ITSF 09 - Time & Sync in Telecoms

3rd-5ft November 2009 - Rome

WCDMA RAN IP backhauling

TIM Network Architecture and Synchronization aspects

TIM - Telecom Italia

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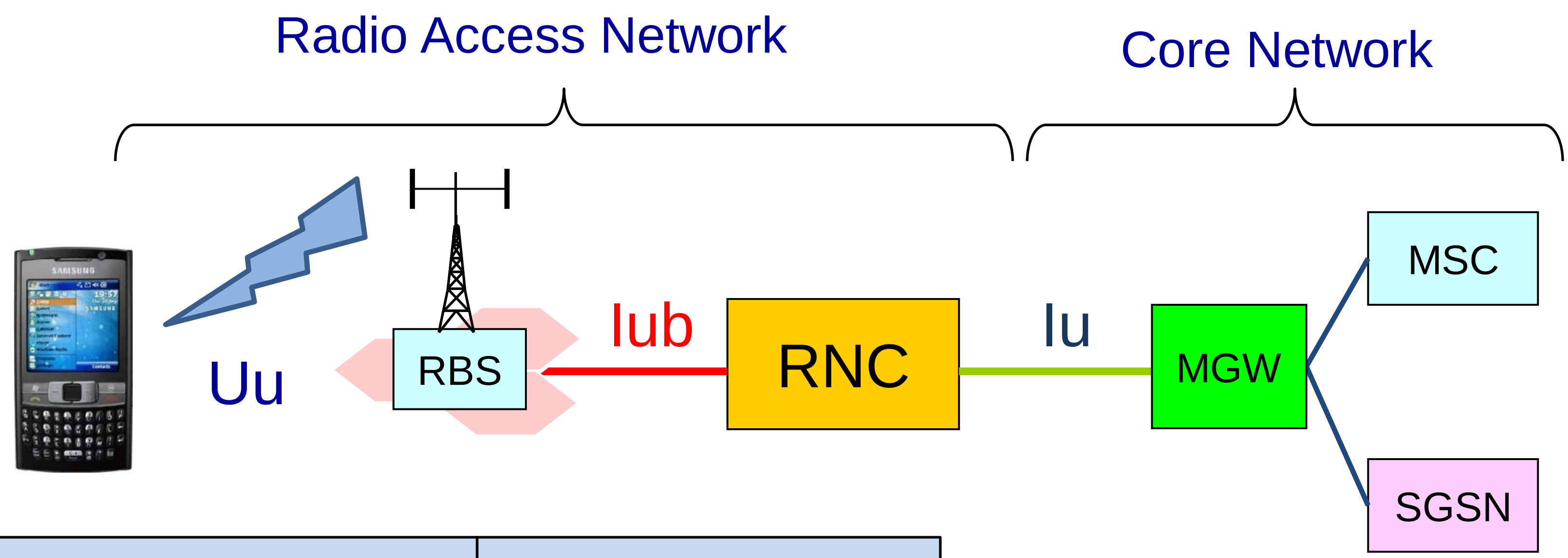
Agenda

- **Synchronization in 3G Radio Access Network**
- **Iub interface evolution from ATM to IP**
- **Iub over IP and synchronization solutions**

Synchronization in 3G Radio Access Network



Radio Interface Synchronization

frequency error < 50 ppb

Frame Synchronization

Node Synchronization

Network Synchronization

Synchronization in 3G Radio Access Network

Network Synchronization is responsible for the distribution of clocks, and allows the clocks to operate at the same frequency in different nodes. Note that clock in this context does not deal with the time of day, but with frequency only.

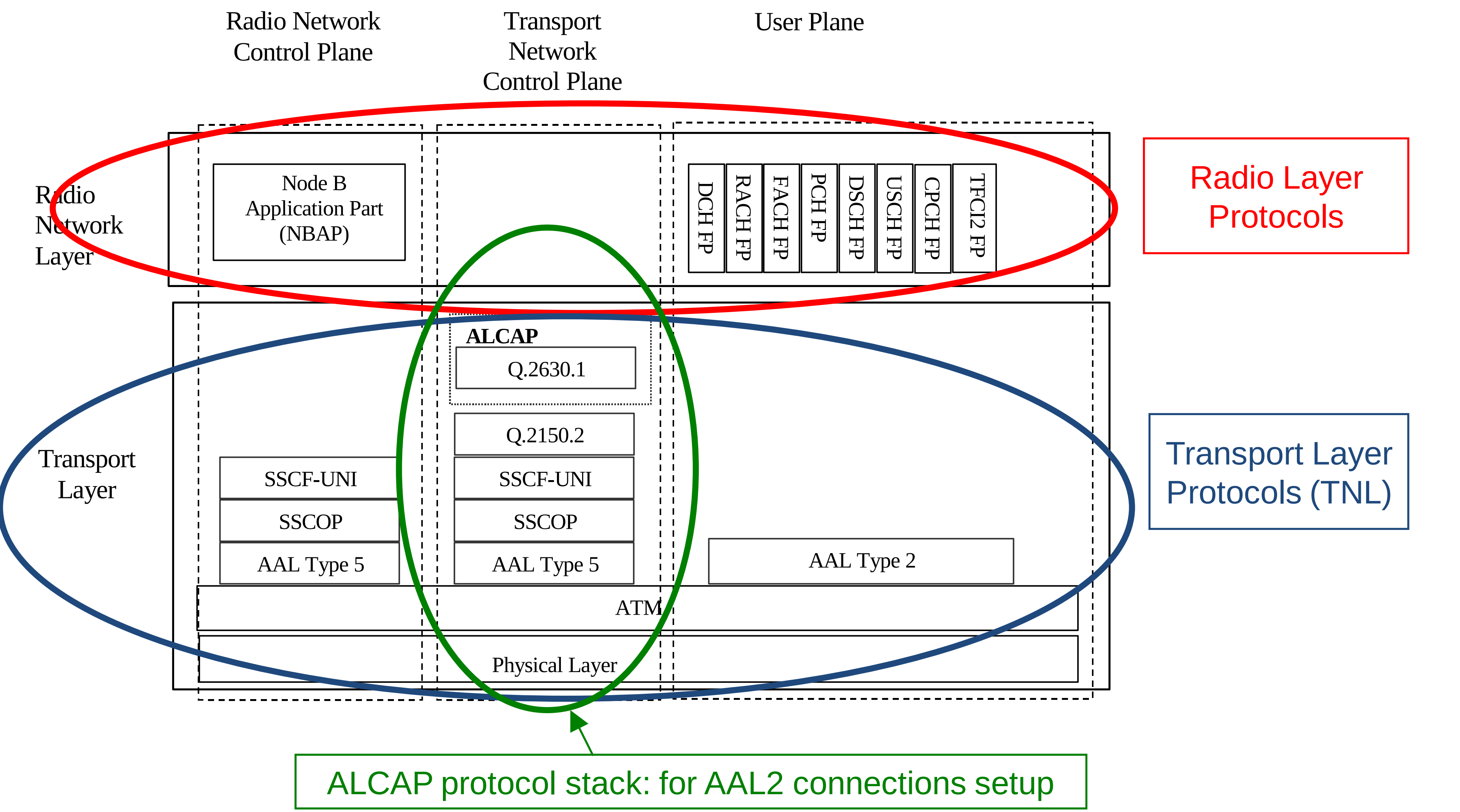
Node Synchronization is the basis for the numbering of frames between the RNC and RBS nodes, and for frame timing. The correct operation of Node Synchronization is dependent on the proper operation of Network Synchronization.

Frame Synchronization is responsible for the numbering of user frames, and for the transmission and reception of frames to and from the RNC node at the correct times, to compensate for transfer and processing delay in the RNC-RBS path. The correct operation of Frame Synchronization in the Intra-RNS case is dependent on the proper operation of the Node Synchronization.

