Slicing Packet Network (SPN) Enabling 5G Transport Network

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New challenges to 5G transport network

The Requirements of 5G transmission network have changed greatly and need to be re-architected.

5G new scenarios

eMBB

uRLLC

mMTC

New challenges to transport network

Networking architecture Changes

5G RAN:

CU/DU separation

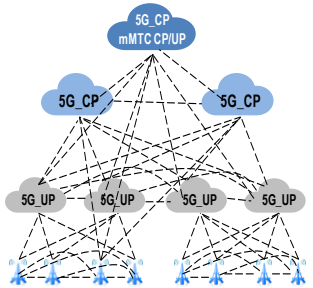
5G Core :

Cloud core network, UPF closed to user , MEC

Connections between network element devices

change into

The interconnection between clouds , which needs to be unified and flexible.



Service Requirement Changes

Bandwidth

320M->10G bps/Single Station

Delay

10ms->1ms One-way Delay

Slicing

For different service types and attributes

Sync

1.5us->400ns Time Sync.

infrastructure Requirement Changes

Fiber :

The density of the site is higher, which promotes the pressure of the terminal fiber.

Machine Room :

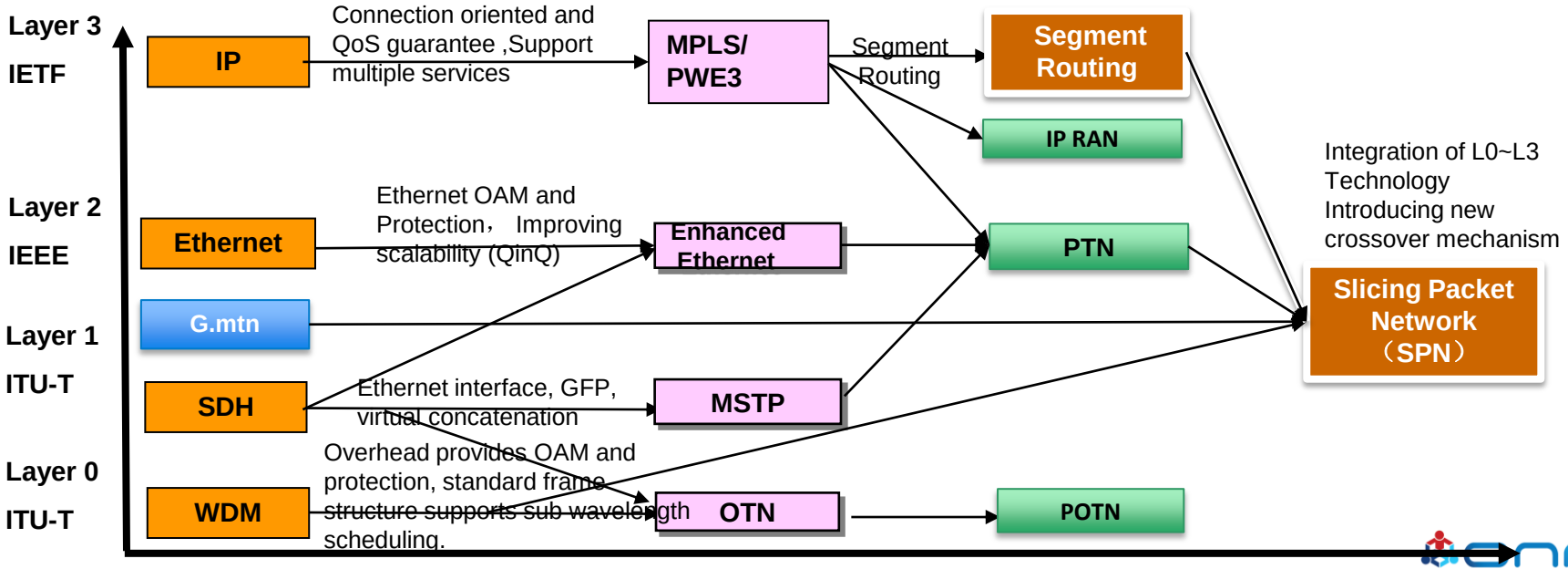
More new equipments, higher requirements for room, power supply and heat dissipation.

The Consideration of the network evolution

① Conform to the trend of IP-based network, and make full use of the advantages of Ethernet ecosystem chain

② Multi-layer resource collaboration is required, L0~L3 capability should be integrated at the same time.

