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Mobile Backhaul Architecture Options

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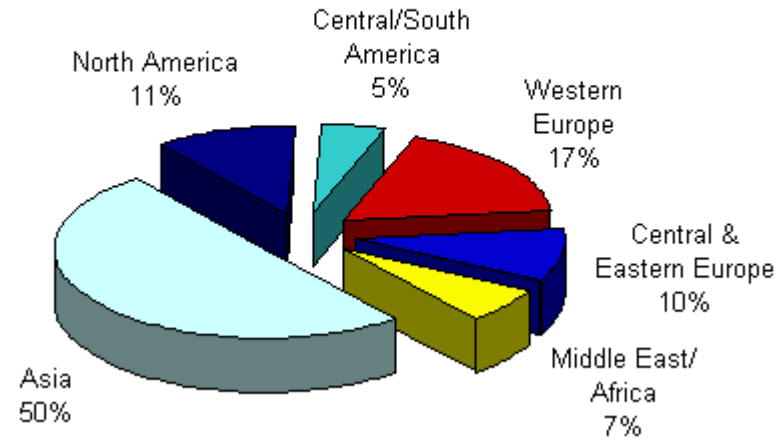
Agenda

- RAN Backhaul Market Analysis
- The Landscape
- IP and Radio techniques in RAN
- MPLS in RAN
- Resiliency and OAM
- Summary

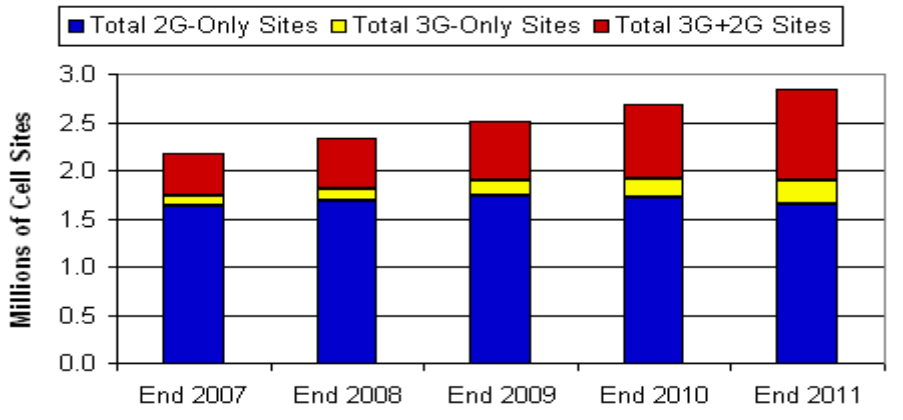
The Global Cell Site Market

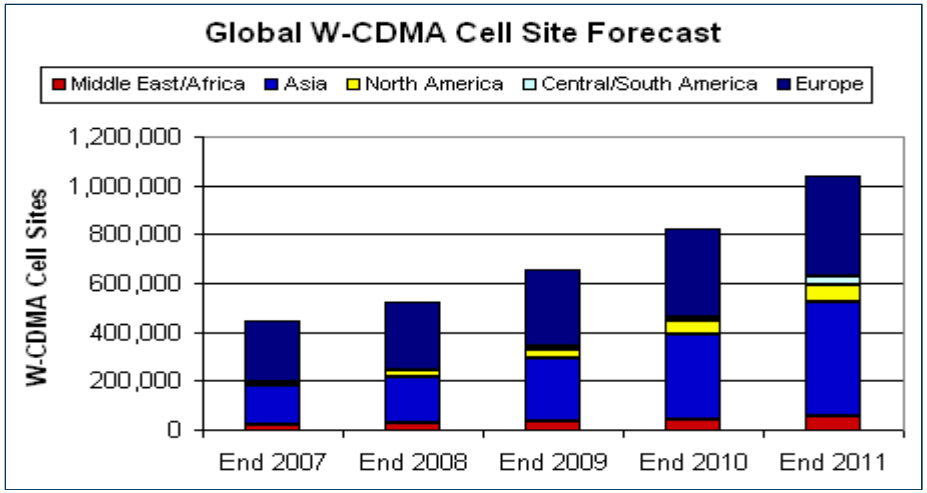
Source: Equipment vendors, service providers, press, and Heavy Reading estimates



GLOBAL CELL SITE FORECASTS

- Chart on left: 2.2 million 2G and 3G cell sites world wide by the end of 2007, half of them in Asia. China Mobile alone has 250,000 cell sites.
- Chart at bottom left: Shows that 75% of the world's cell sites will be 2G-only at the end of 2007, declining to 59% by the end of 2011. This is key because one basic assumption underlying the forecasts in this tracker is that operators will not deploy Ethernet to 2G-only cell sites for at least the next two years.
- Chart at bottom right: growth in W-CDMA cell sites by region, with Europe being overtaken by Asia during 2010.





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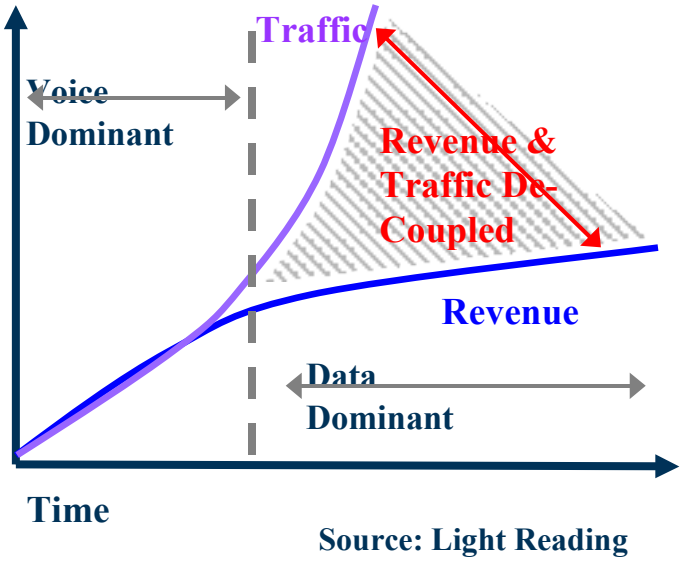
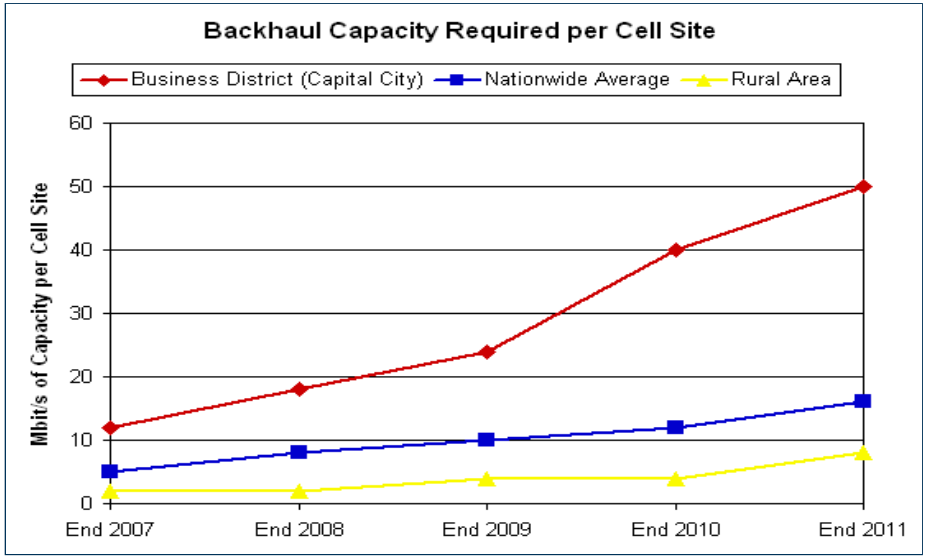
The Mobile Broadband Challenge