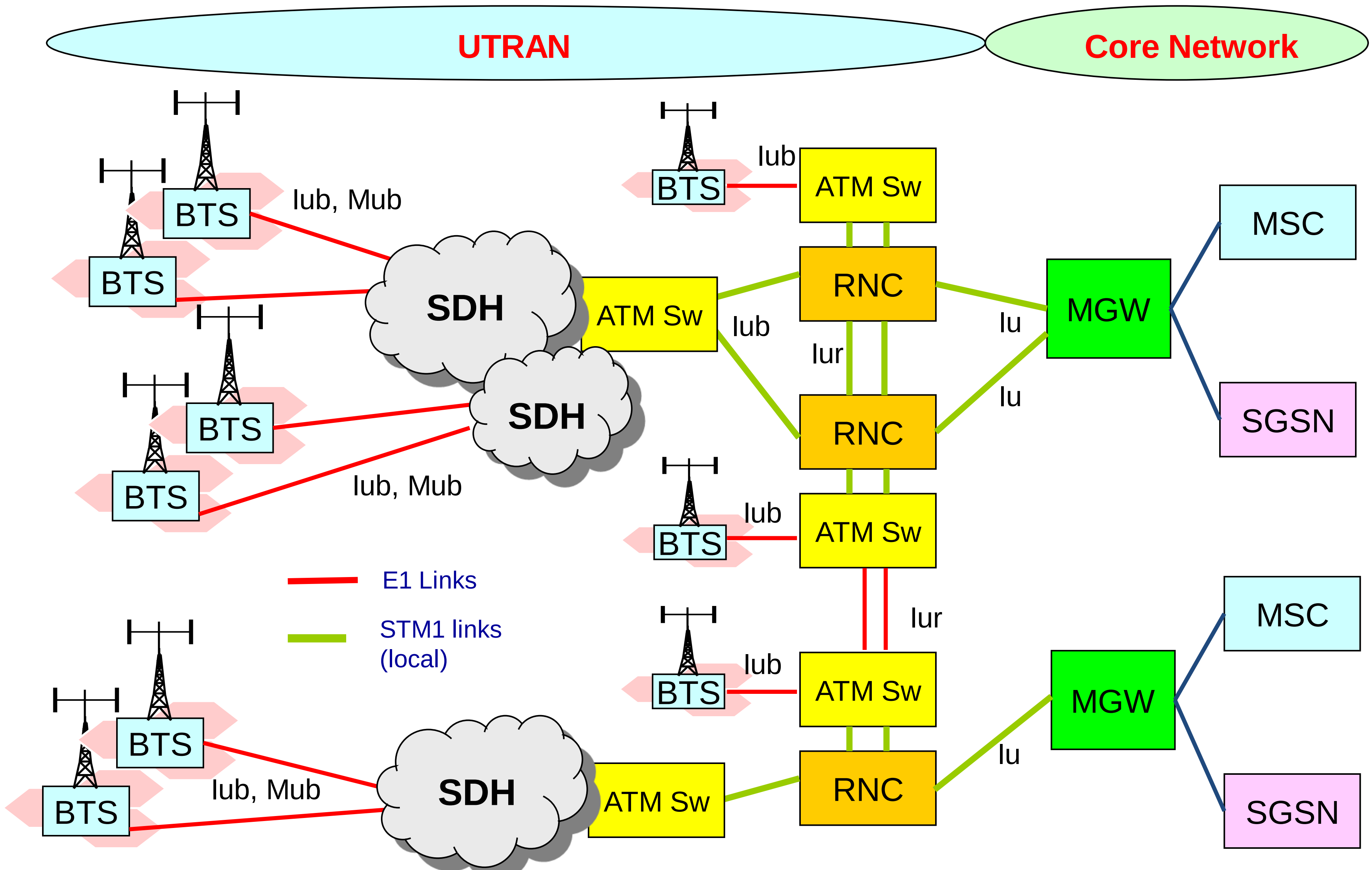
Radio Interface Synchronization is responsible for the alignment of radio frames between the RBS and the UE.

Iub interface evolution in TIM Radio Access Network

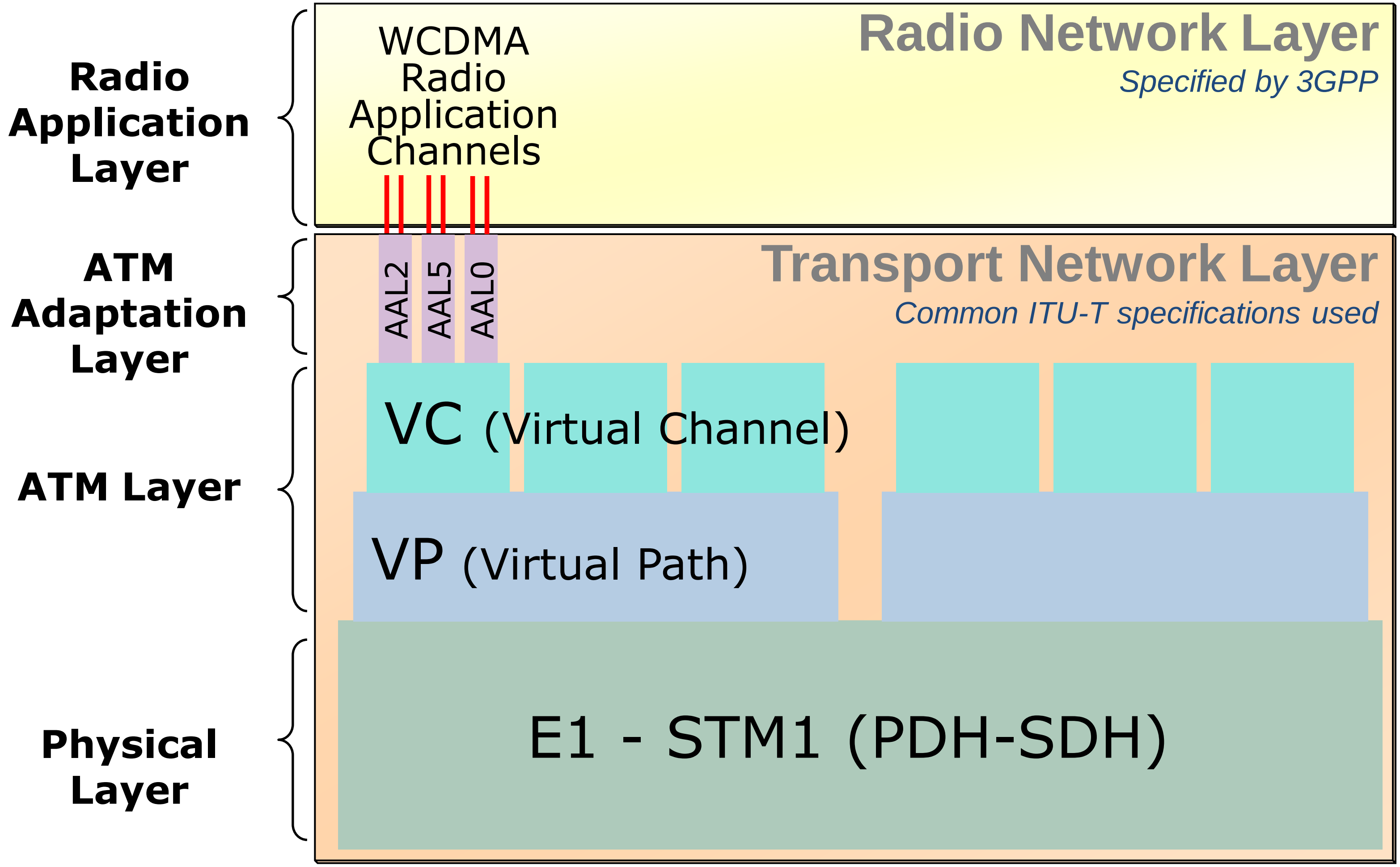
Iub Interface over ATM: the 3GPP Standard