③ For ultra low latency and vertical industries, Both TDM and packet switching should be supported



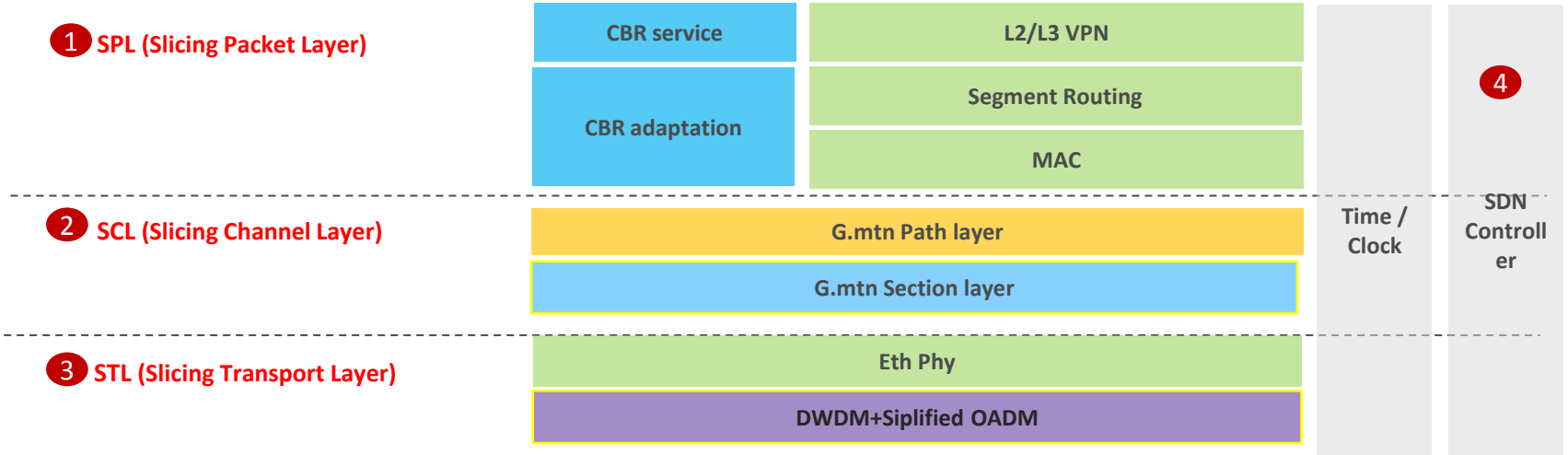
SPN Arch: Integrates L0~L3 multilayer functions

③ L0: WDM and simplified OADM

② L1: 66B block based TDM switching

① L2&L3: MPLS-TP and SR-TP

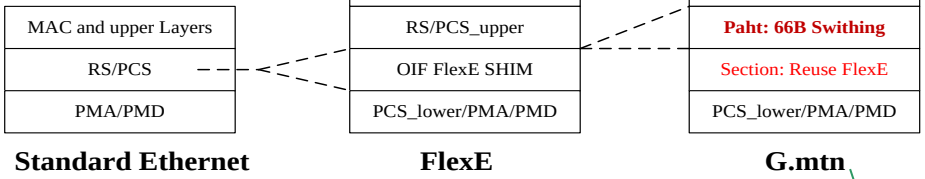
④ SDN centralized control



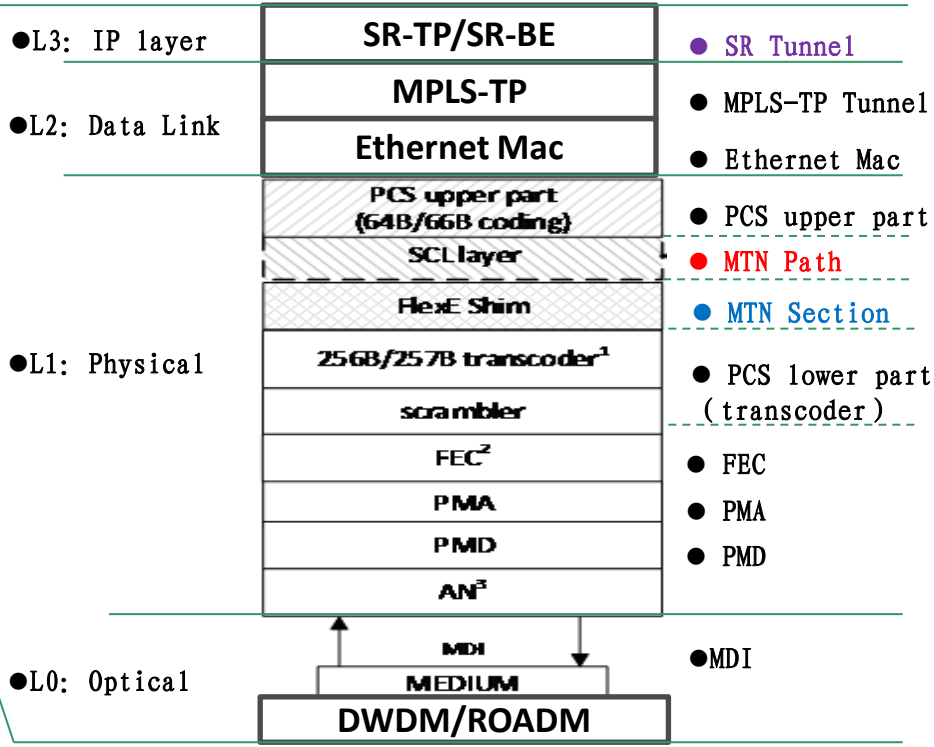
ITU-T SPN project has been approved as the G.mtn project, which marks a new generation of transport network research in ITU-T.

