Real World Deployments: A Pragmatic View Of ITU-T Sync Standards

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Operator & OEM “Information Base” (> 2 bn subs)

APAC Opco

- Telstra
- Optus
- Vodafone Aus
- Vodafone NZ
- Spark
- NTT Docomo
- KDDI / EQ
- Softbank Mobile / Y
- KT
- SKT
- LG+
- China Unicom
- China Telecom
- PCCW/CSL
- Hutchison 3
- Smartone
- Smart
- Globe
- VMS.
- Viettel
- VNPT
- CHT
- Taiwan Mobile
- FarEasTone
- Telekom Malaysia
- Celcom
- Digi
- Maxis
- Indosat
- Smartfren
- Telkomsel
- Hutchison 3
- Singtel
- Starhub
- M1
- AIS
- DTAC
- True
- Reliance
- Bharti Airtel
- Vodafone India
- Dialog

Other Opco

- T-Mobile
- ATT
- Verizon
- Sprint
- Claro group
- Moviles group
- Telefonica group
- CMCC
- Vodafone Group
- Etisalat Group
- STC
- BT
- DT
- Ooridoo
- SFR
- Bouygues
- Wind
- Telefonica
- TIM
- Telenor Group
- Orange Group
- EE
- Orascom
- MTN
- Bezeq
- Vodacom
- KPN
- E-Plus

OEM

- ALU
- Cisco
- E//
- NEC
- Nokia
- Fujitsu
- Samsung
- ZTE

Rapid Change Over Past Five Years

Shift to Ethernet and LTE:	done
Packet Syntonization standards:	done
Increased interest in TDD and LTE-A:	ongoing
Packet Synchronization standards:	ongoing

PREVIOUS SYNC MODEL

- focus on frequency
- hierarchical networks
- SSU based distribution architecture
- PTP frequency overlay standardized within this model
- relatively simple engineering guidelines and deployment

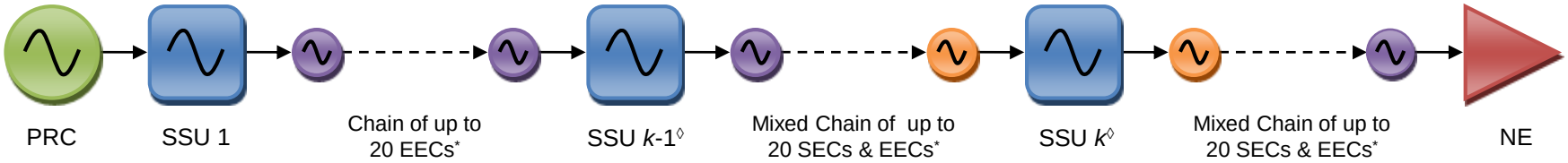
EVOLVING SYNC MODEL

- More focus on phase/time
- Packet based flatter networks
- PRTC based distributed architecture
- standards are still in flux
- multiple time/phase solutions
- engineering guidelines still under discussion

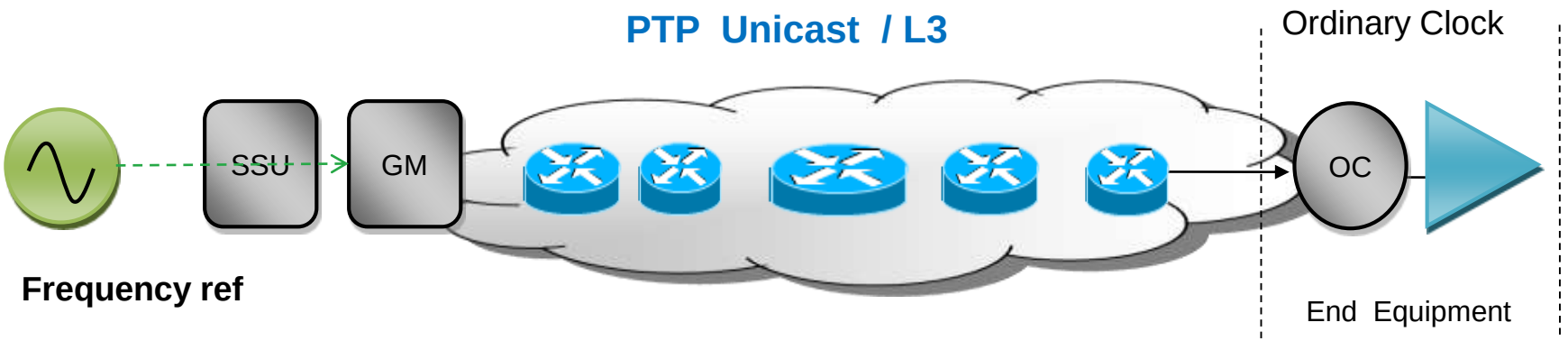
Quick Comment On Standard Sync Architectures

