Bringing IP In The RAN

BRKMWI-2004

Marco Centemeri

Cisco Networkers 2007

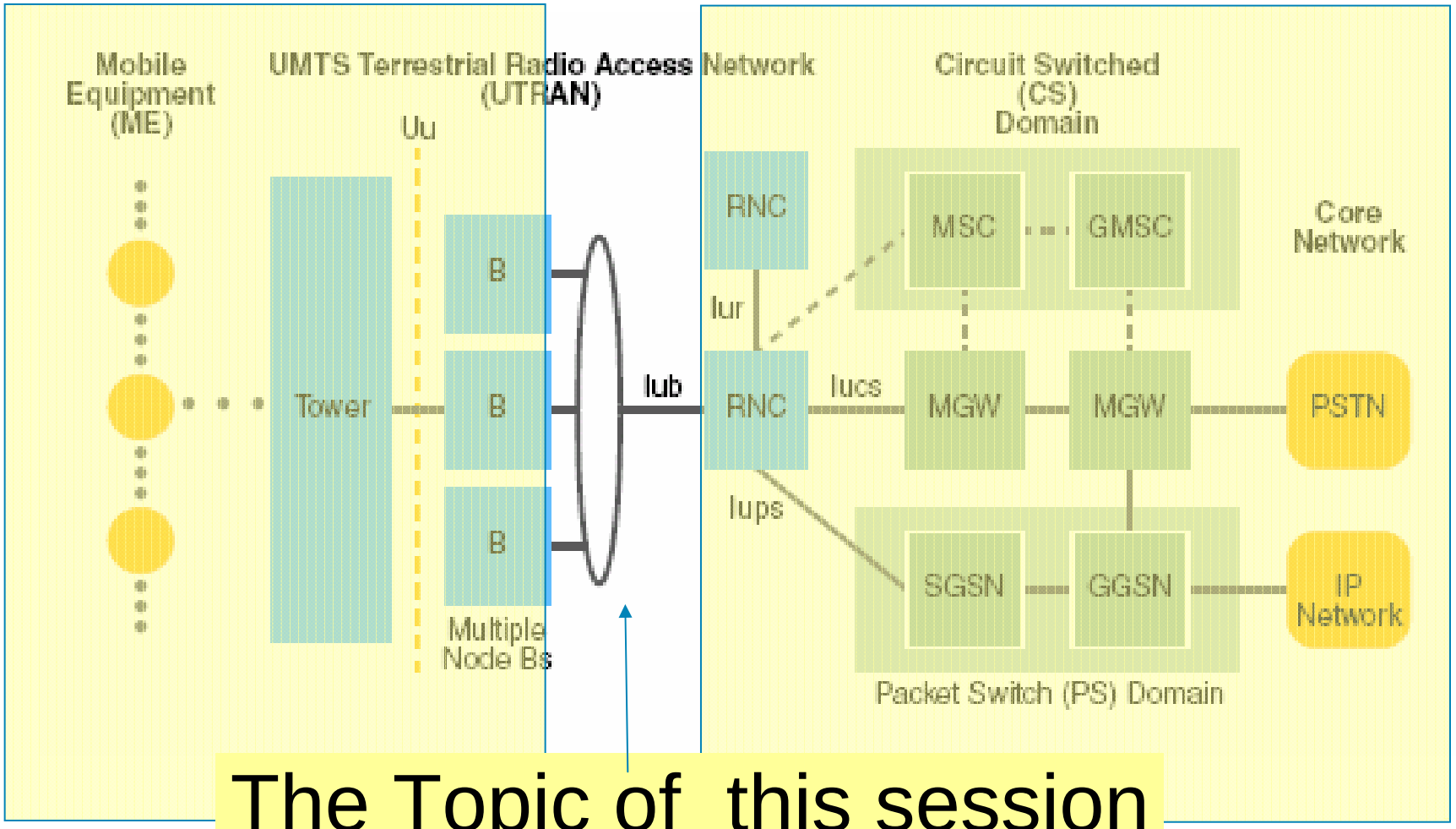
HOUSEKEEPING

- We value your feedback, don't forget to complete your online session evaluations after each session and complete the Overall Conference Evaluation which will be available online from Friday.
- Visit the World of Solutions on Level -01!
- Please remember this is a 'No Smoking' venue!
- Please switch off your mobile phones!
- Please remember to wear your badge at all times including the Party!
- Do you have a question? Feel free to ask them during the Q&A section or write your question on the Question form given to you and hand it to the Room Monitor when you see them holding up the Q&A sign.

Agenda

- Mobile Operator View
- A Roadmap for Mobile Transport
- The Role of PseudoWire
- NG RAN Network Architectures
- What about the clock?
- Summary & Conclusion

3G Architecture



Mobile Operator Challenges

- Operators need an order-of-magnitude more capacity in the RAN to support Next Gen data services (HSxPA)
- Cost per bit of traditional circuit based backhaul is too high to support required expansion. (A Gigabit Ethernet pipe costs less than an STM1 in many areas of the world.)
- Operators are looking at packet-based technology for a better cost model
- Operators would like to cap investment in legacy technologies (TDM, ATM) in favour of a future proof architecture

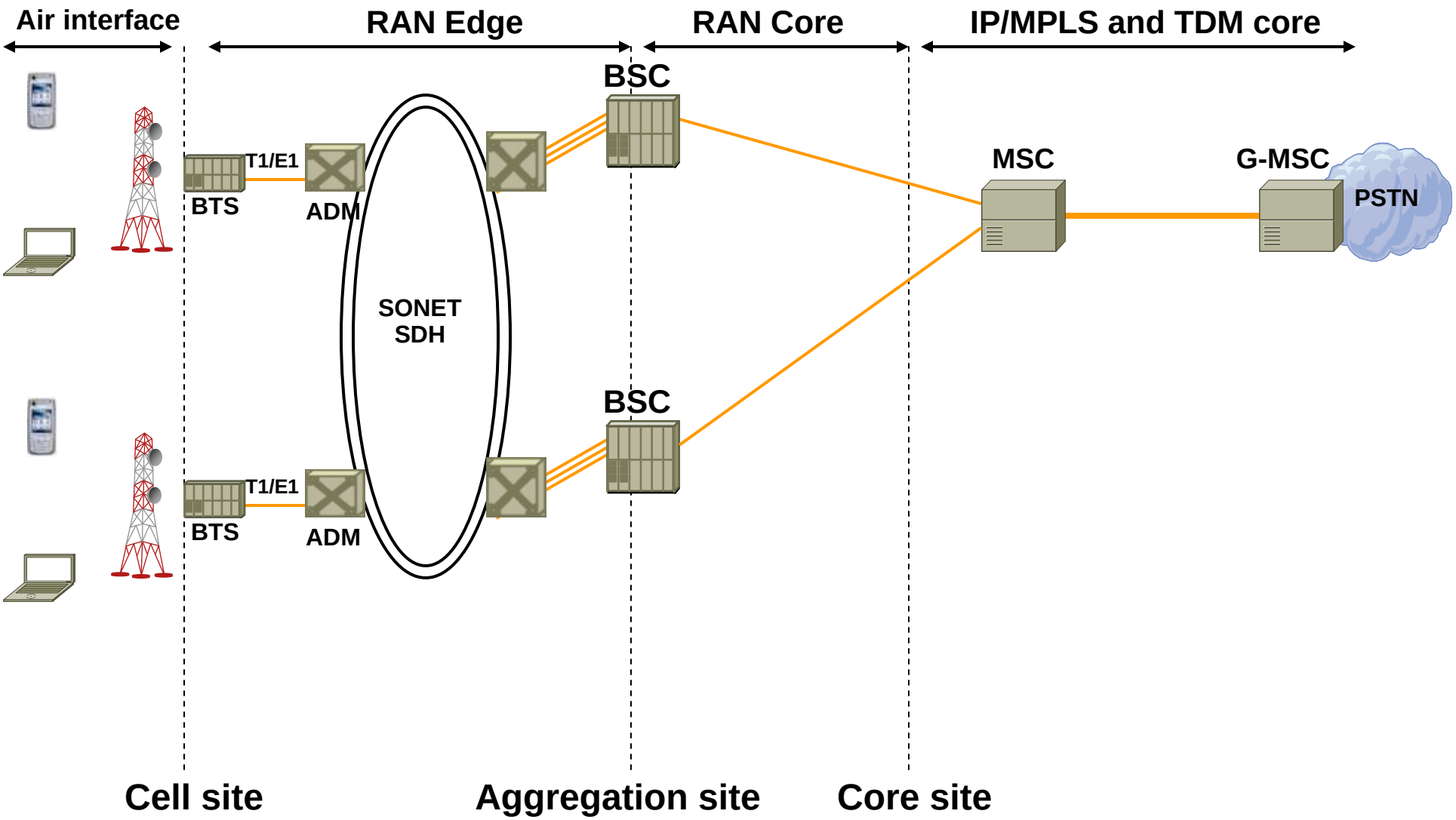
Other Considerations

- Architectural changes should be aligned with 3GPP's strategic direction whenever possible
- Each step in the evolution should ideally deliver both a long term strategic advantage and a near term pay back
- Scalable Management and Provisioning
- Focus on strategies to reduce Opex for maximum impact

