Introduce to UTS Product & Solution Portfolio

Product Management & Marketing (PM&M)

June 2018

UTStarcom – a global telecom infrastructure provider

- Founded in 1991, started trading on NASDAQ in 2000 (UTSI)
- Operating entities in Hong Kong; Tokyo, Japan; San Jose, USA; Delhi and Bangalore, India; Hangzhou, China
- Strong customer base, multiple deployments for tier 1 operators worldwide



SoftBank NEC
CHINA TELECOM
Connecting the World
bharti
building telecom
building partnerships
Reliance Infocomm
PLDT
TATA
KT
Chunghwa Telecom
Bharat Sanchar Nigam Ltd.

UTSTARCOM®



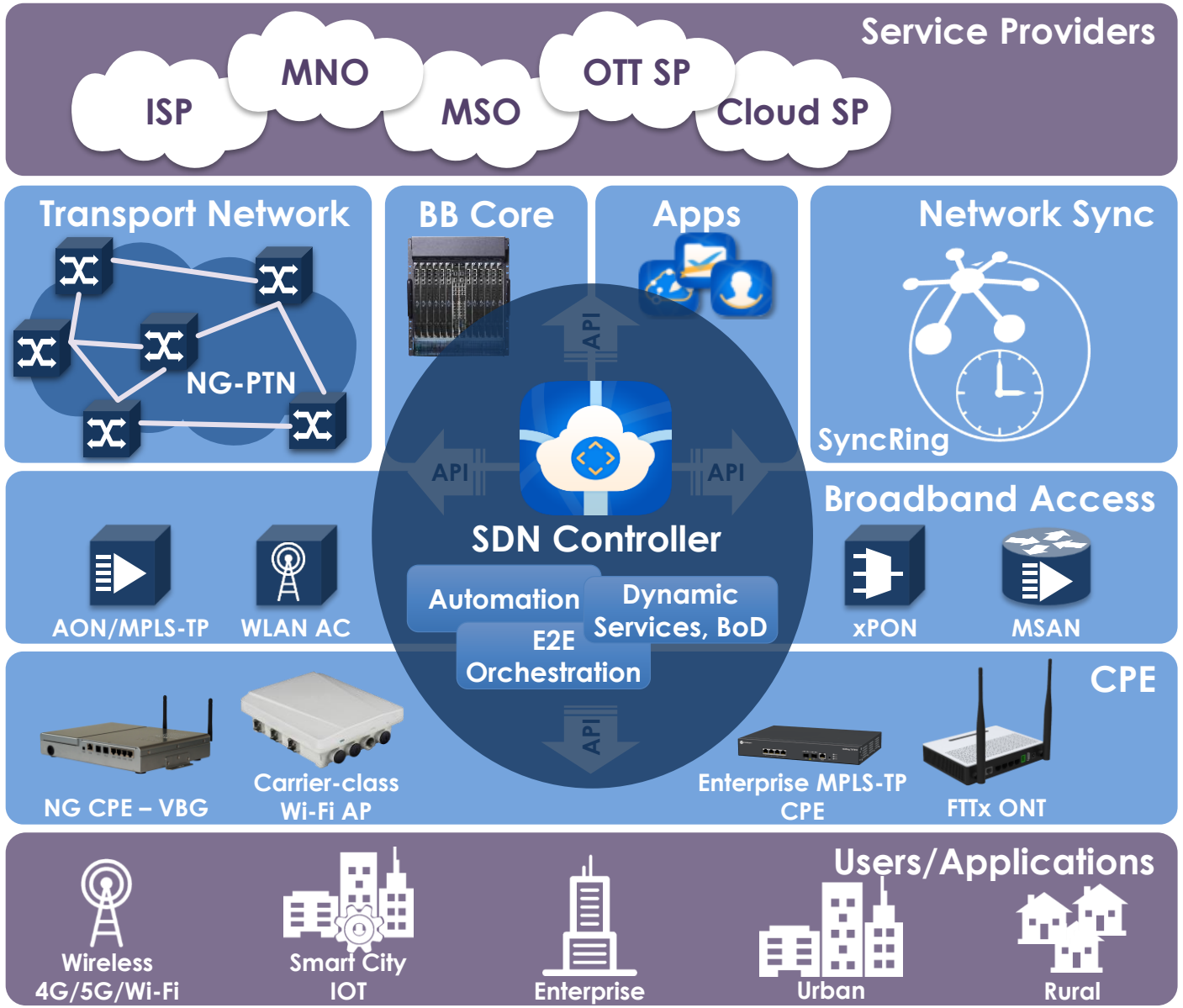
Focus on delivering innovative cutting-edge, packet optical transport, synchronization, wireless and fixed broadband access products and solutions coupled with carrier grade Software Defined Networking (SDN) platform

E2E solutions for hyperconnected era

NG-PTN: Metro transport network with centralized intelligence

Broadband Core: Cloud control, Signaling Gateway, IMS, Core Router

Virtual Broadband Gateway: Intelligent customer edge



E2E service orchestration and automation based on SDN

SyncRing: Precise synchronization over packet network 4G/5G

Broadband access: MSAN, xPON, Wi-Fi

Packet Transport Network
-- “NetRing TN”

Packet Transport Network (PTN)

Packet network:

Efficiency and flexibility

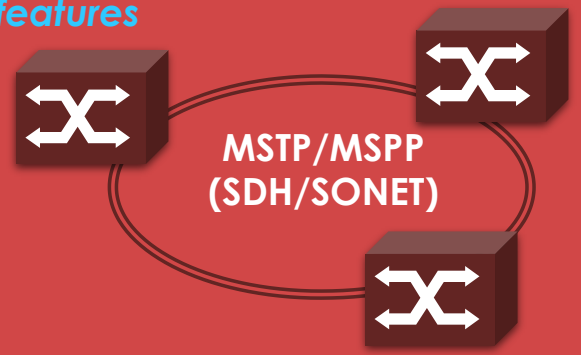
- *Statistical multiplexing*
- *Flexible transport containers*
- *Service-aware*
- *Advanced QoS*
- *Scalability*
- *Cost-effective (Ethernet-based)*

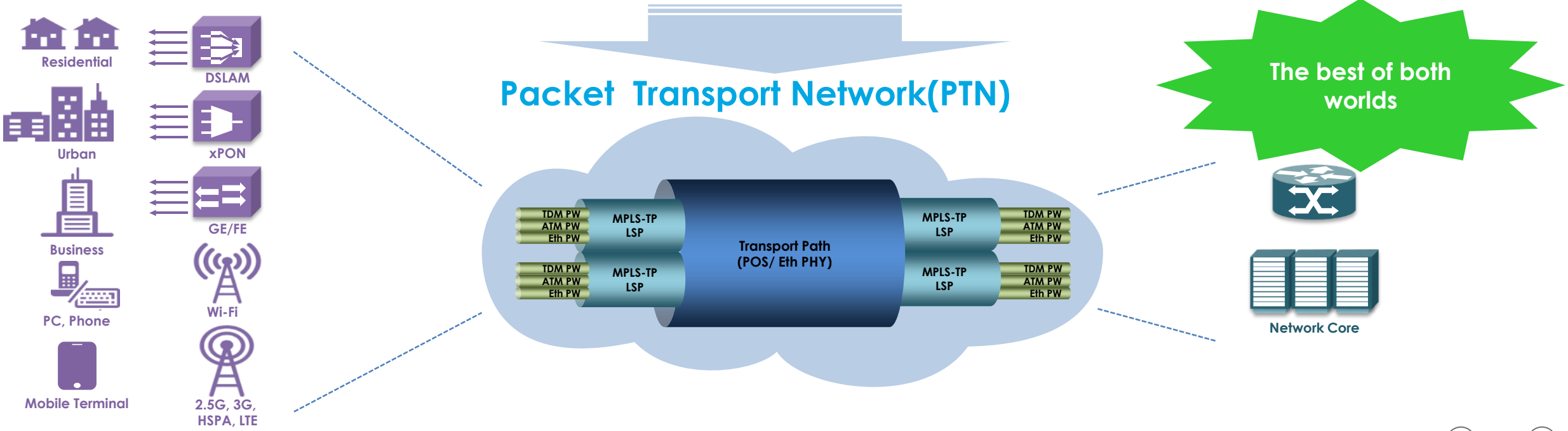


Transport network:

Performance and carrier-grade features

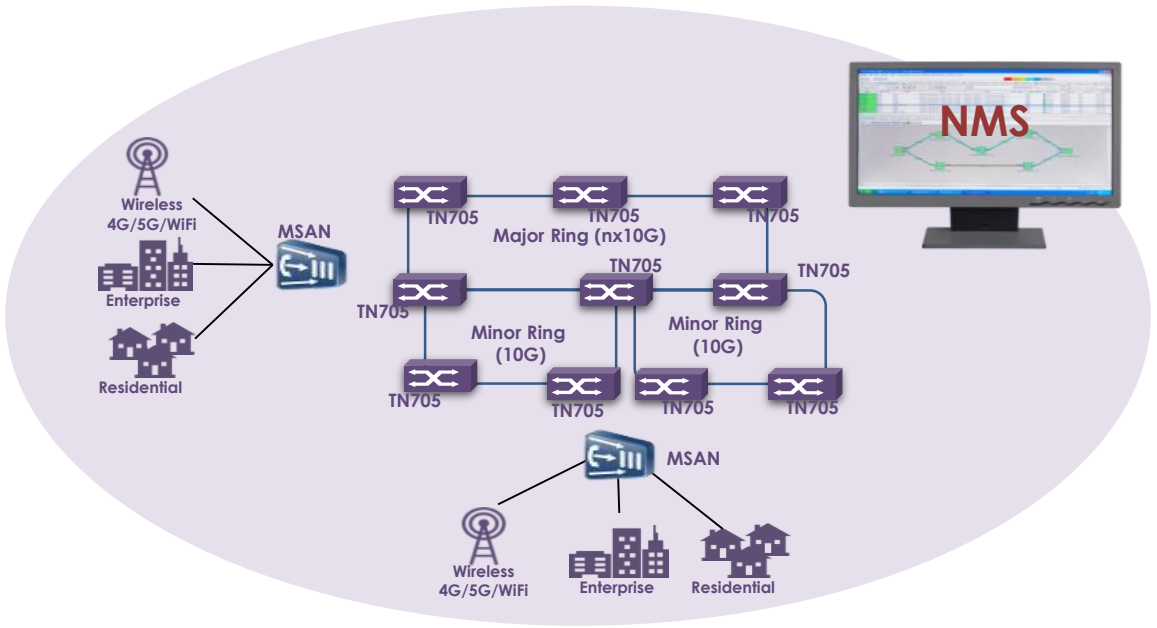
- *Connection oriented*
- *Low delay and jitter*
- *High clock accuracy*
- *Resiliency (50ms switch over)*
- *Comprehensive OAM*
- *Multi-service support*





From HW-Centric to SW-Centric

Today: Hardware-centric PTN Area NW



Upgrade

Future: Software-centric Software defined Packet Network

Next Generation Metro Network



Network Automation and Intelligence

SDN/NFV: *Bandwidth on demand, automation and Orchestration*

L3&SR: *L3 scalability and Segment Routing*

100GE/FlexE & WDM: *High NW throughput and efficiency*

Strong carrier-class platform:

- *MPLS-TP/CE technology*
- *Packet network efficiency*
- *Connection-oriented network performance*
- *Carrier-class features*
- *OAM-based monitoring and alarm handling*
- *NMS-based centralized management*

BUT

- *NMS based Manual operation*
- *Lack of automation*
- *Limited L3 support*
- *Static*
- *Single wavelength*

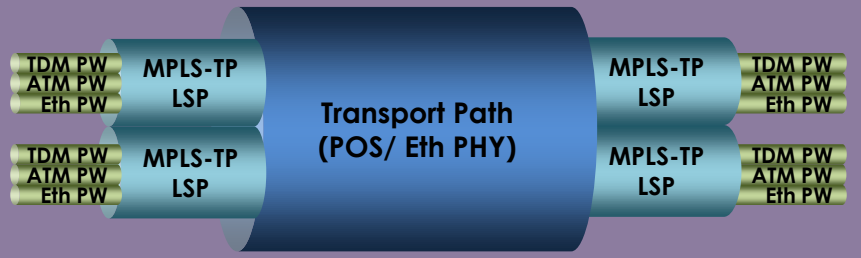
PLUS

- *SDN-based automation*
- *SDN/NFV-based dynamic service orchestration*
- *L3 Service/EVPN*
- *API for APP driven services*
- *100GE above &WDM*