syncE & G.8265.1:

Modified G.803 Reference Chain to include Synchronous Ethernet Clocks (EEC):

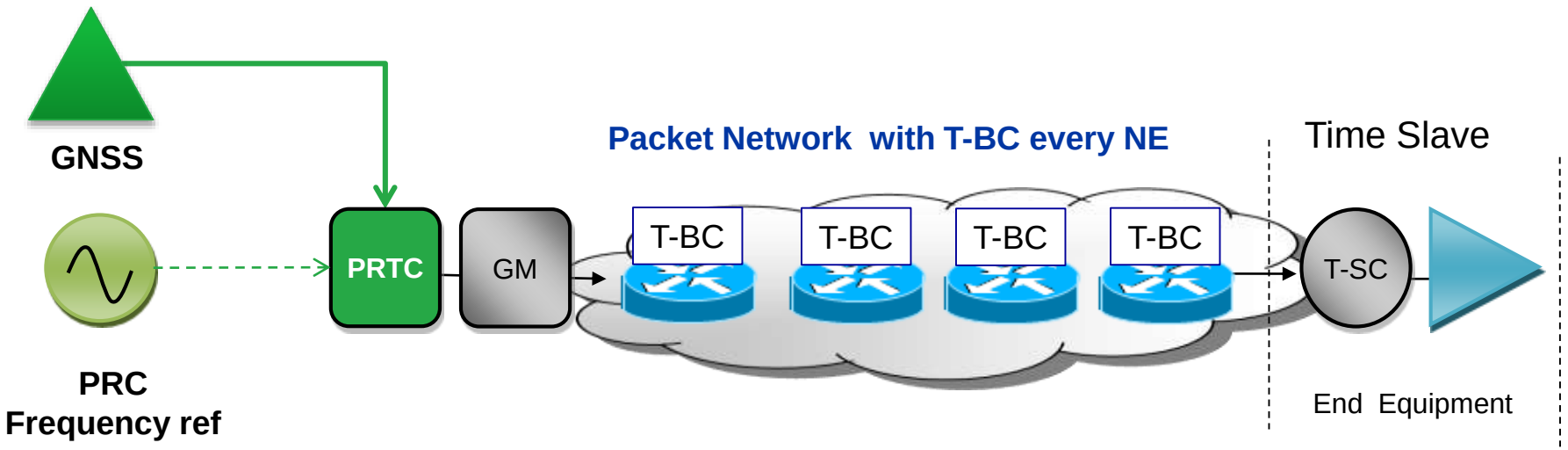


SyncE : a "stealth" success in APAC, EMEA, LatAM



G.8265.1: approx 170 global deployments all regions

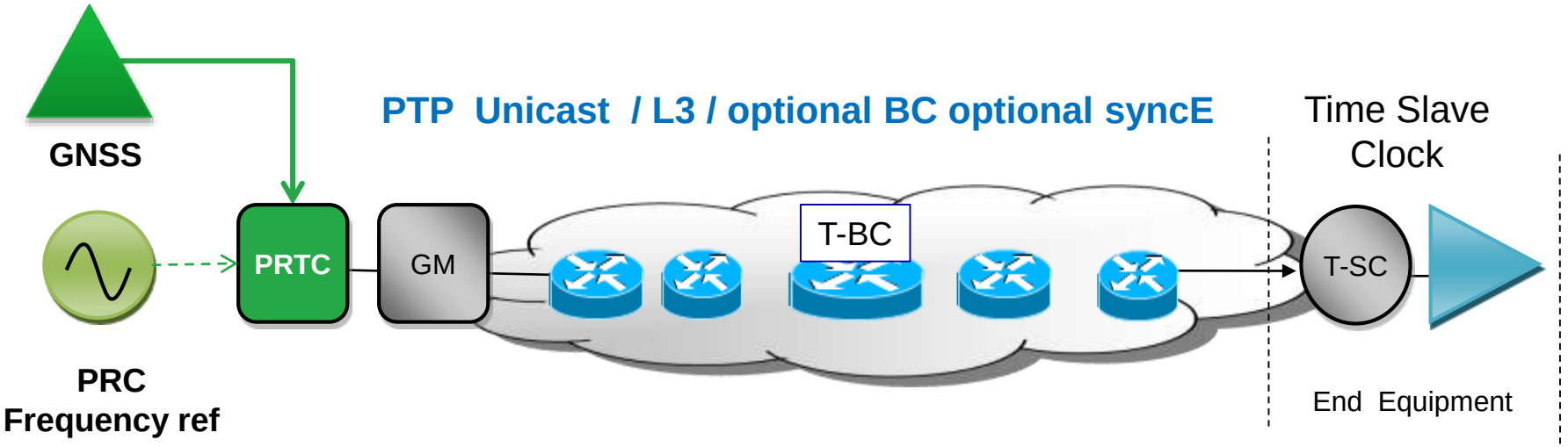
G.8275.1 Time Profile Full On Path Support



- PTP Multicast / L2
- "Time Boundary Clock" (T-BC) on every NE
- Phy layer from syncE
- 10 "Class A" / 20 "Class B" T-BC in a chain

- Based on classical sync hop by hop engineering but completely impractical for MPLS based networks
