Upcoming wireline operators challenge on synchronization

4th International Telecommunications Synchronization Forum

November 16th, 2006

Laurent Montini – Systems Architect
lmontini@cisco.com

Agenda

- Reviewing applications of synchronization
- Evolution of packet networks
- Packet network architecture
- Changes in the architecture
  - For Timing distribution
  - For Time distribution
- What about the Timing & Time within a CO
- Summary

Applications

- Timing (Frequency)

  IT: every legacy system, some broadband technologies (SHDSL, PON)

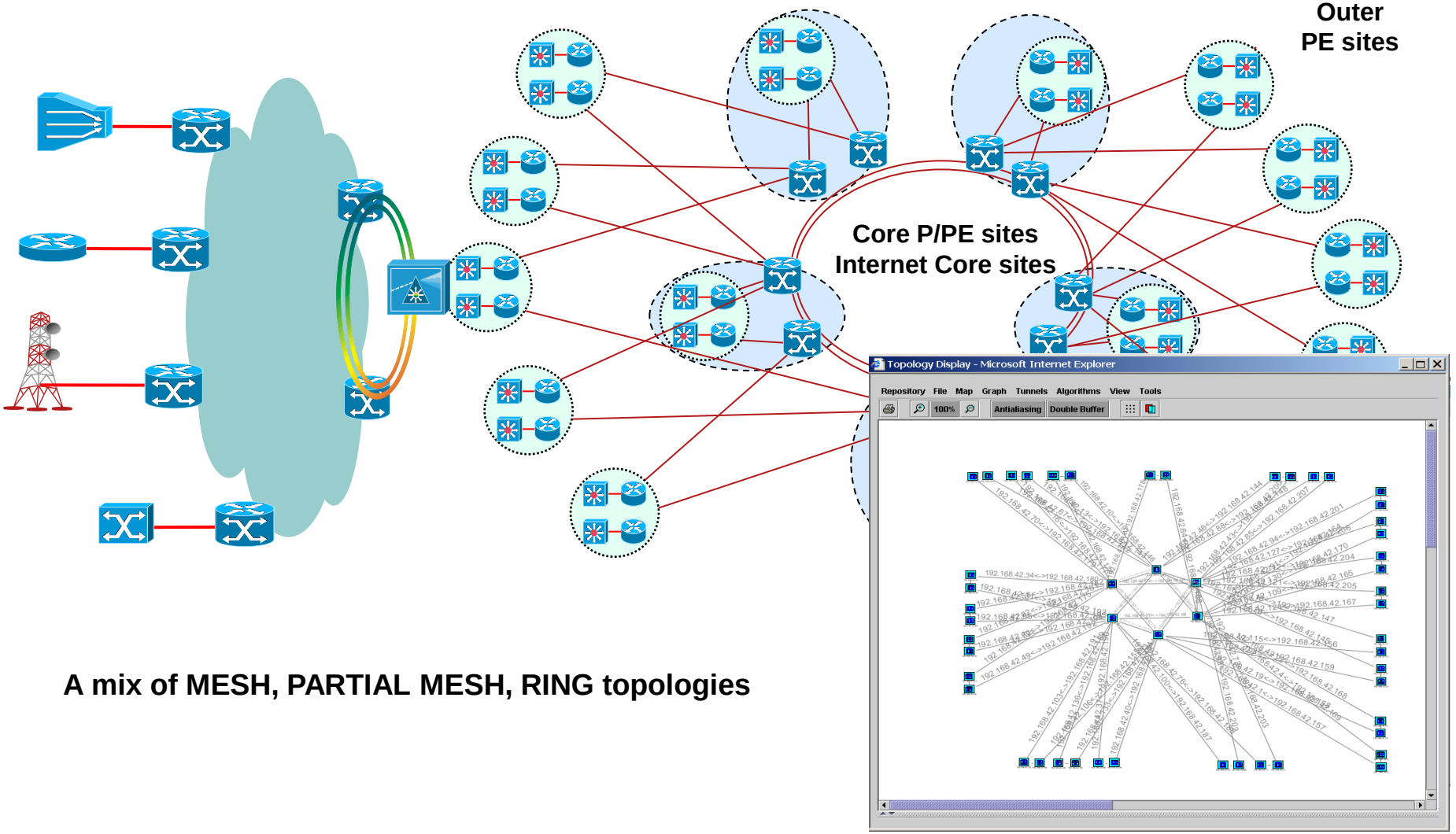
  Customer services: to mobile BS, to enterprise legacy systems