PTN Migration

Packet network:
Efficiency and flexibility

Transport network:
Performance and carrier-grade features



Packet Transport Network

Universal L2/2.5/3/MPLS-TP/Carrier Ethernet/Segment Routing

- Flexibility
- Scalability
- Performance
- Security

Next Generation Metro Network

- Reliability
- Efficiency
- TCO
- Future-proof

SDN/NFV:
Bandwidth on demand, automation and Orchestration

L3VPN & SR:
L3 scalability and segment routing

100G/FlexE & WDM:
High network throughput and efficiency

PTN/NG-PTN Product Portfolio

Control Plane | Data Plane | Management Plane

10GE/100GE Ecosystem

NG-PTN





TN701B/703B
10Gbps SW
GE SFP/RJ45/E1
Indoor/Outdoor



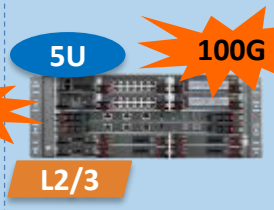
TN703A
64Gbps SW
GE/XGE
E1/STM-1



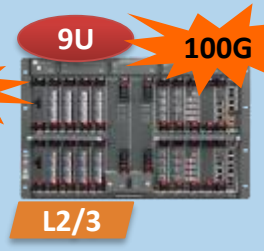
TN725B
64/88Gbps SW
GE/XGE
E1/STM-1



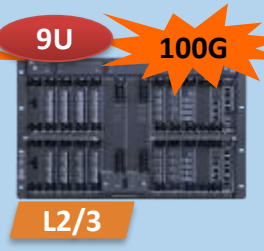
TN704E*
300bps SW
100GE
GE/XGE



TN705E
800Gbps
100GE
GE/XGE



TN765
960Gbps SW
1/10/100GE
10G POS



TN765E*
1.6Tbps SW
1/10/100GE
10G POS

GE/10GE Ecosystem

PTN





TN701A
4.4Gbps SW
GE SFP/FE RJ45
Indoor/Outdoor



TN703C
6.4Gbps SW
FE/GE/E1
Indoor/Outdoor



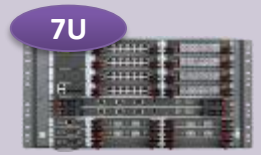
TN703E
44Gbps SW
FE/GE/XGE
E1/STM-1



TN705
88Gbps SW
FE/GE/XGE
E1/STM-1



TN725
108Gbps SW
FE/GE/XGE
E1/STM-1



TN725E
176Gbps SW
FE/GE/XGE
E1/STM-1



TN735
400Gbps SW
10GE/10G POS
FE/GE
E1/STM-1

SDN/NFV

SOO Network





Netman OMC-O

NMS

CPE | Access | Aggregation | Core | Network Intelligence

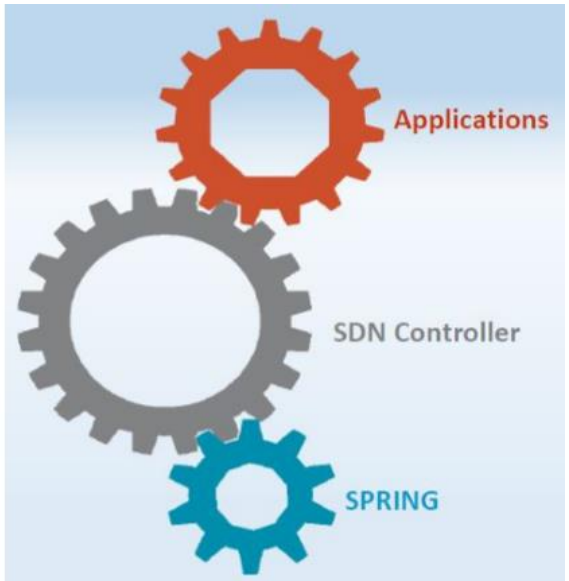
UTStarcom Proprietary and Confidential

Segment Routing IPv6 (SRv6)
-- “SkyFlux UAR”

Here Comes SPRING

- ***Segment Routing- A new forwarding paradigm***
  - A new forwarding paradigm, source routing technology, simplify MPLS networks, Resolving limitations of LDP/RSVP-TE of MPLS
    - The way it works, is that the source (Application flow) chooses a specific desired path (based on the flow needs) from the available paths that may differ from the normal shortest path, and encodes it in the packet header as a controlled list of instructions called "segments"
  - Standardization in IETF: Segment Routing, SPRING(Source Packet Routing In NetworkinG) – in progress
  - Enjoys strong industry support

- ***Perfect match the needs of SDN***
  - Optimized and designed for use with SDN
  - Great match for application-driven networking, network automation etc.
  - Segment Routing could facilitate the adoption of SDN.
  - Segment Routing/SPRING is “Foundation for a SDN-ready network” (Cisco Fellow, Clarence Filsfils says on January 17th, 2017).



Why Upgrade Your Network Infrastructure to SR?



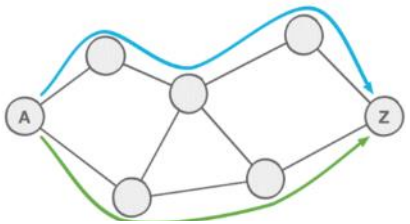
Simple
- Complete control e2e path
- Removes LDP, RSVP-TE complicity



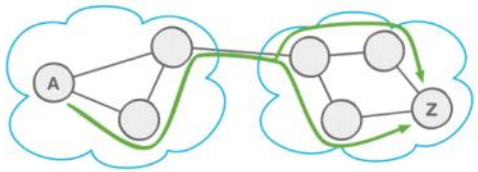
Scalable
- No require any path signaling
- The network fabric is stateless



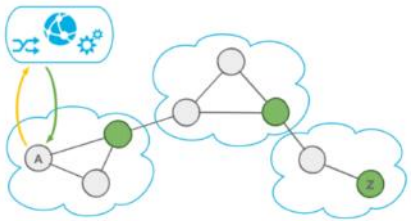
Seamless deployment
- Runs natively on an MPLS or IPv6 data plane.
- Can coexist with your existing network



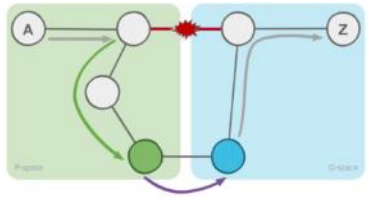
Traffic Engineering



Unified Forwarding Plane



On-Demand Next Hop



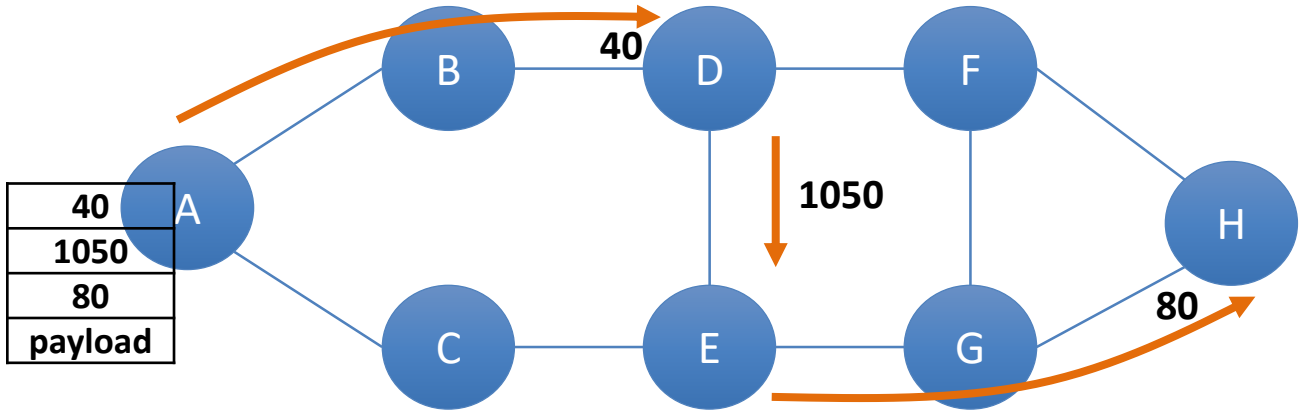
Failure Protection



Network Programming

- **Traffic Engineering:** Segment Routing be used to steer traffic along any arbitrary path in the network.
- **Unified Forwarding Plane:** Segment Routing is capable of creating inter-domain policies for network slicing.
- **On-Demand Next Hop:** SR PCE can configure an inter-domain path automatically either for simple BE or with SLA
- **Failure Protection:** FRR/TI-LFA provide sub-50msec protection upon any single link, node or SRLG failure.
- **Network programming:** Eables program the network to steer different traffic (e.g. voice, bulk data) over different paths.

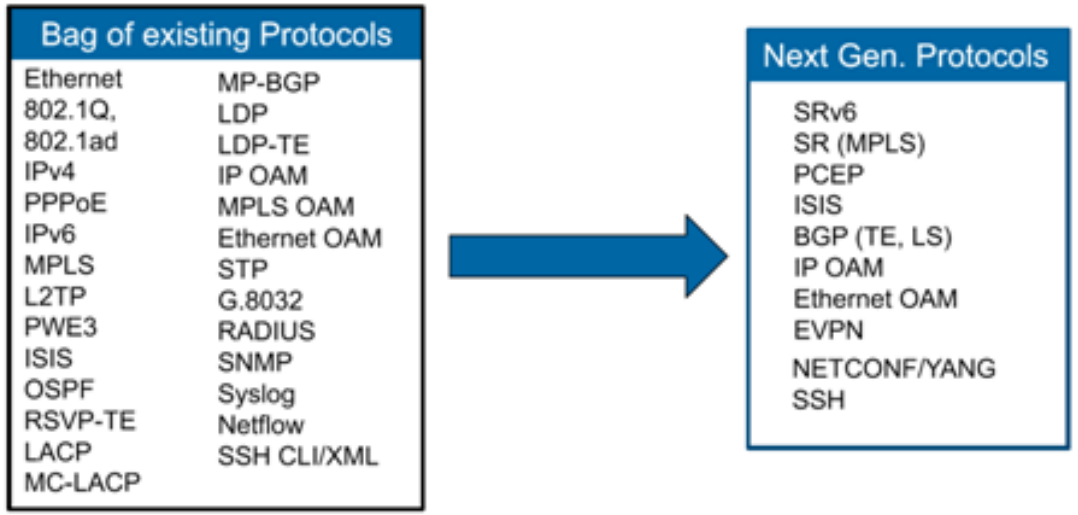
Evolve from IP-MPLS to SR





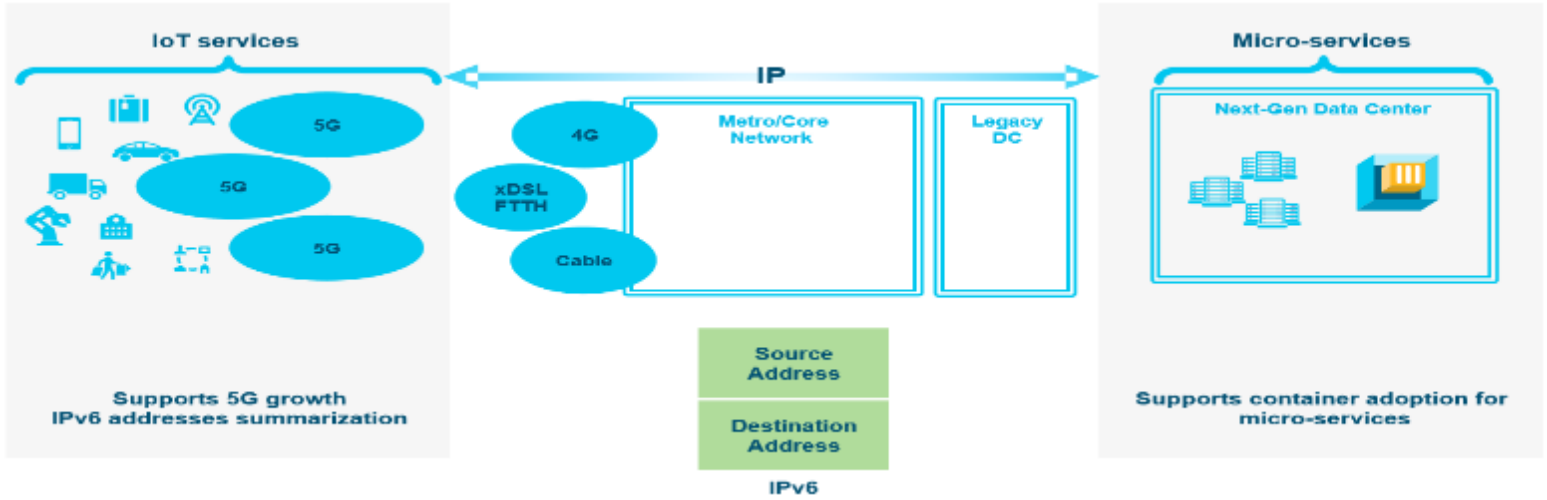
As-is (IP-MPLS Centric)