SPN protocol stack

SPN layer structure evolution



SPN protocol stack architecture

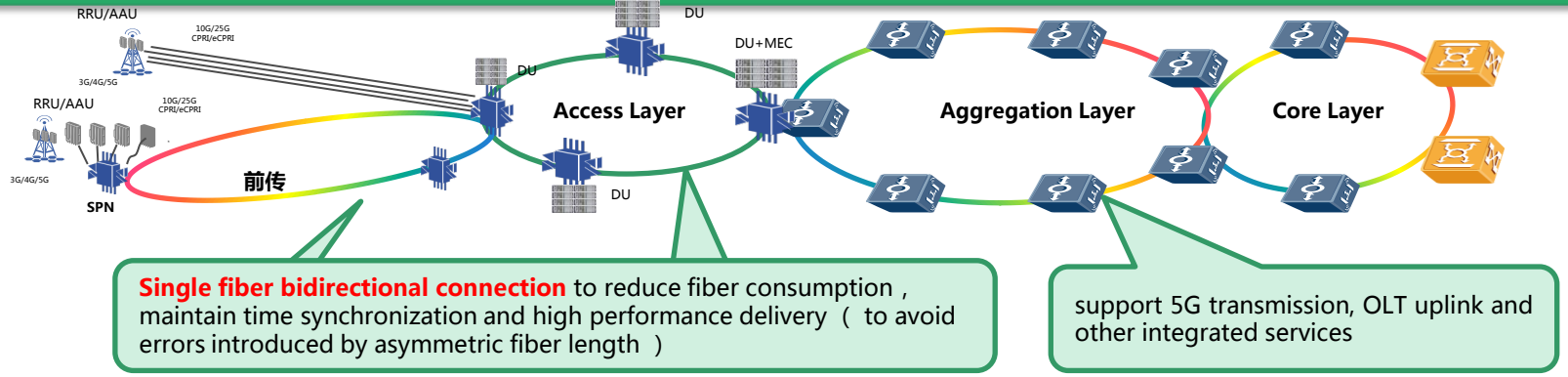


SPN innovatively introduces SPN channel layer, integrates TDM and packet switching, and integrates L0 layer to L3 layer into an organic whole.

Ethernet Optical Layer Interface Requirements

- **Fronthaul Requirements**: fiber direct drive, large core fiber,25GE BIDI module
- **Middlehaul/Backhaul(small city)**:E2E gray Ethernet networking ，50GE PAM4*N
- **Middlehaul/Backhaul(large city)**:access with gray Ethernet， aggregation / core with DWDM

Networking Scheme

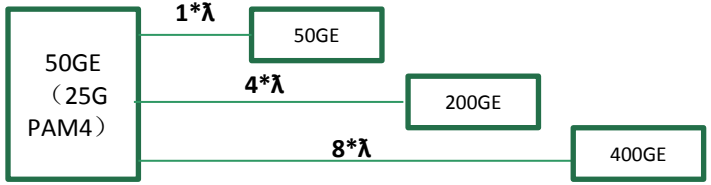


Single fiber bidirectional connection to reduce fiber consumption，maintain time synchronization and high performance delivery（ to avoid errors introduced by asymmetric fiber length ）