RAN Reference architecture – before 2005

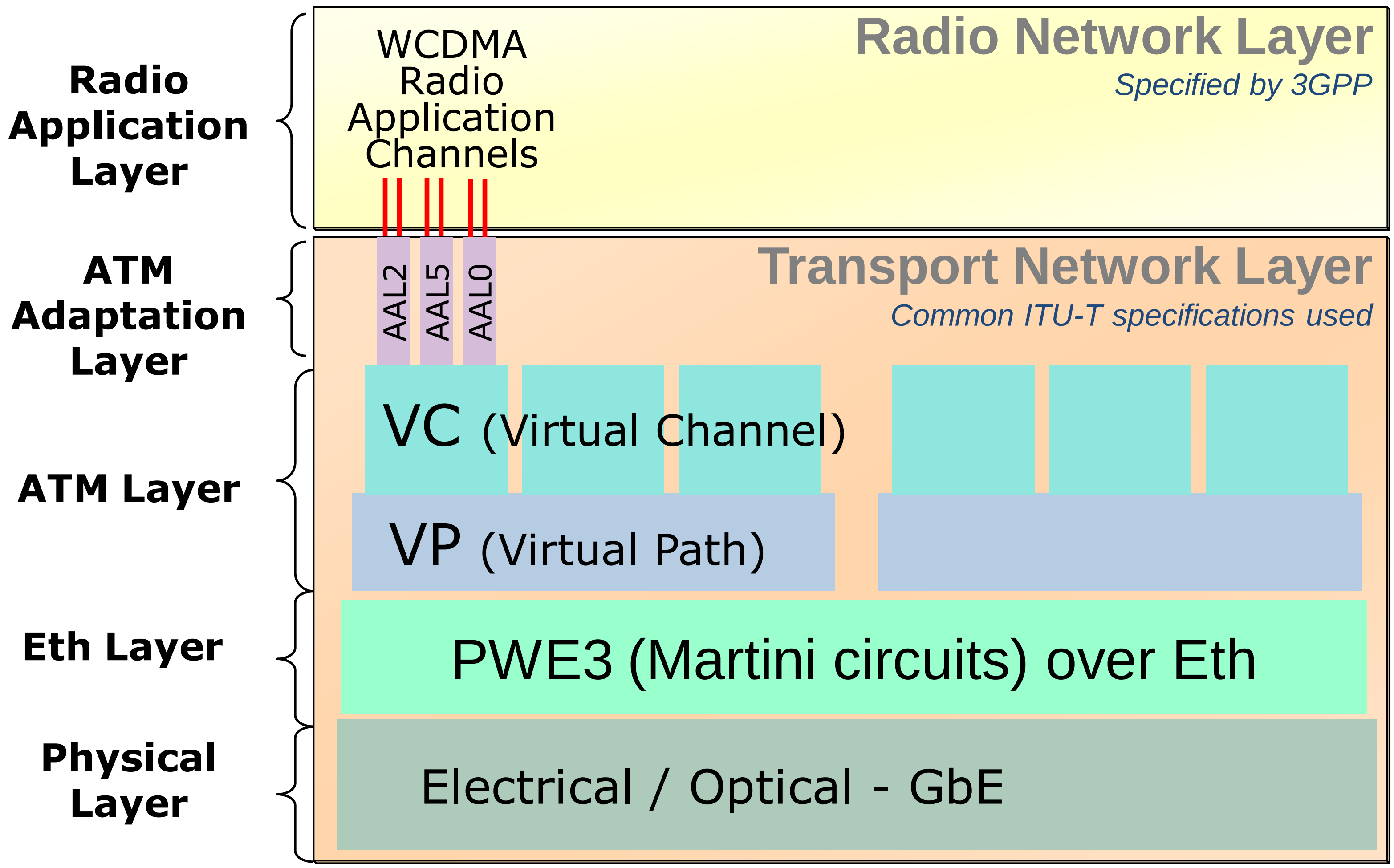


UTRAN Protocol layers - Iub over ATM

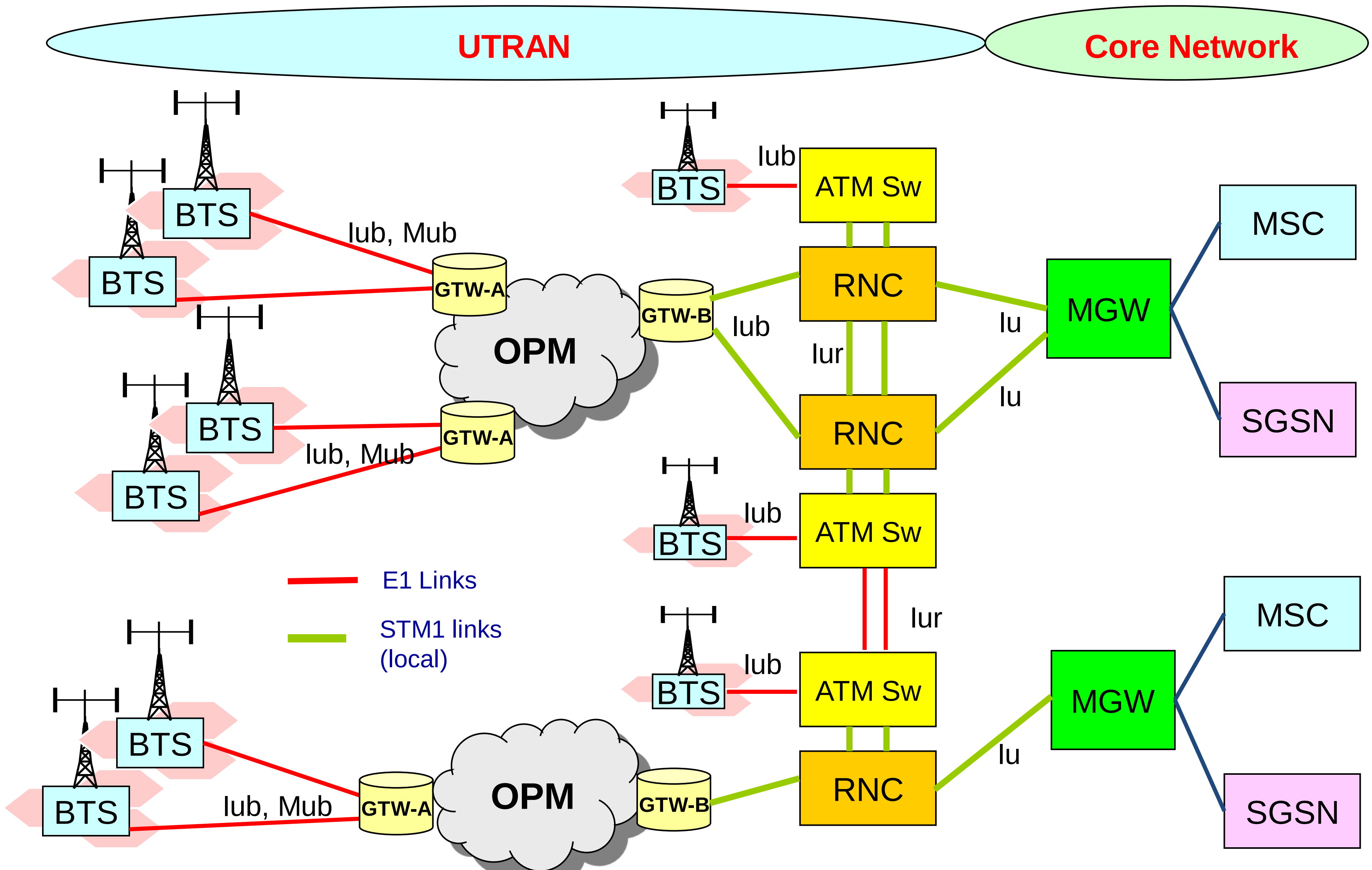


ATM Transport according to 3GPP R99

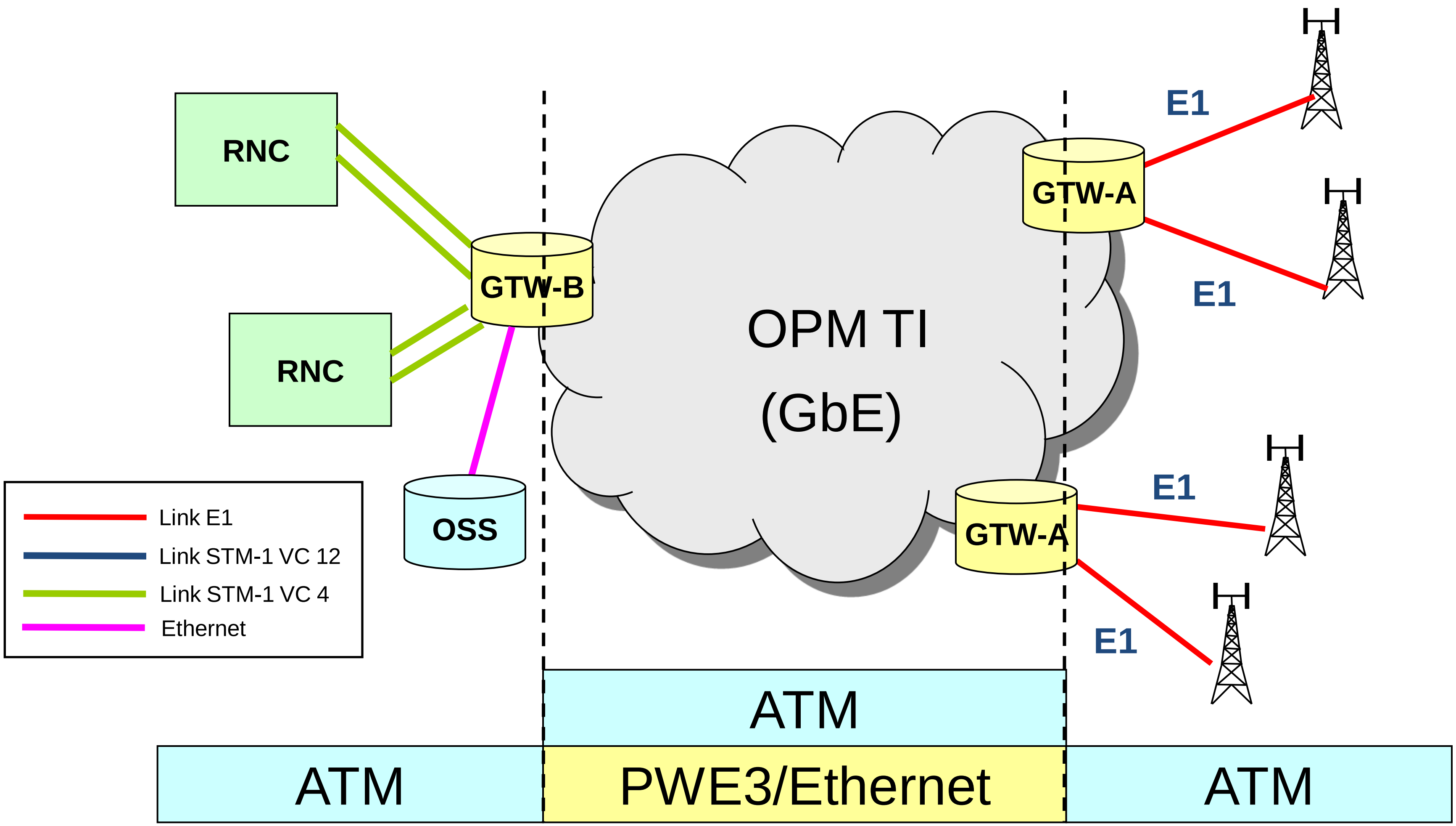
UTRAN Protocol layers - ATM over Eth (generic)