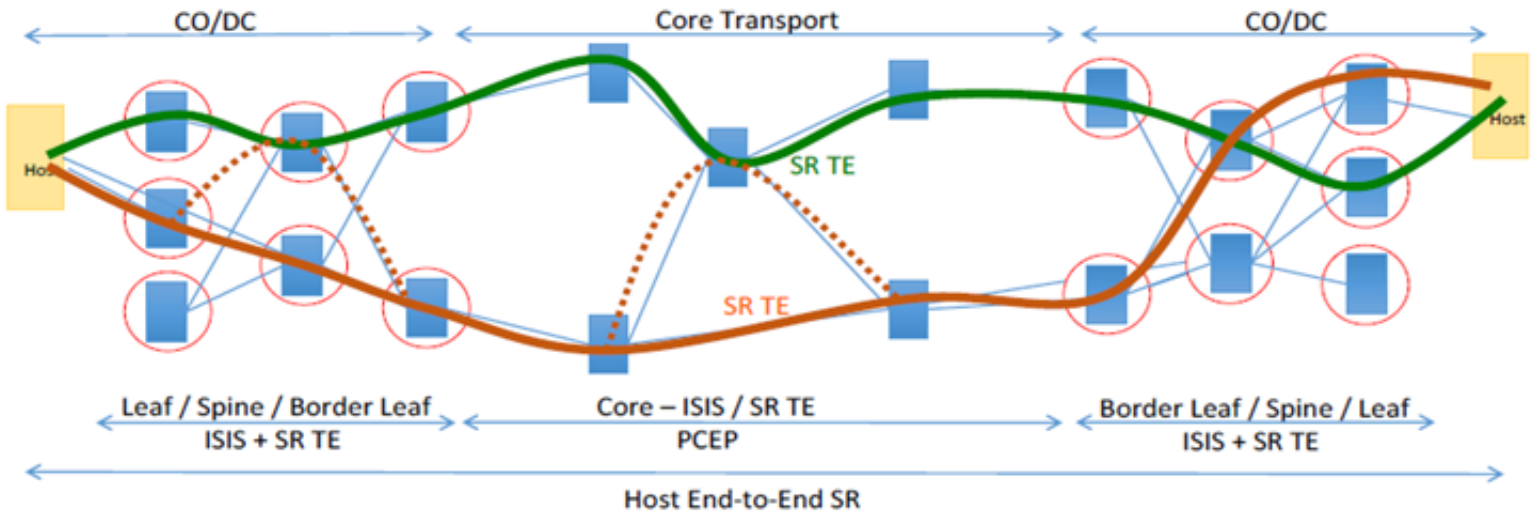
To-be (SR Centric)



- Source Routing
- Simplify Protocol (IP-MPLS → SR)
  - SR-MPLS: LSP Label
  - SRv6: SRH
- Software Defined Network, programmable
- PCE (Path Calculation Engine)
- Traffic Engineering/Telemetry
- TI-LFA (Topology Independent LFA) FRR

Why SRv6?



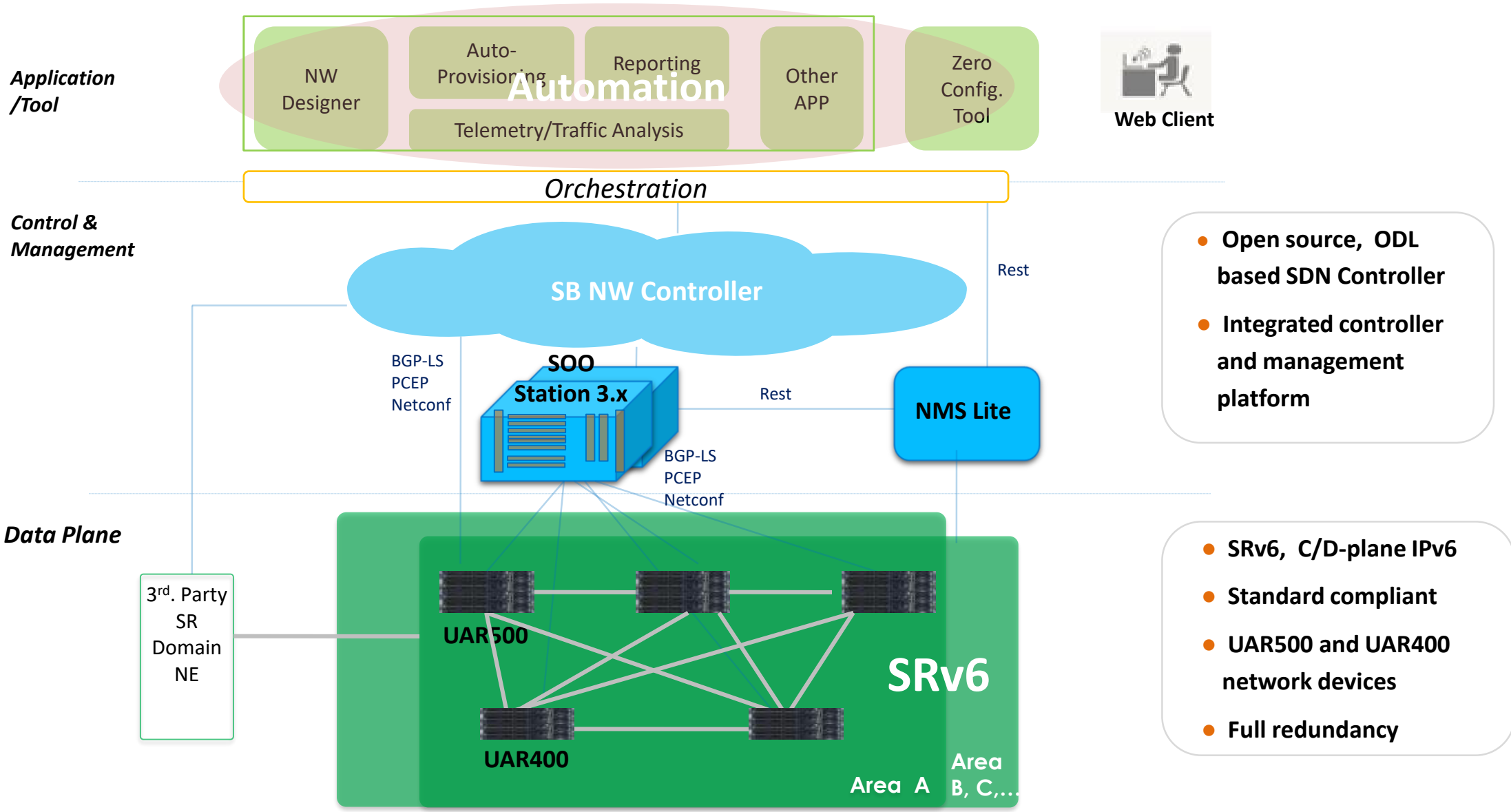


Source: Bell/2017

- **End-to-end SR path,** from access to Data center Application VM host.
- **Application driven,** programmed according to service requirement. NFV and dynamic service chain
- **Standards** getting to mature
- **Fit for green field,** IPv6 network for growing IoT and 5G network build-up
- **Evolution (SRv6)** vs. **migration (SR MPLS).** Network efficiency

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SkyFlux SRv6 Solution Overview



- Open source, ODL based SDN Controller
- Integrated controller and management platform

- SRv6, C/D-plane IPv6
- Standard compliant
- UAR500 and UAR400 network devices
- Full redundancy

SkyFlux UAR500 & UAR400 Hardware Release

SkyFlux UAR500
(Released)



- 800Gbps full duplex switching fabric
- 8 service slots:
  - 6 slots of 1x100GE service card
  - 4 slots of 12x10GE/GE service card (SFP/SFP+/T-SFP)
- 5U, 19”/ETSI/ANSI rack mountable
- Power Consumption: 820W Max
- SDN SOO-Network controlled

UAR400
(Released H1/2018)



FAN	PWIN	MXGF12	MXGF12
	CLKIO	OPCX	OPCX
	PWIN	MPHGF01/2 /MXGF12	MPHGF01/2 /MXGF12

- 300Gbps full duplex switching fabric
- 4 service slots:
  - 2 slots of 1 x 100GE service card or 2x100GE service card
  - 4 slots of 12x10GE/GE service card
- 3U, 19”/ETSI/ANSI rack mountable
- 10GE/GE and 1x100GE Service card compatible with UAR500/TN705E
- SDN SOO-Network Controlled



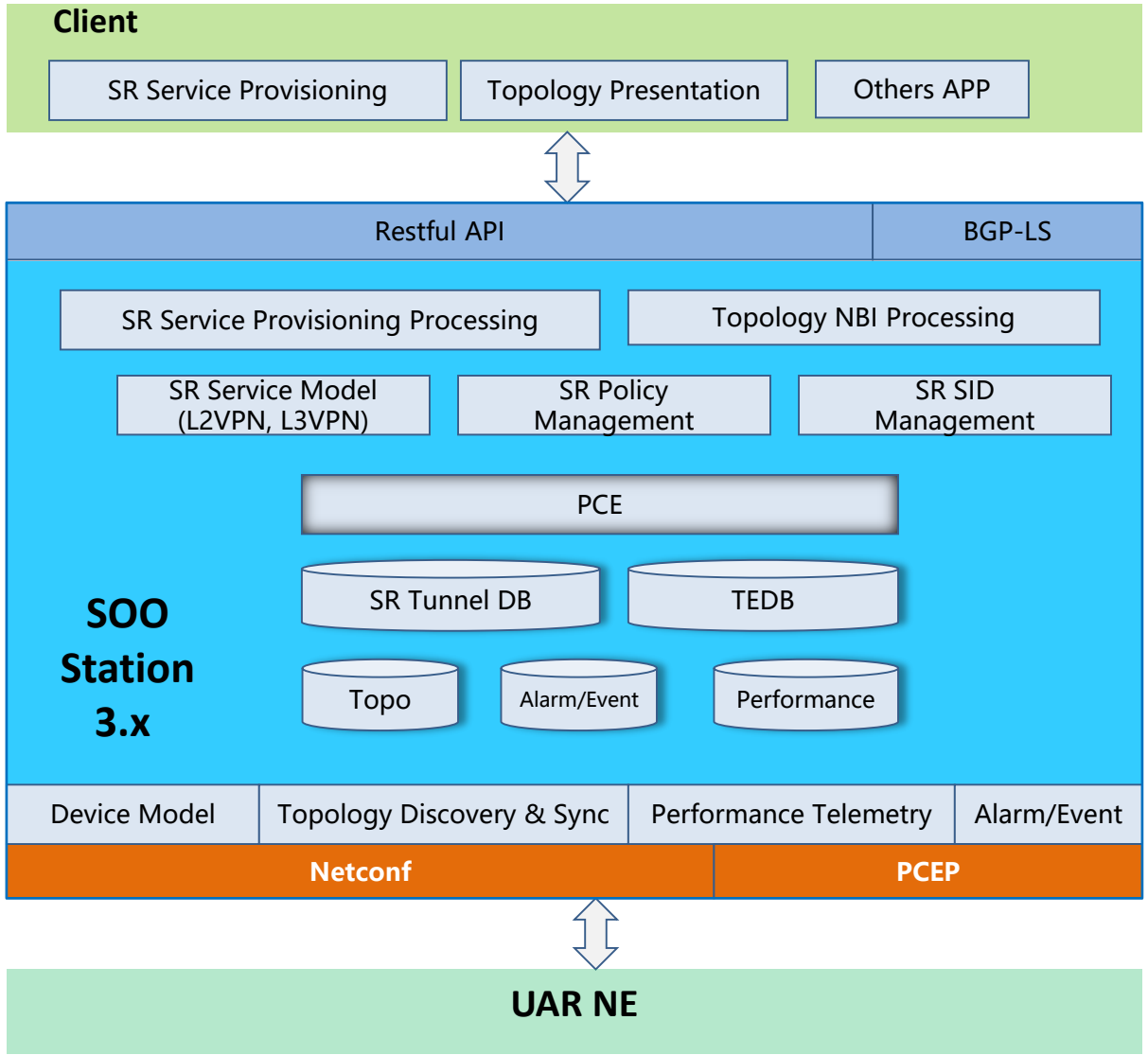
OPCX



MPHGF02

(2x100GE CFP2)