- The Problem
  - Mobile operators use primarily leased lines to Backhaul Mobile traffic.
    - Leased lines are significantly costly
    - Yankee Group: Mobile operators spend today about $22 billion globally to lease transmission backhaul
    - High backhaul costs: 40% of OpEX in 2G, 60% of OpEX in 3G
  - 3G deployments (especially with HSDPA) require significantly more bandwidth



Source: Light Reading



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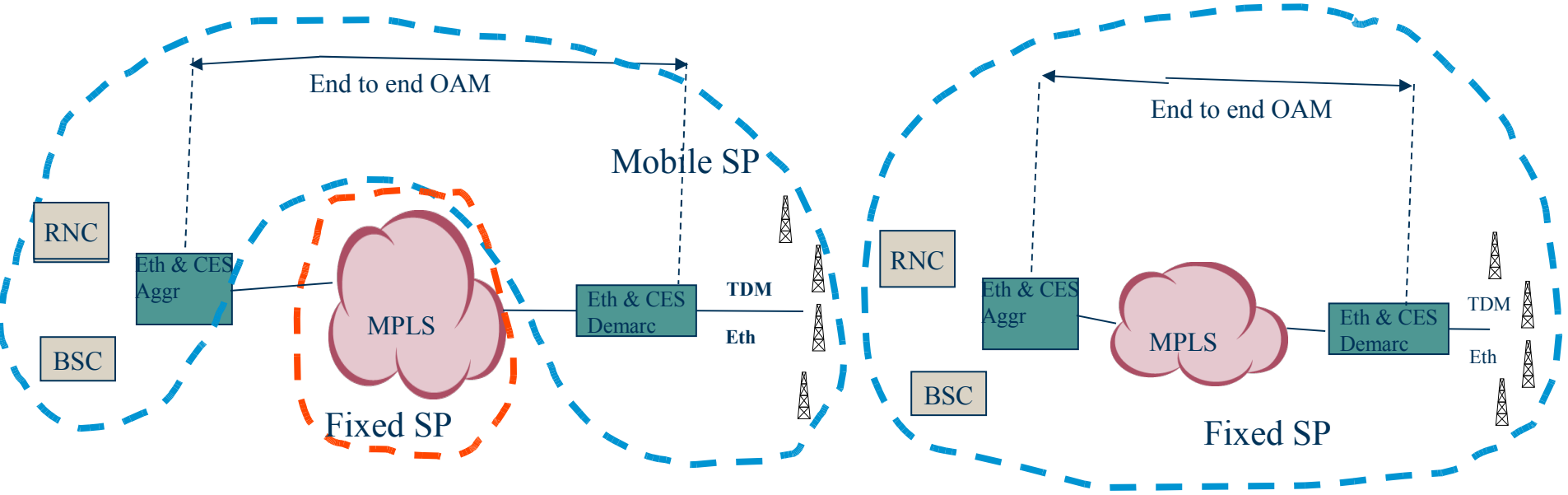
Backhaul challenges

- Reduce operational expenditures per transported bit
  - Self built vs. Leased
  - Cost for spectrum, cost for infrastructure
- Handle the capacity growth to end sites
  - Capacity increase 5-10 times compared with GSM
  - Unpredictable service take off
- Handle transition from circuit to packets
  - Legacy network
  - Integration between RAN and RAN transport planning

Cost focus in every aspect

Business Models



- The backhaul service is provided by wire-line department or leased from wire-line carrier.
  - OAM interworking between fixed and Mobile side can be a big challenge.

- Same department or carrier providing wireline as well as wireless backhaul services
  - OAM interworking relatively easy between MPLS and non-MPLS segments.
  - Easy to tune the network for FMC.
  - Synergy with metroE network