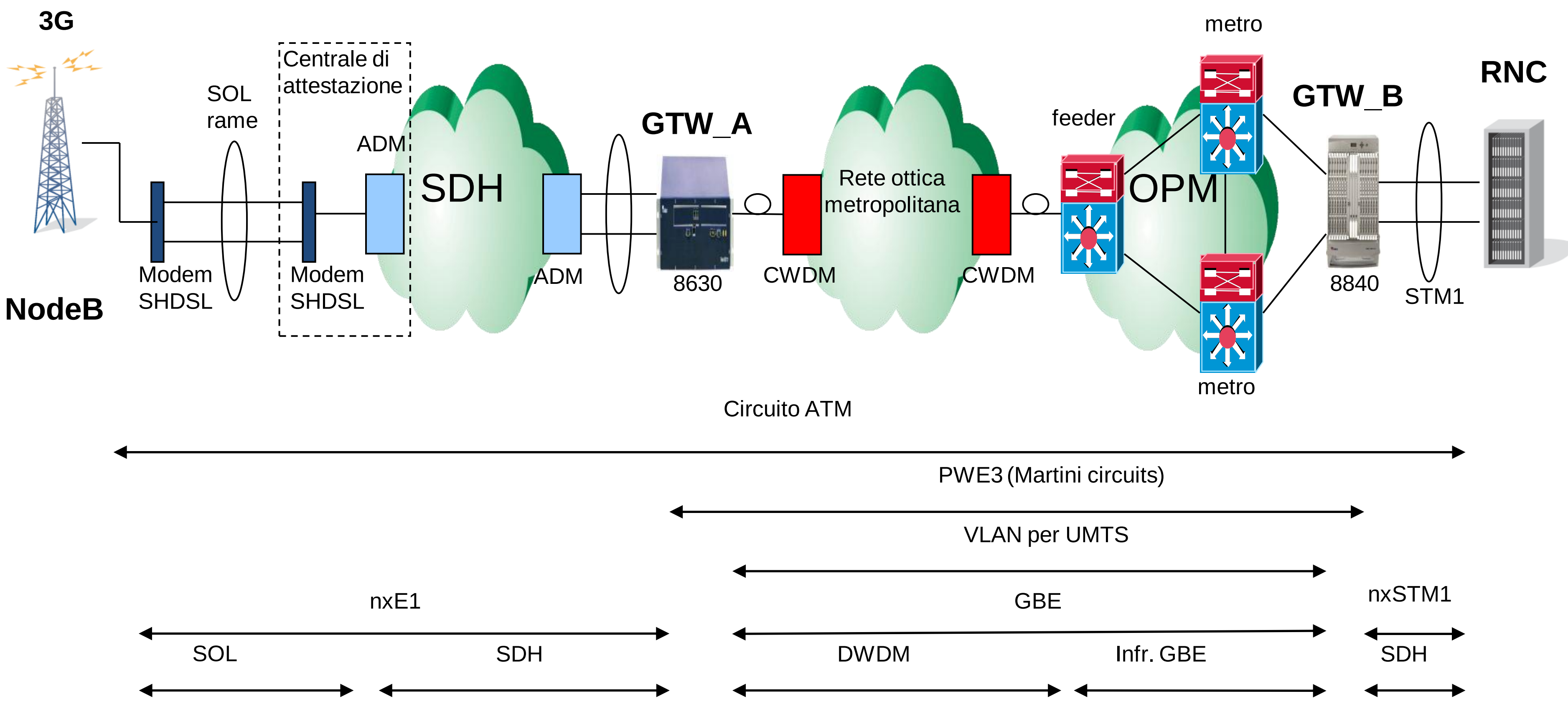
RAN Reference architecture – after 2005



Iub over TI GbE backbone

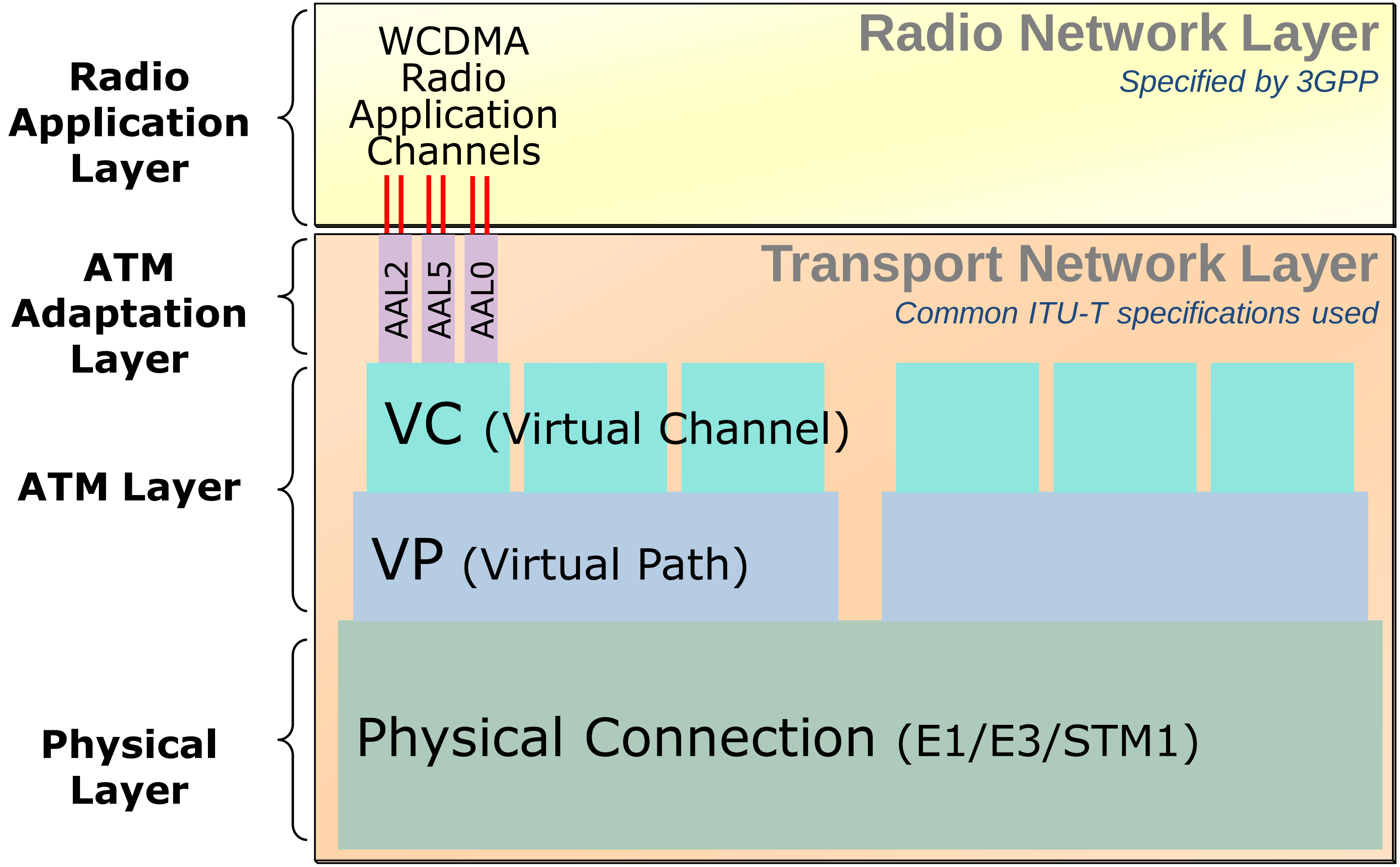


Iub (ATM) over GbE