SRv6 Controller and Netconf/YANG

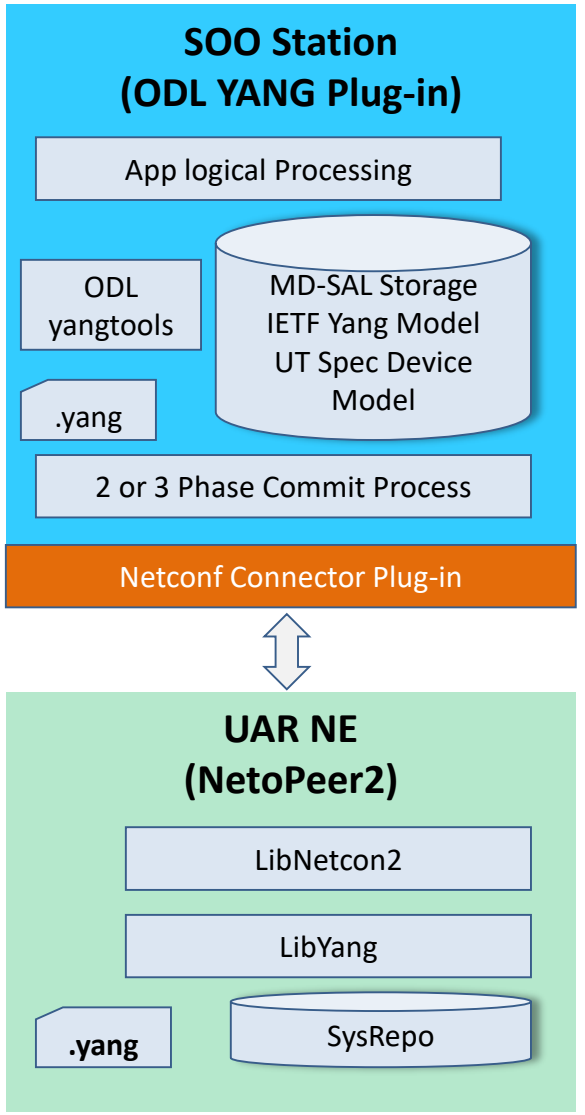


Controller

- SID Mgmt
- PCE
- SR Policy
- ODL (Carbon)
- KVM
- Redhat Enterprise Linux
- Stratus EverRun FT
- HA/DR

Netconf/YANG

- Compliant w IEFT latest standard



SkyFlux UAR500 SRv6 1st Release for PoC

The European Advanced Networking Test Center

MPLS + SDN + NFV World Congress Public Multi-Vendor Interoperability Test 2018



Participate vendors (2018):

Device:

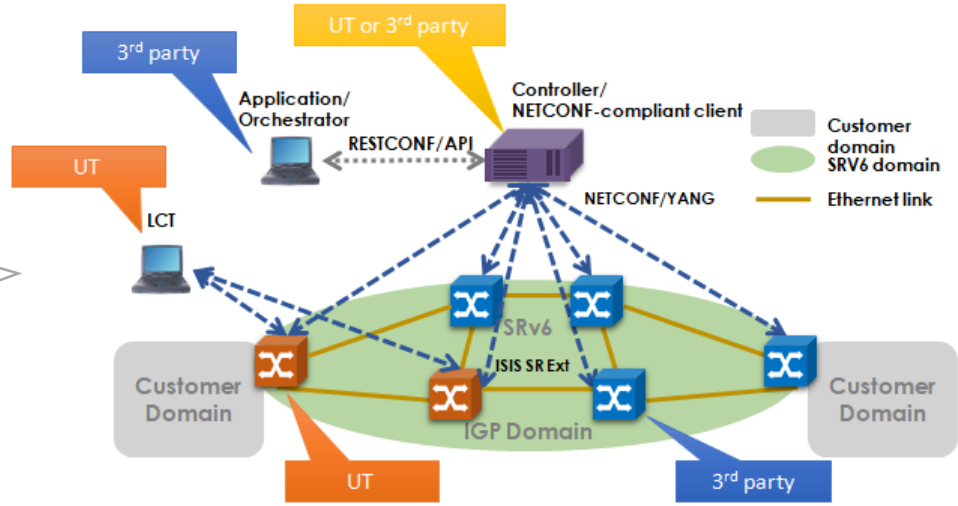
- Cisco, ECI, Ericsson, Huawei, Ixia, Nokia, Spirent, UTS

Controller :

- Cisco/Tail-f, ADVA, Arista, BISDN, Huawei, IP Infusion, Spirent, ZTE, UTS

Pass IOP tests of:

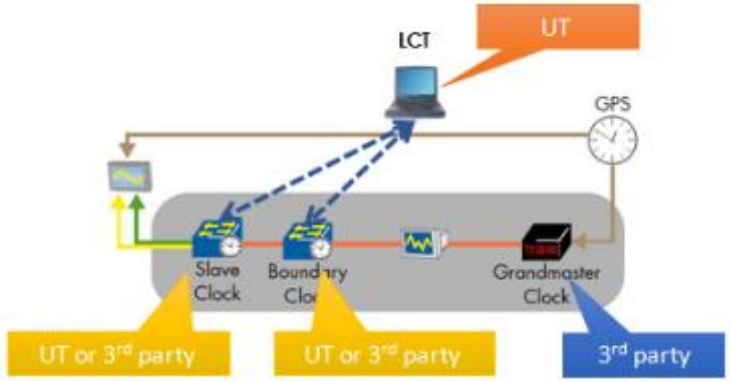
- SRv6 Service
- Netconf/YANG
- Synchronization



March 5-16:
Hot Staging
EANTC, Berlin

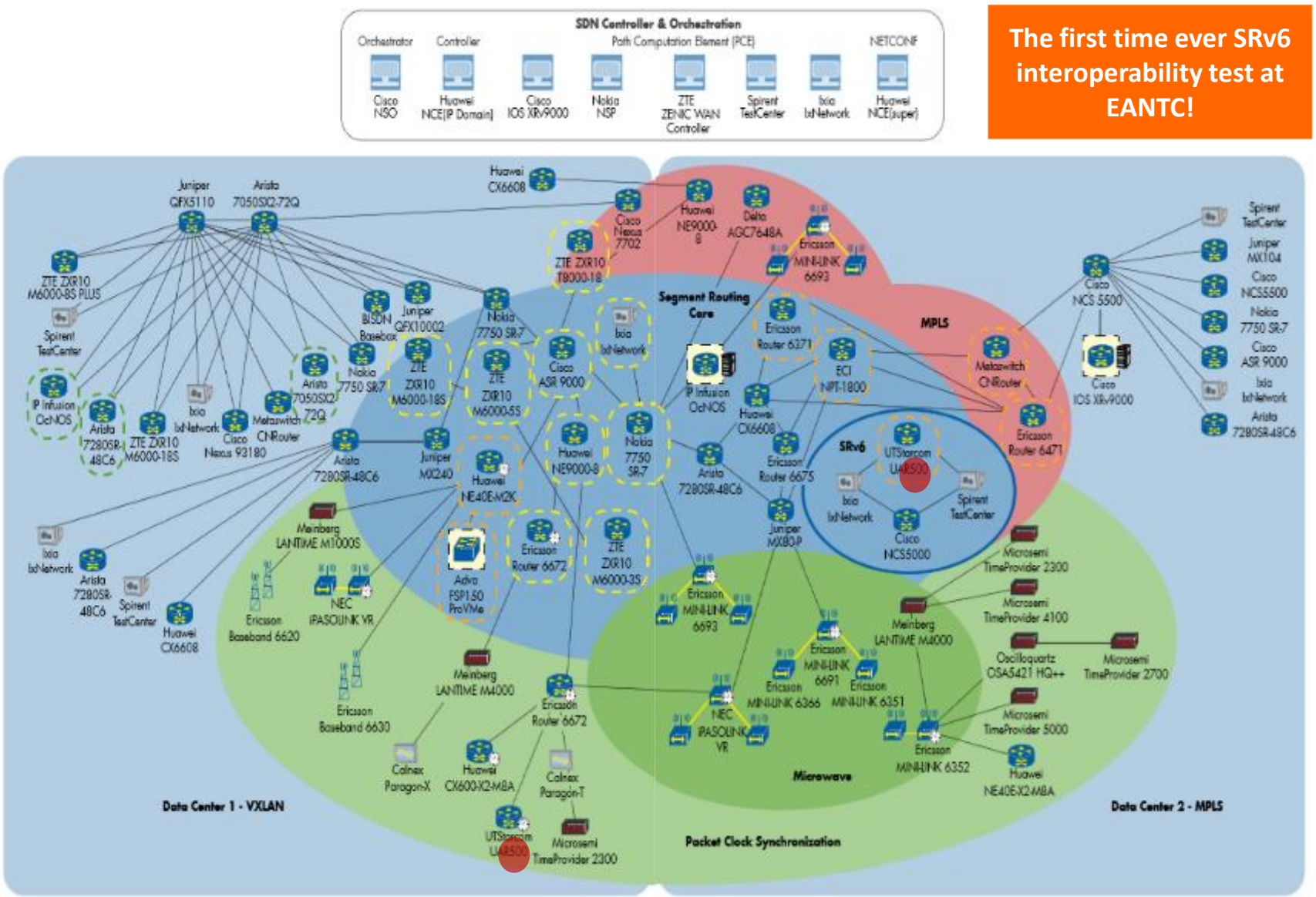
April 9:
Setup, *Paris*

April 10-13:
Public Showcase, *Paris*



Feb. 2018 → **March. 2018** → **Apr. 2018**

EANTC 2018 – interoperability testing in Berlin



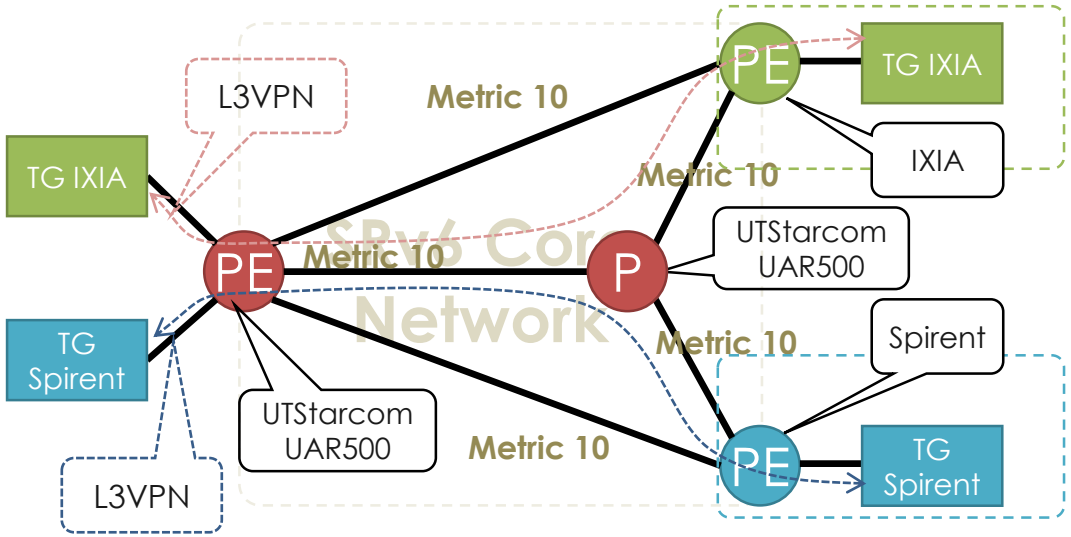
The first time ever SRv6 interoperability test at EANTC!