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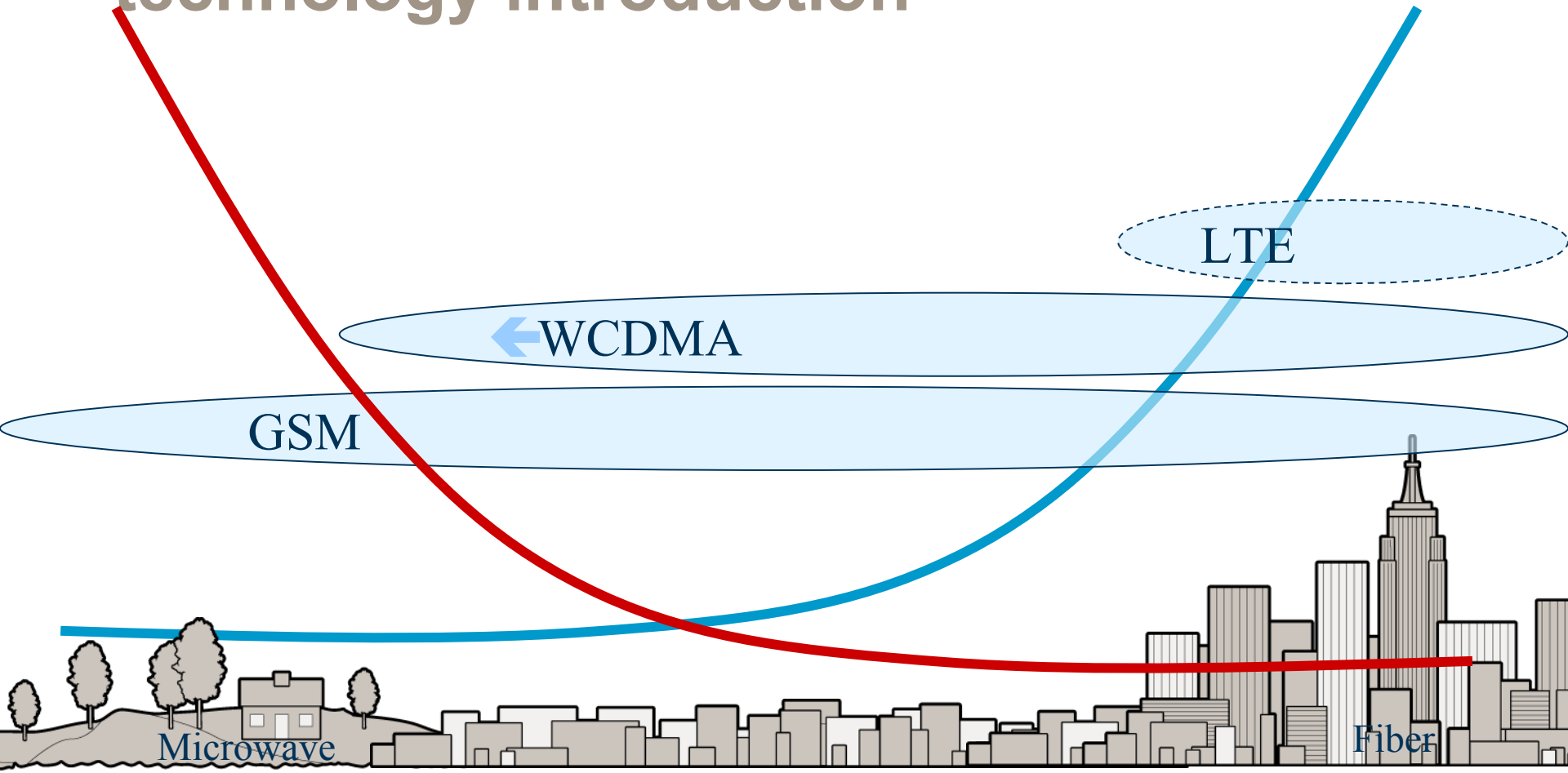
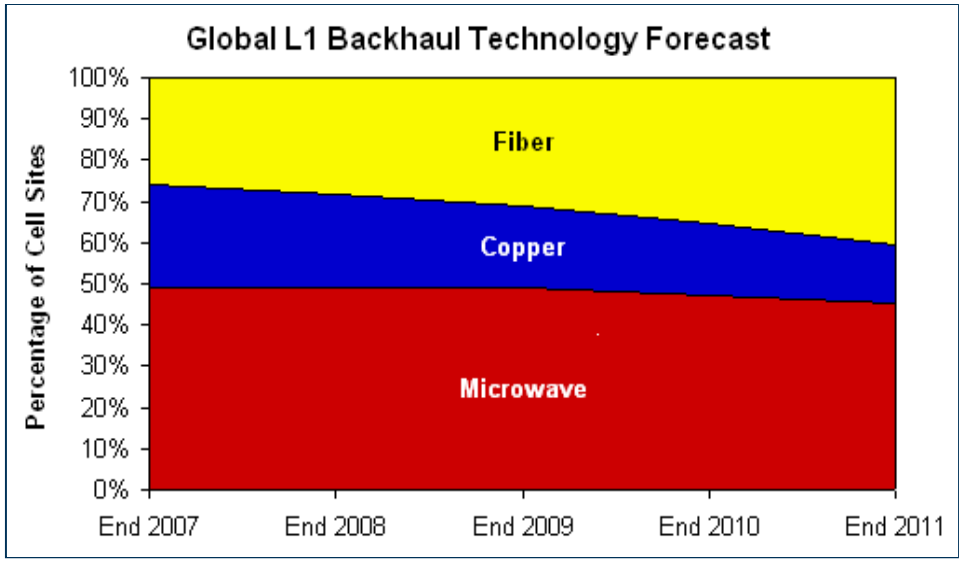
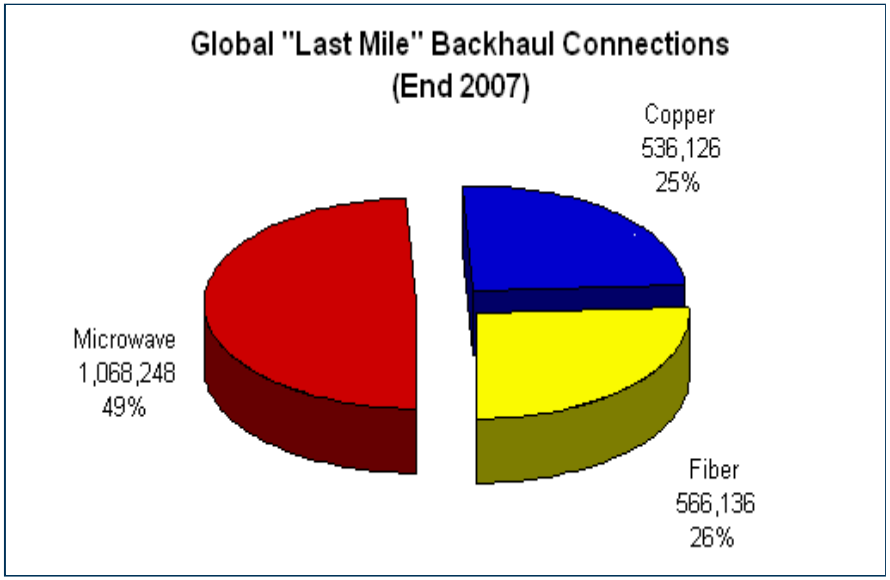
The Landscape?
Key drivers: Traffic growth and technology introduction