- Time

  IT: logs, IP SLA measurement, M-CMTS (cable operators); future applications: protocol enhancements (e.g. routing protocols)

  Customer services: global time service (NTP); future: TDD wireless BS, 3GPP MBMS, new application to enterprise and home

Considering the WAN
Core and Edge, Aggregation and Access

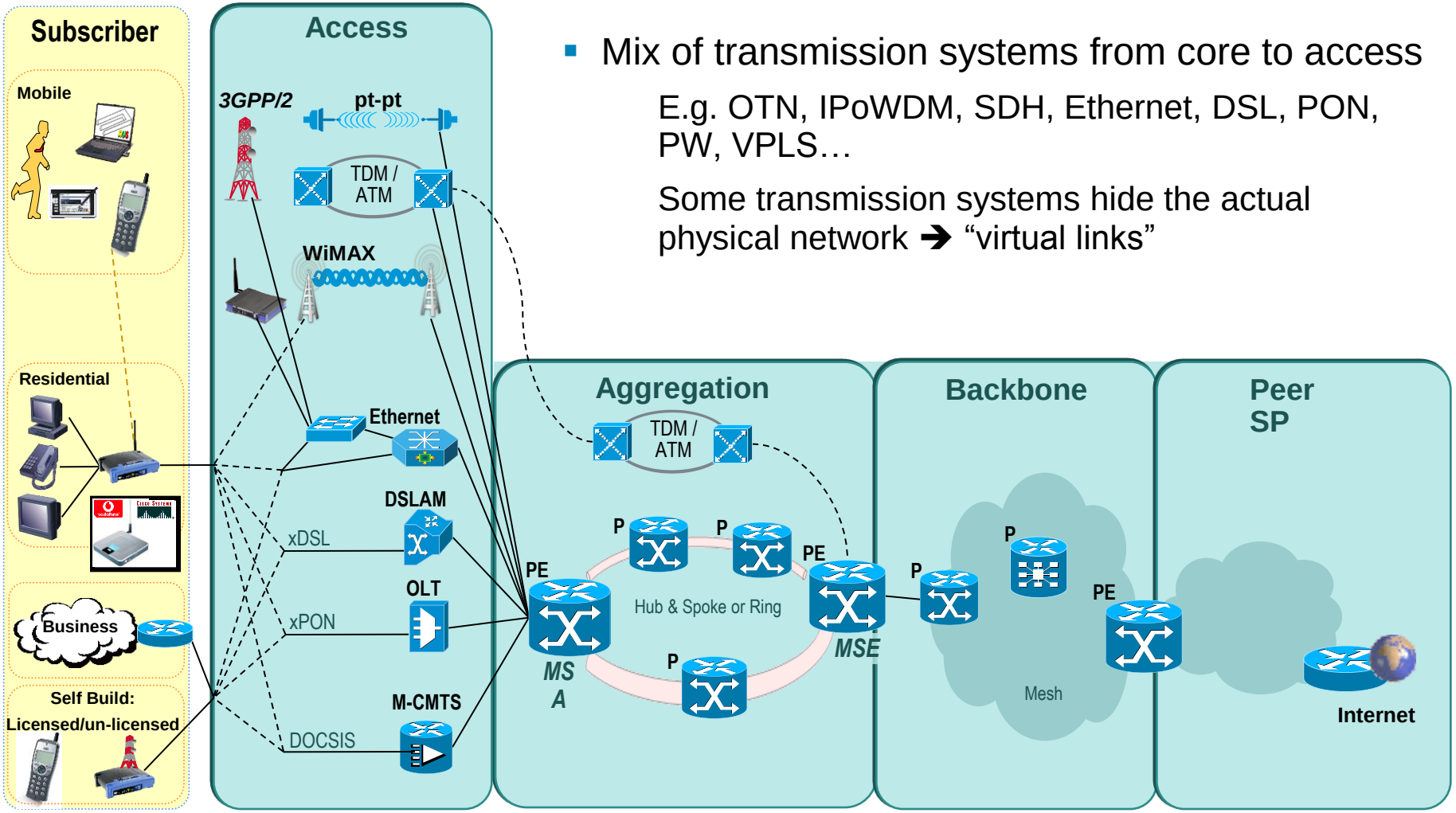


A mix of MESH, PARTIAL MESH, RING topologies

Key evolution points

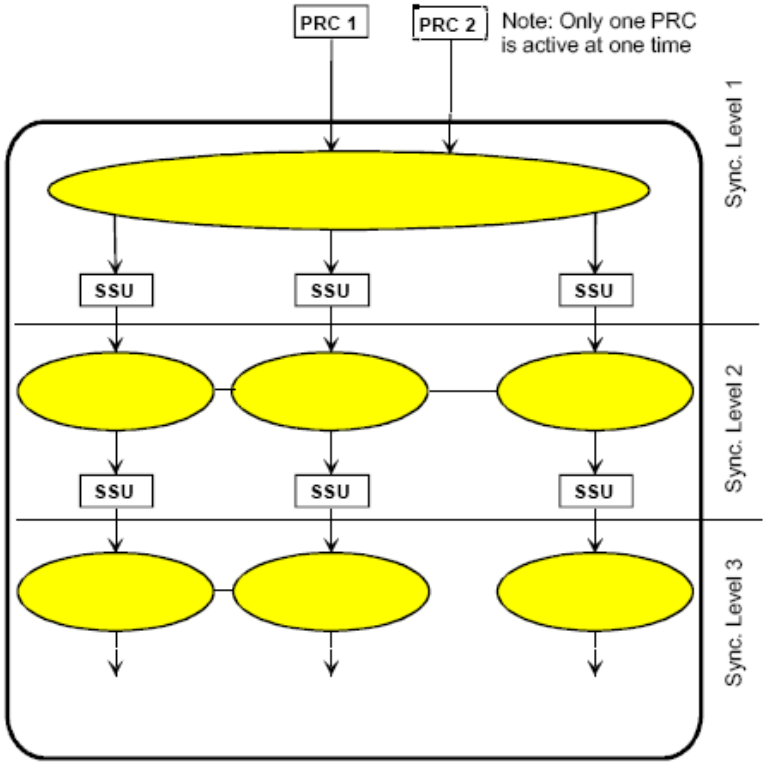
- Synchronization becomes a service
  - To:
    - SP network equipments (IT)
    - SP end users (enterprise, home)
  - Packets transmit synchronization reference(s)
  - Packet network nodes don’t need synchronization to run
