GETTING NETWORK INFRASTRUCTURE READY FOR 5G

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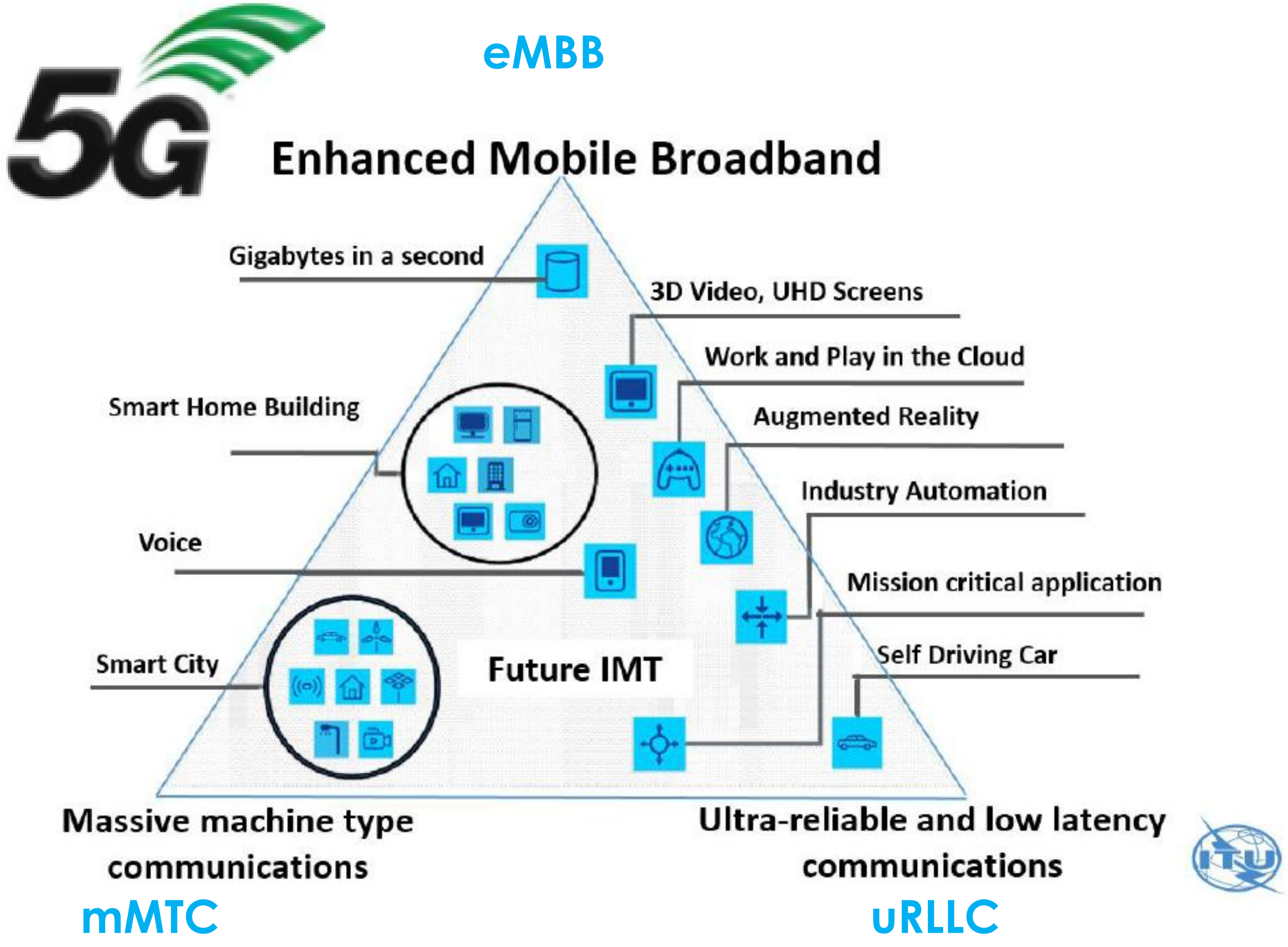
UTStarcom – a global telecom infrastructure provider

- 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

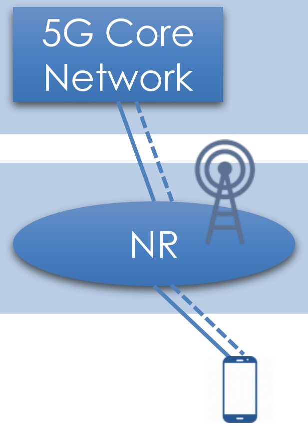
Focus on delivering innovative cutting-edge, packet optical transport, synchronization, wireless and fixed broadband access products and solutions coupled with carrier grade Software Defined Networking (SDN) platform