GPON, xDSL, High-Cap Microwave, Fiber

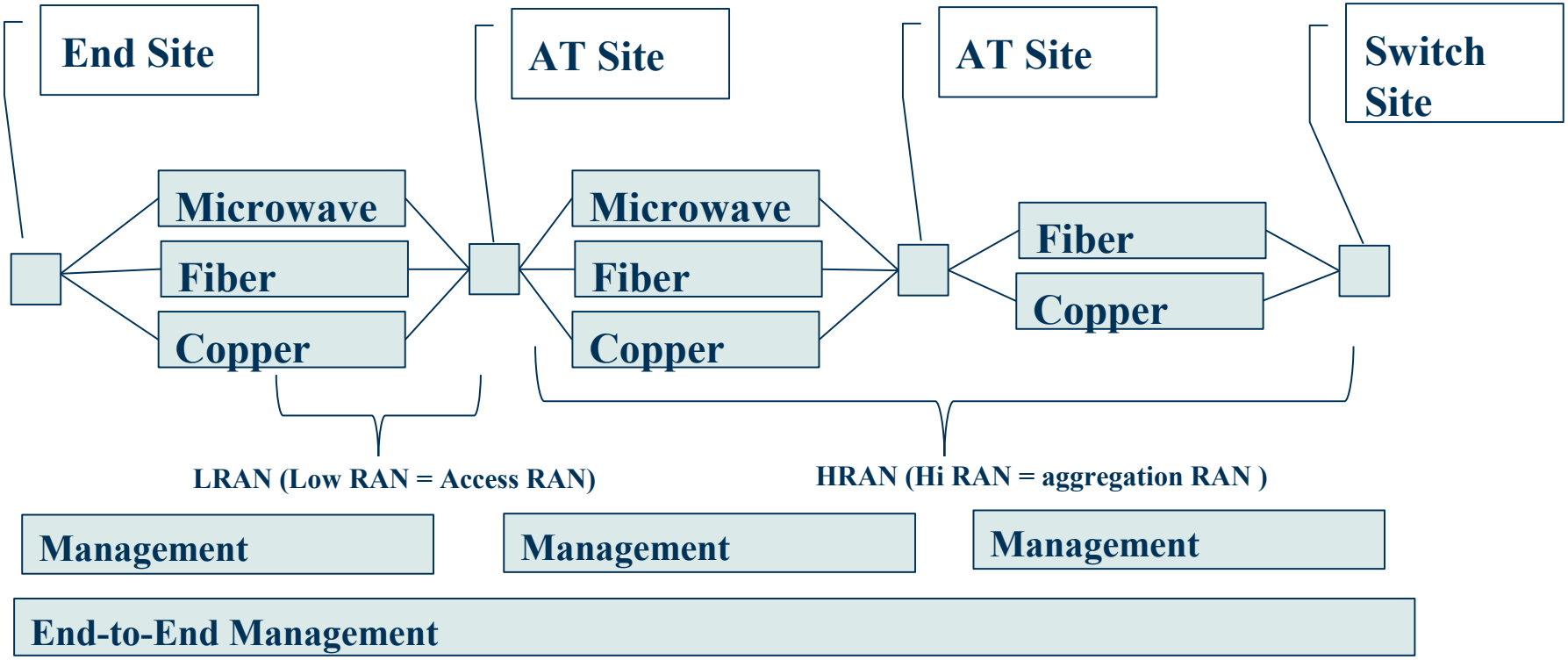
Physical-Layer Access Technologies: Global Forecast





- 50% of cell sites connected by microwave, 25% by copper and 25% by fiber
  - Fiber penetration is still far off reaching nearly 40% in 2011 but not at the cost of microwave.
- Microwave is dominant in emerging markets too where the wired infrastructure is still lacking.
  - Microwave as L1 technology, but TDM or Ethernet as the transport protocol.

Lay of the Land (1)



- End Site
  - A site that contains the radio base station(s)
  - Does not provide aggregation from other Sites
- Aggregation and Transit Site (AT)
  - A site for traffic concentration/aggregation.
  - There can be more than one level of AT Site, noted by Level 1, Level 2, .. Level n
  - An AT Site can contain radio base station(s)
- Switch Site
  - Where the radio controllers (RNC) are located. Provides hand-off to the Mobile Core.

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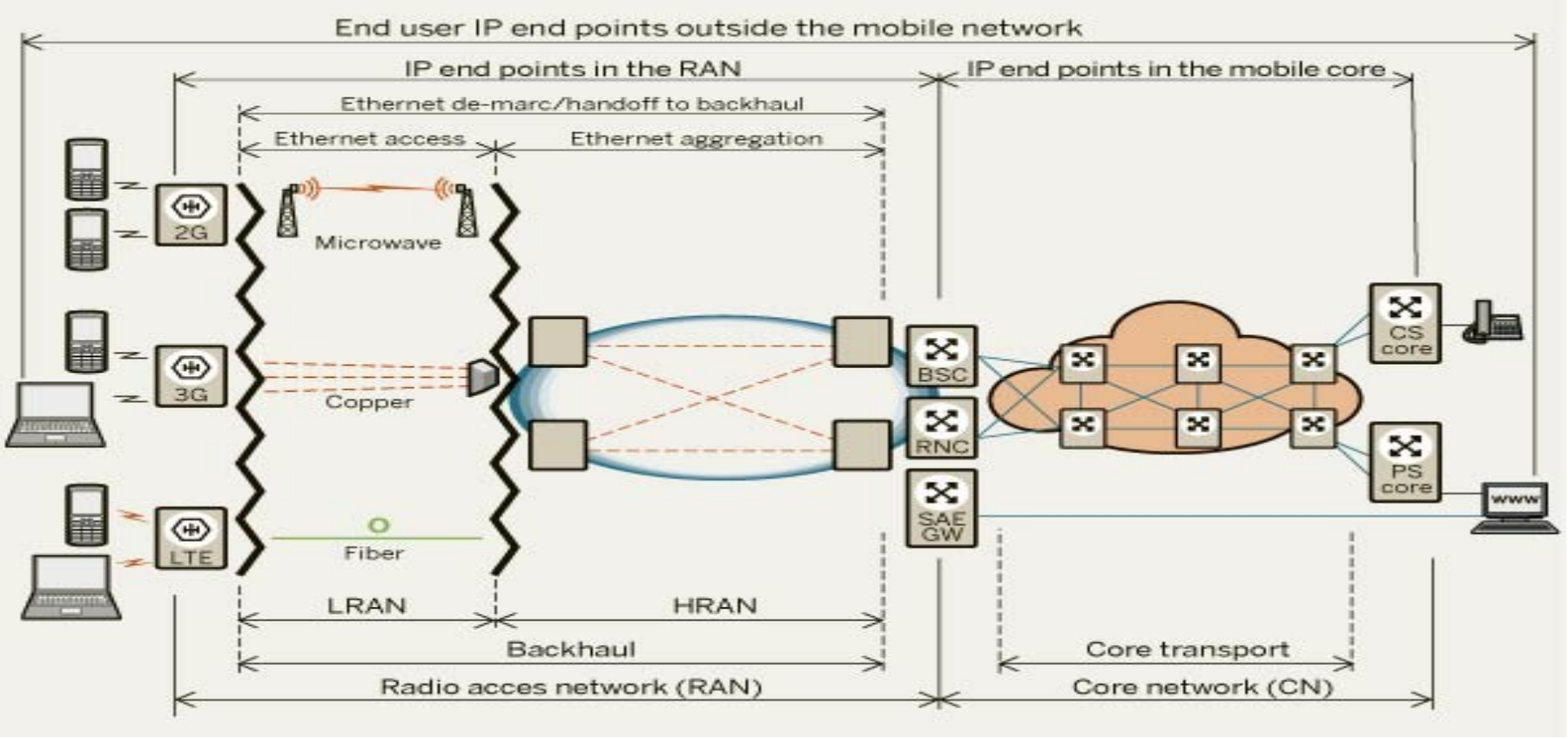
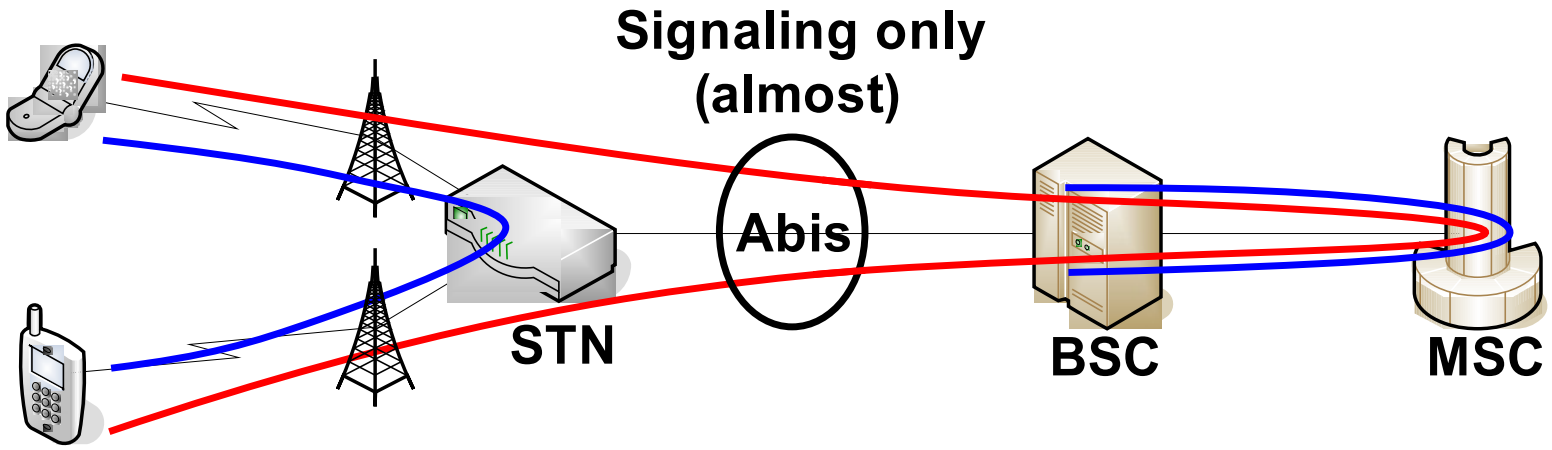
All IP