  - Packet network nodes can make use of synchronization
- Number of hops (and links) in NGN
  - Work is needed to better characterized the numbers of hops compare to synchronization points
  - Typical core diameter in large ISPs is approximately 8 hops
    - From survey of production networks
    - From IP to IP nodes
  - To compare with current SDH network and synchronization chain (G.803)

High Level Service Provider Architecture

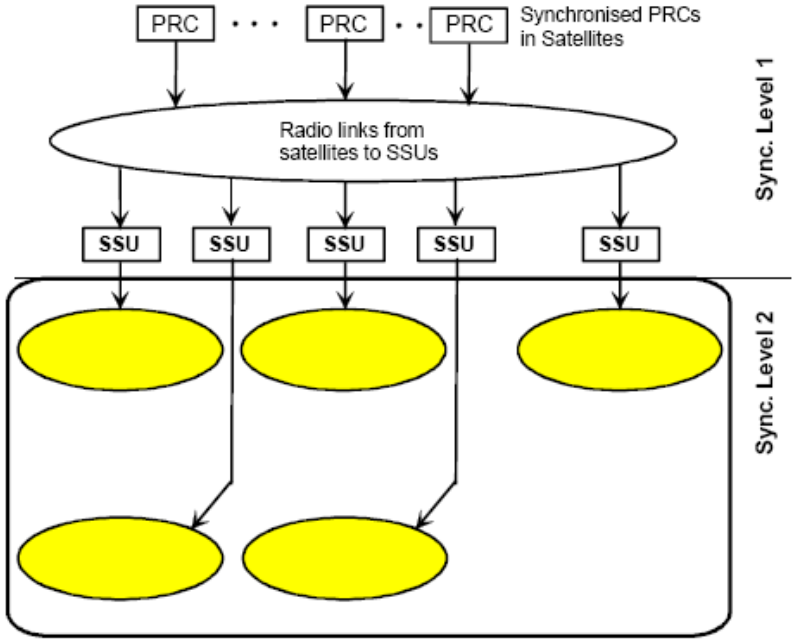


- Mix of transmission systems from core to access
  - E.g. OTN, IPoWDM, SDH, Ethernet, DSL, PON, PW, VPLS…
  - Some transmission systems hide the actual physical network ➔ “virtual links”