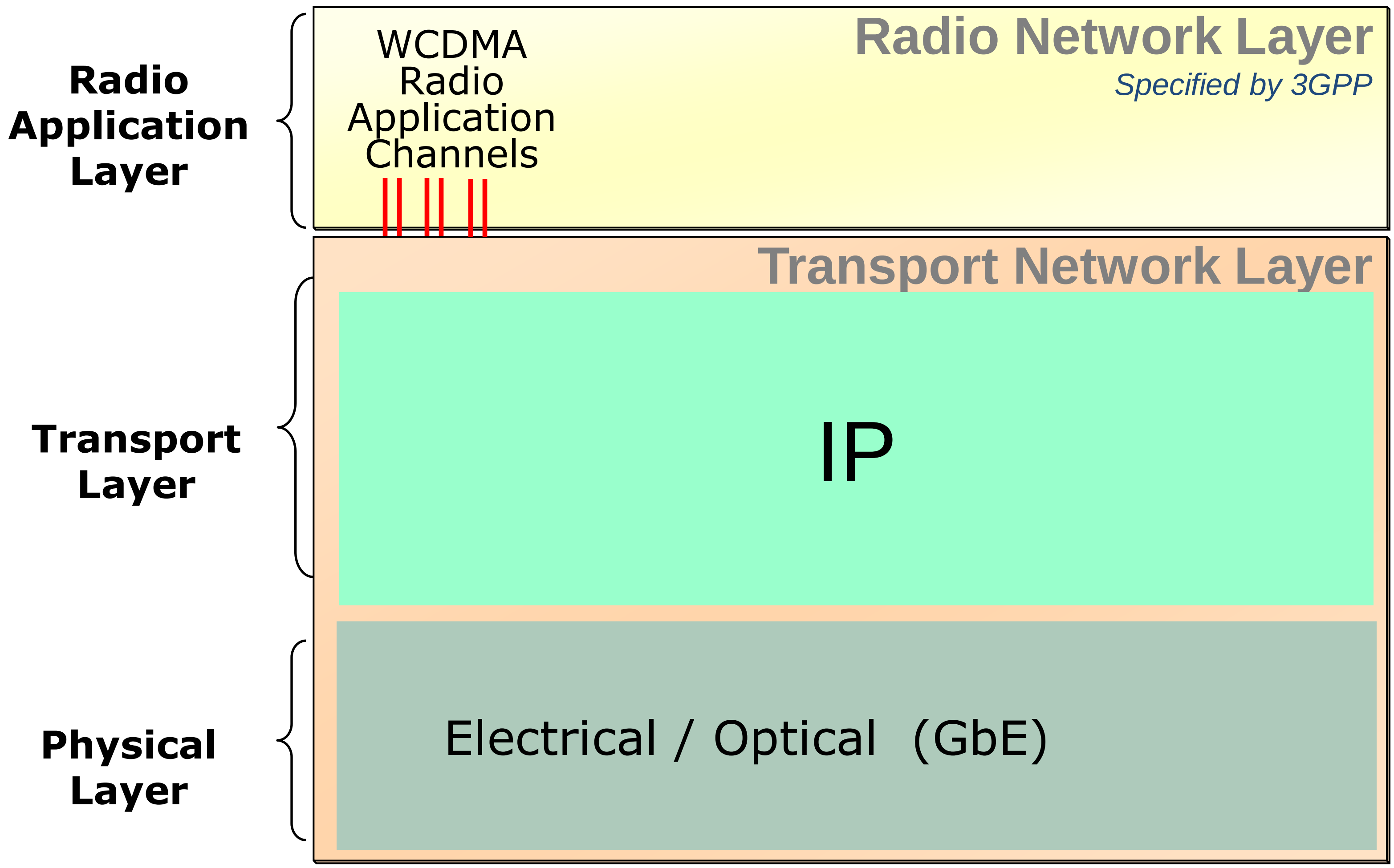
Iub over IP

UTRAN Iub over ATM



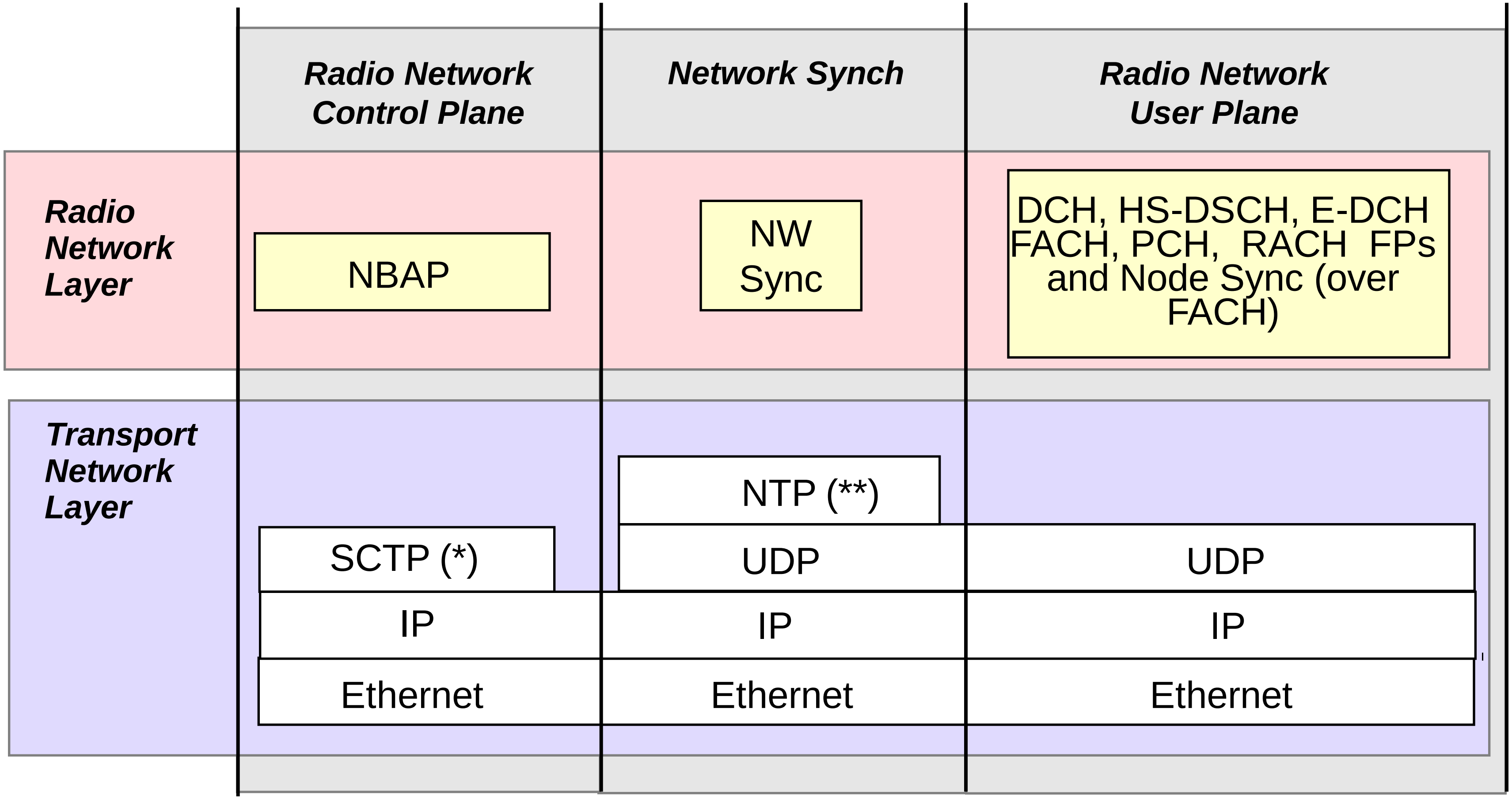
ATM Transport according to 3GPP R99

UTRAN Iub over IP



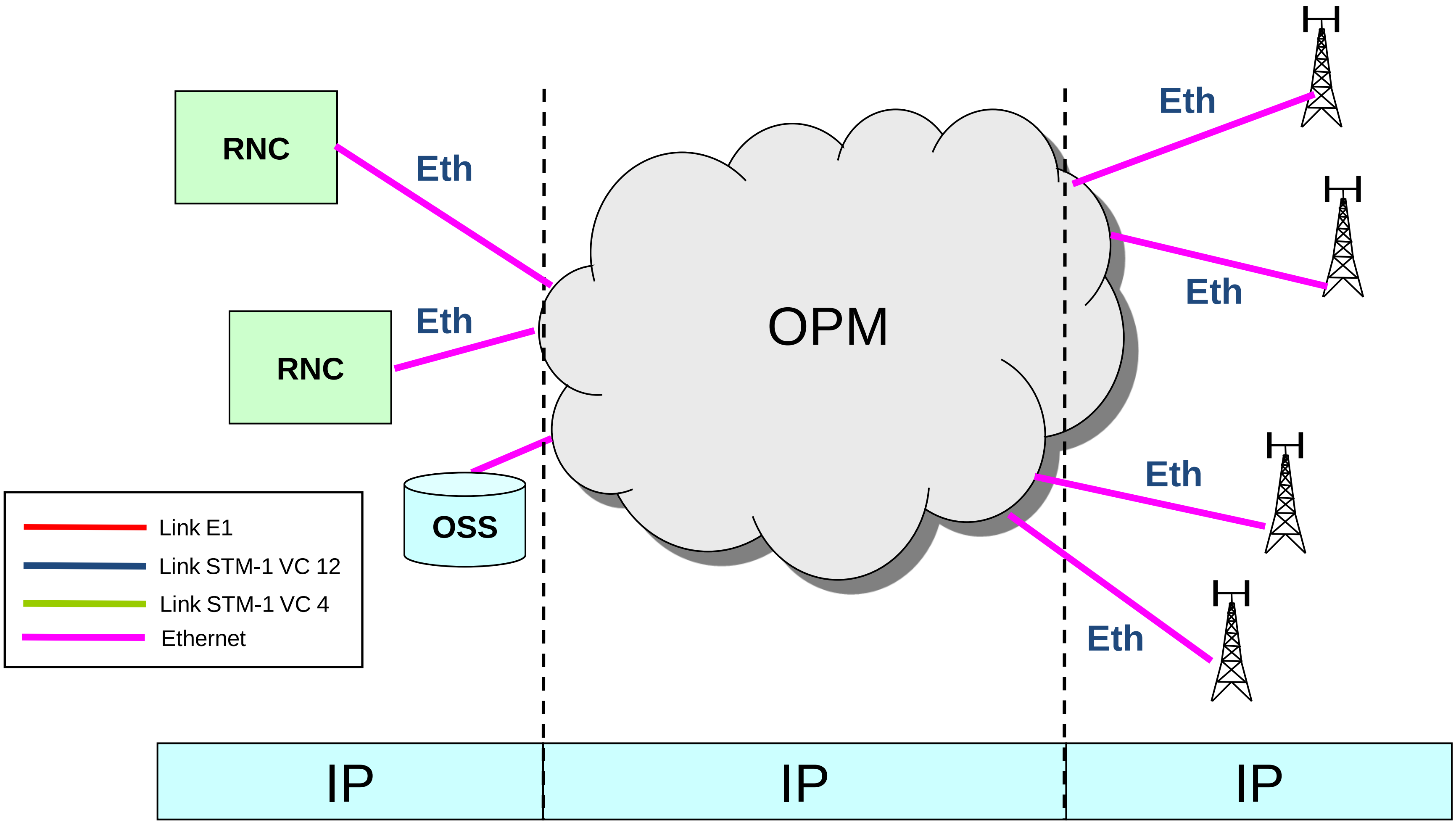