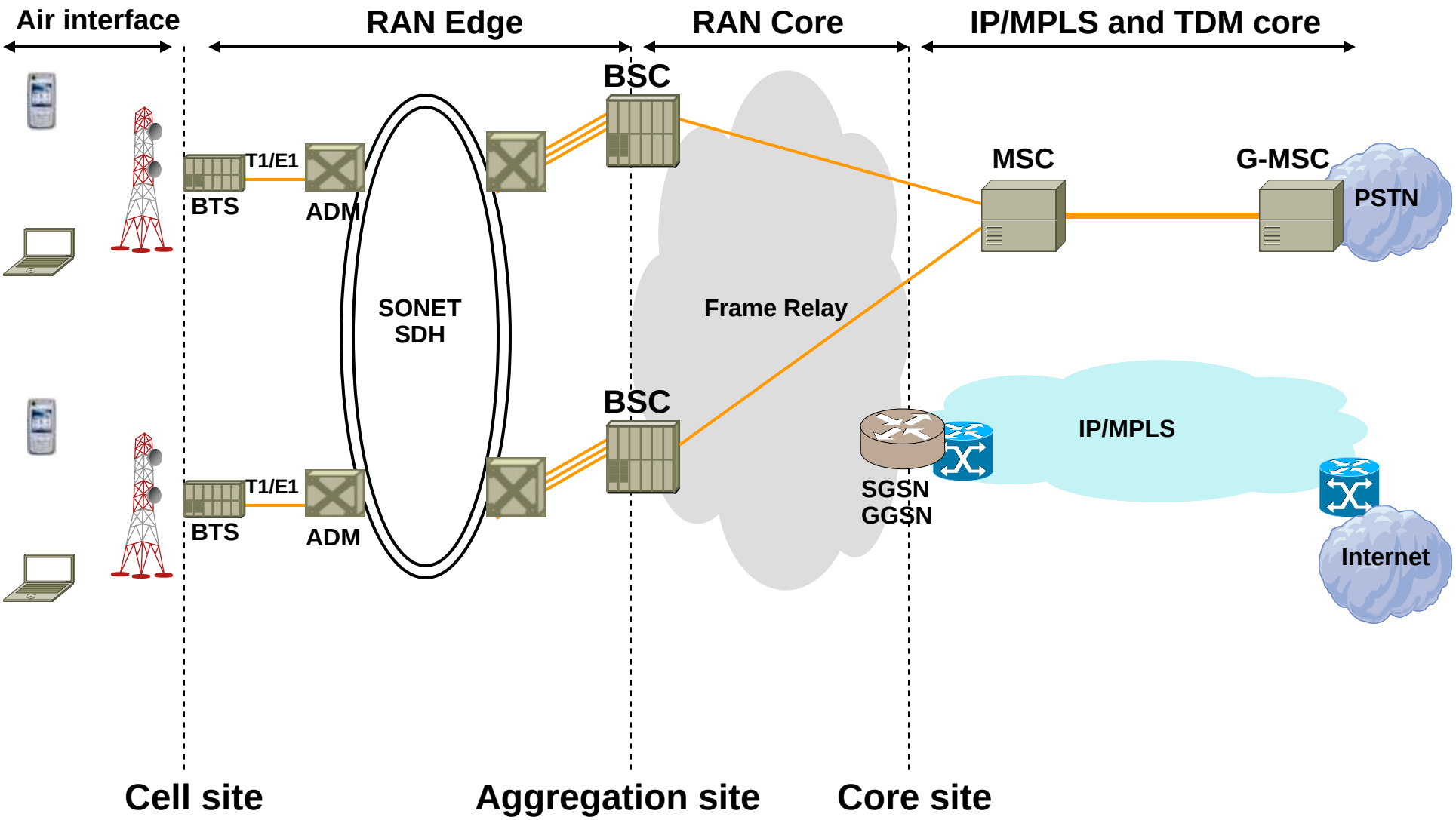
A Roadmap for Mobile Transport

Cisco Networkers 2007

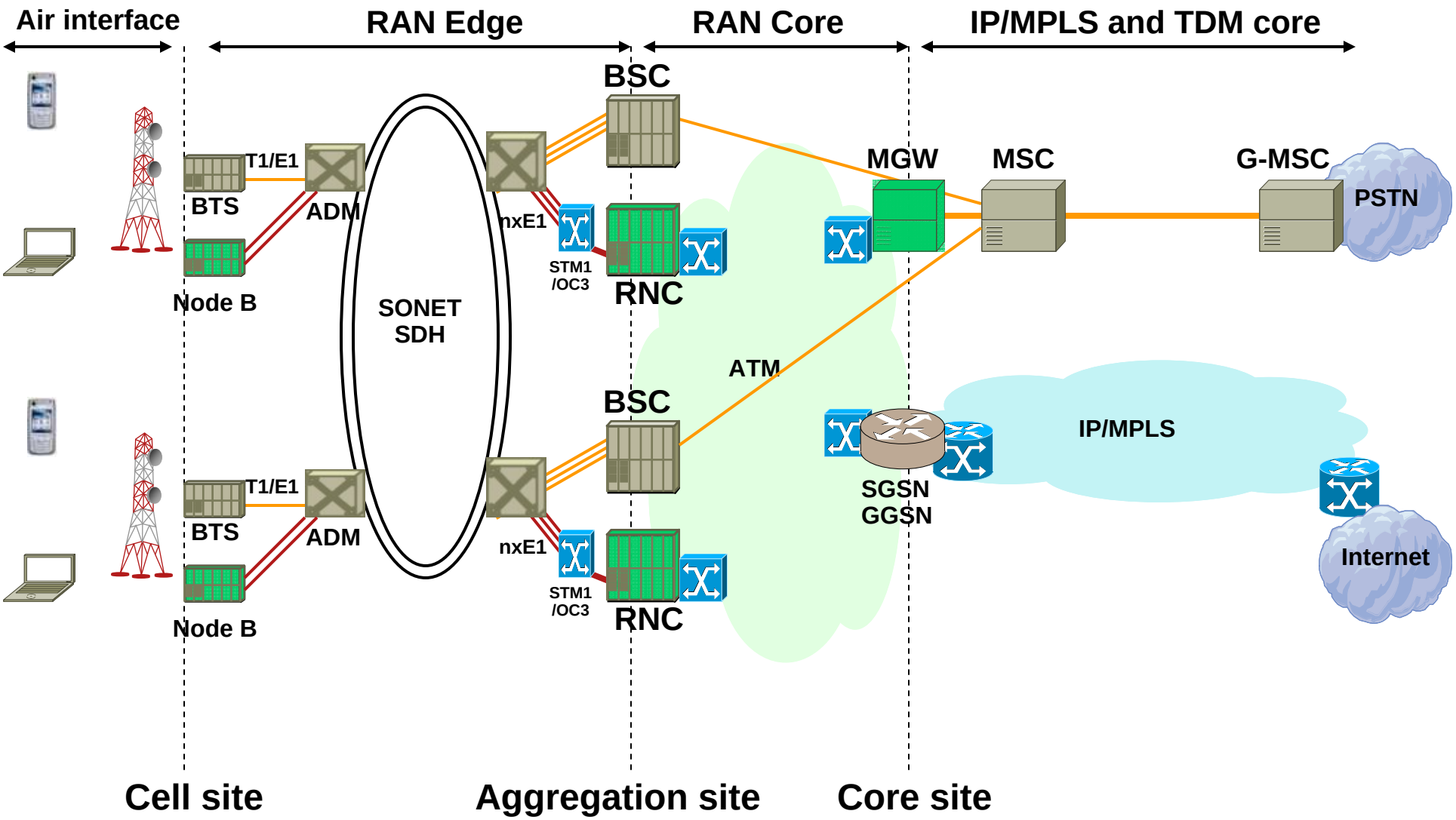
2G TDM voice solution



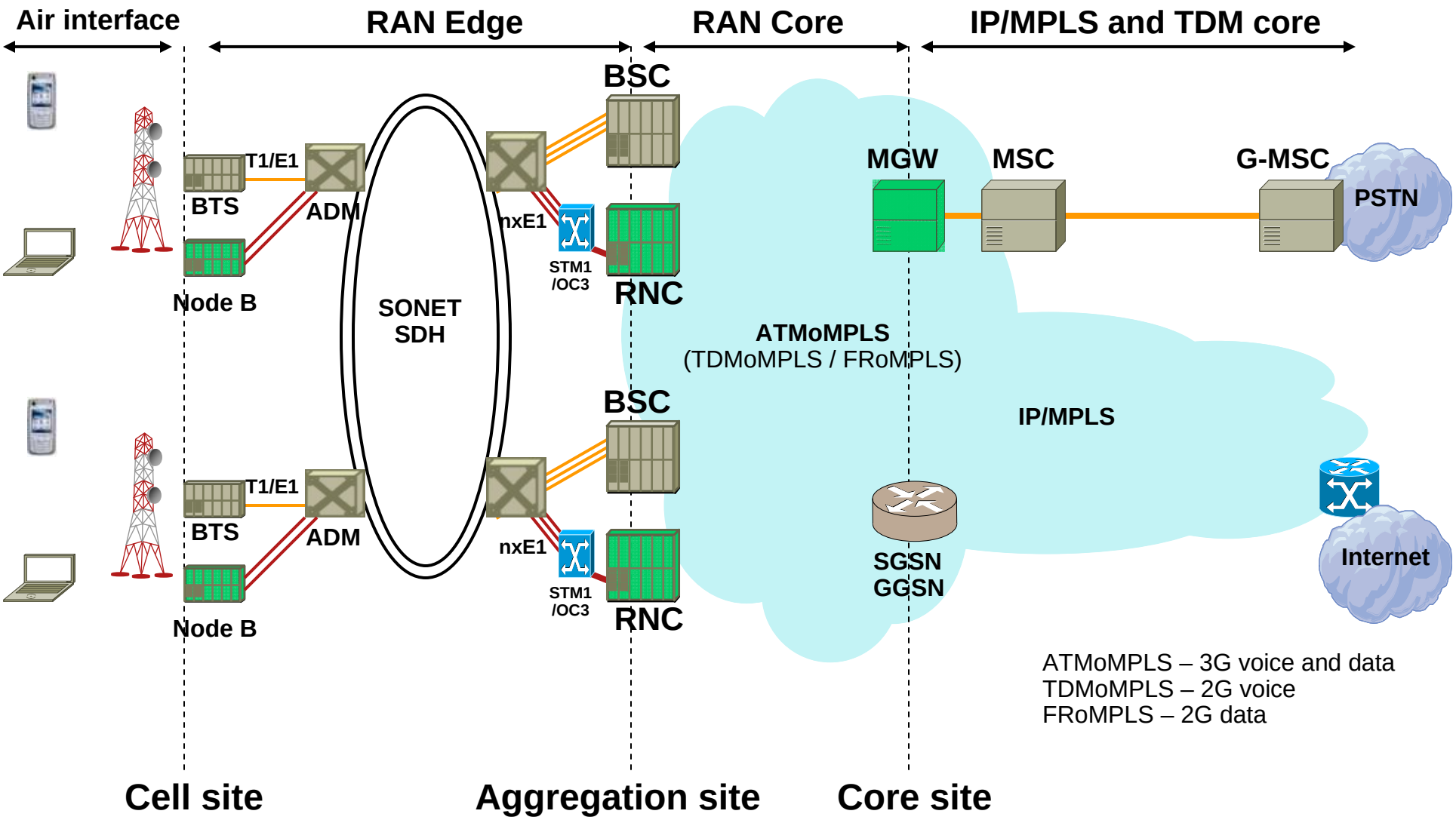
2.5G adds GPRS low speed data



3G R99 adds ATM RAN and higher speed data

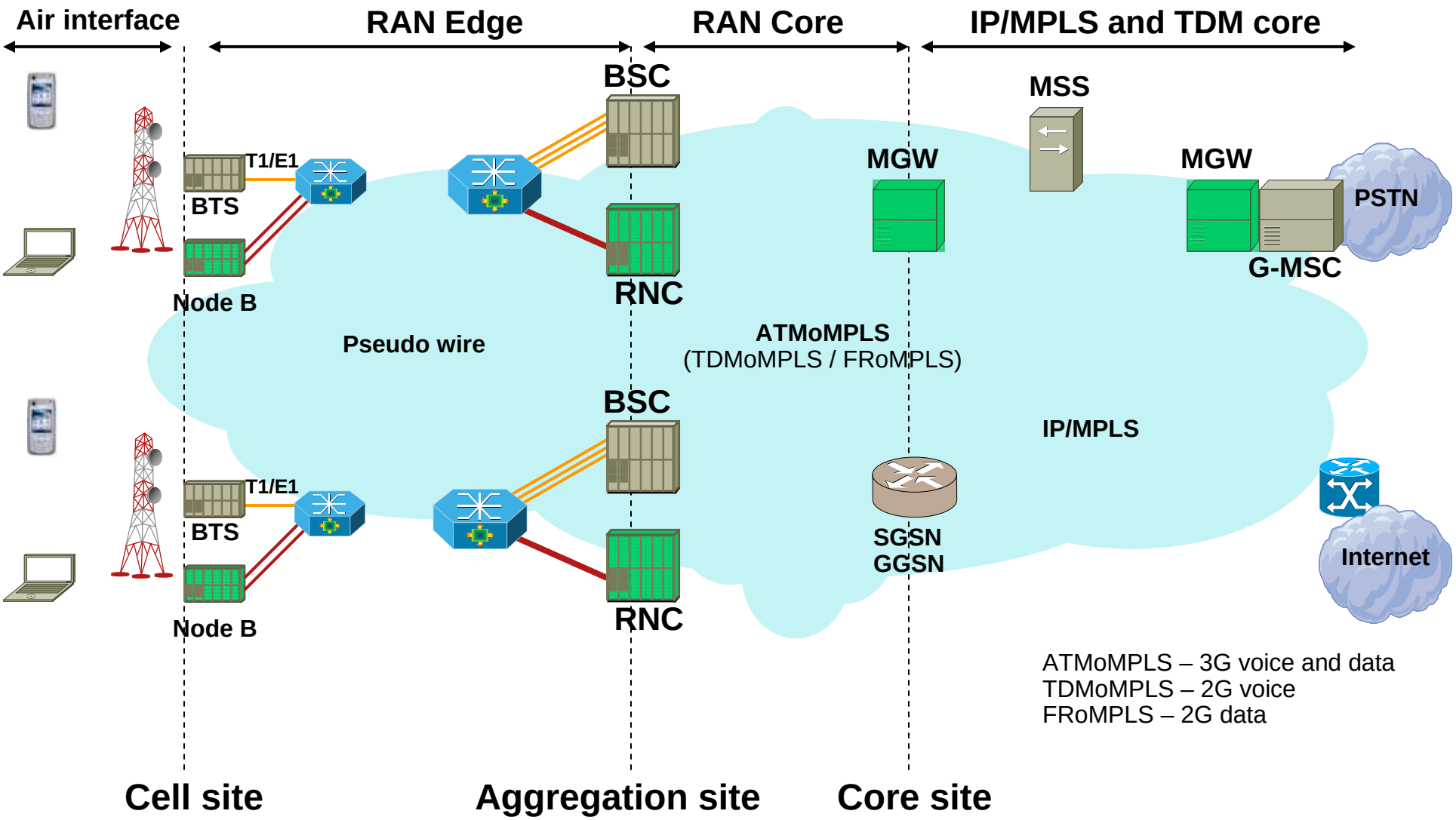


ATM pseudowire in the RAN core allow operator to cap investment in ATM



ATMoMPLS – 3G voice and data
TDMoMPLS – 2G voice
FRoMPLS – 2G data

3G R4 IP or ATM true converged IP backbone



3 Emerging Technologies

- **Next Generation Packet Networks (IP/MPLS)**

  Reliable (< 50ms recovery)

  Scalable

  Efficient (QoS and FRR => High bandwidth utilization => lower cost)

- **Pseudowires**

  A comprehensive set of pseudowire types enables convergence of all legacy networks over a single packet infrastructure

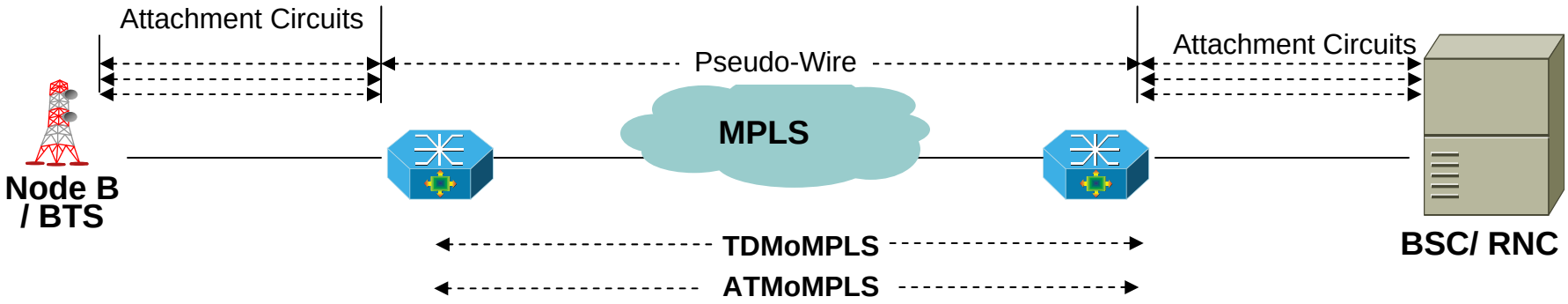
- **Timing Over Packet**

  Provides true TDM emulation to the cell site

The Role of PseudoWire

Cisco Networkers 2007

Pseudowires



- Pseudowire (PW): A mechanism that carries the essential elements of an emulated service from one Device to one or more other Devices over a Packet Switched Network (PSN).