support 5G transmission, OLT uplink and other integrated services

Interface Technology

Gray Ethernet module requirements



Distance： •2km •10km •40km

Color Ethernet module requirements

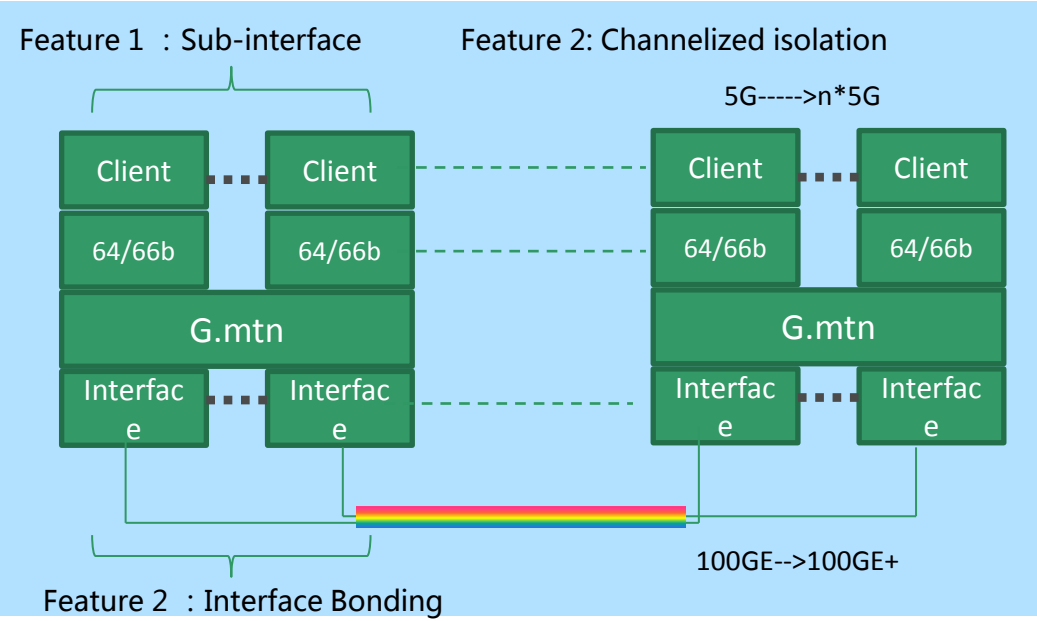
- Coherent Ethernet Color Light Module
  - 400G ZR
  - 200G ZR
  - 100G ZR

