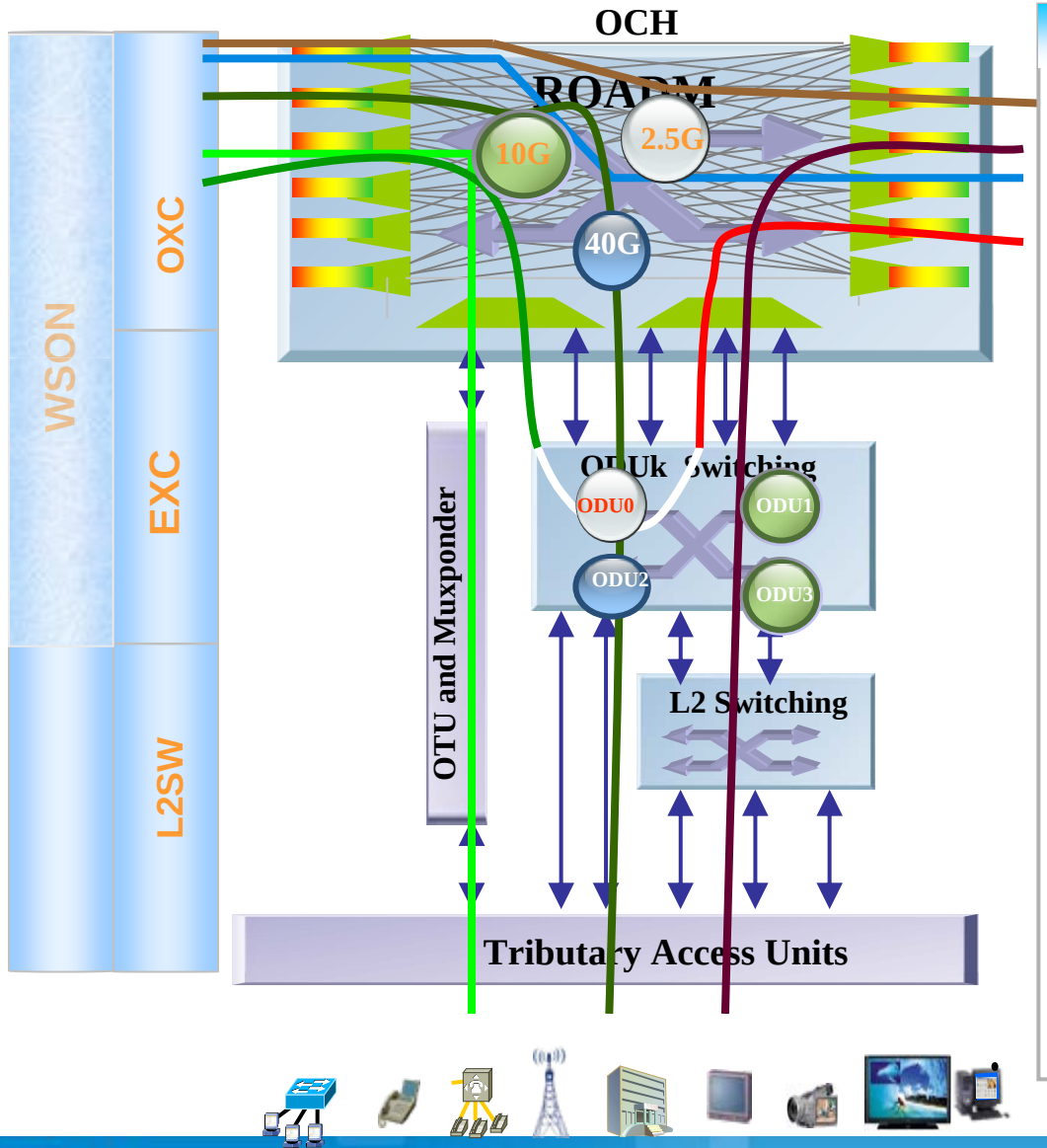


FA-LSP



- An LSP created in lower layer and advertised as a TE link into the higher layer is called a Forwarding Adjacency LSP (FA-LSP)
- There are two alternative way to form FA-LSP
  - Statically pre-provisioned by operator or NMS
  - Dynamically created by triggered signaling
- Related standards
  - RFC 4206, Label Switched Paths (LSP) Hierarchy with Generalized Multi-Protocol Label Switching (GMPLS) Traffic Engineering (TE)
  - draft-ietf-ccamp-lsp-hierarchy-bis-xx