- Within the context of PWE3, this is a network using IP or MPLS as the mechanism for packet forwarding

- Having a common PW layer provides the simplification of deployment, management and provisioning

- Industry has GOOD experience deploying some of these PW types already, and the concept now can be extended to TDM & ATM for RAN purpose

TDMoMPLS – either SAToP or CESoPSN
SAToP : Structured Agnostic TDM over Packet : draft-ietf-pwe3-satop-05.txt , RFC-4553
CESoPSN : Circuit Emulation Services over Packet Switched Network : draft-ietf-pwe3-cesopsn-07.txt

Pseudowire Types

- **ATM pseudowire**

  Used for 3G only

  Inefficient for a single cell but only sends traffic when required

  Use of cell packing can reduce overhead with minimal impact on latency

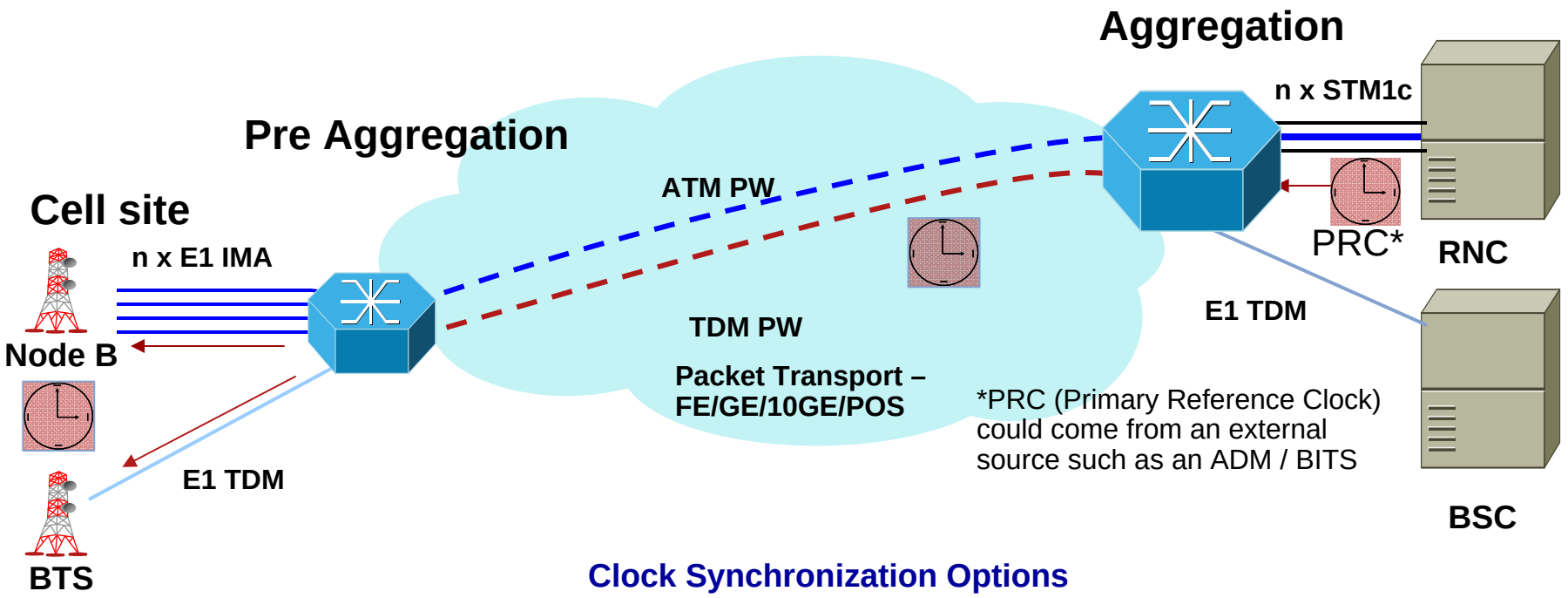
- **TDM pseudowire**

  Used for 2G and 3G

  Just as a real TDM circuit, bandwidth is wasted when the circuit is not being fully utilized.

- **For 3G networks an ATM pseudowire offers an advantage over a TDM pseudowire**

Clock Distribution
Mixed TDM/ATM Cell Sites



Clock Synchronization Options

1. **Synchronous** : Cell site receives the same TDM clock from an external source, like, BITS, SONET, GPS, etc. Most expensive option.