• Distance： •80km •120km

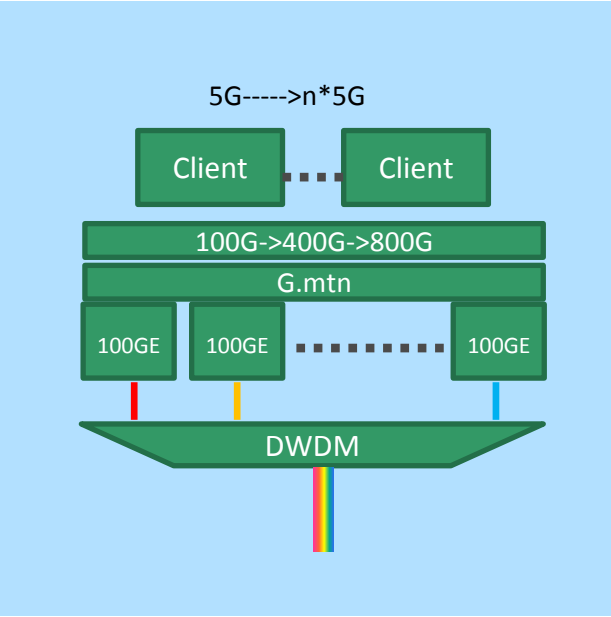
DWDM Colorful Ethernet and G.mtn

- **G.mtn and DWDM enable flexible expansion and segmentation of bandwidth**

G.mtn over WDM Networking



G.mtn and DWDM

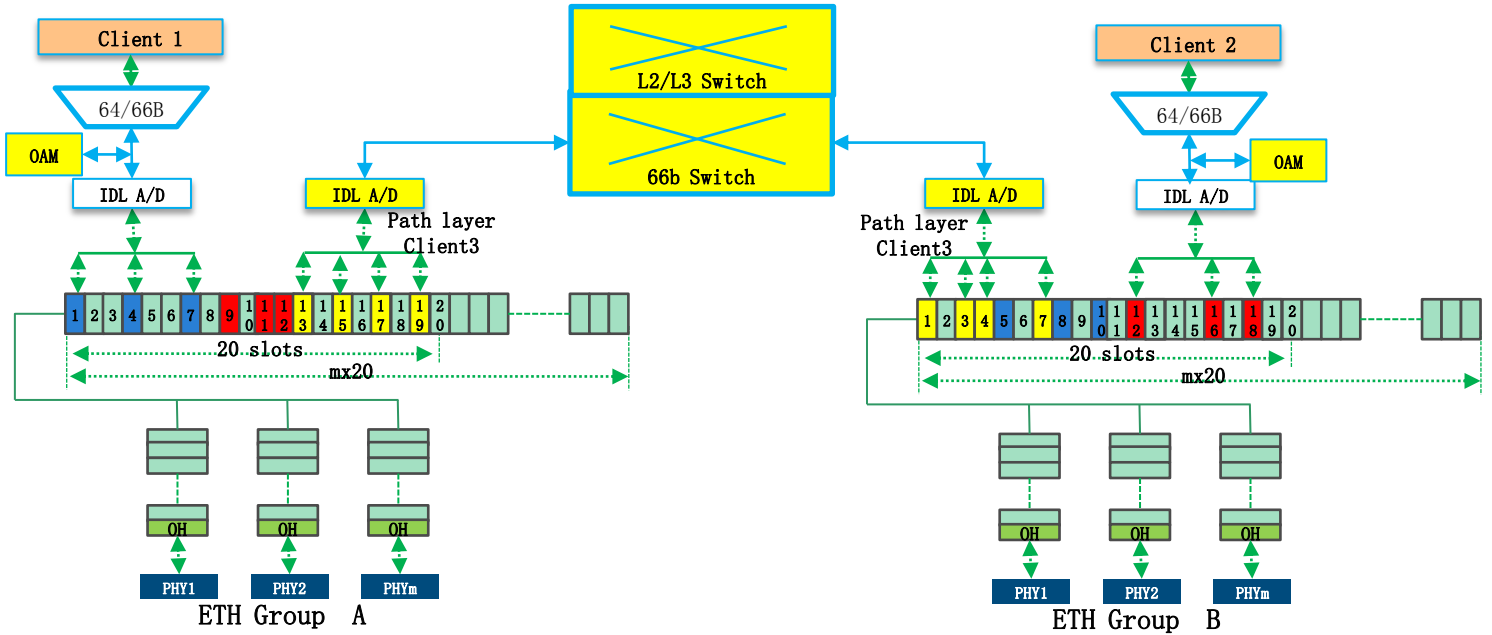


- G.mtn supports bandwidth that exceeds the physical interface rate through multiple interface bonding
- G.mtn+DWDM not only provides single-fiber large-bandwidth capability, but also combines DWDM channels to flexibly increase bandwidth on demand
- G.mtn supports sub-interface channelization with n*5G bandwidth to achieve network slicing

The Path Layer cross connection and OAM

New Switch: based on 66bit Slot which is the basic block of original Ethernet

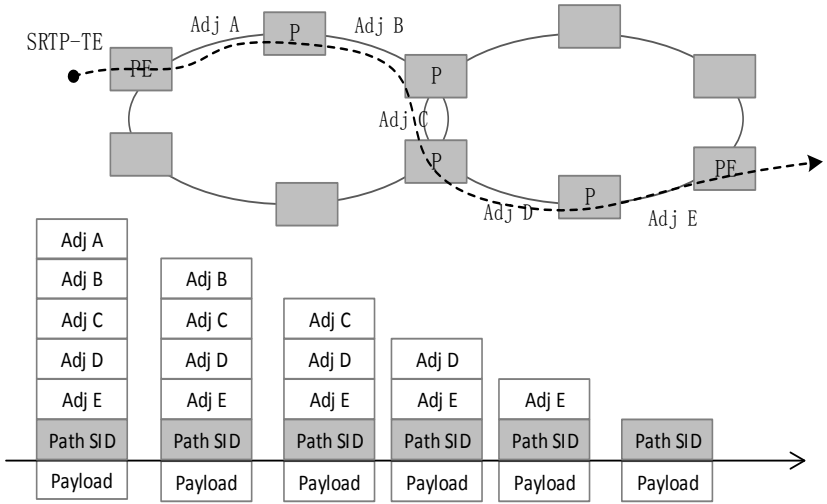
New OAM: Using the IDEL block slot as the OAM message block slot and provide OTN like OAM