ATM Transport according to 3GPP R99

Iub over IP Protocol Stack

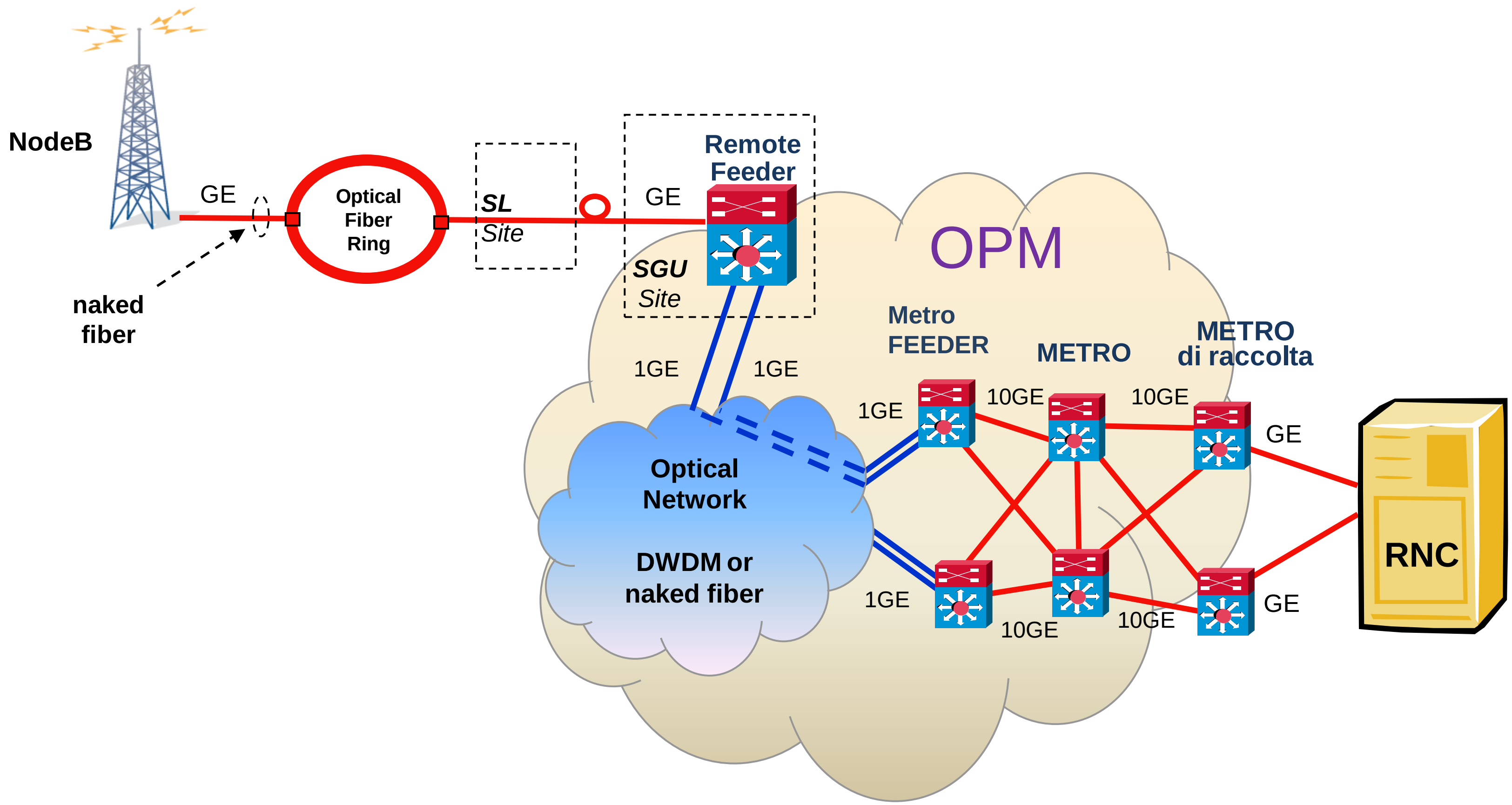


(*) SCTP (Stream Control Transmission Protocol)
(**) NTP (Network Time Protocol)