TDM Timing Architectures



Master-slave synchronization network architecture



Radio-distributed PRC synchronization network architecture

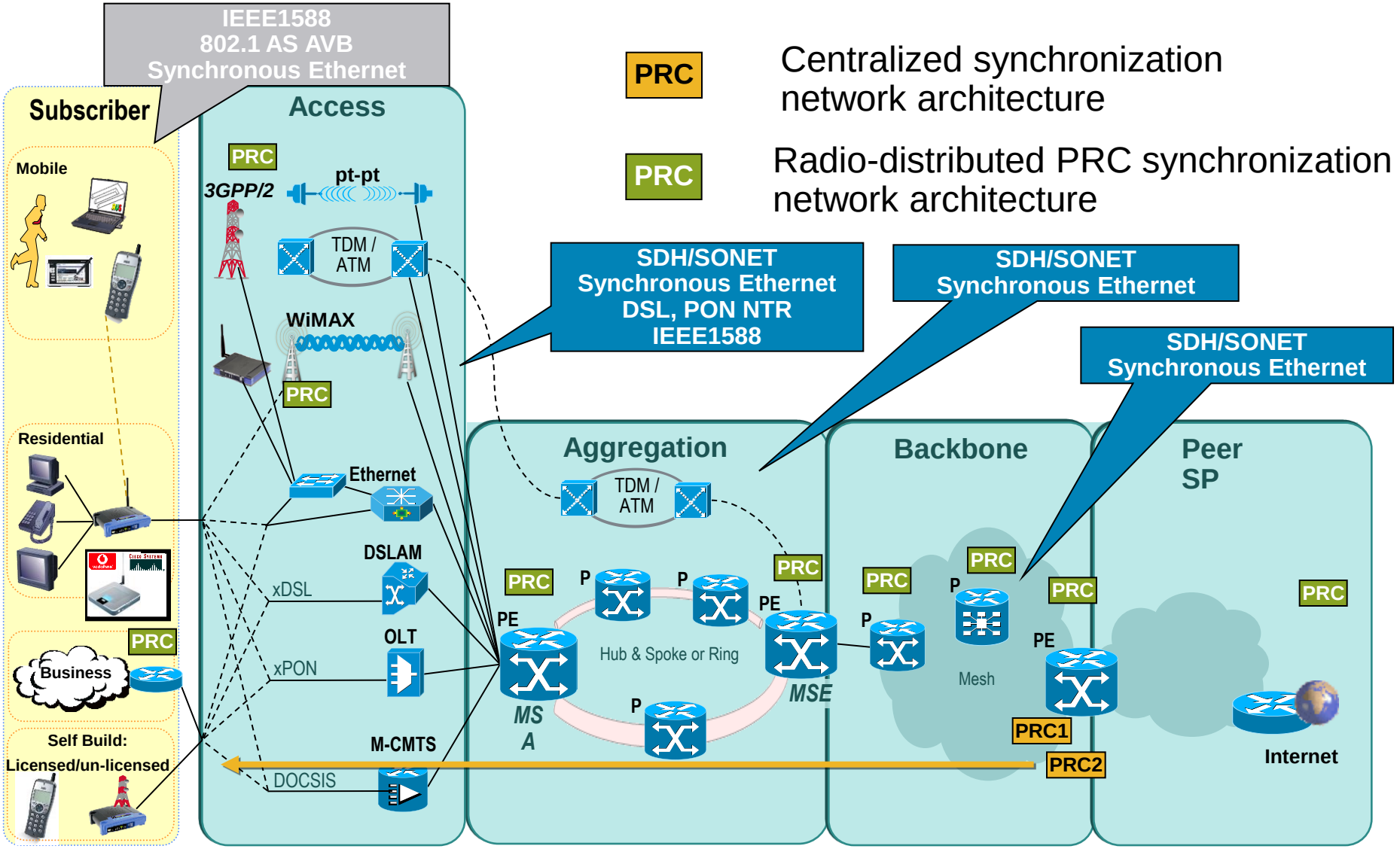
Transport subnetwork, synchronisation domain