WSON Evolution

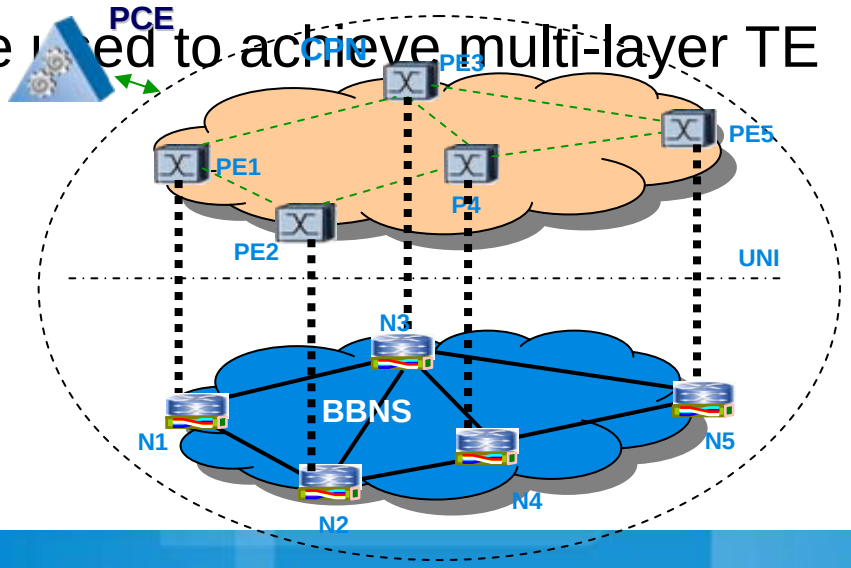


WSON Evolution

- Multi-degree ROADM provide wavelength dispatching, switching matrix supports smooth upgrade from 32/40/48 λ to 80/96 λ, support 2.5/10/40G line rates
- ODUk switching including centralized and distributed switching matrix, switching granularity support ODU0/1/2
- OEO processing overcome OOO blocking problem, realizes real unblocking switching infrastructure
- WSON supports united .grooming for OEO and OOO processing, and implements O/E correlative operation
- Optical-Electrical Convergence (ROADM and OTN switching) is the best way to maximize the capacity and flexibility. WSON is a fully integrated optical and electrical solution.

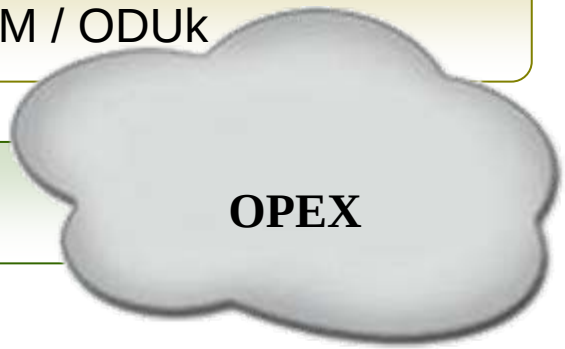
IP/MPLS over GMPLS based optical network

- Overlay model based solution
  - Interworking through UNI between IP/MPLS network and GMPLS based optical network
  - Separate topology, don’t need routing interworking
  - Clients in the border must support UNI signaling
  - Server LSPs forming tunnels across server networks can be used as virtual or real TE-links by client network
  - PCE can be used to achieve multi-layer TE



Key Technologies for NG-WDM Network

1. Large Capacity -- 100G
2. Packet over WDM
3. Dynamic Switch Functionalities --ROADM / ODUk
4. Universal Control plane --WSON



TCO ↓

Efficiency ↑

与作者联系（Contact Author)

感谢您下载并阅读王加莹先生的演讲稿，针对本演讲内容如您希望与作者本人交流，可先联系：

- 中国光电产业高层论坛办公室
- OFweek光电新闻网编辑部

林先生、于先生
电话:0755-83279360/61/63/65
传真:0755-83279008
Email:market@coeic.cn;editors@ofweek.com
地址:深圳市深南中路北方大厦705室
邮编:518033

ZTE中兴

Thanks!

Talking to the future