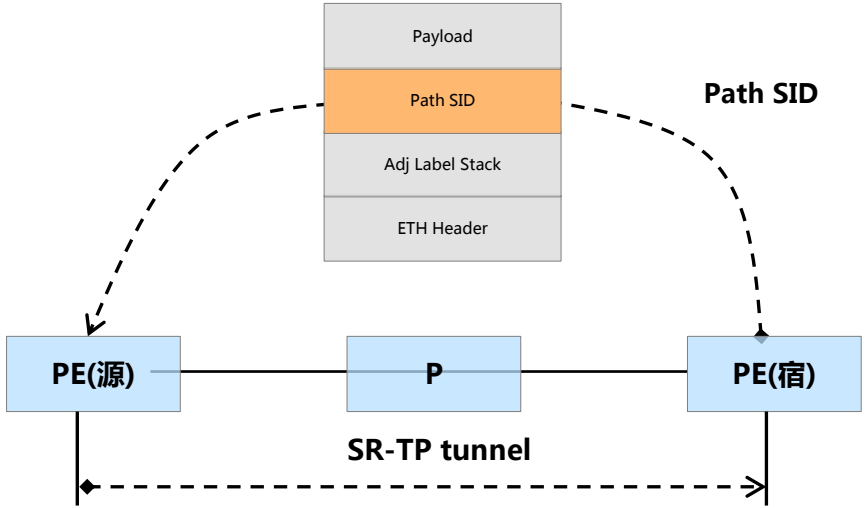
Path Segment solution

SR-TP： On the basis of SR-TE, we adds a layer of Path SID to guarantee the path of SR can be monitoring.

Path Segment： **Path segment for Connection oriented OAM**



Path SID Distributed：the destination nodes distribute the Path SID to source node



Enhanced sync requirement

4G Sync

TD-LTE: ±1.5us

5G Sync

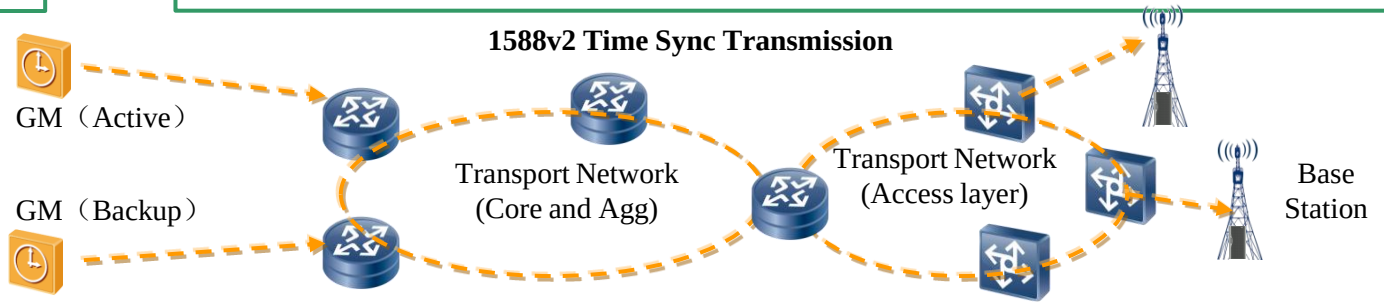
A. **Basic radio interfaces (Whole Network)**: Ultra-short Frames，about ±390ns