5G NETWORK



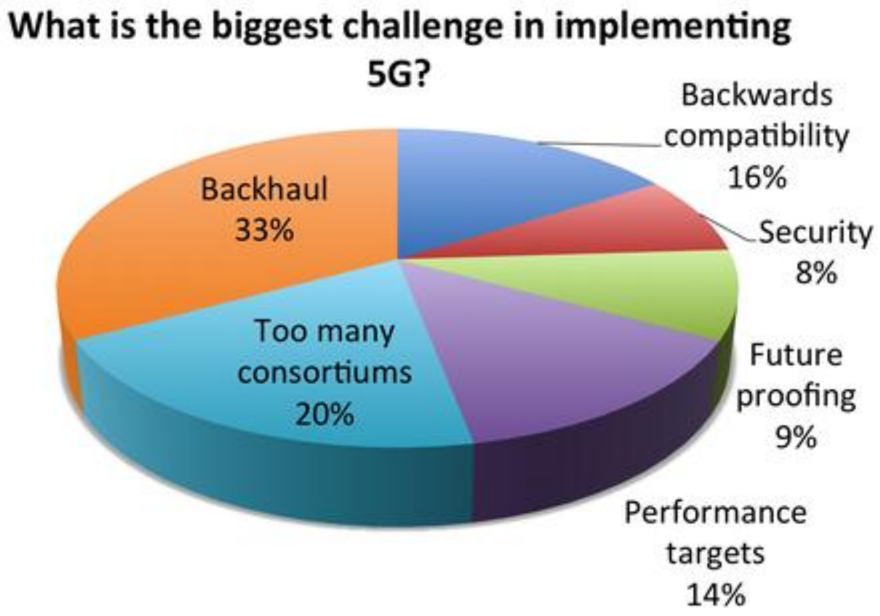
- ✓ **High bandwidth**: 10Gbit/s per user
- ✓ **Low latency**: 4ms for eMBB, 1ms for URLLC
- ✓ **Density**: 1 000 000 devices per km^2
- ✓ **Flexible connection**: >10K nodes Full-Mesh data connection
- ✓ **High spectral efficiency**: up to 30bit/s/Hz (downlink)
- ✓ **Mobility**: stationary to <500km/h
- ✓ **Energy efficiency**

5G REQUIRES NEW TRANSPORT NETWORK



✓**New Core** – Service-based architecture, C/U separation, Network slicing

✓**New Radio** – new frequencies, new waveforms, massive MIMO, CA, CoMP



Lightreading Poll: Backhaul Presents 5G's Biggest Challenge

✓**New Transport** – 5G needs a new network infrastructure

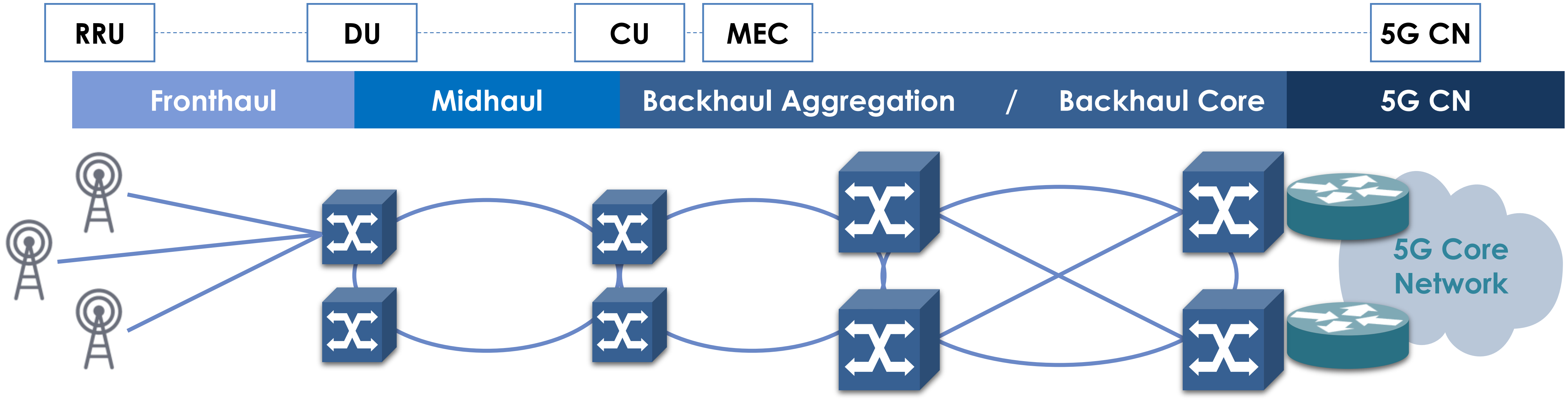
5G REQUIREMENTS TO INFRASTRUCTURE

UTSTARCOM®

Transport network for 5G

- Architecture: L3 Access to Core, high density, DCI-like
- Scalability, flexibility, service agility
- Bandwidth: Access: 10G/100G, Aggregation/Core: 100G/200G/400G
- Latency: Fronthaul <100μs, DU-CU 1.5…10ms
- High synchronization accuracy: ±10ns positioning, ±130ns CA, CoMP, ±390ns…±1.5μs basic system
- Network slicing: network-as-a-service, optimized per application/use case, service isolation
- Carrier-grade infrastructure: sub-50ms protection, end-to-end OAM, performance monitoring, management