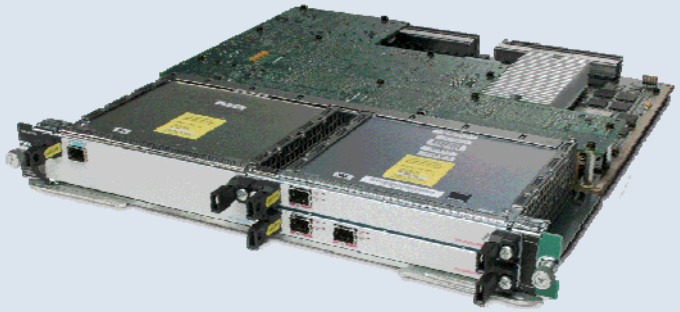
2. **Differential** : Both ends of the PW source clock from the same reference. The TDM clocks are derived at the pre aggregation point from differential information passed in the PW.

3. **Adaptive** : PW endpoints do NOT have common clock source. Instead, the clock is derived based on packet arrival rates.

Cisco 7600 CEoP Solution Components
7600-SIP-400 + CEoP SPA

7600-SIP-400

- Rich QoS capabilities for real-time traffic prioritization and protection
  - 32,000 hierarchical queues per SIP-400
  - Dedicated LLQs with CBWFQ and WRED per VC
- Zero forwarding performance degradation when enabling edge services
  - Layer 2 + Layer 3 VPN with QoS



CISCO 7600 SIP-400

CEoP SPAs (ATM/TDM over Packet)

- **Channelized SPA supporting TDM/ATM**
- **Standards based CEoP solution for ATM & TDM**
- **Support for Structure Aware & Agnostic TDM Circuit Emulation over Packet**
- **BITS Clocking Support**
- **Three versions at FCS**
  - **24 Port ChT1/E1/J1**
  - **2 Port ChT3/E3 (Post FCS)**
  - **1 Port ChOC3**
- **Supported with SUP720-3BXL/3B & Sup32**

CEoP SPA - ATM/TDM Over Packet

Cisco 7600 CEoP solution
Circuit Emulation over Packet & ATM Aggregation

- Standards based Offering
  - Compliant to G.823/G.824 traffic interface (T1/E1 and T3/E3)
  - Meets Mobile Wireless 3GPP requirements (clock accuracy better than 15ppb)
  - IETF draft-ietf-pwe3-cesopsn-xx.txt: Structure-aware TDM Circuit Emulation Service over Packet Switched Network (CESoPSN)
  - IETF RFC 4553: Structure-Agnostic TDM over Packet (SAToP)
  - ITU: Y.1413 TDM-MPLS Network Interworking (Post FCS)
- Key Features
  - BITS Clocking Support
  - Unstructured -- Emulate full DS1, E1, DS3 or E3 services
  - Structured -- Emulate Nx64kbit/s services w/ Channel Associated Signaling (CAS)
  - Configurable jitter buffer 1-500ms (+/- 250 ms)
  - Data protection based on RFC-2198 (Post FCS)
- Support for ATM (Including IMA)
  - Channelized OC3/STM1 down to T1/E1

***Post FCS**

NG RAN Network Architectures

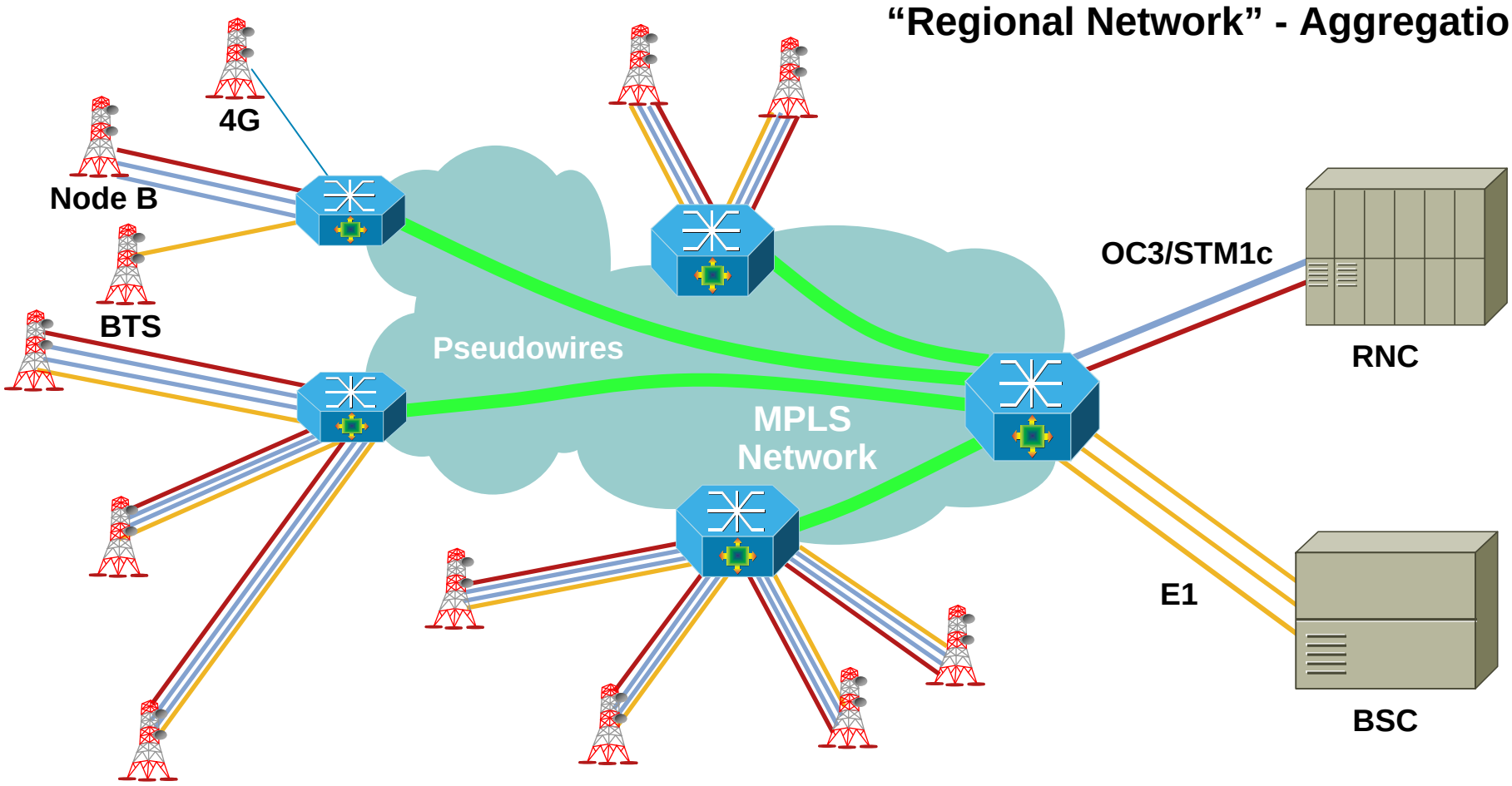
Cisco Networkers 2007

What is Pre-aggregation

Pre-aggregation refers to building transport aggregation nodes closer to the cell sites

- Move traffic from the circuit infrastructure to a packet network at the earliest opportunity
- Take advantage of statistical multiplexing and other bandwidth efficiencies where traffic aggregates
- Low hanging fruit for operators whose RAN architecture was originally driven by time to market more than cost

Pre-aggregation



Pre-aggregation of
~50-500xT1/E1

What does MPLS Pre-aggregation offer?

- Take advantage of reliable packet infrastructure where it exists
- Extend the MPLS network to the point where it makes business sense to do so
- Cap legacy investment (ATM, TDM) sooner rather than later
- A pragmatic and cost effective step towards the IP enabled RAN (3GPP)

Additional Benefits

- The pre-aggregation router becomes a natural PoP for supporting additional services and technologies (2G,3G,WiFI,WiMAX,VPN,etc)

  Some operators are already using alternate service revenue from this type of PoP to offset the cost of the backhaul for all the aggregated cell sites

- The multi-service PoP capabilities also enable Fixed Mobile Convergence
- Routing capability within the RAN will become increasingly important as intelligence moves out towards the cell site

Network Architectures

- Hub and Spoke with no Path redundancy and Single N-PE node
  - Typical for Mobile operators migrating from TDM/ATM infrastructure to packet based RAN transport
  - E1 TDM still at regional access level and in most cases provided with microwave links