- **LRAN (access RAN) includes multiple physical technologies (uwave, copper, fiber etc)**
- **HRAN (aggregation RAN) comprises the aggregation network – optical fiber as one of the underlying technologies**

Radio techniques to the rescue

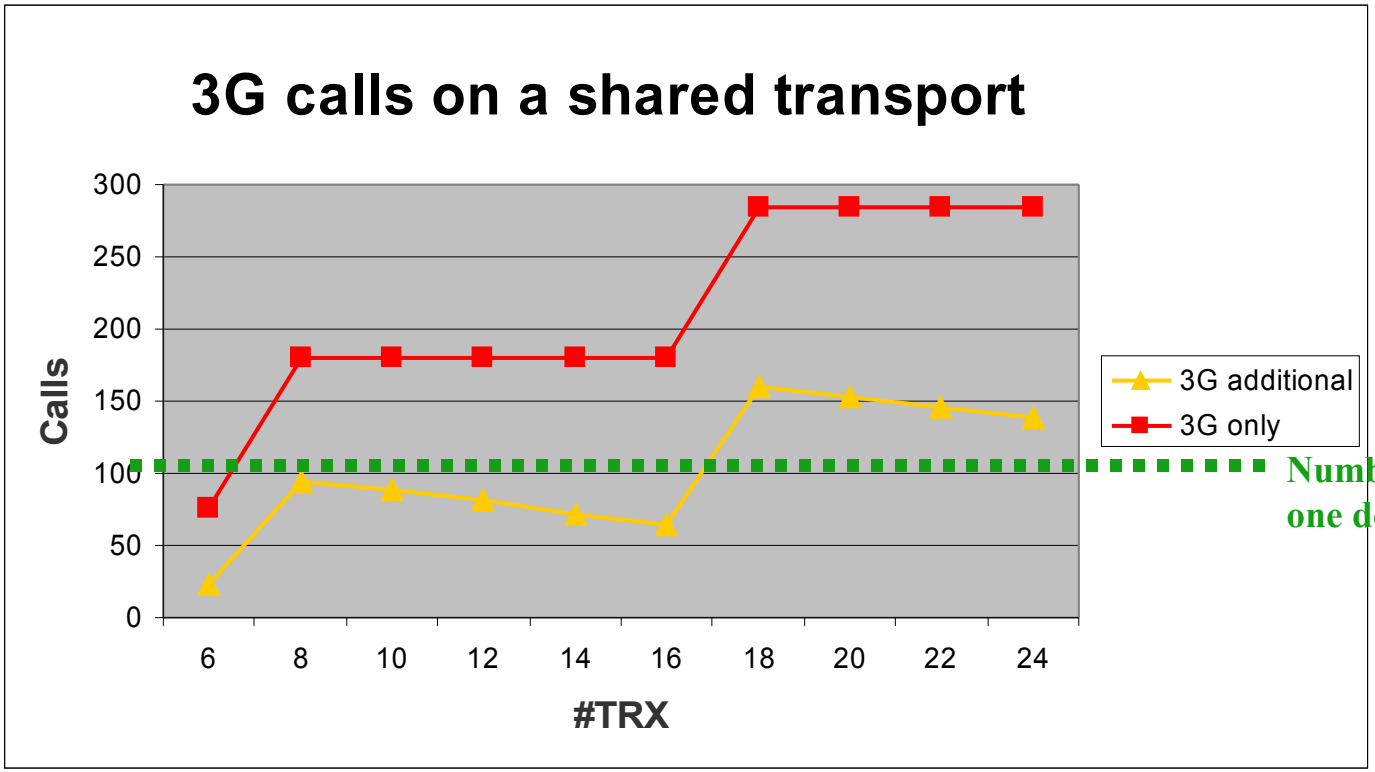
- **Abis optimization**



- LCF (Local Call Forwarding)
  - Basic idea: Don't send speech further than necessary
    - Save Abis bandwidth
    - Reduce speech path delay
  - Savings on speech only
    - No impact on signaling
    - No impact on PS data or CS data