Synchronous transport network

: Note: SSUs do not belong to the Transport network

Source: ETSI EG 201 793

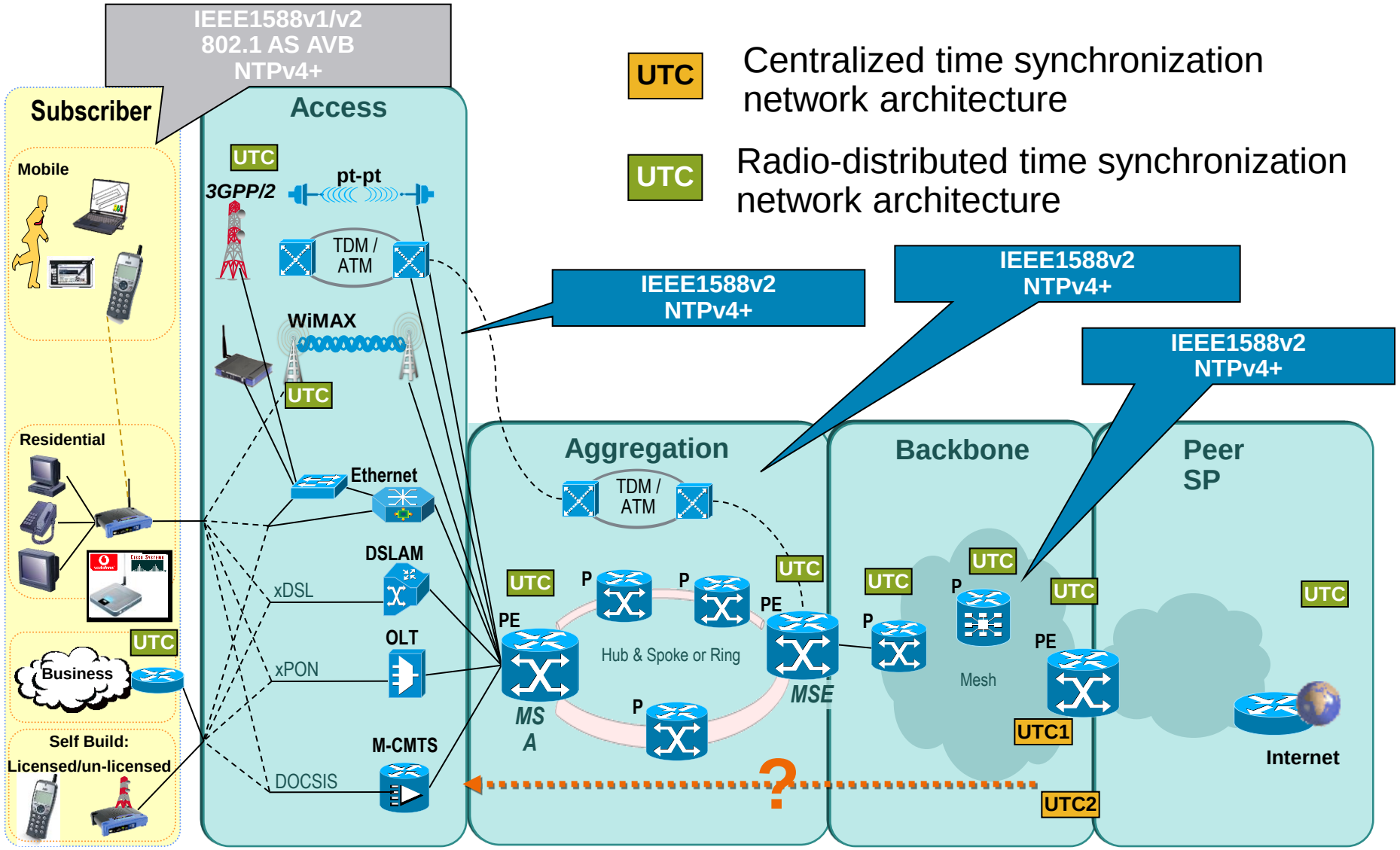
NGN Timing Architectures



Challenges for Timing architecture

- A number of solutions would be needed to cover large network
- Sync Eth solution will require router and switches upgrade
  - Recalling ITSF'05 presentation, routers and switches would need changes to play a timing SEC function
- For a service provider, Layer 1 is best solution to transmit its own timing reference… when owning network end-to-end
  - ➔ When using wholesale service, L1 timing distribution may be broken
- Solutions
  - Use sync service from wholesale if available and trusted
  - Packet technologies are flexible and would become necessary in other cases
- When providing timing service to customer, end equipment may not be L1 compatible
  - Equipment may support only IEEE1588 for instance
- In large centralized timing architecture a mix of solutions may become an issue
- In large distributed timing architecture this would be less an issue
  - Assuming every solution use PRC as clock sources

NGN Time Architectures