UTS SkyFlux UAR500 performs good in IOP tests:

- **IPv6 segment routing (SRv6)**
  - SRv6 Data Plane
  - IPv6 segment routing (SRv6) – L3VPN over SRv6 Core
  - TI-LFA in SRv6 Network
- **SDN controller with NETCONF/ YANG models**
  - L3VPN service setup by SDN Controller using NETCONF/YANG
  - L2VPN service setup by SDN Controller using NETCONF/YANG
- **100GE PTP Synchronization tests**
  - 100GE Phase/Time Synchronization with Source Failover

EANTC 2018 – Live showcase in Paris

- MPLS+SDN+NFV WORLD CONGRES PARIS 2018
  - Conference, exhibition and live showcase
  - Paris Marriott Rive Gauche, April 10-13
  - UTStarcom, Ixia, Spirent ran a live demo: **L3VPN over SRv6 Core**

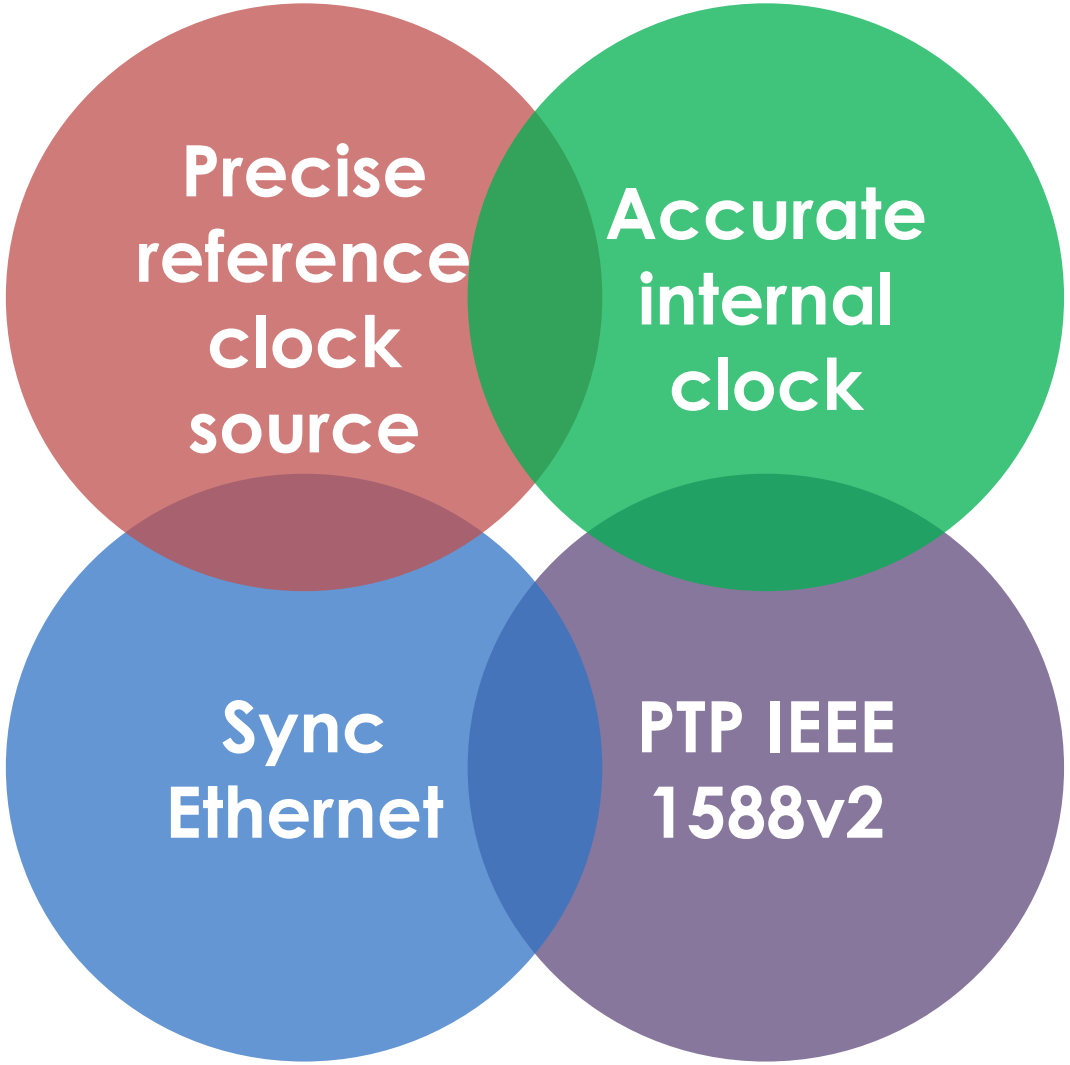




Timing Synchronization -- “SyncRing”

SyncRing: Synchronization Solution

Atomic PRTC and/or GPS feeding a Grand Master

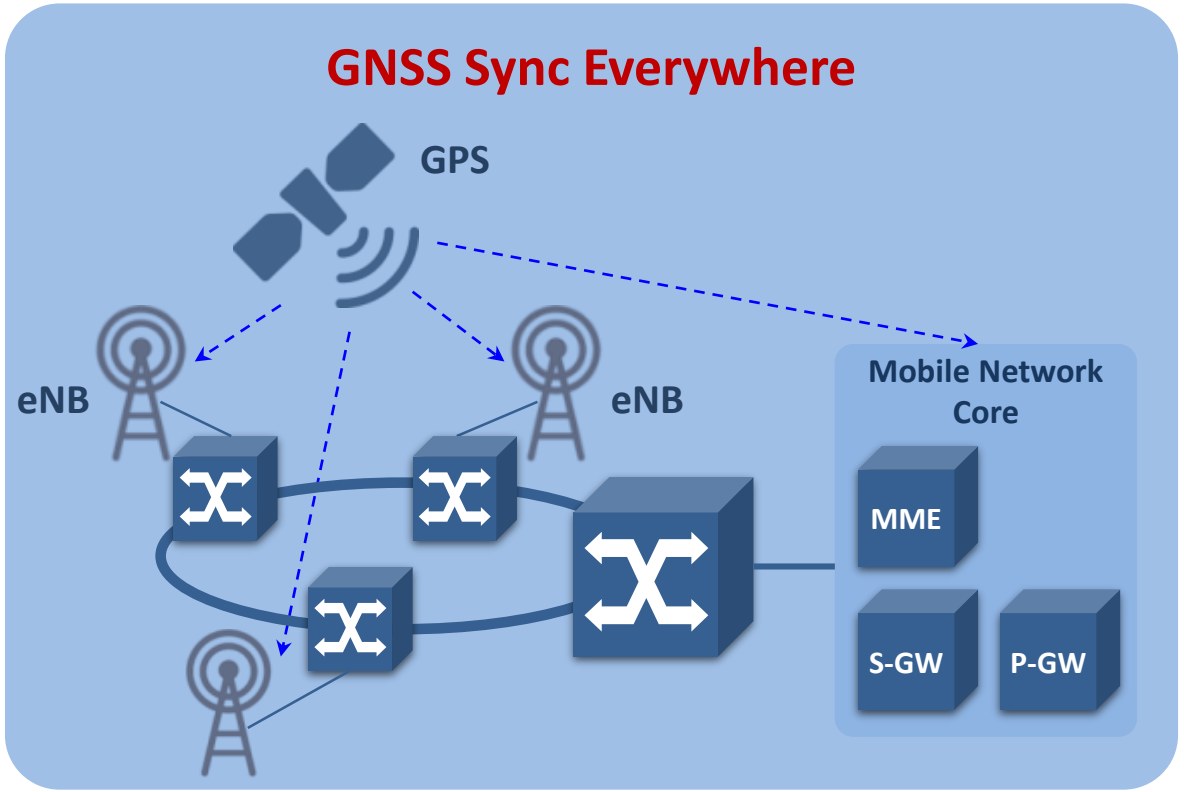


Accurate internal clock in network equipment for reliable holdover operation

Accurate network-based frequency synchronization

Precise network-based frequency/ phase/ time synchronization

Traditional synchronization based on GNSS



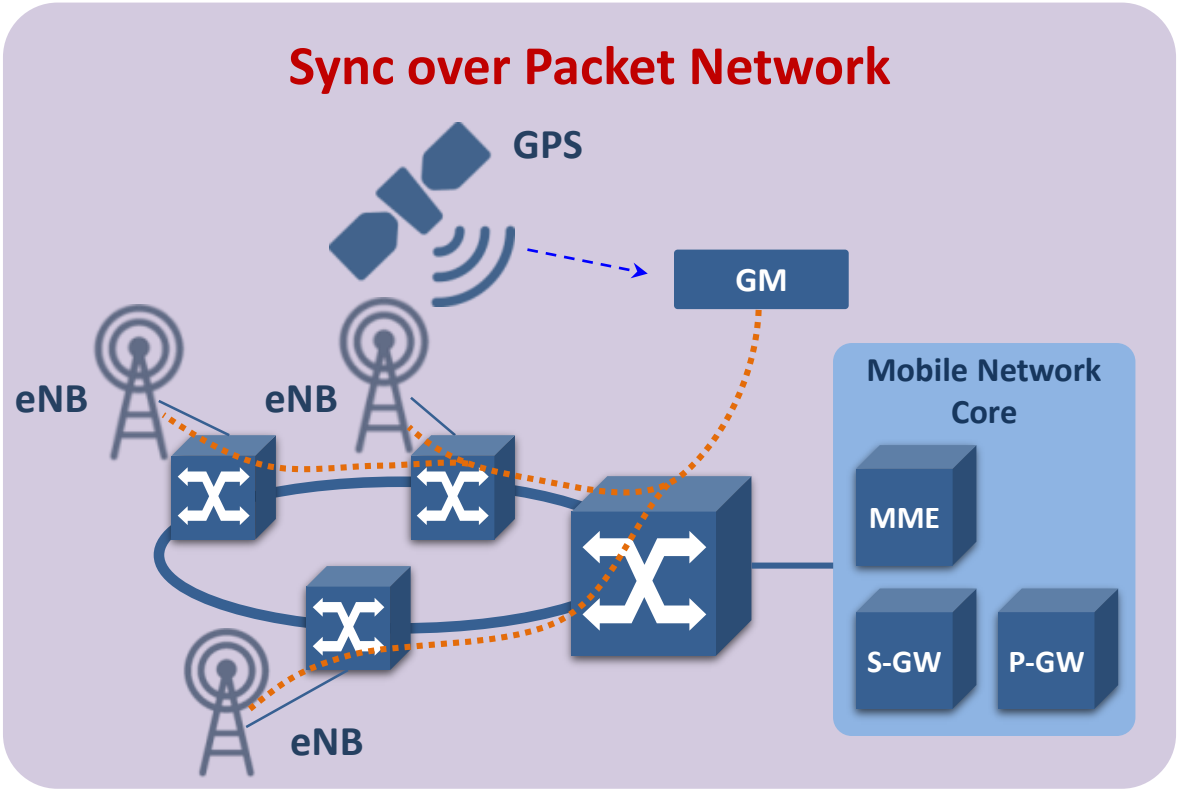
- Each cell site receives clock from GNSS - independently
- Accurate frequency and phase synchronization

BUT

- High cost of installation and maintenance
- No centralized management
- No protection, longer time to restore
- GNSS installation and signal reception in dense urban environment or indoors can be problematic
- Availability issues – antenna/cable vulnerabilities, lack of redundancy, GNSS jamming, GNSS spoofing

Centralized Timing Architecture

- Each eNodeB receives clock via packet data network
- Accurate frequency and phase/time synchronization between eNodeB and an external reference source
- Can be combined with backhaul network – low additional cost on sync
- Centralized management for all components



SyncE

- Frequency sync
- Physical layer
- All network nodes must support SyncE
- G.8261/ G.8262/ G.8264

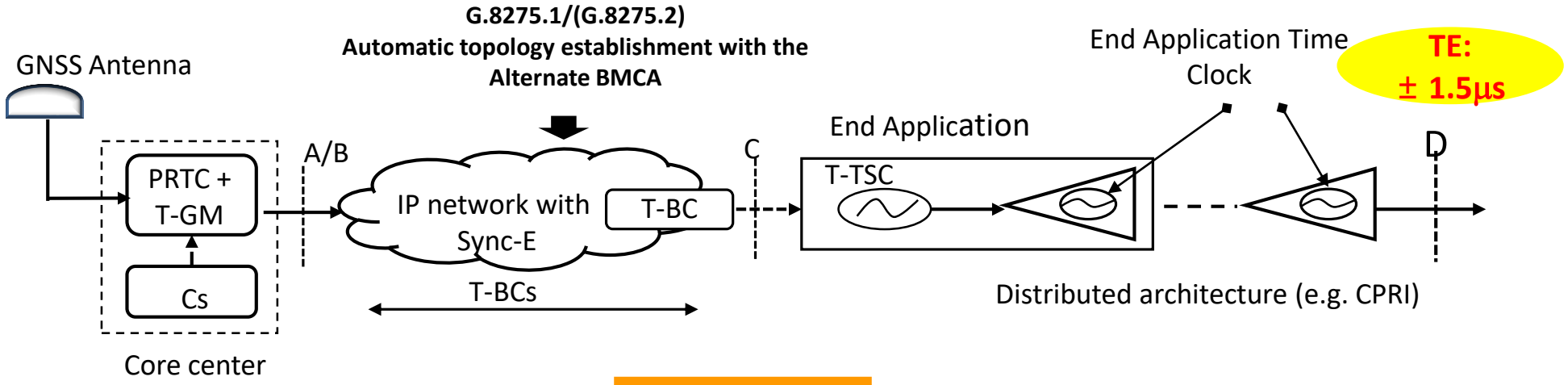
PTP / IEEE1588v2

- Frequency and time sync
- L2/L3
- Full or partial network support
- Profiles G.8275.1, G.8275.2; T-GM, T-BC, T-TSC