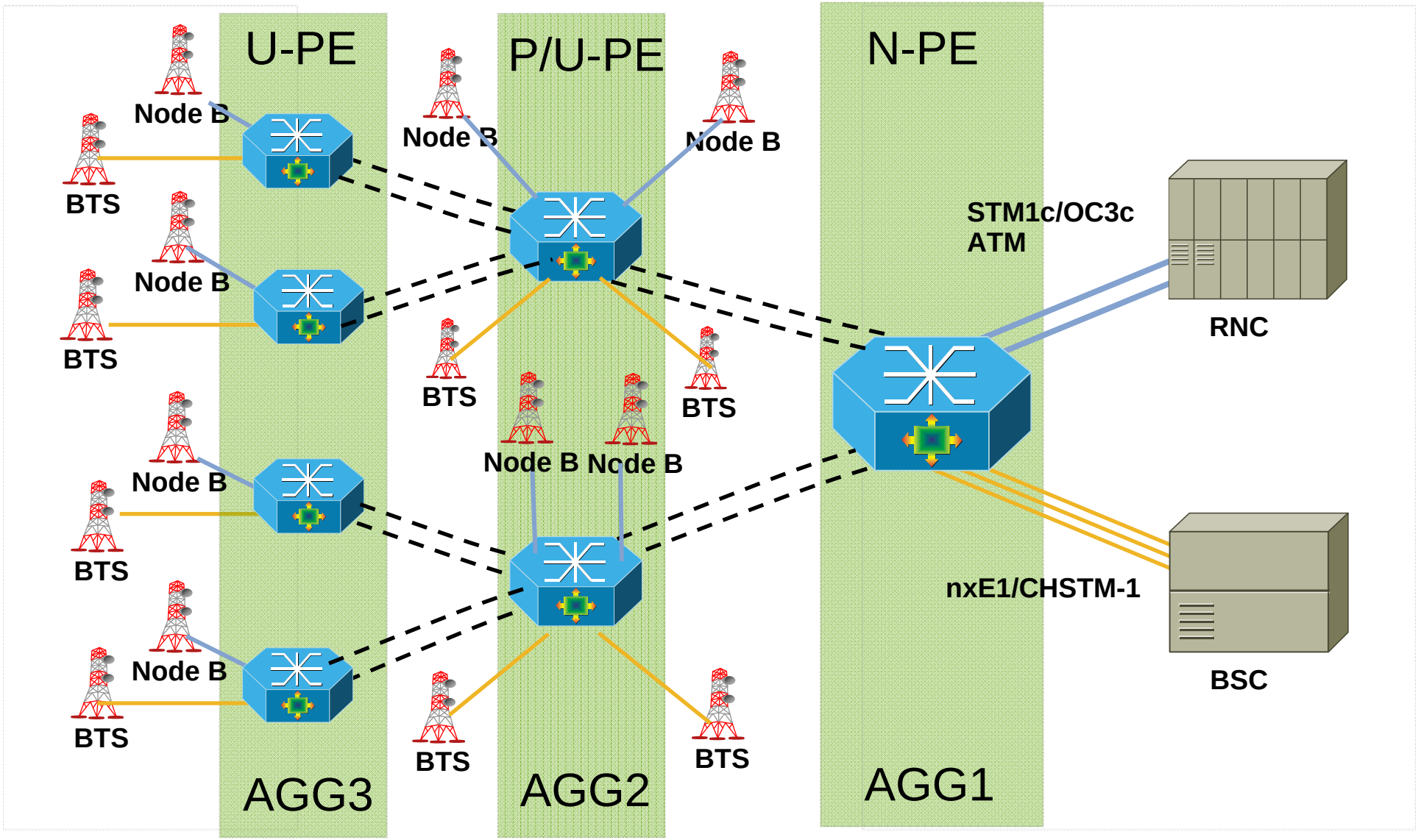
- Hub And Spoke with Path Redundancy and Dual N-PE device

  Variation of previous architecture with introduction of more resilient node failure protection and box redundancy at Aggregation site

- Ring Topology

  Primarily implemented in the conjunction with broadband access

Network Architecture – Topology #1



Details of Network Architecture #1

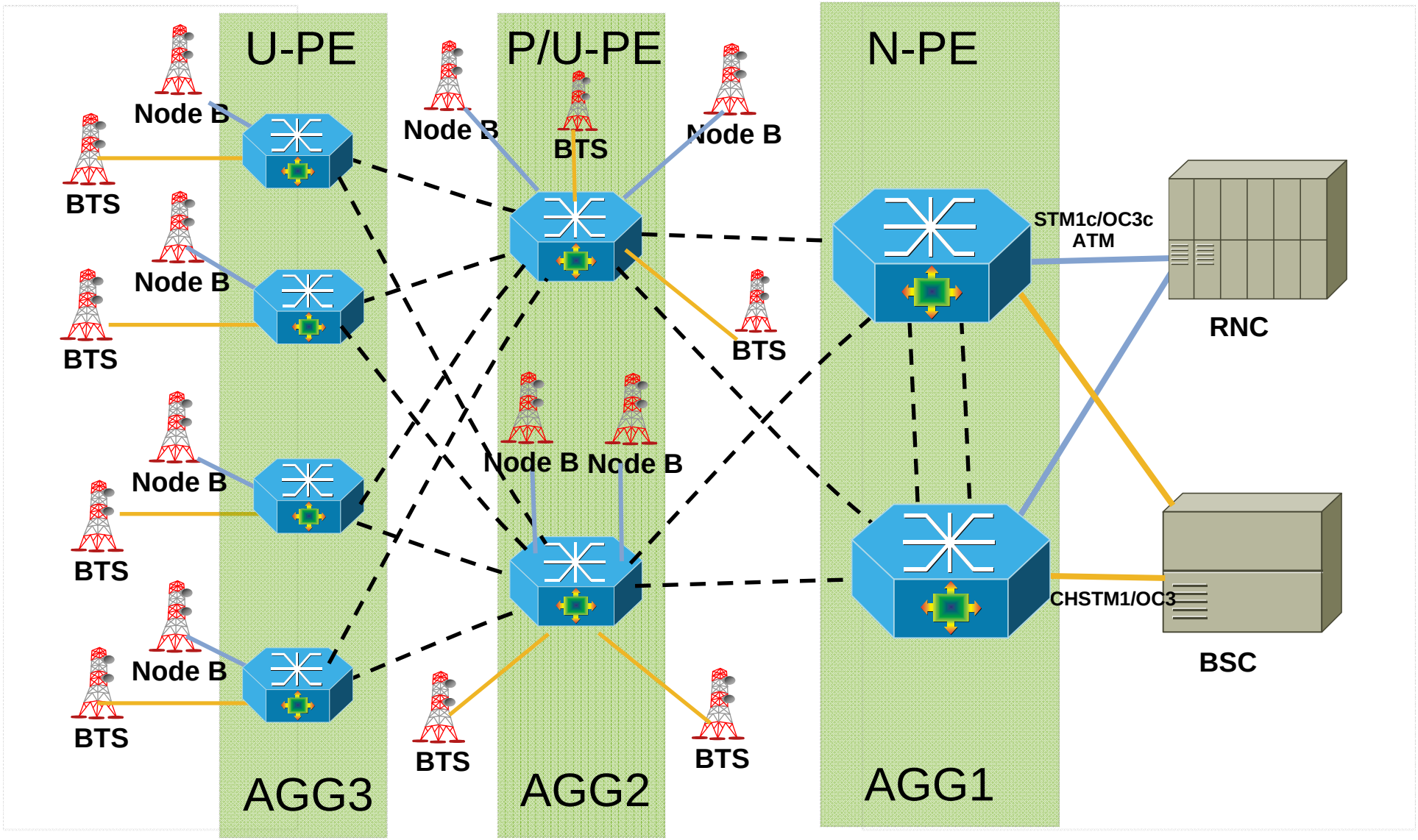
- Connectivity between AGG3 and AGG2
  - E1 Multilink PPP (can be over CHSTM-1)

    or
  - STM-1 POS

    or
  - GE
- Connectivity between AGG2 and AGG1
  - STM-1/SMT-4 POS

    or
  - GE

Network Architecture- Topology #2



Details of Network Architecture #2

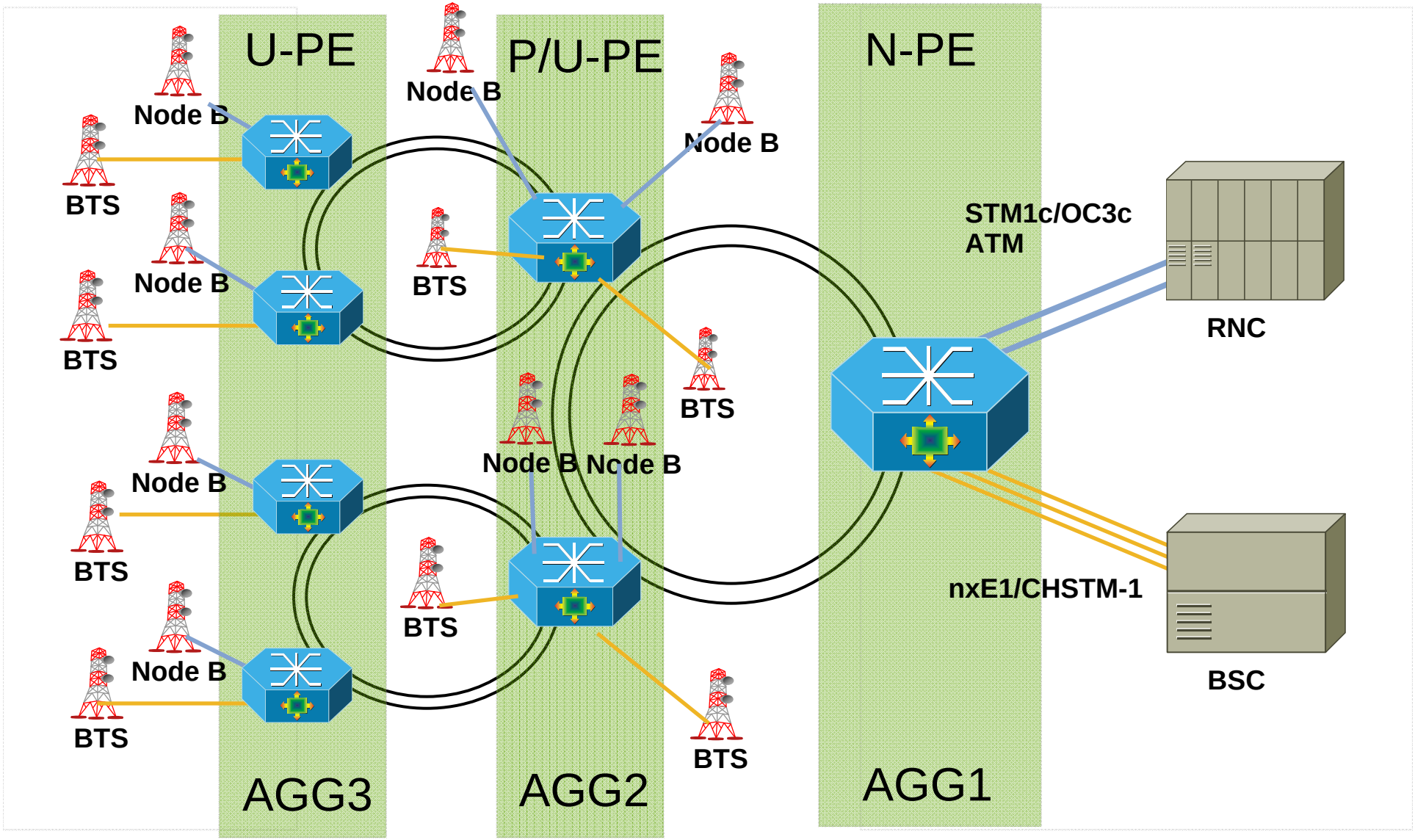
- Connectivity between AGG3 and AGG2
  - E1 Multilink PPP (can be over CHSTM-1)