Essential to marry radio techniques with the network and transport

Transport Sharing Gains



- **Huge savings by utilizing the underlying physical layer (T1) better.**
  - **Statistical multiplexing**
  - **Abis Optimization**
  - **LCF (Local Call Forwarding)**

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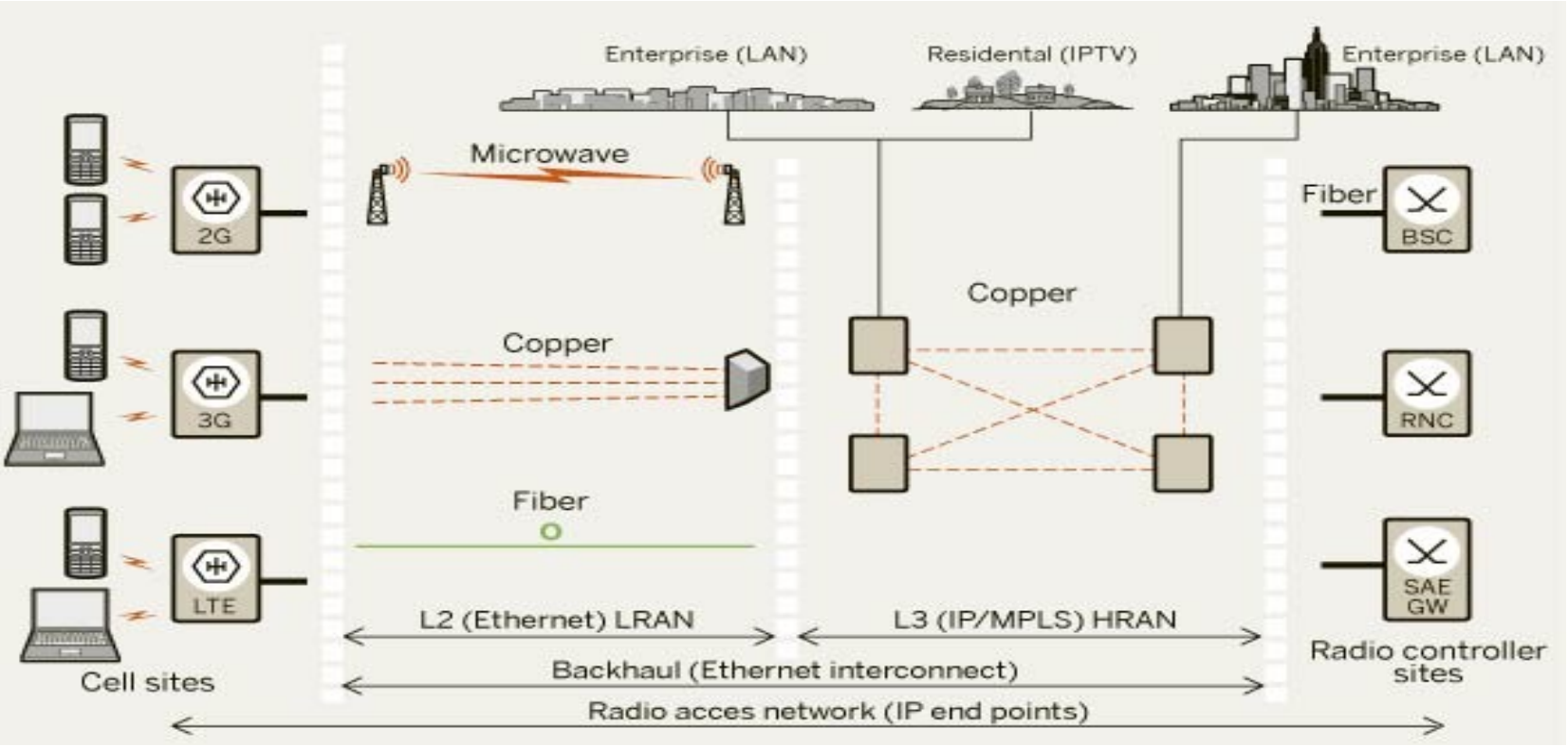
MPLS in RAN

- IP is a viable option for wireless backhaul as discussed in previous slides. MPLS offers unifying infrastructure for converged networks backhauling wireline and wireless traffic.
  - Agnostic of underlying transport
  - No overlay networks => saves capex and opex.
- MPLS is already a proven and mature technology in Mobile cores and metroE domains.
- Carrier Grade capabilities of MPLS
  - Traffic Engineering capabilities for better managing network resources.
  - Resilience and Fast restoration capabilities
  - Well defined OAM tools at tunnel and service level.
  - Traffic segregation and security