5G TRANSPORT NW IN A NUTSHELL: FH/MH/BH



Fronthaul

- ✓ Ethernet-based, eCPRI, NGFI
- ✓ Star or ring
- ✓ Required BW depends on functional split, num. of antennas
- ✓ Up to 20km
- ✓ Low latency <100us

Midhaul

- ✓ L2/L3
- ✓ Ring or mesh P-to-MP or MP-to-MP
- ✓ Statistical multiplexing possible
- ✓ 20-40km
- ✓ Normal latency <1ms

Backhaul

- ✓ L2/L3
- ✓ Mesh MP-to-MP
- ✓ Statistical multiplexing possible
- ✓ Access <20km
  Aggregation 10-80km
  Core 20-300km
- ✓ Latency <10ms

TODAY'S NETWORKS

Typical today's network: Many independent MPLS domains

- Long provisioning cycles
- No E2E Traffic Engineering
- Complex with state in the network
- No E2E OAM
- Poor visibility
- Complex troubleshooting

IP/MPLS

- Distributed control plane
- Weak or no management plane
- Configure via CLI needs more qualified engineers
- Dynamic routing and signaling
- Unpredictable latency and jitter
- Weak OAM
- Layer 2/2.5/3
- Higher CAPEX/OPEX
- No sync support

MPLS-TP

- No control plane
- Strong centralized management plane
- Static provisioning via NMS
- Deterministic performance (delay, jitter)
- Supports transport-like OAM
- Simple installation, operation and troubleshooting
- Layer 1/2/2.5
- Simpler and cheaper HW
- Sync E and IEEE 1588v2 support

Better for backhaul/transport, but still …

- Mostly manual operation, network design, service provisioning, and maintenance
- Lack of agility
- Lack of automation

FUTURE BACKHAUL INFRASTRUCTURE

SDN	Segment Routing
L3VPN, EVPN	VxLAN
IPv6	Carrier Ethernet
PTP/ 1588v2	Sync Ethernet
Ethernet	FlexE
100/200/ 400GE	WDM