- More acceptance as more phase is required, problems such as network asymmetry are better understood, more "greenfield" deployments

G.8275.2 Time Profile Partial On Path Support



- WIP to facilitate more flexible engineering models for existing heterogeneous networks
- Performance issues remain to be resolved
- Role of APTS ?

Alternative Sync Architectures

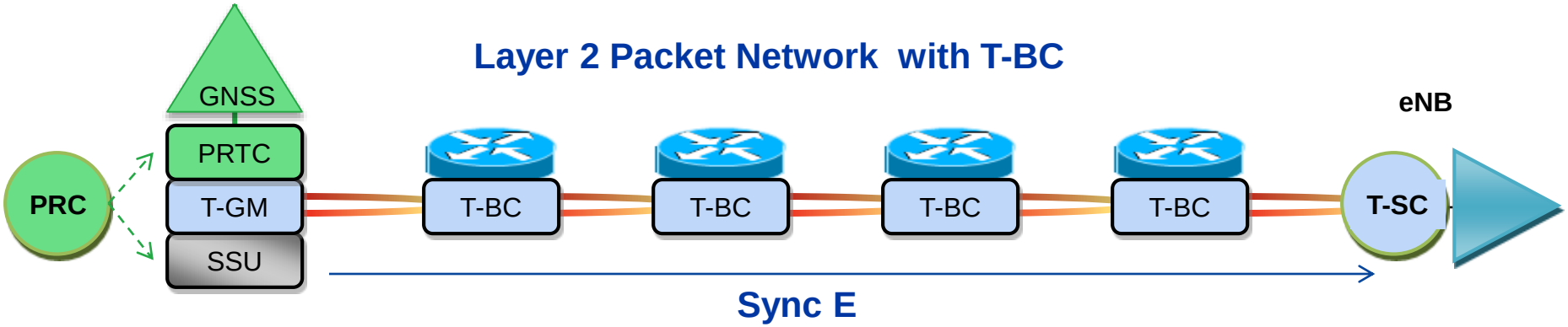
Common Public Radio Interface

- Alternative sync architecture controlled by small group (cartel?) of OEM
  - Appears to have Some issues for time/phase engineering – most probably because of network asymmetry.