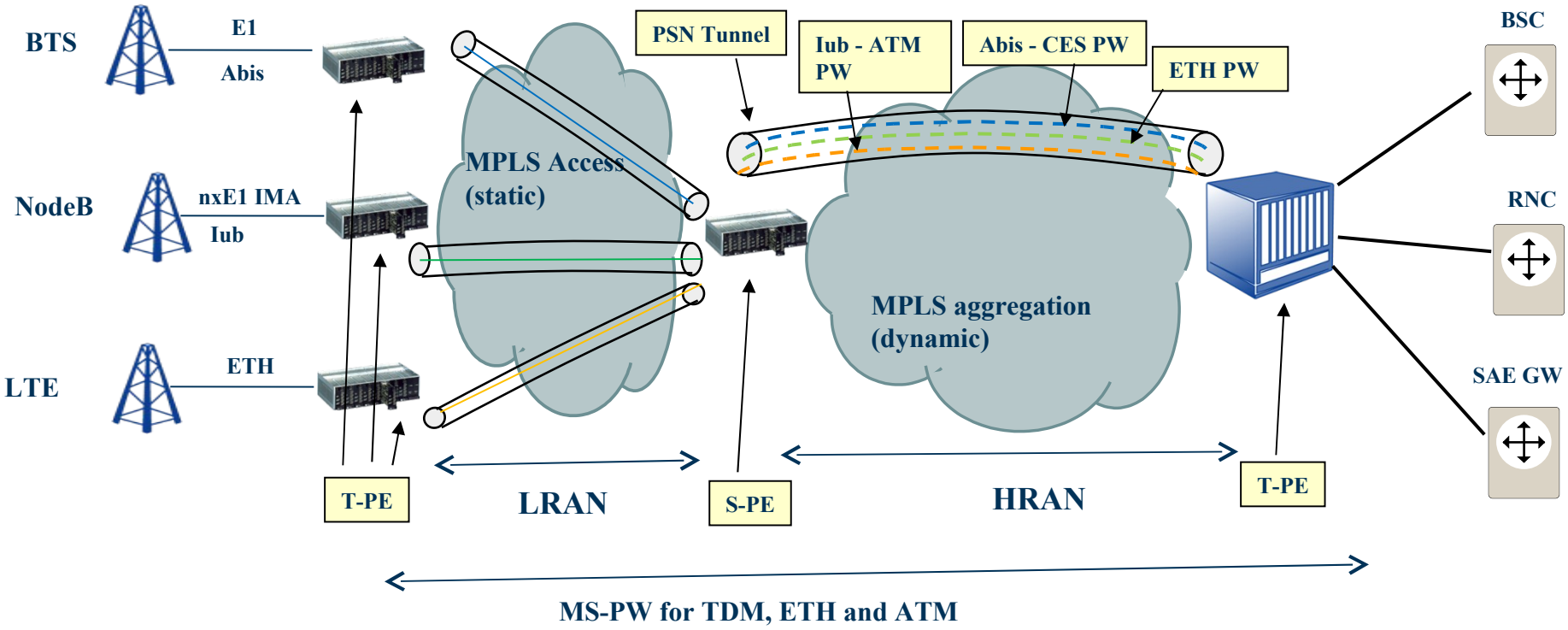
MPLS in HRAN



- **HRAN carries additional services like business services (VPN etc) besides the wireless backhaul**

Keep MPLS light weight in LRAN

Cost is even more critical in LRAN



Pros:

- Ease of provisioning: Not too many PWEs end to end.

Cons:

- Complexity at S-PE to stitch the service PWEs
  - Cell Site Router no longer a simple and cheap device if acesss network also has dynamic PWs.

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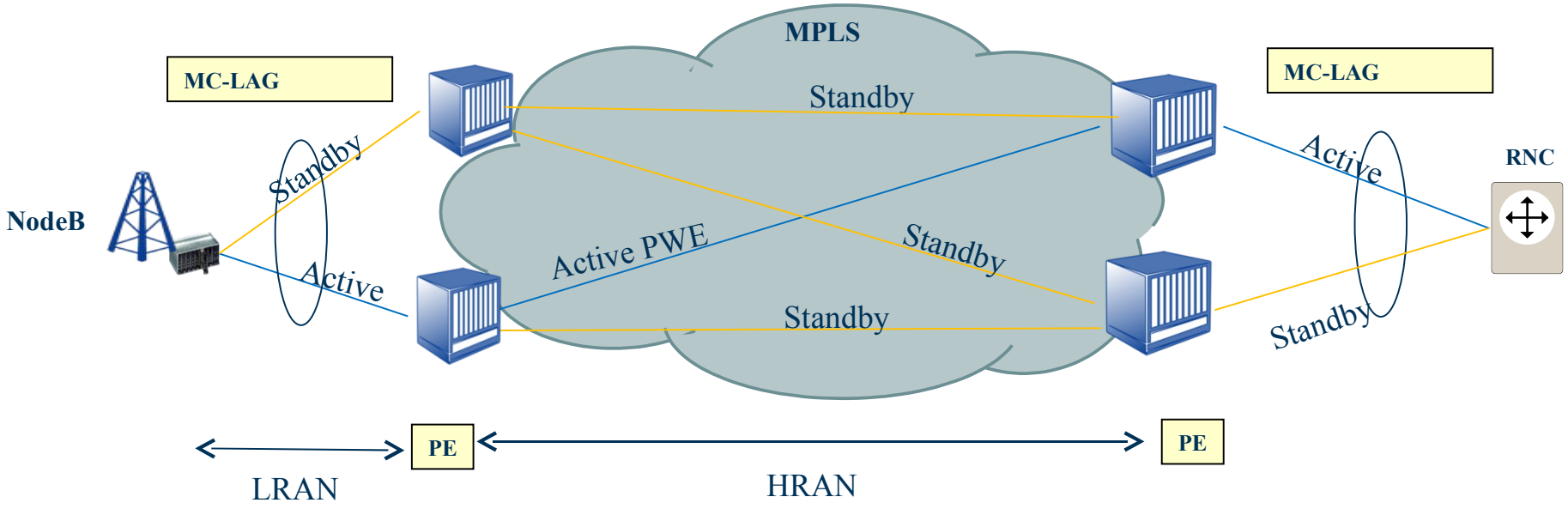
Resiliency (1)

- Resiliency at both network and node level.
- Node level resiliency support:
  - Hitless Switchover
  - IGP / LDP / RSVP Graceful Restart
  - Non Stop Forwarding
  - In Service Software Upgrade.
- MPLS Network resiliency:
  - FRR
  - Backup LSP
  - Backup-backup LSP
    - Tiered protection
  - PWE backup (draft muley)

Resiliency (2)