Evolution for PTP Sync Network Architecture

AS IS

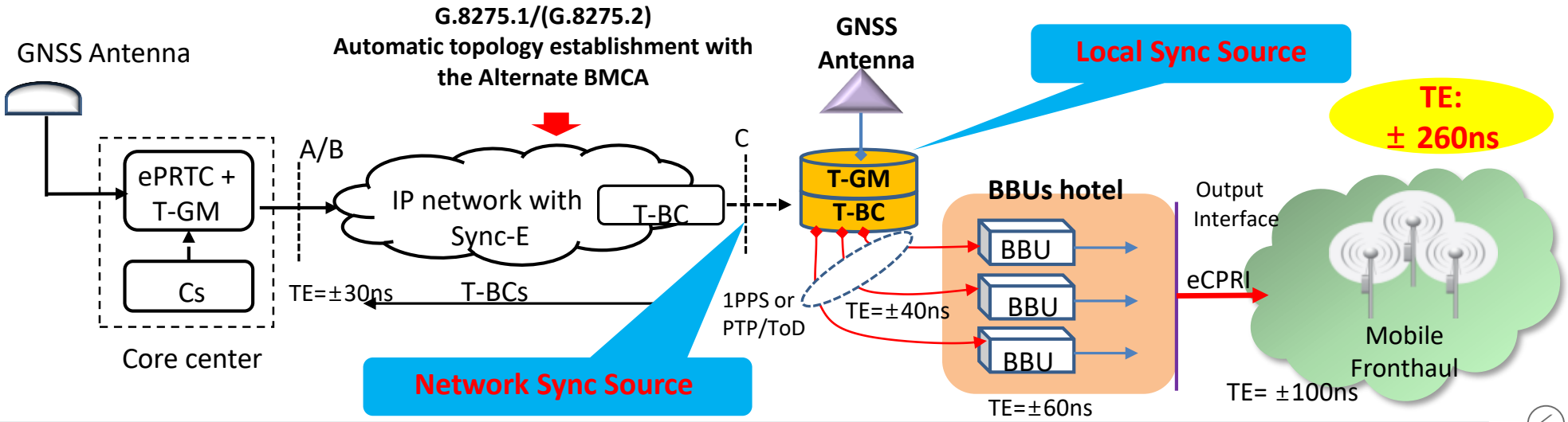
Centralized Timing Architecture



Evolution

Future

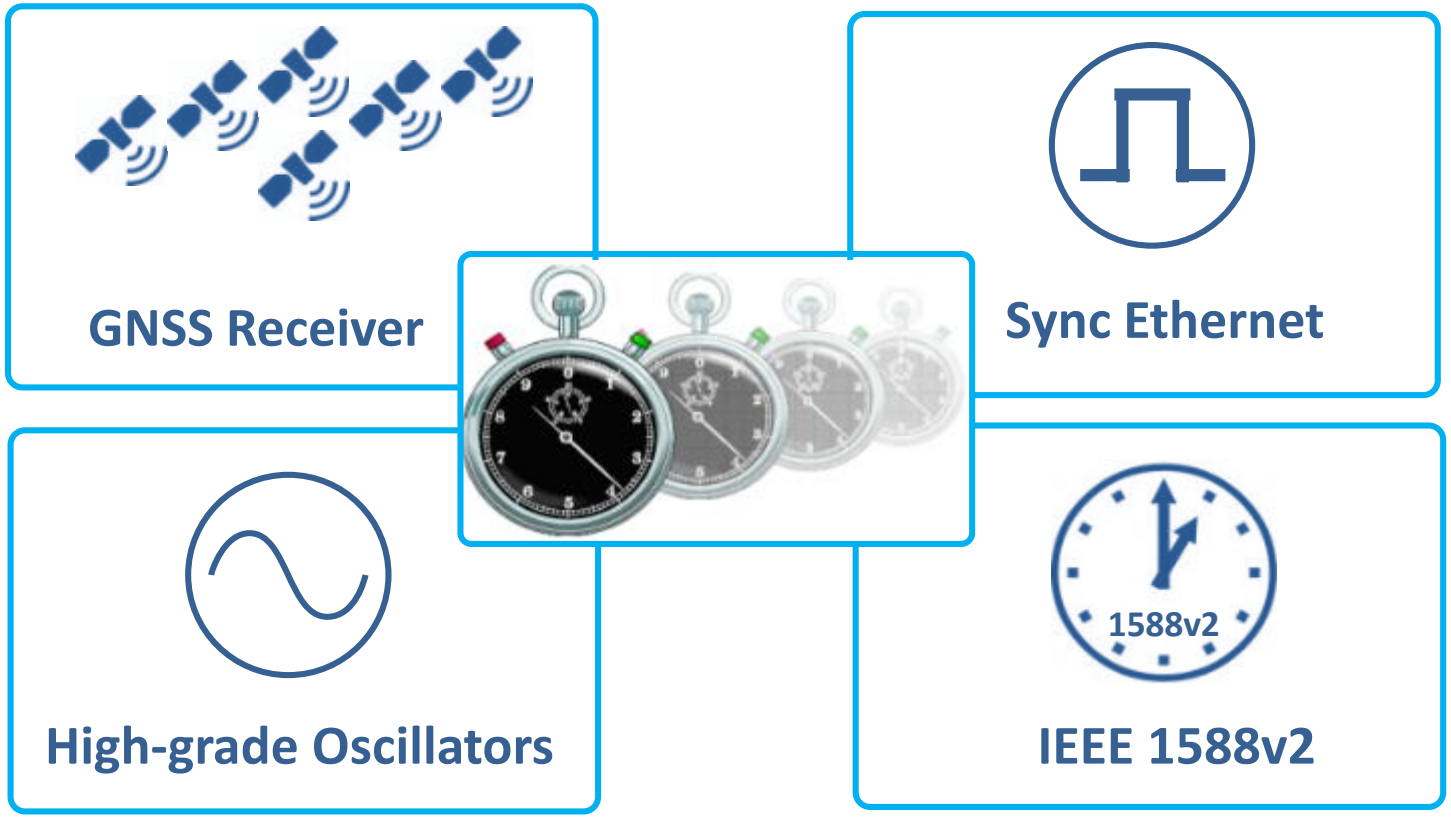
Protected Timing Architecture w/ local sync source

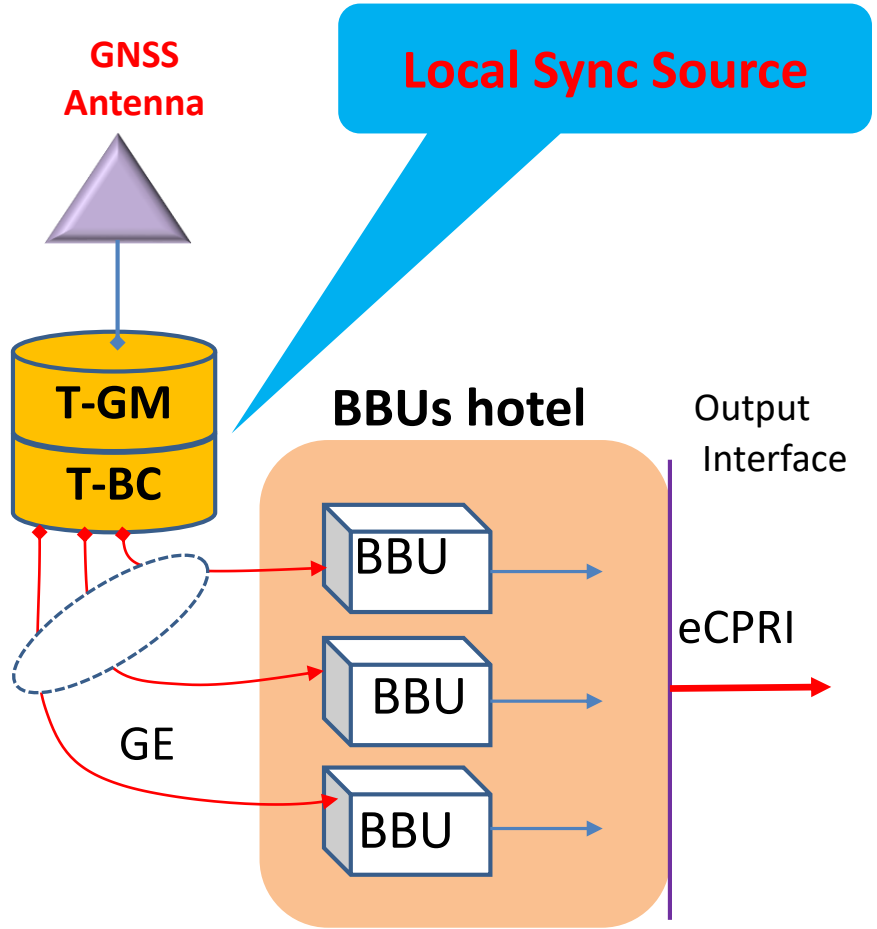


Distributed Sync Scenario

High performance local sync source

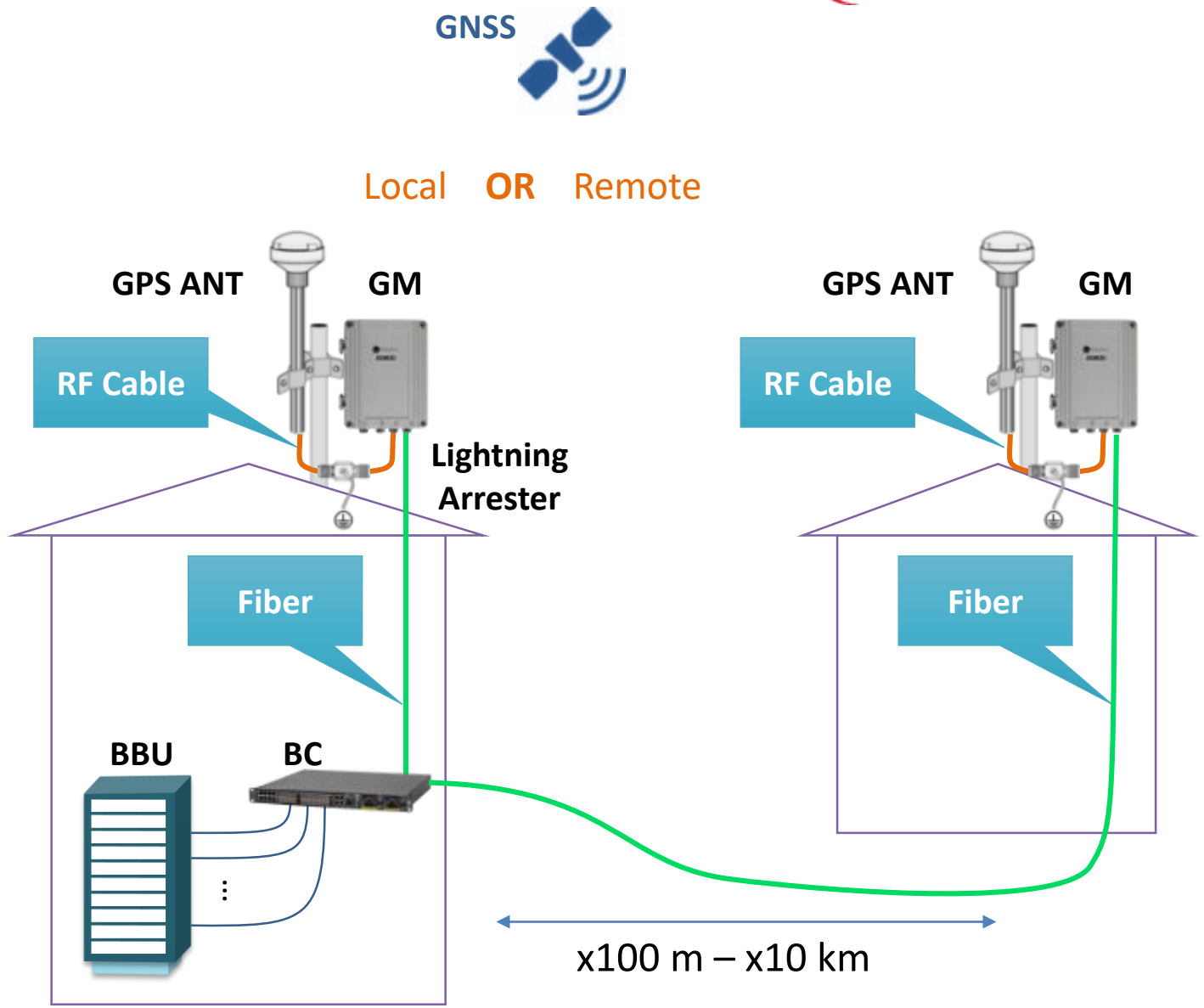
- T-GM receive GNSS signal and convert to SyncE +PTP
- T-BC duplicate to multiple 1588v2/PTP feed to BBUs
- T-GM+T-BC with integrated or separated design