- MPLS core with GPS on every eNB
  - Macro eNB biais – may be disrupted by Small Cell PTP systems
  - Favored by GPS centric ex-CDMA carriers almost exclusively US and Korea
  - May or may not have frequency support from legacy TDM

What Else Operators Are Doing

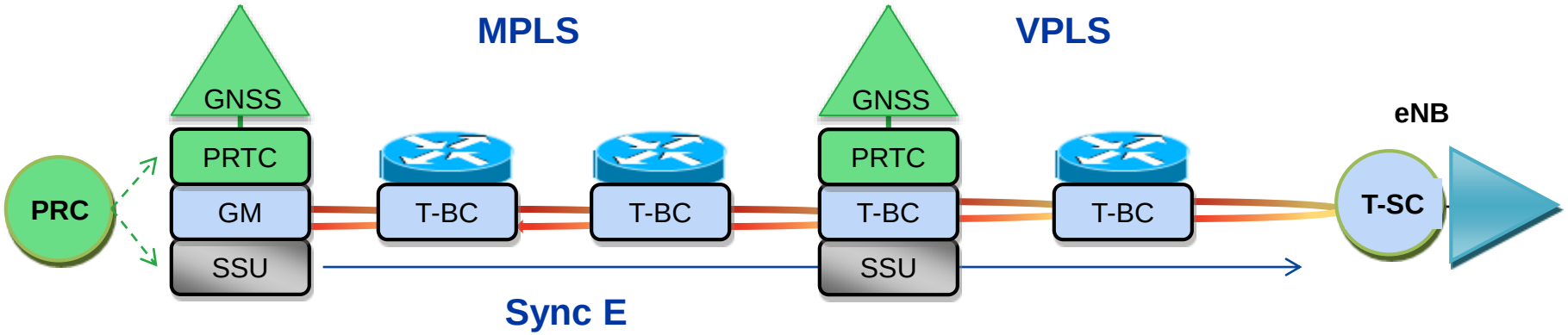
Example 1: Full On Path Support + Unicast PTP over Layer 2



Attributes

- "Centralised " architecture, PRC + SSU + PRTC + GM
- PTP Unicast over Layer 2, "Time Boundary Clock" (T-BC) on every NE
- Traceable Physical layer frequency support from syncE
- 10 hops or less
- Extensive testing to measure overall time-transfer accuracy determined the choice of Unicast over Multicast and Ubiquity of T-BC

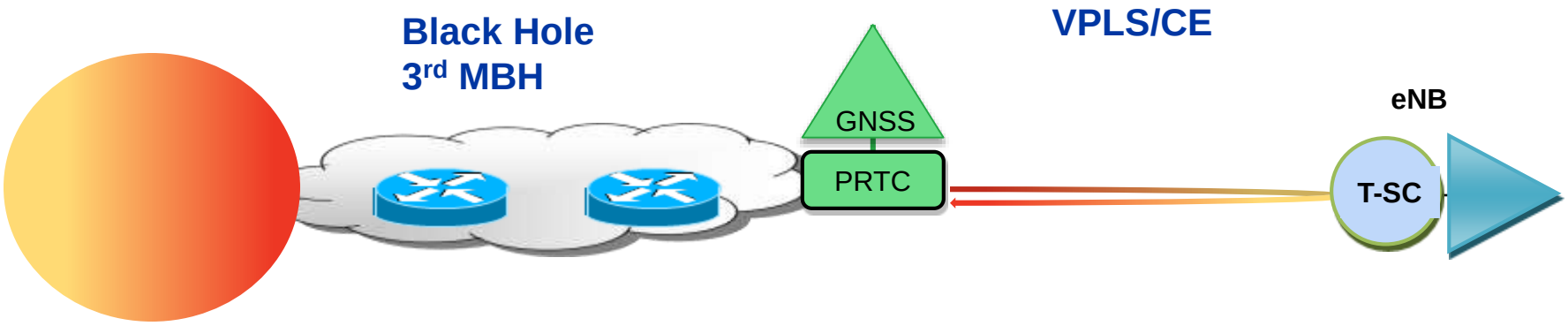
Example 2: Full On Path Support + Unicast PTP over MPLS with Distributed PRTC