B. **Cooperations among stations (Local)**: CoorapCA, CoMP etc., about ±130ns

C. **5G new services (Local)**: Base station positioning etc. about ±10ns

Sync Model

1588v2 Time Sync Transmission

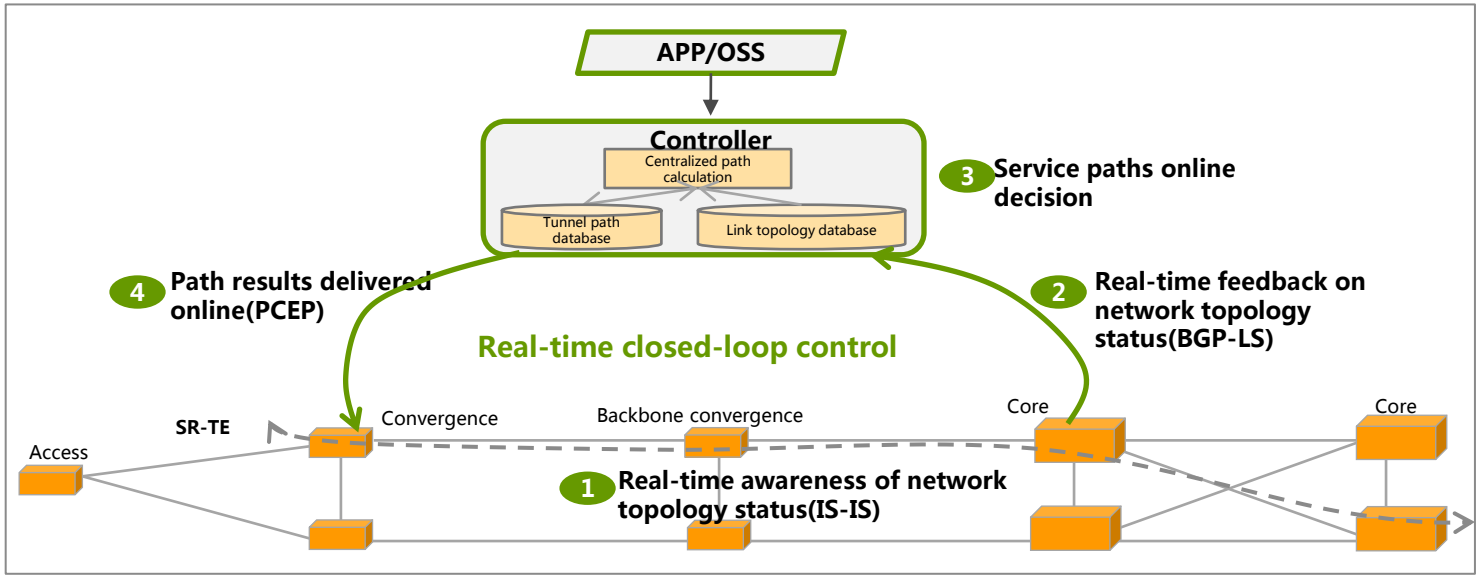


Network budget	PRTC	Transmission Network	Base Station
4G	250ns	1000ns（including holdover），30ns per hop，>20 hops	250ns
5G	50ns	Tracing 100ns，5ns per hop，>20 hops	50ns

- **Fronthaul, mid-haul, and backhaul should support time sync functions. End-to-end budget could be +/-200ns without holdover**
- **The multi-lane interface need be supported and BiDi modules should be used in front haul and access layer of backhaul**
- **Compared with 4G, innovative time source and time transmission technologies are required to improve time sync precision.**

SPN Control Plane Solution

- Functional Requirements ： SPN enhances service dynamic capabilities through SDN centralized control plane
- Design Ideas ： “Integration of management and control, centralized control supplemented by distributed control “

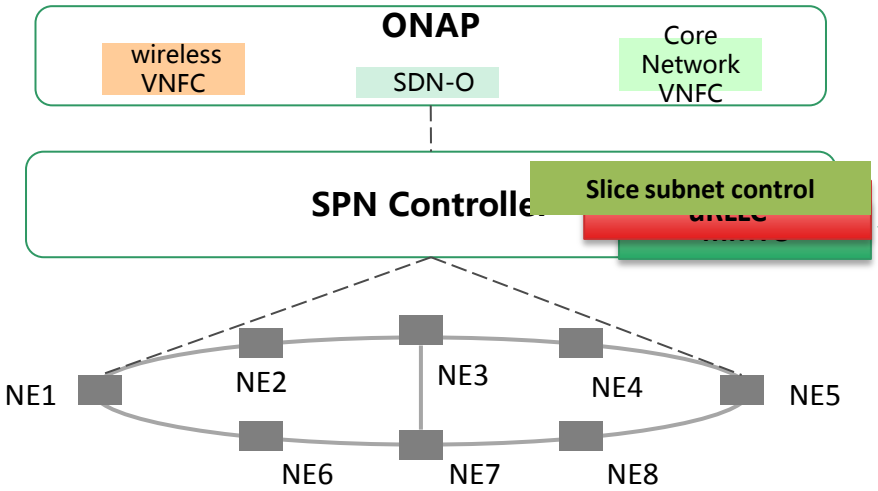


With the combination of IS-IS、BGP-LS and PCEP protocols, SPN realizes real-time closed-loop control of service paths.