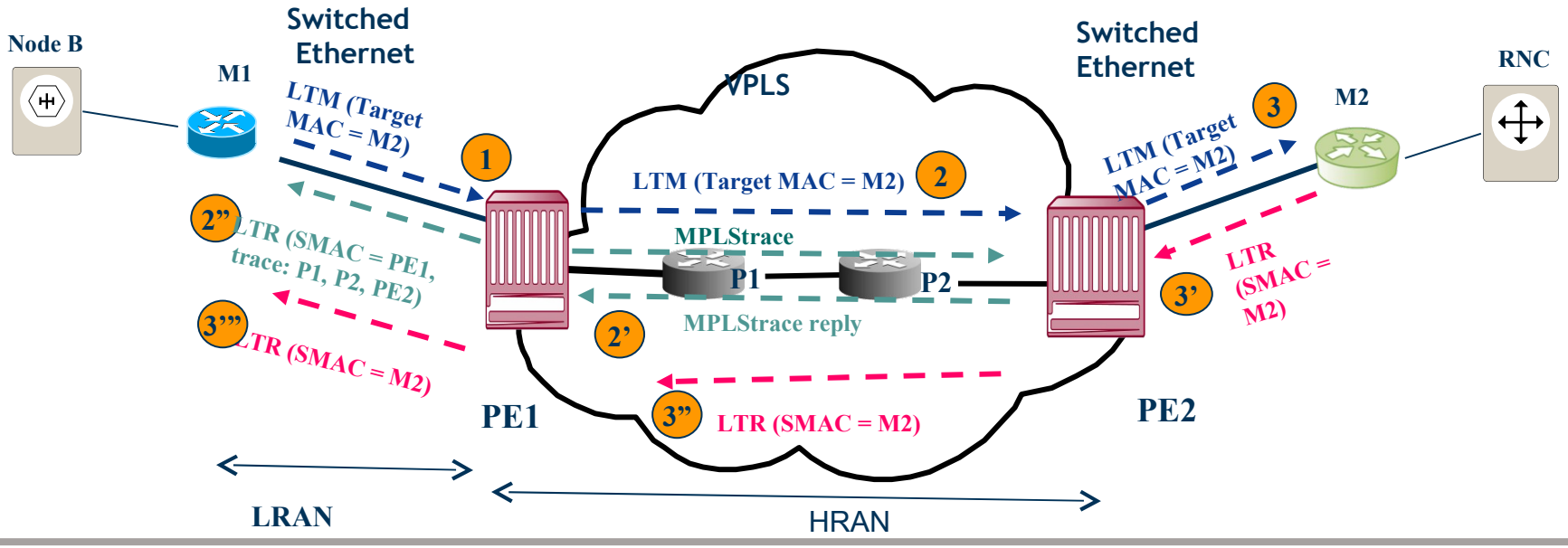
- Resiliency in LRAN:
  - If ethernet transport, then use MC LAG
  - If MPLS, then leverage on similar techniques as mentioned in HRAN
- Resiliency in HRAN:
  - LAG
  - FRR
  - Backup
  - Hierarchical protection
  - Active vs standby PW using draft Muley
- Resiliency towards RNC:
  - Multi-chassis LAG

OAM

- Timely fault detection and management critical to restore services and honor SLAs.
- Choose the OAM tools based on the underlying transport and higher level services offered in LRAN and HRAN. Example:
  - 802.1ag CFM: troubleshoot problems in switched ethernet networks (LRAN)
  - MPLS/VPLS OAM like LSP ping, LSP traceroute, VCCV geared towards troubleshooting problems in MPLS networks (HRAN)
- Interworking of OAM tools is critical between LRAN (say switched ethernet) and HRAN (MPLS) segments to offer end-to-end fault management.
  - Easier to manage the interworking challenges if LRAN and HRAN are owned by the same operator.

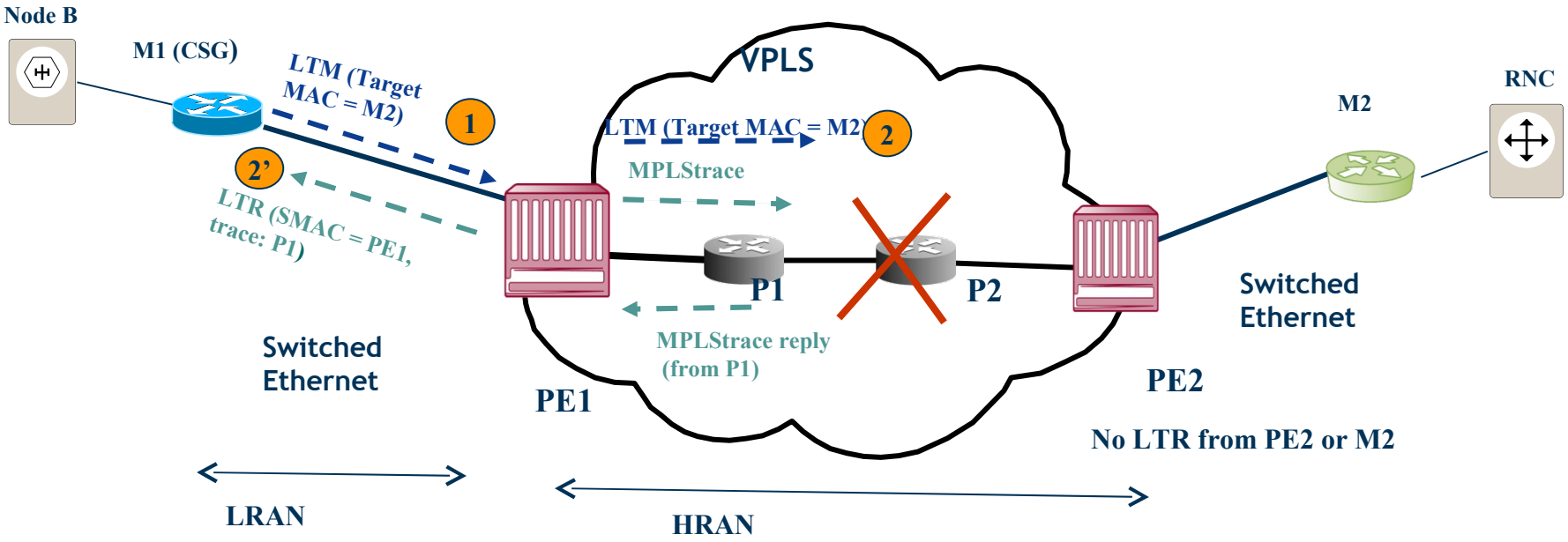
OAM Interworking (1)

- 802.1ag linktrace and MPLStrace interworking to pinpoint the faults in RAN comprising ethernet and MPLS domains
- Ingress LER, PE1, not only passes LTM further but also initiates MPLStrace in the VPLS network.
  - PE1 translates MPLStrace reply into LTR and sends to M1.
- PE1 needs to have translation function
  - LTM -> MPLStrace
  - MPLStrace reply -> LTR
- LTR from egress LER, PE2, and end station, M2, is tunneled back via PW and reaches the originator.



OAM Interworking (2)

- LTR from ingress LER, PE1, contains the indication that MPLStrace was only partially successful (up to P1 node).
  - Helps operator to pin point the problem more precisely within core of VPLS network.



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Summary

- Be cognizant of the transport and topology already in place e.g. whether microwave, SDH/PDH or ethernet
  - Not one solution fits all.
- Cost is a key factor in RAN network, so choose the technology (Radio optimizations, IP, MPLS etc) judiciously.
- Marry IP and Radio techniques where RAN backhauls just the wireless traffic and doesn't carry wireline or VPN traffic.
  - IP and Radio techniques collaboration applicable to T1/E1 infra as well.
- MPLS serves best in the converged networks where both wireline and wireless traffic go over the same RAN network.
  - However keep MPLS light weight (static MPLS) at least in LRAN.
- OAM infrastructure critical to isolating faults quickly in order to meet restoration and latency requirements.
  - OAM interworking between LRAN and HRAN: be cognizant of underlying transport.

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Thank You!

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