Outdoor Design Grand Master

- Designed for distributed sync scenario
- Resolves issues of RF cable
- Short RF cable, predictable performance, easy delay compensation
- Easier site acquisition
- Great flexibility in deployment options
- Reduced risks of damaging indoor equipment due to a lightning strike



Case Study: Commercial Deployment

- Deployment of distributed sync scenario for LTE mobile network
- One of largest mobile network operators(MNO) in Japan
- Hundreds of sets GM and BC to serve thousands of BBIs
- Enables instant implementation of precise clock/time solution
- Deployment flexibility due to separate BC & outdoor GM
- Centralized network management system (NMS)
- Customer satisfied with clock accuracy and operation experience
- Early adopter



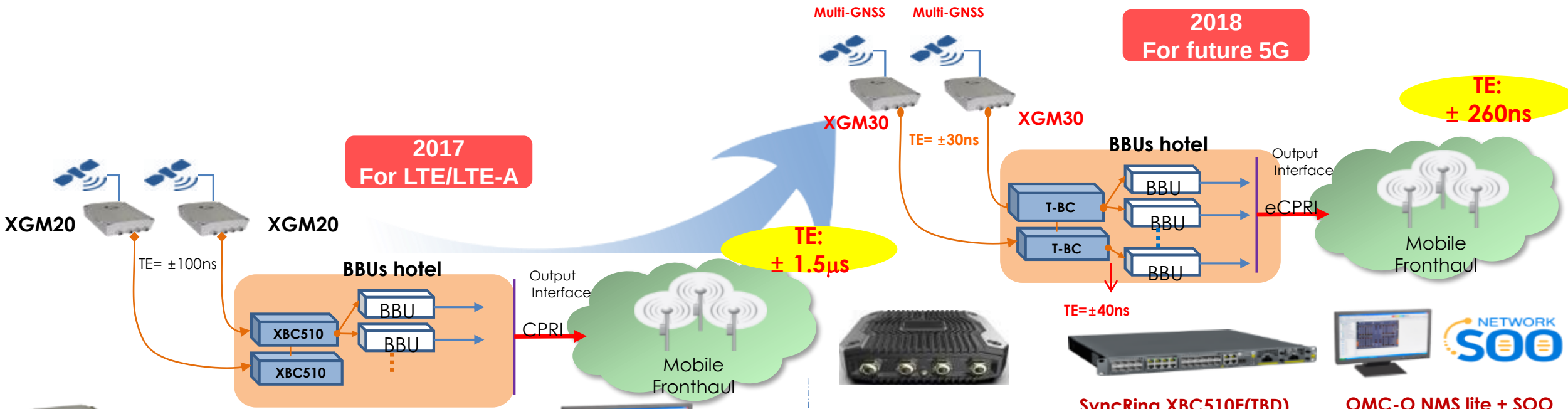








SyncRing Products Product Portfolio



SyncRing XGM20

- Grand Master
- PRTC T-GM ± **100ns**
- Single GNSS timing source
- OCXO HQ Oscillator
- IEEE 1588v2 + SyncE
- Outdoor
- Zero-configuration installation

SyncRing XBC510

- Boundary Clock
- T-BC Class A ± **100ns**
- IEEE 1588v2 + SyncE
- Access/Aggregation Device
- 64Gbps full duplex switching fabric
- 10GE(SFP+), GE(SFP)

Netman 6000 OMC-O

- Centralized network management
- Distributed architecture
- Geo-redundancy
- Up to 20K reference nodes per management segment
- Intuitive GUI for easy element, network and service management

SyncRing XGM30

- Grand Master
- PRTC-B T-GM ± **30ns**
- Multi -GNSS timing source
- OCXO HQ Oscillator
- IEEE 1588v2 + SyncE
- Outdoor
- Zero-configuration installation

SyncRing XBC510E(TBD)

- Boundary Clock
- T-BC Class C ± **10ns**
- IEEE 1588v2 + SyncE
- Access/Aggregation Device
- 64Gbps full duplex switching fabric
- BiDi optical transceiver 10GE(SFP+), GE(SFP)

OMC-O NMS lite + SOO station SDN controller

- Network management lite version for NE device management
- SDN controller for topology, alarm, PM, service management & automation

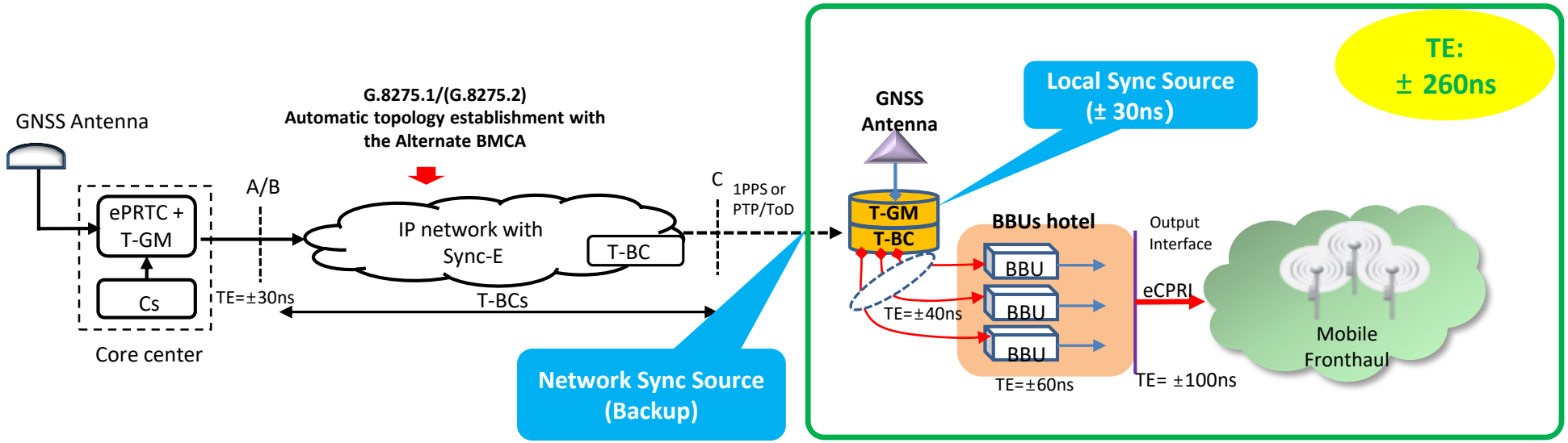
SyncRing XGM30 Product Overview



- Designed for **LTE-A (TE Budget: ± 1.5μs)** and **5G (TE Budget: ± 260ns)** mobile application
- **Grand Master Clock**, together with Boundary Clock XBC510, applied in mobile Backhaul and Mid-haul transport network
- **Multi-GNSS, multi-frequency support**, advanced clock algorithm to ensure the **high timing accuracy (± 30ns)**
- **Most up-to-date PTP and SyncE standard support**
- **Enhanced operation, administration and monitoring function**

5G

Protected Timing Architecture w/ local sync source



Design for 5G Synchronization

XGM30 Target :

Lock= **±30ns**

Holdover= **± 1.5us/24hours**

Item	PRTC T-GM	PRTC-B T-GM	ePRTC-A T-GM
ITU-T	G.8272	G.8272	G.8272.1
Time Error	TE=±100ns	TE=±40ns	TE=±30ns
Holdover	Not applicable (1.5us/4hours)	Not applicable	± 100ns over 14 days



Concurrent GNSS Receiver

- Support GPS L1C/A,GLONASS L1OF, BDS B1,Galileo E1B/C, **QZSS L1SAIF**
- Support up to 4 systems concurrently
- Multi-system multi-frequency, up to 72 channels
- **Time accuracy:** ±**20ns**



Superhigh Quality OCXO

- Super-high Double Oven Controlled Crystal Oscillator
- Precision Frequency Stabilities
- Accuracy PPS :±20 ns
- Accuracy of time is less than ± 5μs after 1 day free run



Wide band GNSS Antenna

- Frequency band：1559-1610.55MHz
- Support GPSL1C/A,GLONASS L1OF, BDS B1,Galileo E1B/C, **QZSS L1SAIF**
- High GNSS signal Gain: up to 38 ± 2 dBi
- Excellent out-band suppress ability: (fL-70)MHz > 70dB , (fH+70)MHz > 55dB

Software Defined Network (SDN)
--“SOO Network”

“SOO Network”– UTS SDN Product Family

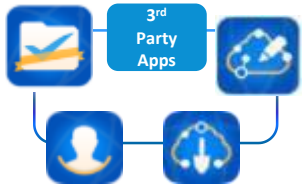
“SOO(Software Defined Open Packet Optical) Network”

“SOO Director”: Service Orchestration

- Life-cycle E2E service management
- Advanced services L2/3VPN, BoD

“SOO Analyst”: Comprehensive Network Analytics

- Automated collection and analysis of network data
- Network deep learning engine
- Network behavior simulations and forecast
- Dynamic continuous network optimization



“SOO APP”: Applications

- Apps for customer management, network design, deployment, service ordering and management etc.



“SOO Station”: SDN Controller

- Orchestration of abstracted underlying network resources
- Automated service provisioning and network operation
- Path computation and management



“SOO Device”: SDN-ized Network Device

- Controlled by SOO station
- MPLS-TP PTN/ OpenFlow SPTN
- Segment Routing v6 (SRv6) SkyFlux
- Open& standard interface for 3rd party systems integration

Open& standard interfaces for 3rd party systems integration

“SOO Network” Architecture

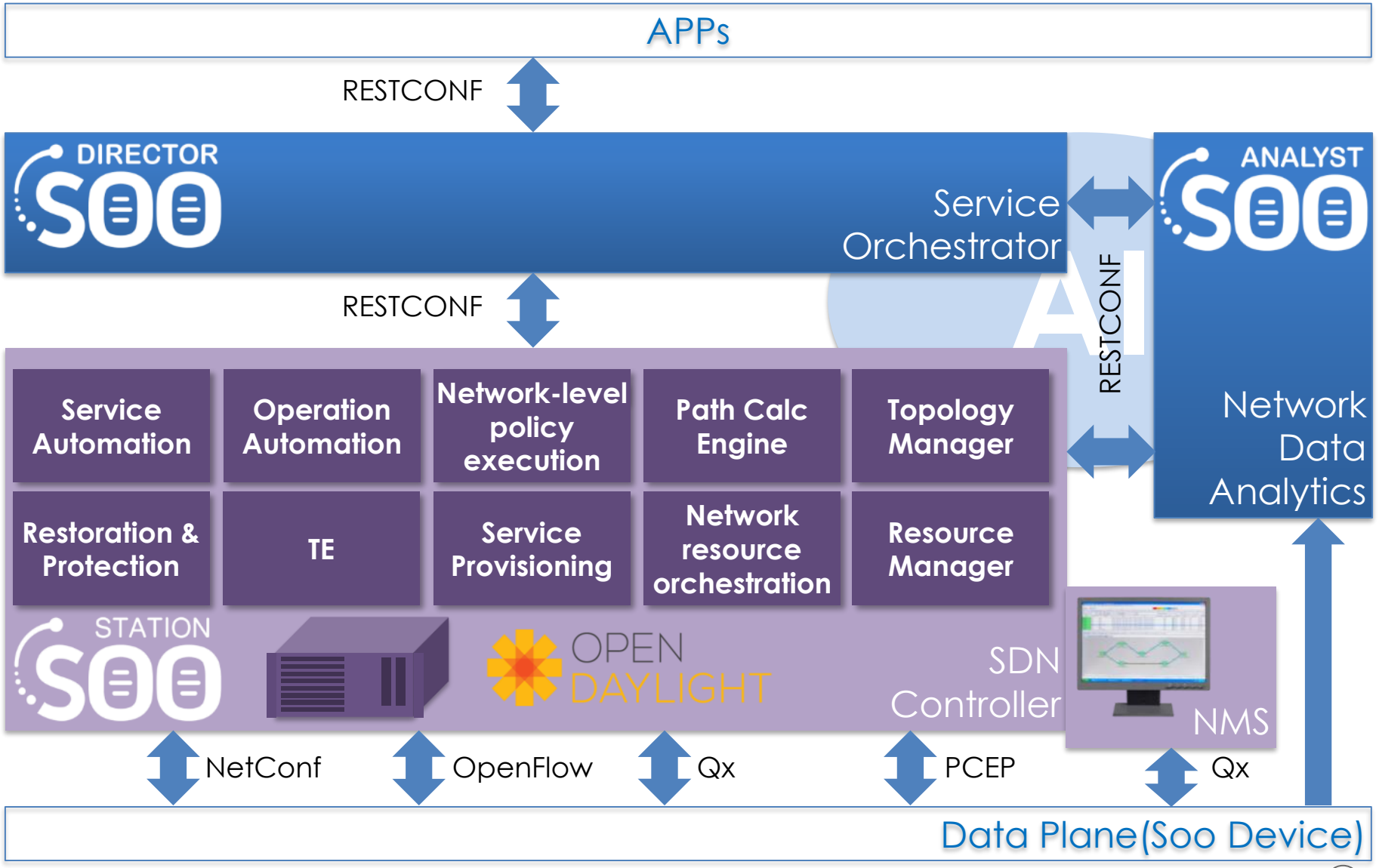
Open API for vertical integration of applications

Centralized **Service Orchestrator** for E2E service orchestration over single- or multi-segment network

Centralized **SDN Controller** for automation and orchestration of underlay network resources

ODL Open source-based solution

SDN-enabled network. L2/L3VPN. EVPN. Bandwidth-on-Demand. MPLS-TP/SRv6/OpenFlow etc.