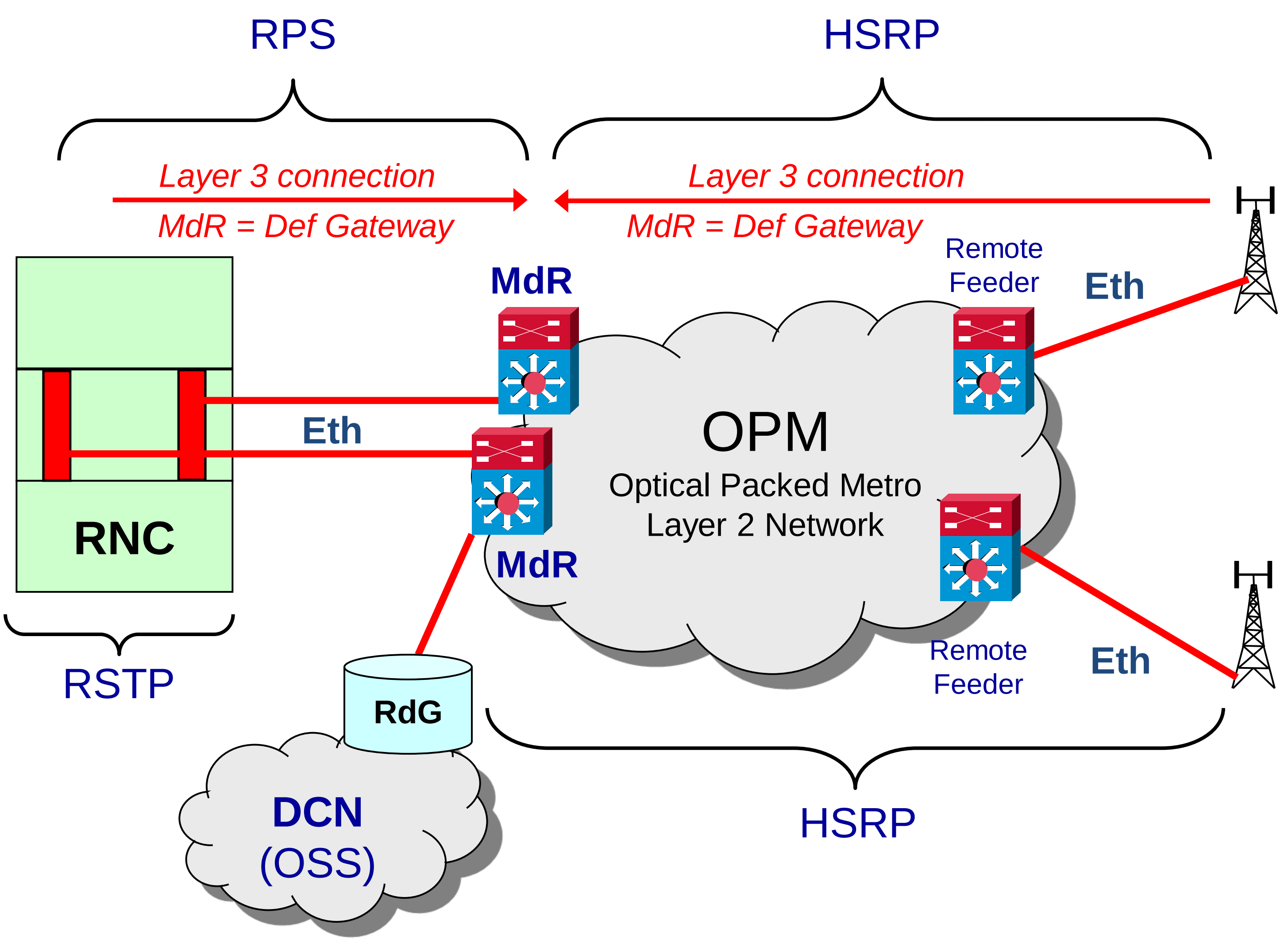
Iub over IP


RNC
Eth
RNC
Eth
OSS
OPM
Eth
Eth
Eth
Eth
Link E1
Link STM-1 VC 12
Link STM-1 VC 4
Ethernet
IP
IP
IP

Iub over IP Architecture (FTTB)

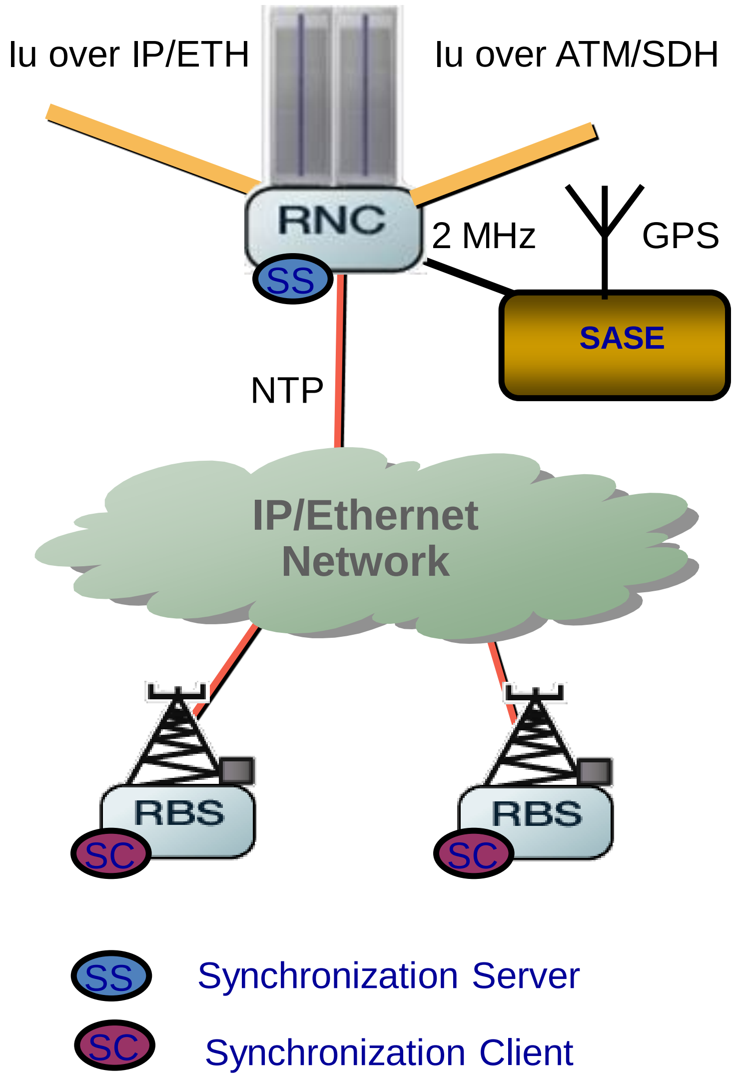


Iub over IP - “Layer 3 Architecture”