    or
  - STM-1 POS

    or
  - GE
- Connectivity between AGG2 and AGG1
  - STM-1/SMT-4 POS

    or
  - GE
- Connectivity between Elements in AGG1
  - GE

Network Architecture – Topology #3



Details of Network Architecture #3

- Connectivity between AGG3 and AGG2
  - STM-1 POS

    or
  - GE
- Connectivity between AGG2 and AGG1
  - STM-1/SMT-4 POS

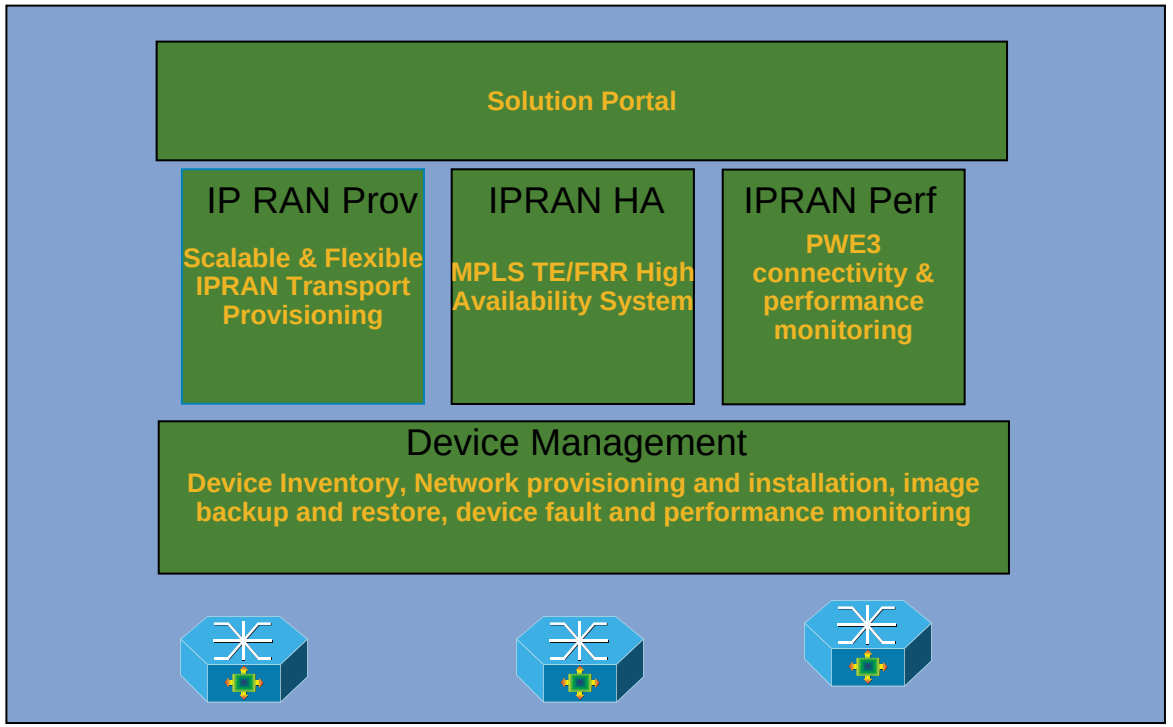
    or
  - GE

IP RAN Management Aspects

- Comprises functional components

  Provisioning, High Availability, Performance and Device Management

  Solution Portal offers a single point of access and summary level information

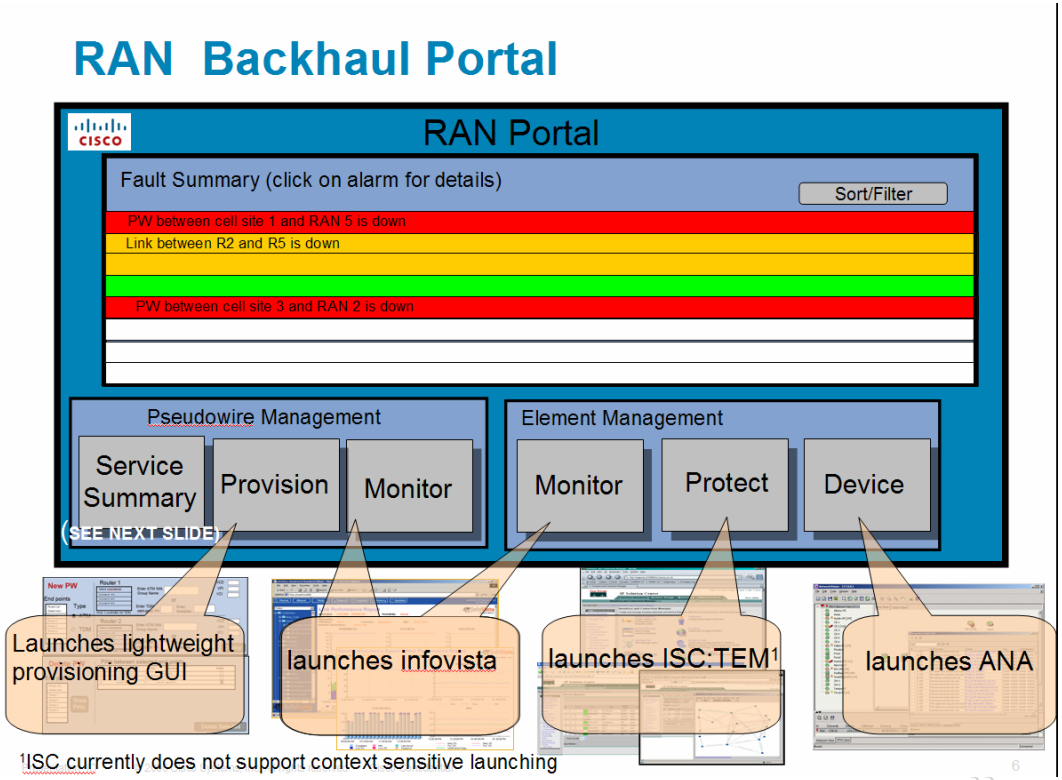


Management Solution Components

- Solution Portal is the common access point

  It is a GUI level integration.

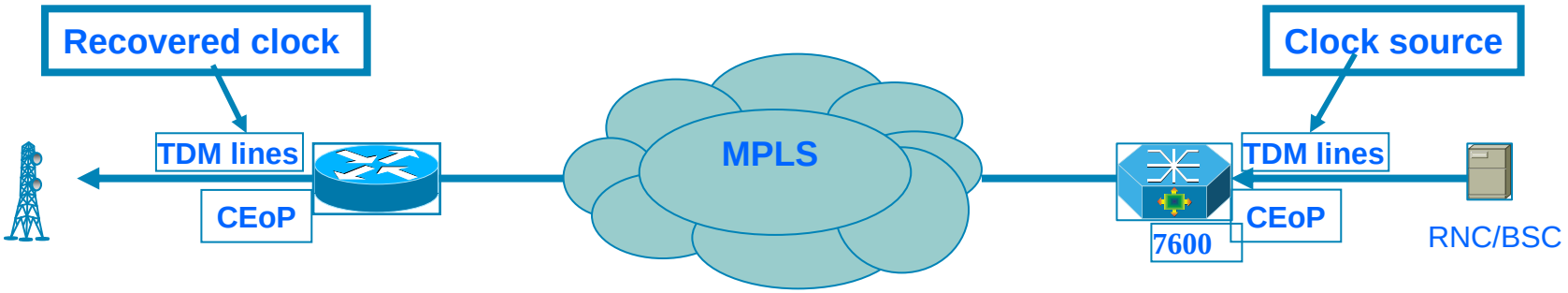
- ANA is used for element and PW fault monitoring plus element management
- Infovista provides performance reporting and data collection



What About The Clock ?

Cisco Networkers 2007

Network Clock Synchronization Options



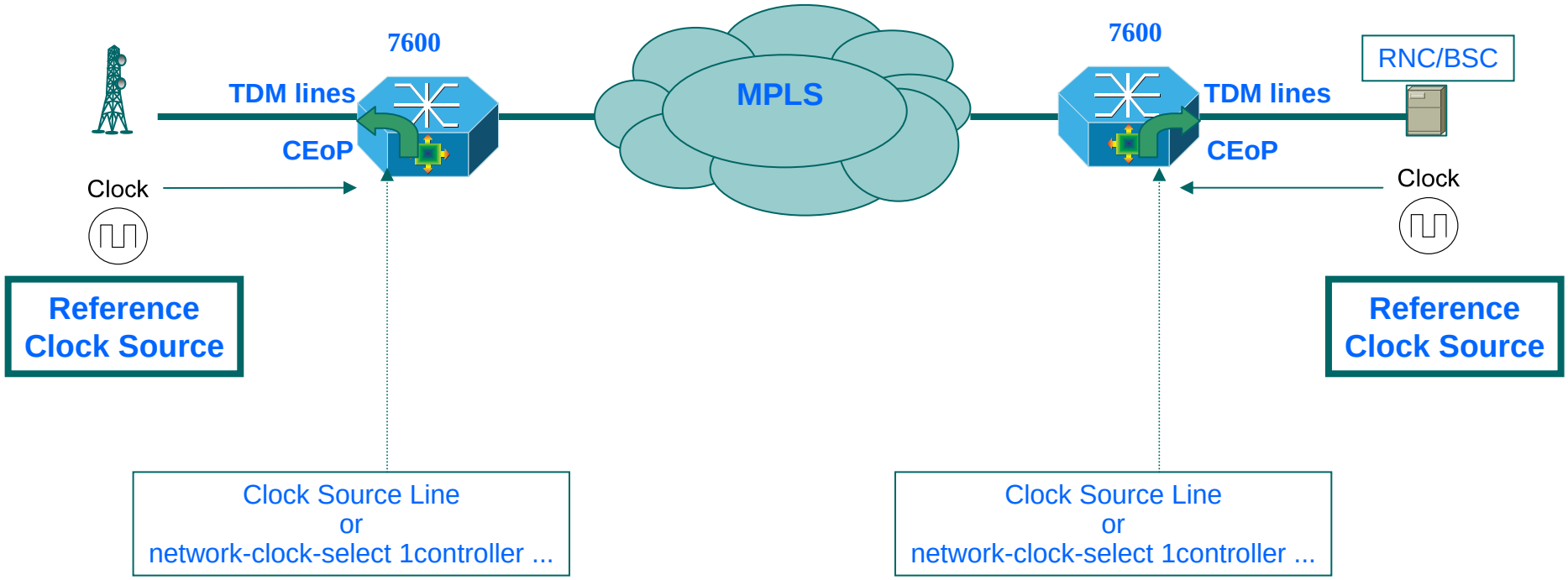
Synchronize the clock between the disjoint TDM Links

1. **Synchronous** : Cell site router receives the same TDM clock from an external source, like, BITS, SONET, GPS, etc.