UTC Centralized time synchronization network architecture

UTC Radio-distributed time synchronization network architecture

Challenges for Time architecture

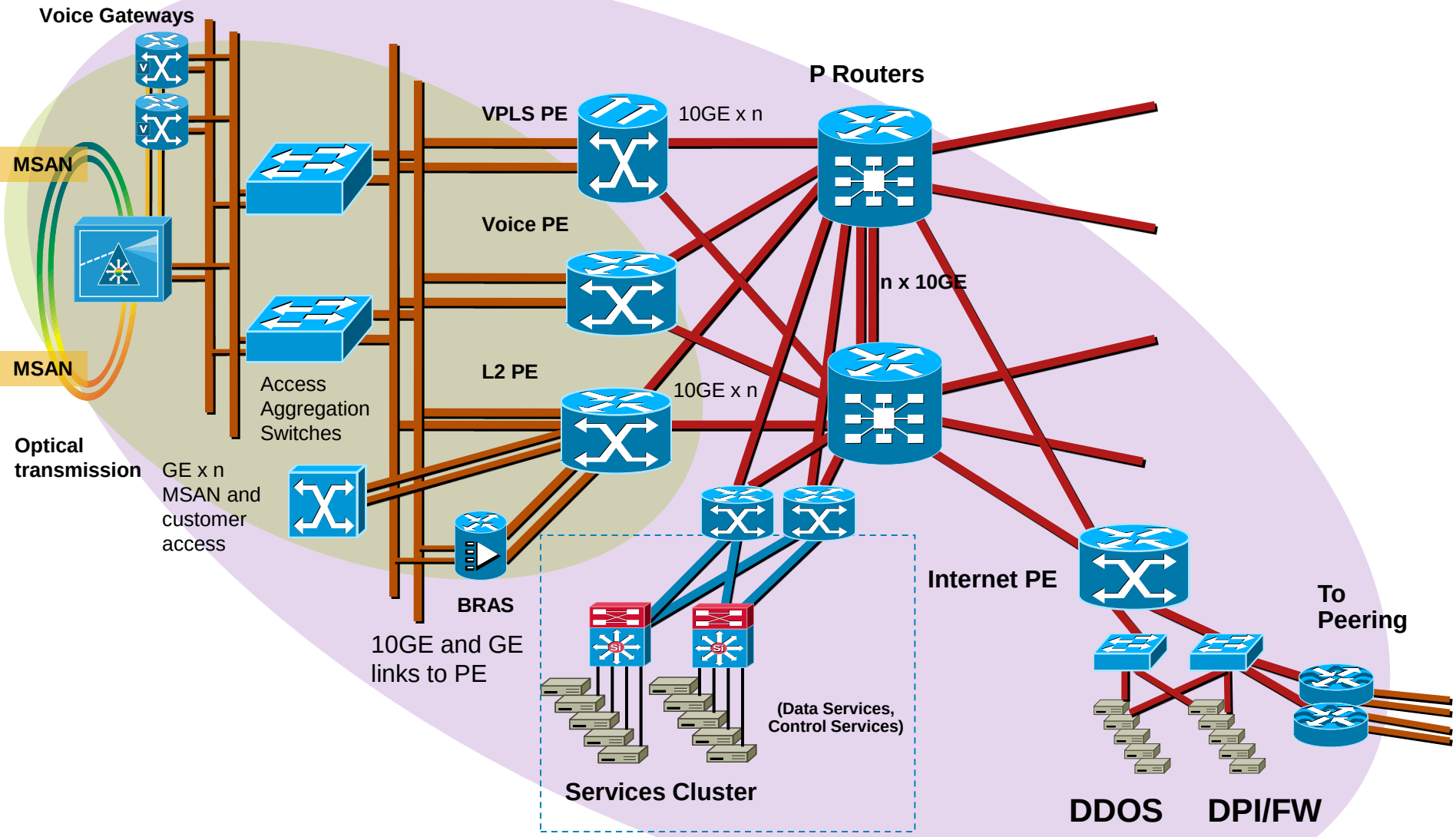
- High quality timing distribution (i.e. at L1) would significantly help high quality time distribution
  - The use of a time distribution protocol is unlikely to simplify the timing distribution architecture for a given quality level
- Number of time distribution solutions would be needed
  - Although there are a small number of time distribution protocols (IEEE1588 and NTP) it not clear if one will prevail ... at least in the short term
- Lot of emphasis on IEEE1588v2 does not make NTP irrelevant in SP networks
  - IEEE1588v2 goal is very precise time distribution
  - NTP has a high level of adoption (protocol and design are well-known)
- In a SP networks both would have to deal with same constraints
  - Packet-based two-way transfer time
  - Improvements done on one protocol can help improve the other
- Main question would be: how far is the master/server from slave/client?
  - Assumption: longer the path from reference, lower the received time quality