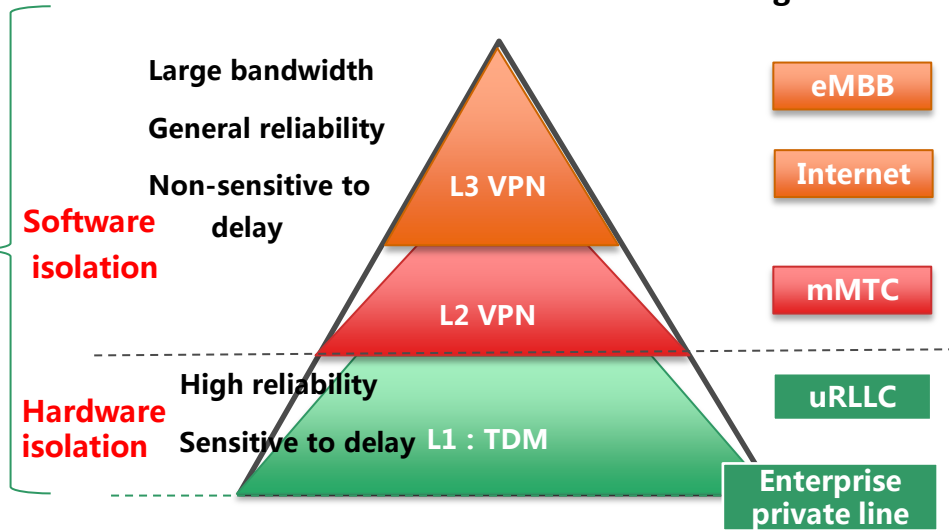
Centralized Controller Achieving Network Slicing

SPN Network Slicing : With the management and control plane integration, SPN implements logical abstraction of physical resources , achieving "one physical network and multiple networking architectures" .

SPN Physical Network View

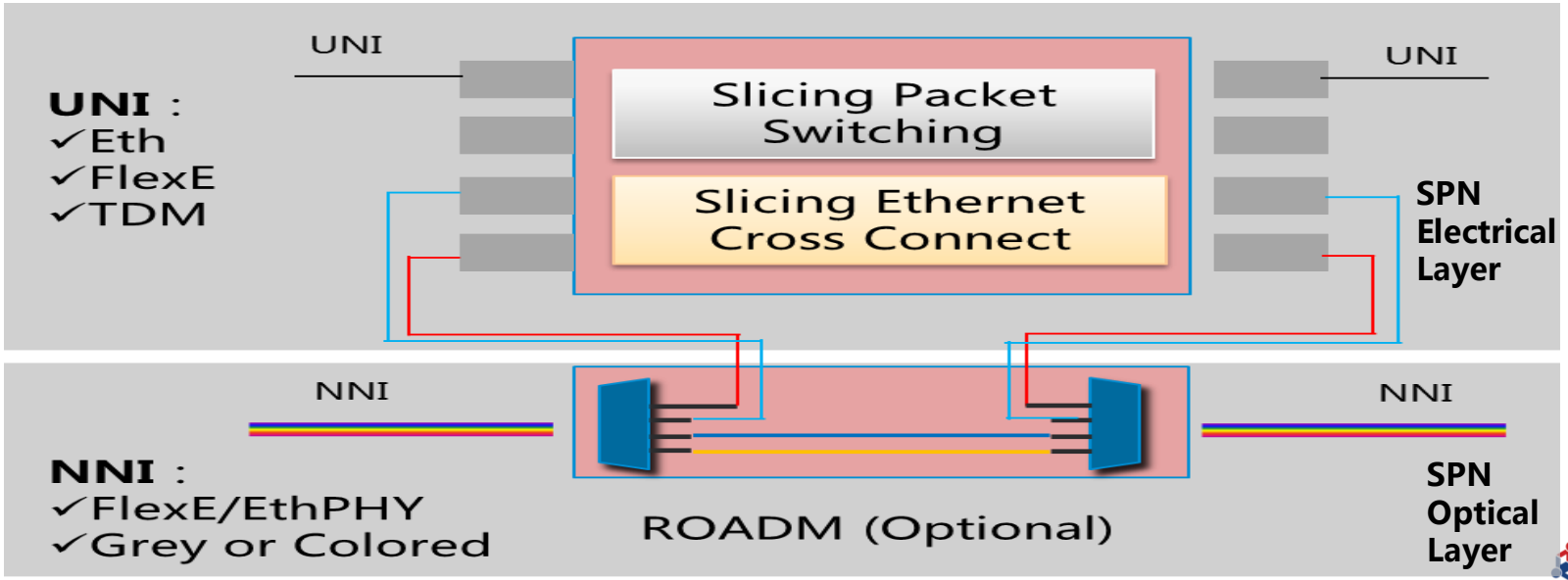


SPN Network Slice Presenting



Disaggregated SPN Equipment

- Packet Switching and Slicing Ethernet cross connect (Required) should be supported and mutual integrated.
- ROADM (Optional) , to achieve wavelength switching, save the optical module. It is recommended to use low-level crossover to support static configuration only ;
- Building block design: The electrical layer and the optical layer of the Equipment can be a flexible combination according to the application scenarios.



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