Attributes

- "Centralised " PTP & syncE
- PTP Unicast over MPLS, "Time Boundary Clock" (T-BC) on every NE
- Traceable physical layer frequency support from syncE
- Up to 15 hops(or more)

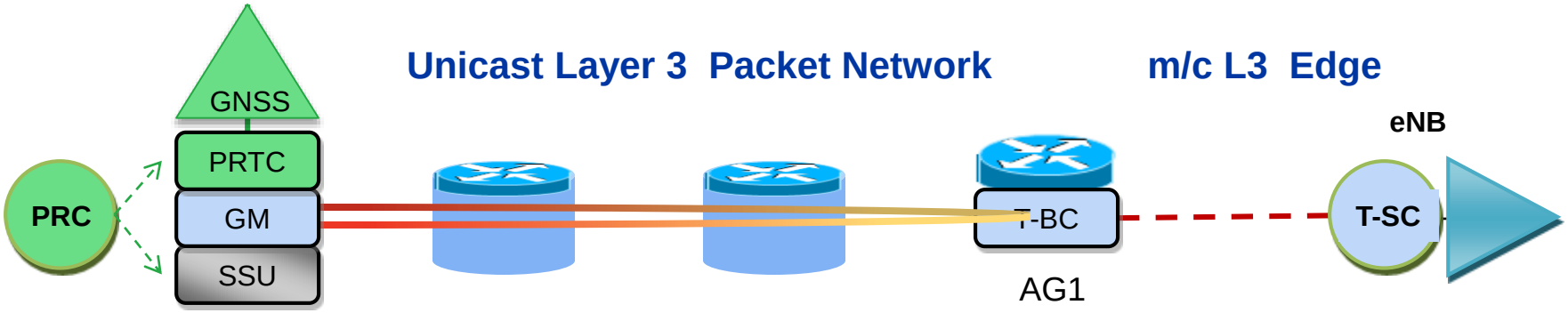
Example 3: SDH/SONET in Core PTP (Unicast PTP over MPLS with Distributed PRTC



Attributes

- MBH is 3rd Party black hole
- Sync is at “islands” (Campus, high rise, malls
- Edge can be PTP Unicast over MPLS or Multicast over L2,
- Now proposed as G.8275.2 PTS
- May have PRTC backing up PRTC at the edge if visible