IEEE1588v2 and NTP

- For general purpose IT needs, NTP is the dominant time synchronization protocol.
- For applications requiring high precision time synchronization, IEEE1588v2 will probably become a requirement.
  - Because adoption in end equipments
  - The extent to which IEEE1588v2 broadens from the specialist to the general purpose market is unknown, and is the impact of schemes to improve the synchronization performance of NTP
- We need to analyze the candidate time synchronization protocols against the SP network design parameters:
  - End system requirements (e.g. performance)
  - Network equipment requirements (e.g. hardware changes)
  - Network link requirements
  - Scalability
  - Security
  - Management

Considering a CO (or PoP)

Internet core and small/medium metro nodes



Timing and Time distribution in a CO

- BITS/SSU are already deployed for timing
  - Would every packet nodes in a CO need a timing interface?
  - Would Sync Eth be a good and cost effective replacement?
- For time, NTP is currently the most deployed solution
  - Time source is often NTP server with GPS receiver
- IEEE1588v2 may become an alternative
  - This would require IEEE1588 slave in every node
- Locally, between nodes in a CO, time quality would be marginally degraded
  - Short & fast links
- However CO may impact end-to-end time quality
  - Particularly in a centralized time distribution architecture - more nodes and links to go through
  - A large distributed time distribution architecture should improve time quality – but at a cost of significantly more reference time sources

Timing and Time distribution in a CO *Cont'd*

- New local time & timing interface : UTI
  - UTI could solve timing & time distribution in a CO
  - Distribute timing and time locally thru dedicated links (like BITS/SSU today)
  - Every node would need UTI interface
- What about service equipments (service cluster)?
- What is the impact on CO design?
  - In a centralized distribution architecture, how would the local UTI server be fed?
  - Should CO egress nodes become masters/servers?
  - Will this improve the quality of time delivered to the end user?

Summary
Synchronization Domains

	Intra-CO ("LAN")	Inter-CO ("WAN")
Timing (frequency)	G.703 (BITS/SSU) *SDH* Sync Eth TTI/UTI	SDH Sync Eth IEEE1588v2 *GPS/Galileo/…*
Time (relative and absolute)	IRIG-B, PPS, … NTP IEEE1588v2 TTI/UTI	NTP IEEE1588v2 *GPS/Galileo/…*

Summary

- New applications
  - Mainly based on time requirements
- New protocols
- Hardware changes
- Modified architectures?
  - From strict centralization to light distribution of time sources
- Virtual overlay networks
  - Virtual links
- New management?
  - Common framework
  - Automatic vs. manual source selection

Q and A