SDN

Agility, intelligence, automation

Segment Routing

Simplicity and scalability

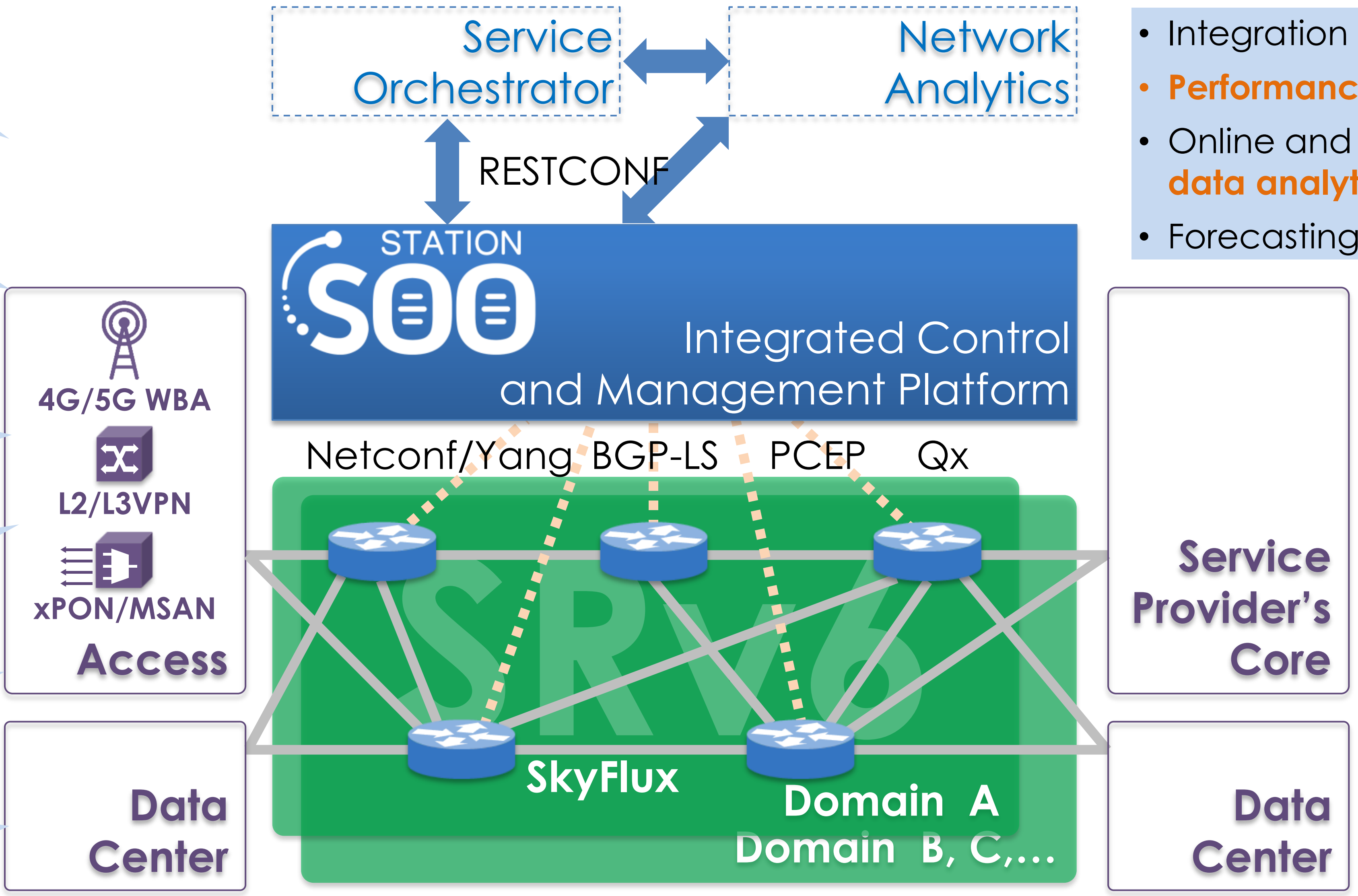
+

Timing over Packet

Accurate frequency, phase, time synchronization

AGILITY, INTELLIGENCE, AUTOMATION: SDN

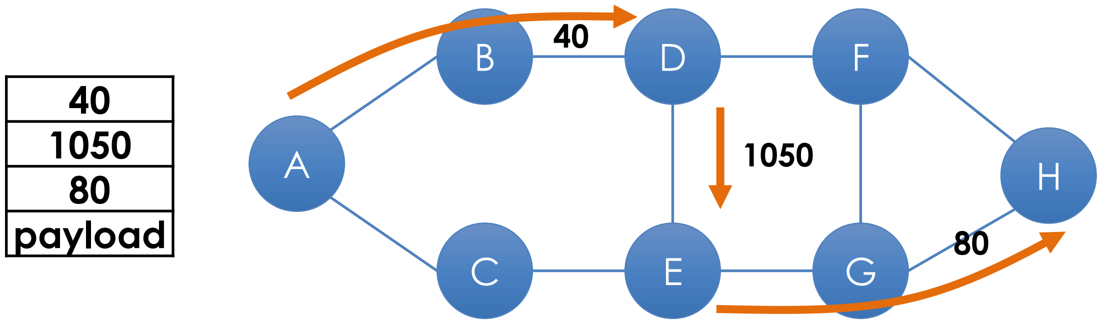
- **Global network view**
- **Separation** of control plane and data plane
- **Automation** of operation and service provisioning
- Intelligent **path calculation**
- **Dynamic** service management, BoD etc.
- **Open APIs** for vertical integration, **YANG models**



- Integration with **AI/ML**
- **Performance monitoring**
- Online and historical **data analytics**
- Forecasting, Simulations

SIMPLICITY AND SCALABILITY: SR

- **Segment Routing** – **source routing** paradigm: a source can define a route as an ordered list of instructions (segments)
- Standardization in IETF: SPRING (Source Packet Routing In NetworkinG) – in progress



2 flavors:

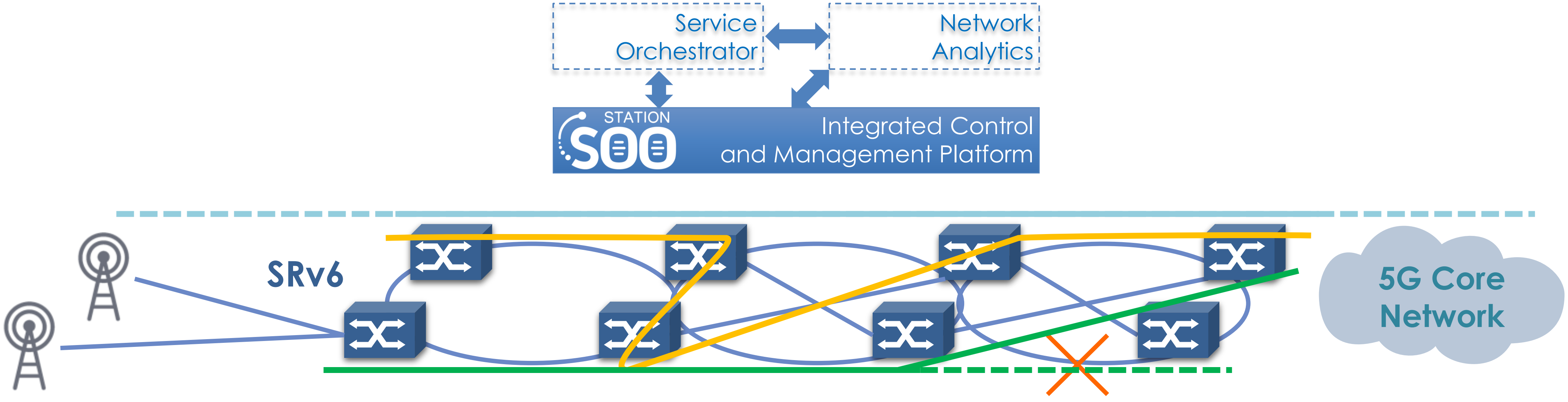
- **SR MPLS**: segment list is a stack of labels
- **SRv6**: segment list is a list of IPv6 addresses in SRH of IPv6 header

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

Scalable
- Does not require any path signaling
- The network fabric is stateless

Seamless deployment
- Runs natively on MPLS or IPv6 data plane
- Can coexist with existing networks

SRV6-BASED NETWORK SERVICES



Traffic Engineering: steer traffic along any path in the network

E2E service, e.g. from IoT device to VM in DC

Variety of services: **VPLS, VPWS, L3VPN, EVPN, VxLAN**

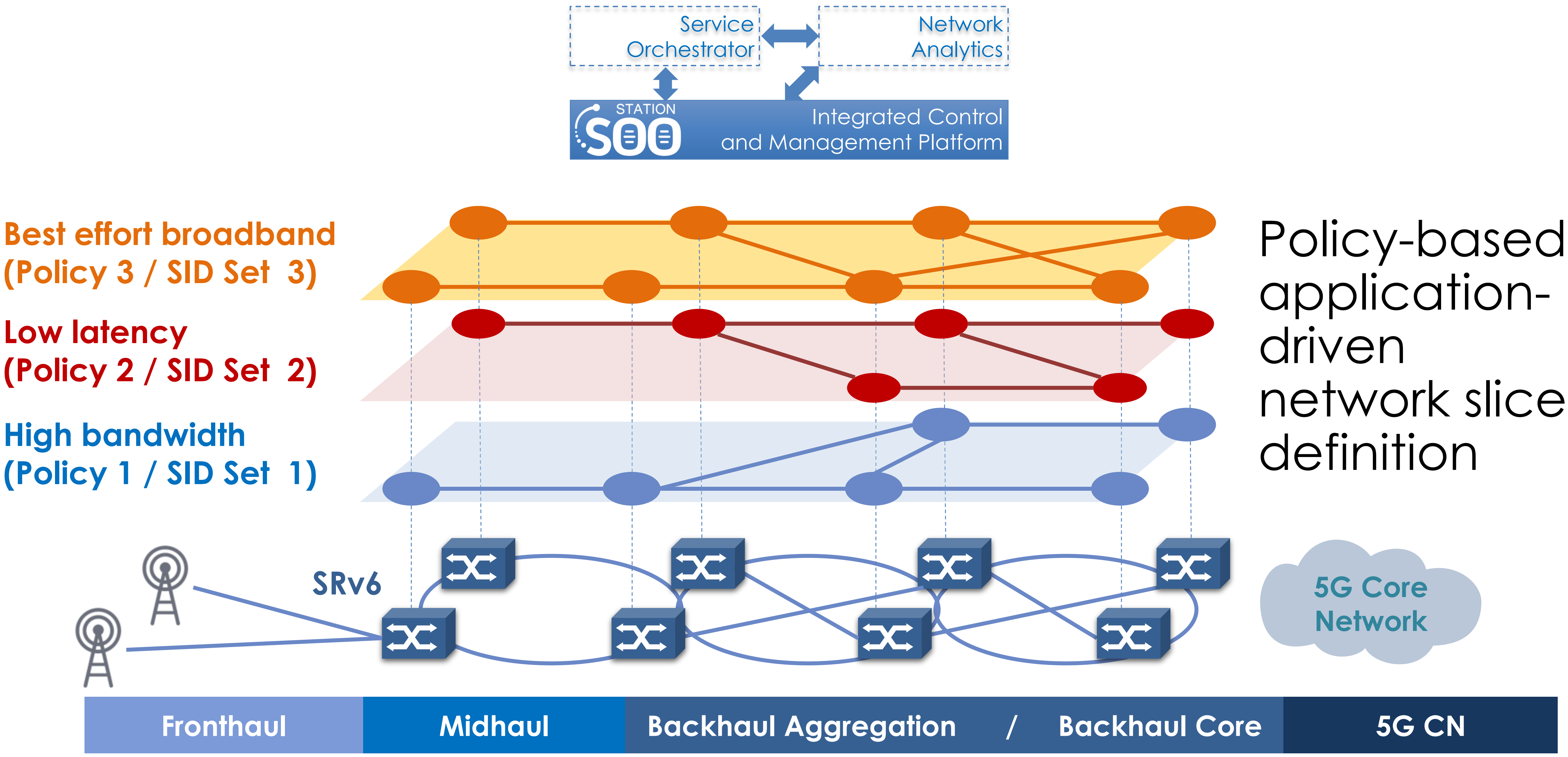
Failure Protection: FRR/TI-LFA provide sub-50msec protection