2. **Differential** : Both Cell site and Aggregation routers have the same clock source. In addition, the TDM clocks are derived from differential information in RTP header of the packet with respect to the common clock.

3. **Adaptive** : Routers do NOT have common clock source. Instead, the clock is derived based on packet arrival rates.

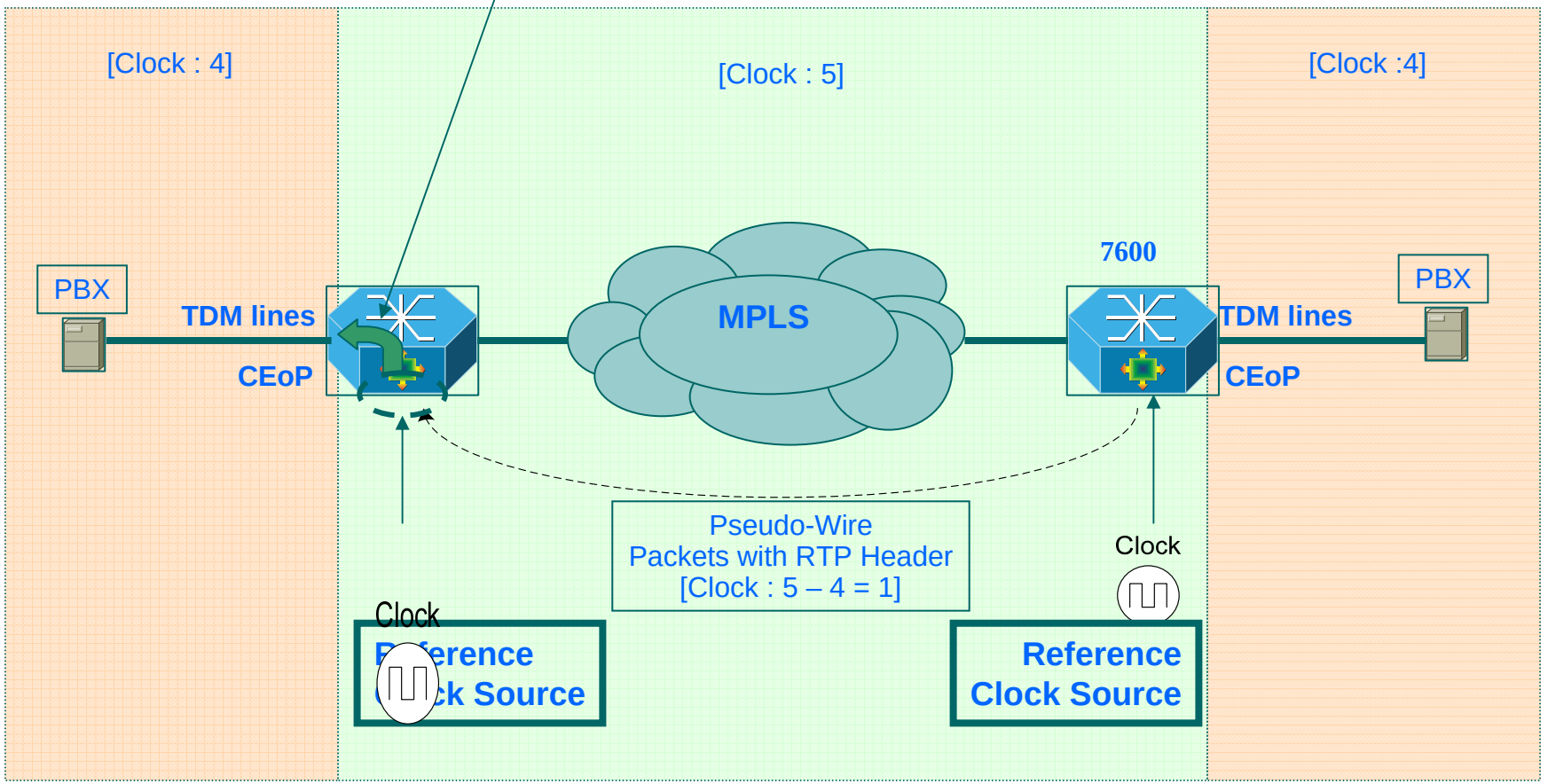
Clocking : Synchronous Mode



Reference Clock may originate from the same source.

Clocking : Differential Mode

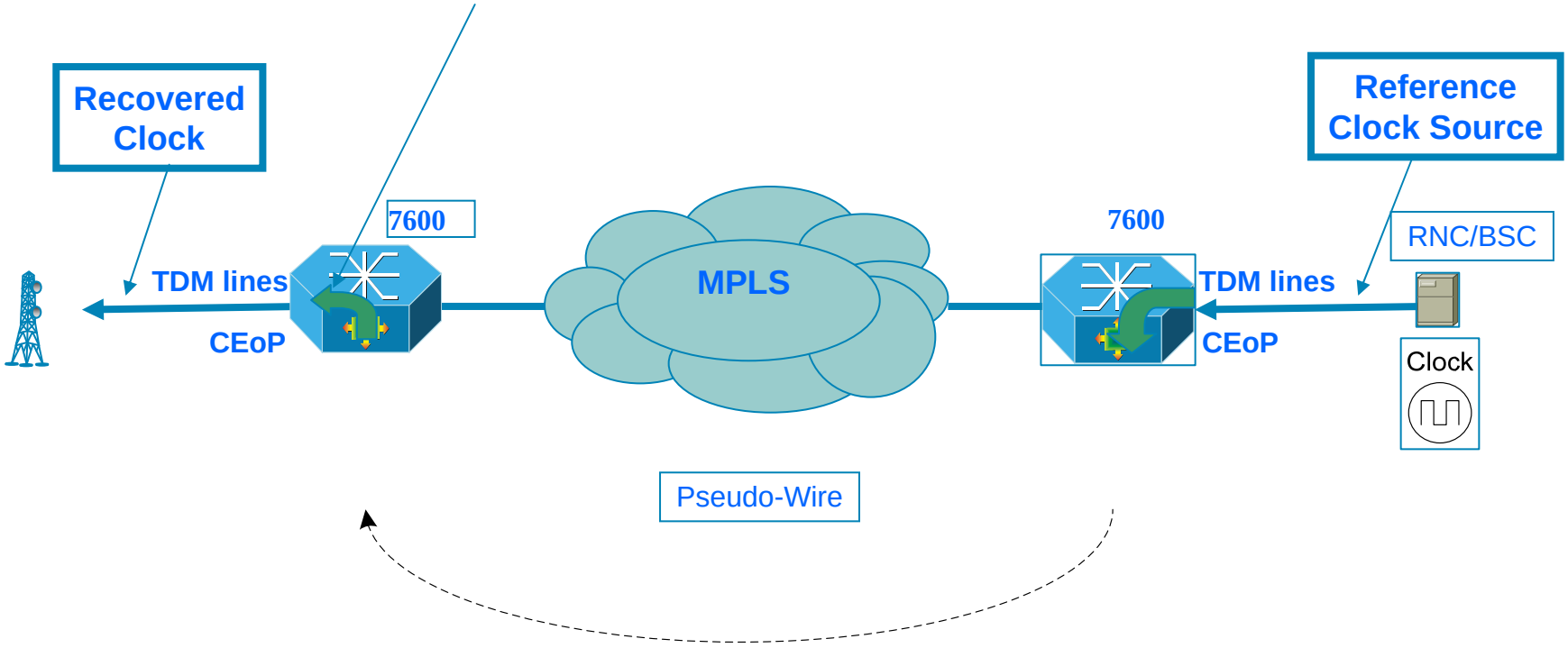
TDM Clock derived from the differential information in the RTP header and the reference clock.



Reference Clock Source does not provide the same clock as needed for TDM line.

Clocking : Adaptive Mode

Adaptive clock is derived from the rate of arrival of packets.



How is clock quality measured?

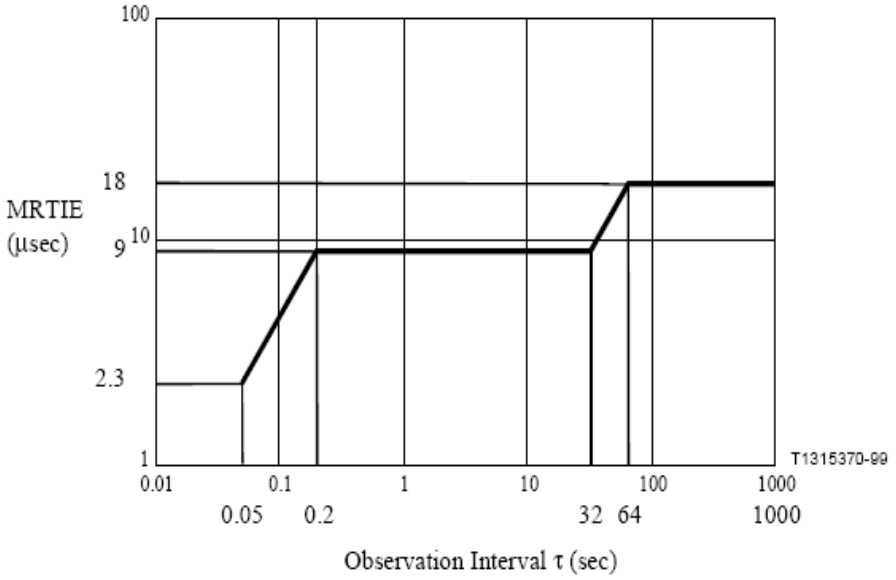
- The clock quality is measured by Maximum Relative Time Interval Error (MRTIE).
  - MRTIE shows how far the clock drifted from its ideal location during measuring time.
- The measured clock has to be below the MRTIE mask

Observation interval (τ) in seconds	MTIE in µs
$\tau \leq 900$	8.4
$900 < \tau \leq 86\,400$	18.0

T1 MRTIE mask from G.824

Observation Interval τ (sec)	MRTIE requirement (µs)
$0.05 < \tau \leq 0.2$	46 τ
$0.2 < \tau \leq 32$	9
$32 < \tau \leq 64$	0.28 τ
$64 < \tau \leq 1\,000$ (Note)	18