From NMS to IMCP

Integrated Management and Control Platform (IMCP)

Network operator routines

Network planning



Network deployment



Network operation



Service handling



CONTROL PLANE AND APP (SDN/NFV Controller):	MANAGEMENT PLANE (NMS):
• Automated Network planning (IPv6 address scheme, label*, topology*, BW*, etc.) • Zero configuration: plug-and-play NE installation	• Automated Network planning (topology*, BW*, etc.)
• Auto topology discovery • Auto topology change discovery	• Element/card auto discovery • Auto NE configuration • Auto NE configuration backup • Auto topology construction
• Auto restoration protection • Network big data analytics* • Service orchestration!	• Auto topology re-construction • Element/card auto discovery • Real-time OAM-based monitoring • OAM-based alarm handling • Line/ring protection configuration
• Automatic ordering • Automatic E2E provisioning • Service on Demand (BoD etc.) • L2/L3 VPN	• Wizard-based E2E service provisioning • Routing auto configuration • Bandwidth Auto Calculation • PW/LSP Auto BW adjustment for CE • Batch Provisioning

* In development. Subject to change

SDN-based Intelligent Features

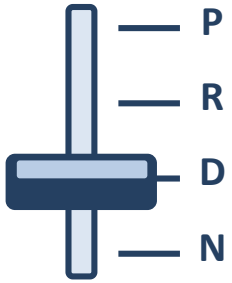
Service orchestration



Network on Demand
- BoD:
  - Schedule/Time-based
  - Dynamic (APP/API driven)
- Dynamic QoS
- Policy*
- SLA*



Automation:
- PCE
- Auto E2E service ordering and provisioning
- Zero-touch installation
- Auto restoration protection
- Network data analytics

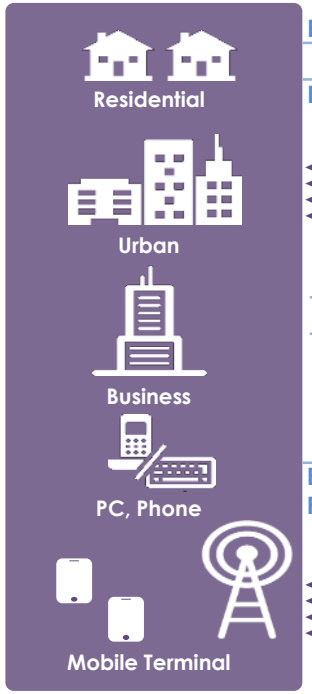


Automation

L2/L3 VPN/SR

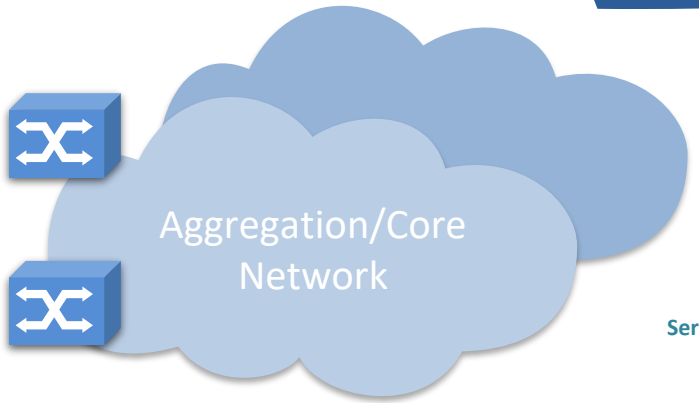


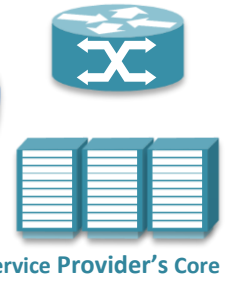
E2E service provisioning across multiple network segments



Customer Edge / Access

Network Edge



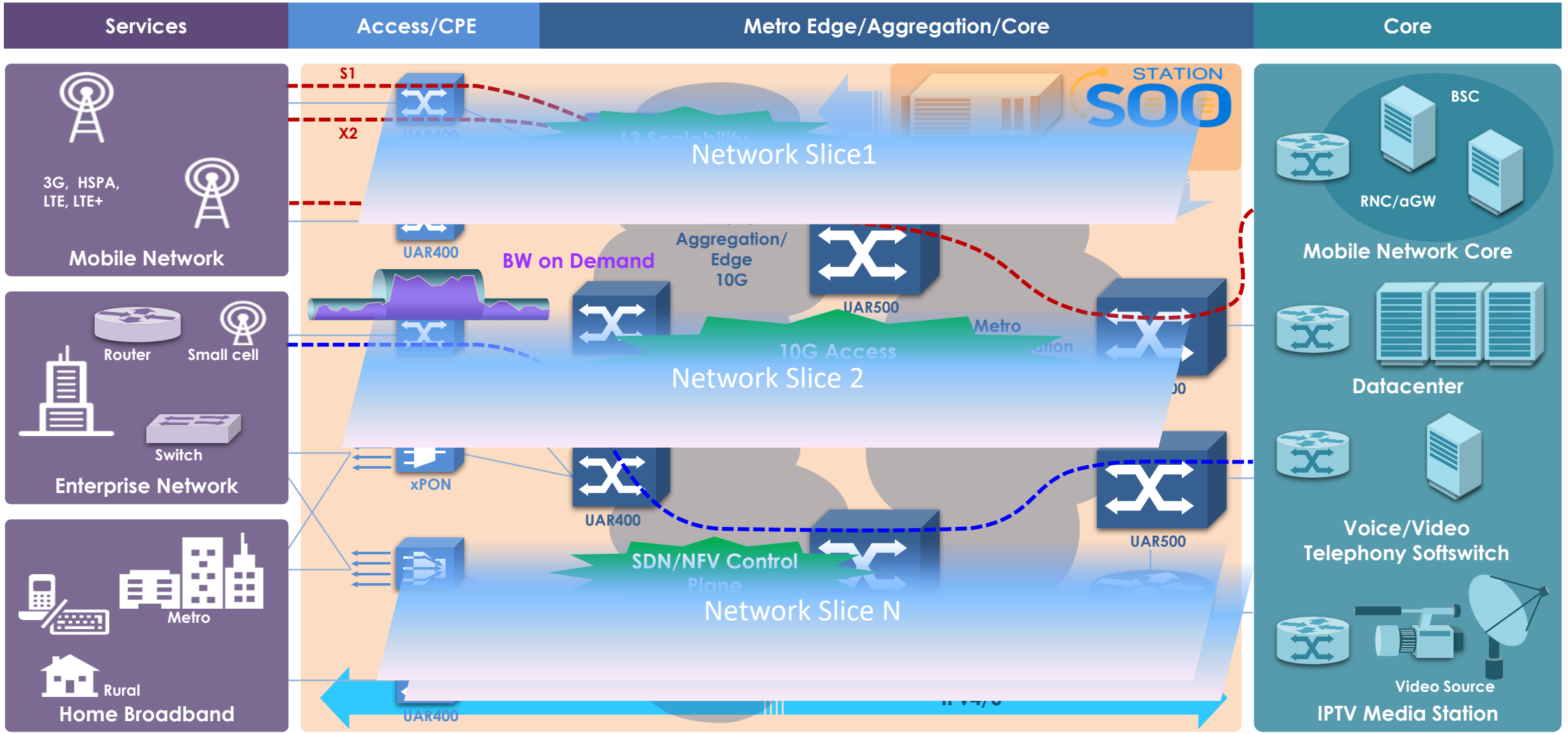


Based on **Open source software platform**



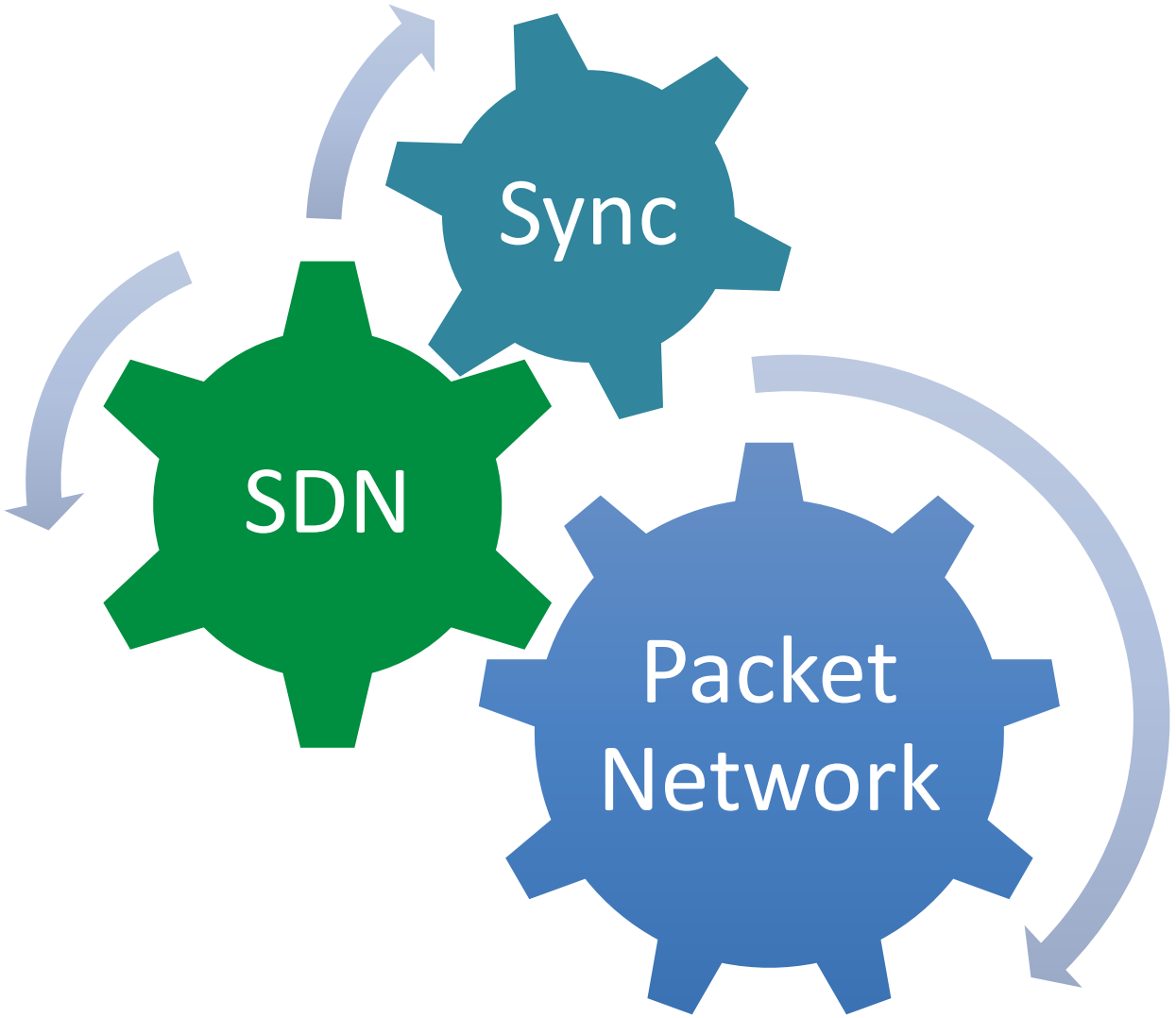
API
- Towards user: for service self-ordering and self-management. Portal and app-based.
- Towards network: for network resources and services orchestration

Network Slicing for Future Application



Metro Network Ecosystem

for sync support and network evolution



Metro network: Packet Network

- Based on MPLS-TP/Carrier Ethernet/SR
- GE/XGE/100GE support, great scalability
- Sub-50ms resiliency, OAM
- Embedded PTP & SyncE support

Distributed Synchronization: SyncRing

- Very high accuracy for 4/5G networks
- PTP & SyncE
- Outdoor GM +T-BC
- Flexible deployment

Software Defined Network: SOO Network

- Optimized for metro networks
- Service and operation automation
- Dynamic services


UTSTARCOM®
Thank you !