Network programming: Program a path, and actions along the path

…and much more!

Fronthaul	Midhaul	Backhaul Aggregation / Backhaul Core	5G CN

SRV6-BASED NETWORK SLICING

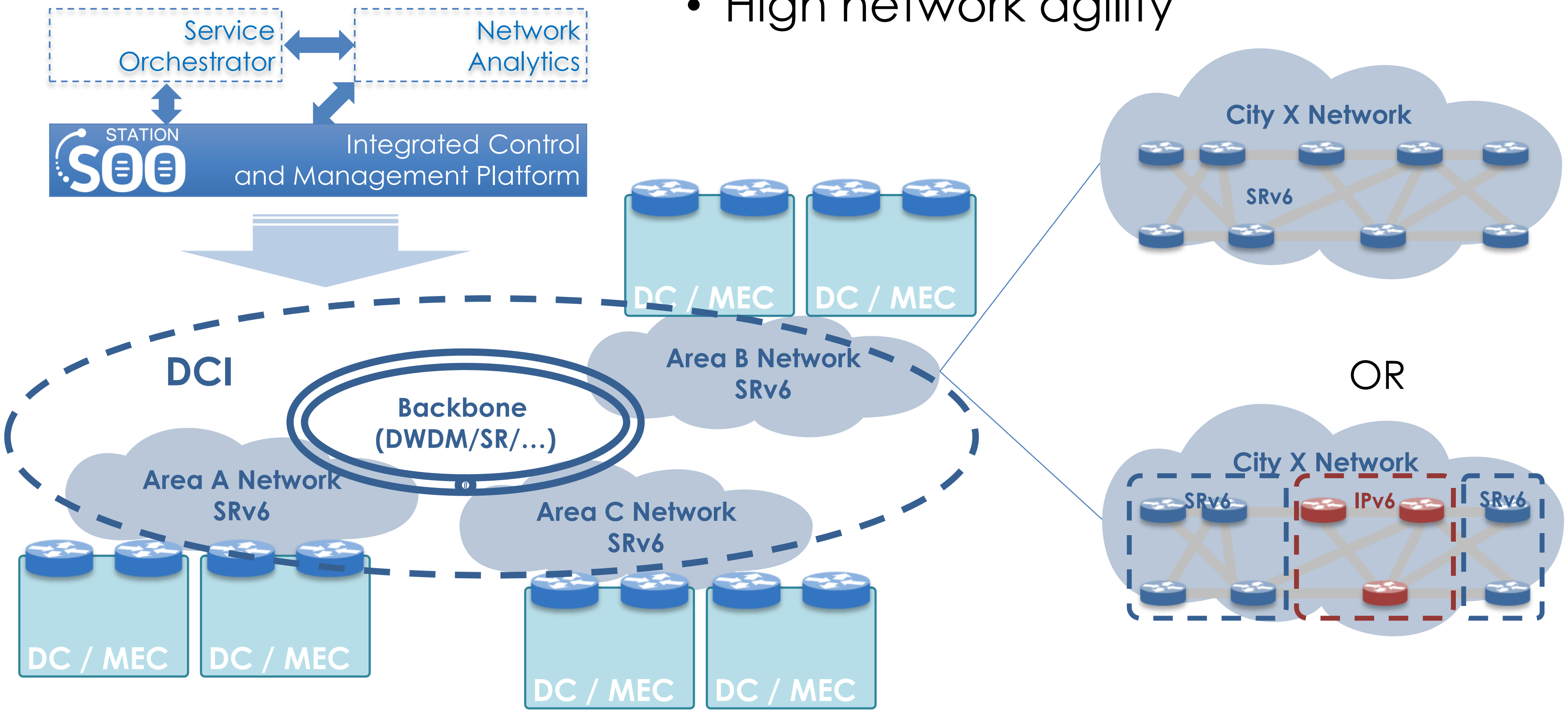


Policy-based application-driven network slice definition

SRV6-BASED DC INTERCONNECT (DCI)

SRv6 for DCI (MEC interconnect)

- End-to-end services (down to VM level)
- Excellent scalability
- Improved network bandwidth efficiency
- Differentiated quality of services per flow / network slicing
- High network agility



Full SRv6 network

- ✓ Full SRv6 feature set with end-to-end TE, programming etc.