E1 MRTIE mask from G.823

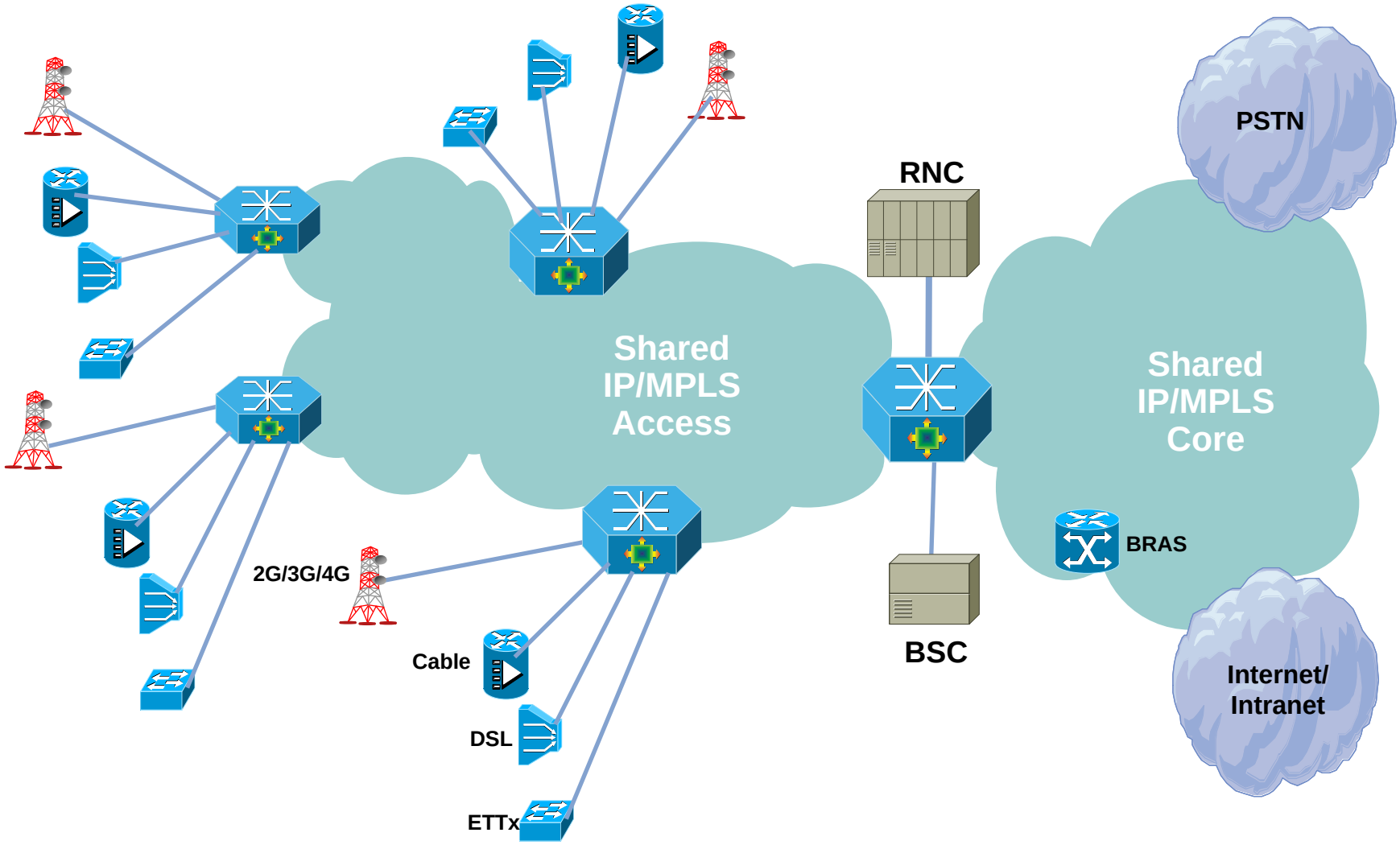


Graphical E1 MRTIE mask from G.823

Summary and Conclusions

Cisco Networkers 2007

Fixed Mobile Convergence



Pre-aggregation nodes with pseudowire capability enable Fixed Mobile Convergence

Revolution vs Evolution

- The restructuring of the RAN is driven by the anticipated revolution that must occur in the operator's source of revenue (i.e. next gen data services)
- Incremental improvements are insufficient to meet this demand
- However, when you consider the enabling technology, it is much more evolutionary than revolutionary

  High speed, robust packet networks and even pseudowires of various descriptions have been deployed in mission critical applications for years. (e.g. stock exchange, airports, etc)

Meet the Experts
Mobility

- Eric Hamel
  Consulting Systems Engineer

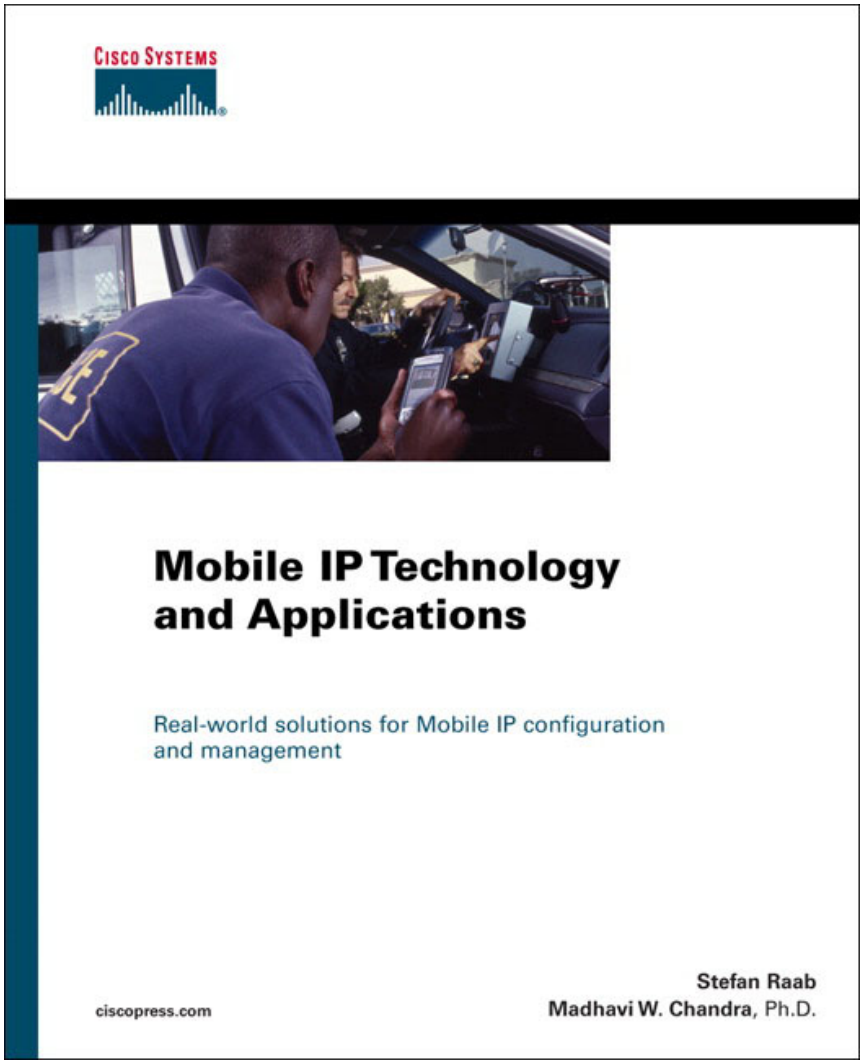
- Gaétan Feige
  Consulting Systems Engineer

- Marco Centemeri
  Distinguished Systems Engineer

Recommended Reading

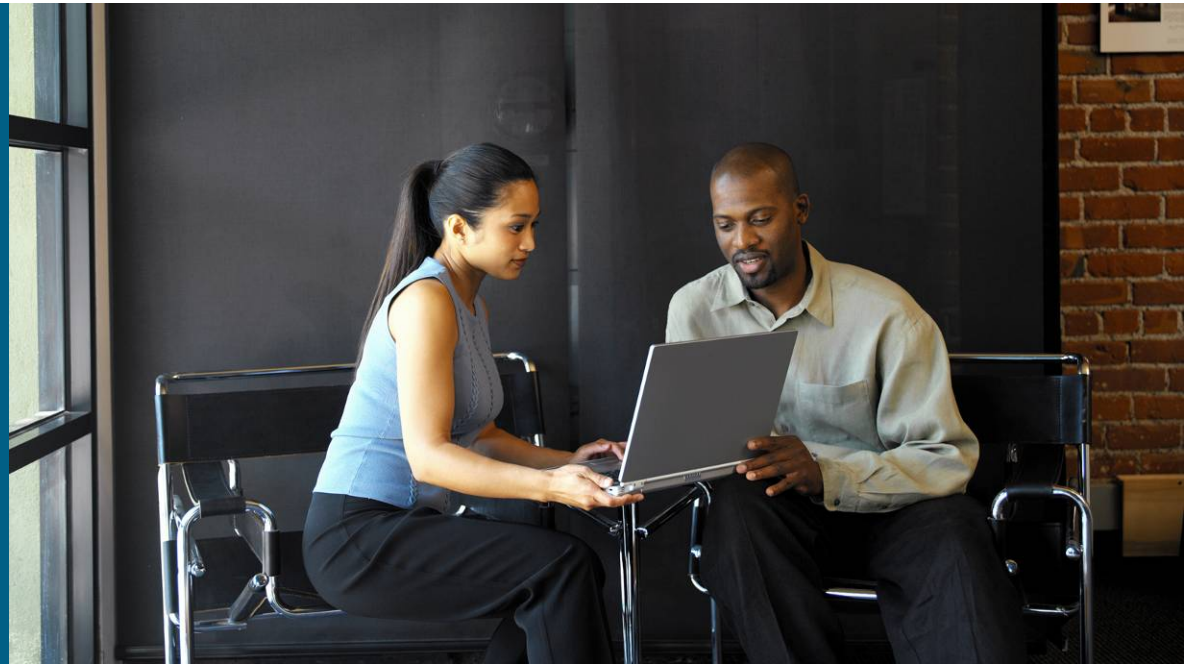
BRKMWI -2004

- Mobile IP Technology and Applications



Available in the Cisco Company Store

Q and A
Option 1: Work



Summary and Conclusions

- Cap investment in legacy technology and move to a better cost model
- Pre-aggregation can be used to take advantage of your packet network today
- The MPLS edge will vary from operator to operator
- Use the right Pseudowire for the right job
- Use RAN POPs to launch services and drive convergence
- RAN evolves to a multi-service access network