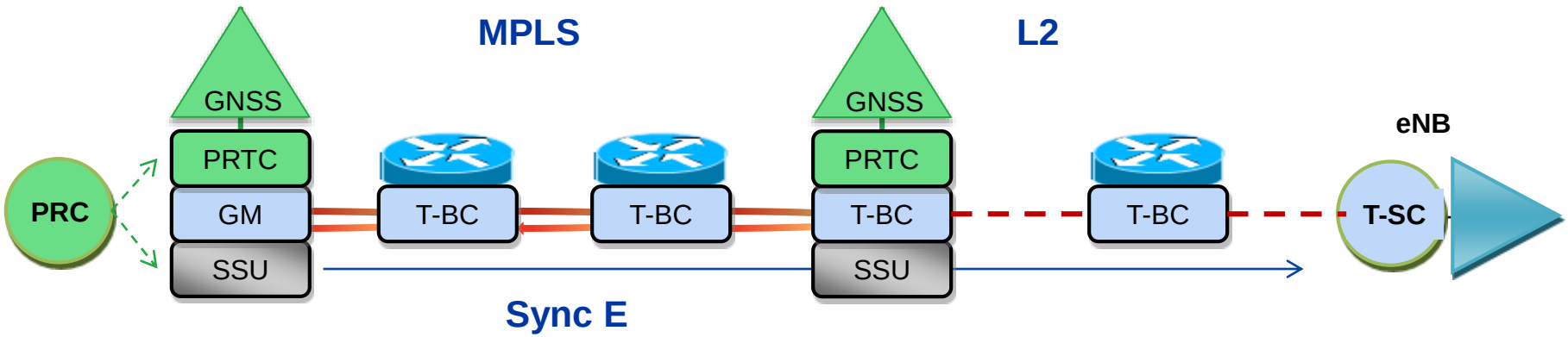
Example 4 : Unicast / L3 + m/c PTP / L2



Attributes

- SSU + PRTC + GM + PTP Unicast over Layer 3 to AG1
- Dimension = “restrained” G.8265.1 (< 5 “hops”)
- No Physical layer frequency support
- L2 multicast AG1 edge to eNB

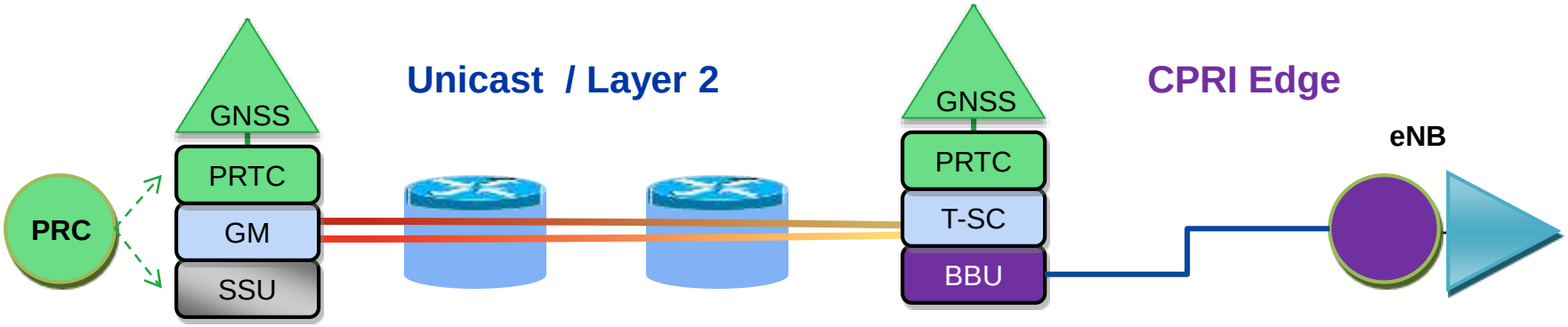
Example 5: Full On Path Support + Unicast PTP / MPLS + Distributed PRTC + m/c / L2



Attributes

- "Centralised " PTP & syncE with distributed PRTC at edge
- PTP Unicast over MPLS, T-BC on every NE in core network (pre-G.8275.2)
- PTP multicast over L2 , T-BC) on every NE ("G.8275.1")
- Traceable physical layer frequency support from syncE
- Up to 10 hops

Example 6: Unicast / L2 + CPRI



Attributes

- SSU + PRTC + GM + PTP Unicast over Layer 2 to BBU site
- No Physical layer frequency support

Summary: Pragmatism Rules

- G.8275.1: complex, investment heavy engineering
- G.8275.2: unknown issues and late out of WG
- Hybrid “pragmatic” architectures are usually developed to solve immediate problems
- Some OPCO are conservative and wait for the ITU to “bless” an architecture but some are innovative & charge ahead.
- Final arbiter is not the standard **per se**, but “Does it work?” “Is it cost effective?” “Can the OEM deliver it?’ “Does it give me an edge?”

Thank You