SRv6 segments co-exist with IPv6 segments

- ✓ Previous investment protection. Gradual migration

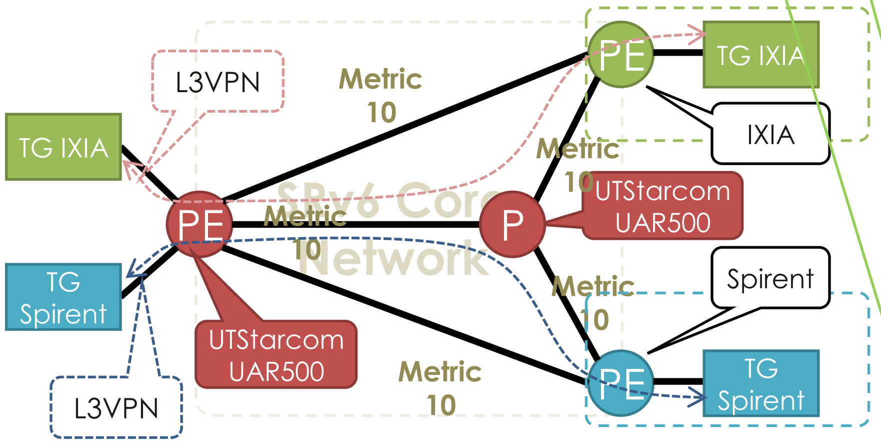
SKYFLUX UAR: SRV6 ROUTERS FAMILY

UAR500
- SRv6
- 800Gbps capacity
- Interfaces up to 100GE
- Modular full-redundant, 5RU

The European Advanced Networking Test Center

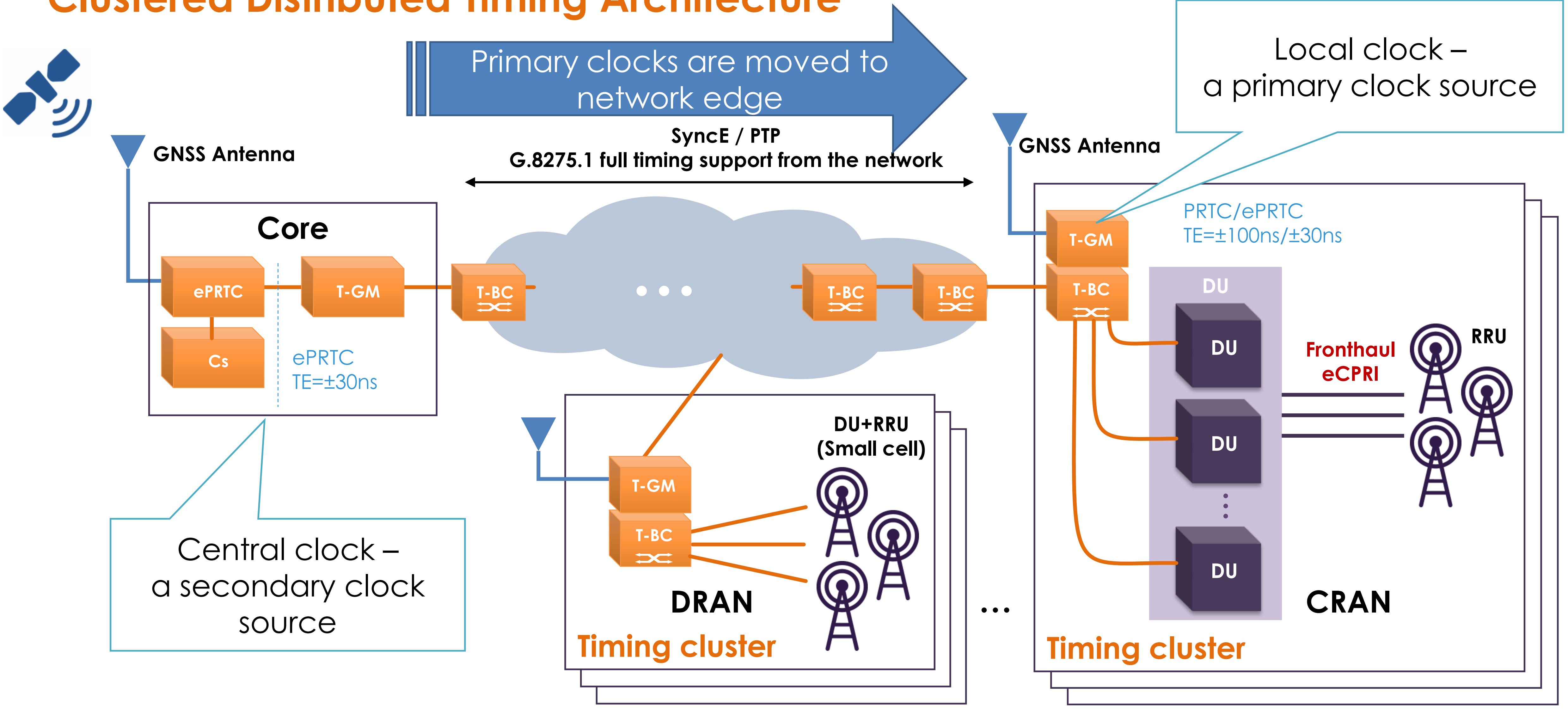
✓**Multi-vendor interoperability testing** @ EANTC lab in Berlin (March 2018)

✓**SRv6 live demo** during MPLS+SDN+NFV @ Paris 2018 (April 2018)



TIMING OVER PACKET NETWORK

Clustered Distributed Timing Architecture



TIMING OVER PACKET NETWORK

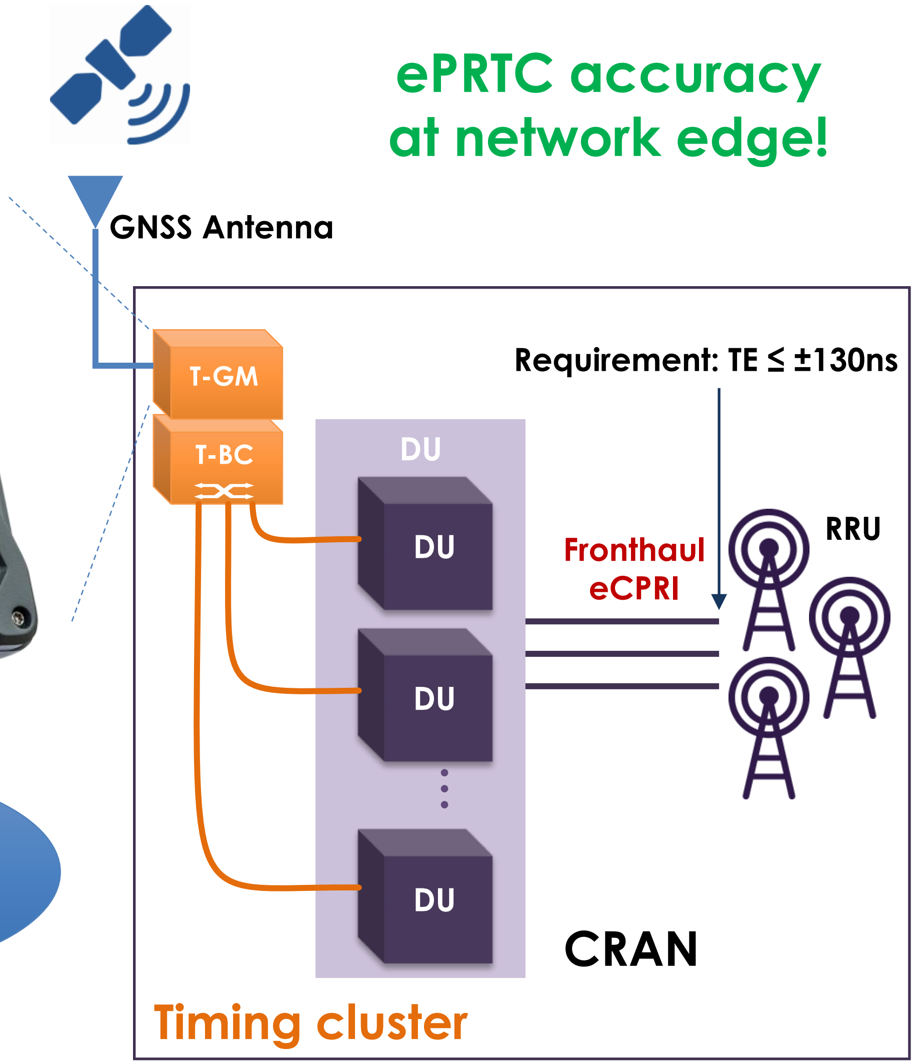
UTSTARCOM®

Concurrent multi-system / multi-frequency	Sync Ethernet
High-grade OCXO	PTP IEEE 1588v2
Outdoor deployment	Performance monitoring

XGM30

TE ≤ ±30ns

ePRTC accuracy at network edge!



Thank you !

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