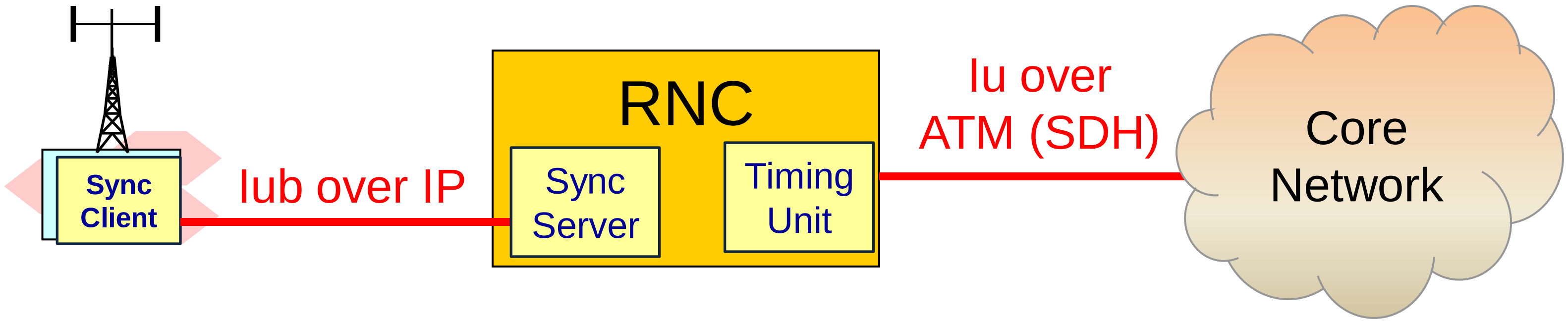
Synchronization over IP solution

Network Synchronization over IP

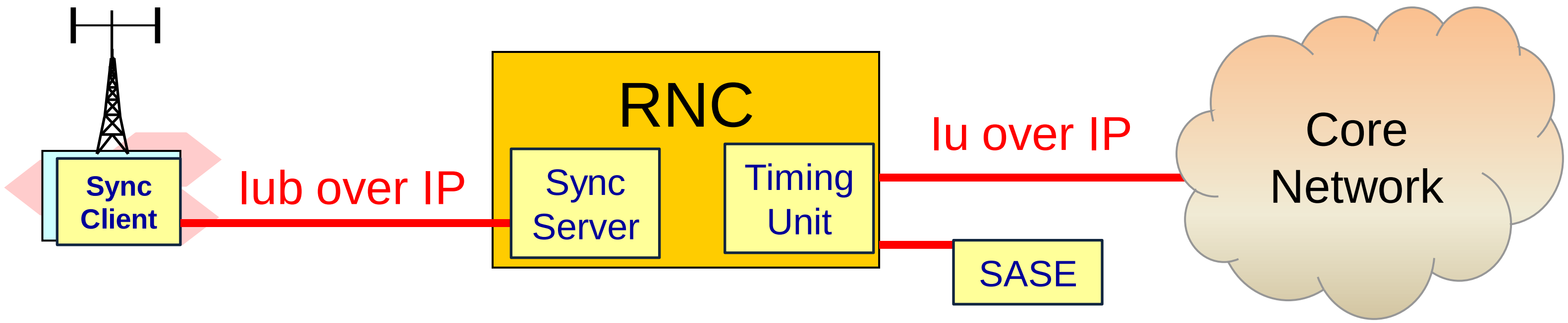


- Client - Server synchronization architecture. A Network Synch NTP Server is integrated in RNC and a client is in RBS
- Synch - Server connection is based on NTP Protocol (Network Time Protocol) over UDP/IP
- Network synchronization for an IP connected RBS is achieved by aligning the frequency of the RBS to the frequency of an NTP server with traceability to a G.811 source.
- RBSs are synchronized using ad hoc clock recovery algorithm that uses NTP packets (OCXO in RBS)
- No other synchronization functionalities required (external devices, Synch nodes, GPS etc.)

Network Sync details

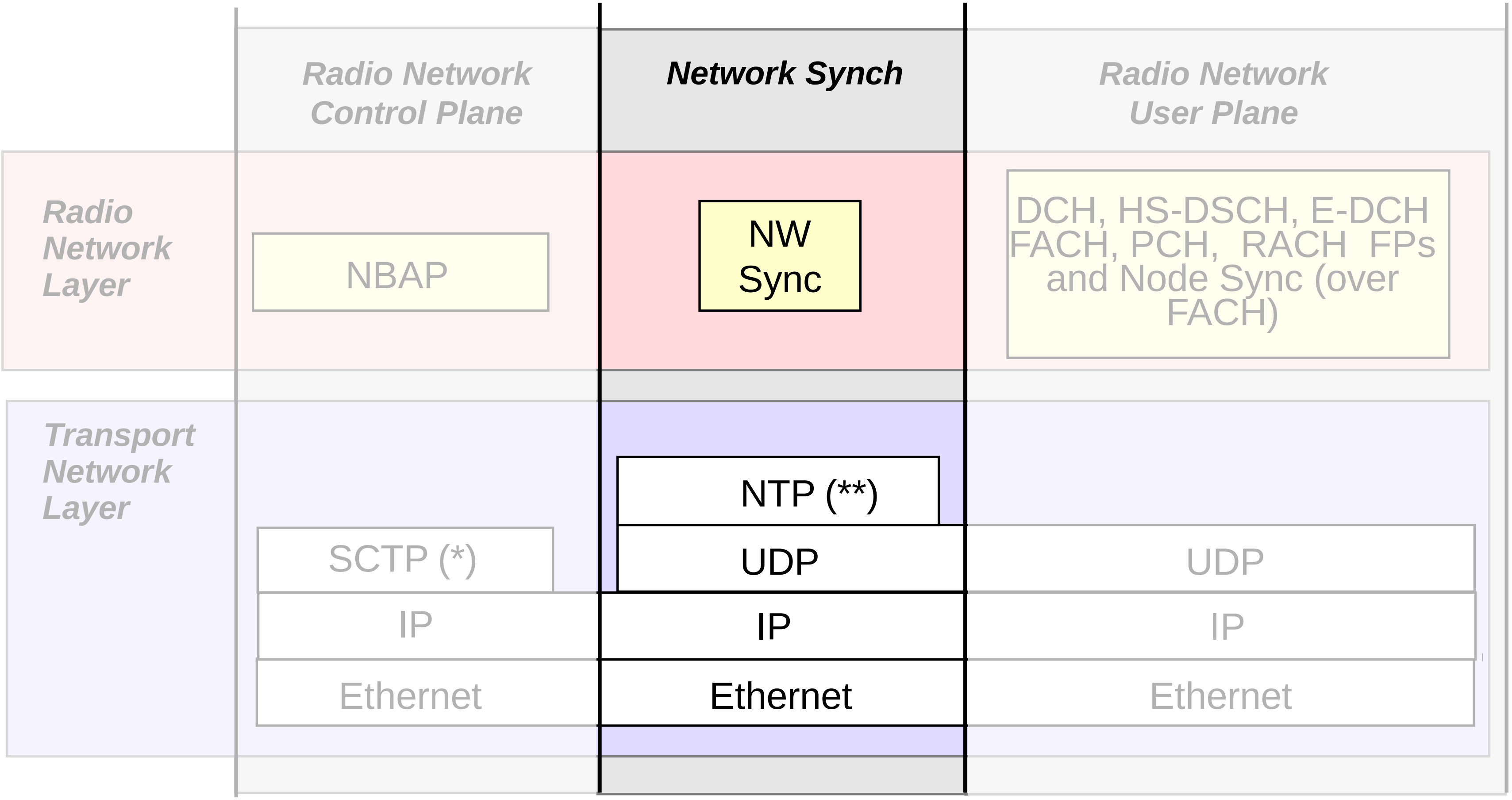


In order to meet performance requirements, the Synch Client sends an NTP request at regular intervals. The regulator selects the NTP packet frequency based on its need. The range of 1-10 packets per second. The higher request frequency is used at start-up or acquisition to make convergence time shorter, and then when steady state is reached, the rate is decreased.



In case Iu is connected only over IP, there will be no transmission interface available from which the RNC can take its synchronization. In this case, the RNC must take its synchronization from the physical synchronization port on its Timing Unit. The signal to this physical synchronization port can be e.g. a 2.044 MHz signal from a SASE, or from an SDH multiplexer on site

Iub over IP – Network Synch Protocol Stack



(*) SCTP (Stream Control Transmission Protocol)

(**) NTP (Network Time Protocol)

Backhauling requirements for Iub over IP

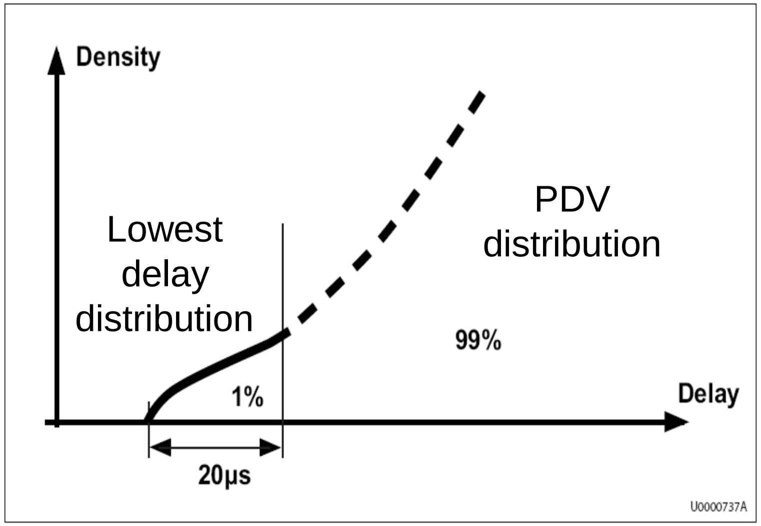
Traffic	Maximum delay	Max Delay Variation	Maximum Packet Loss
Real Time	≤ 30 ms (≤ 5 ms)	≤ 10 ms	10^{-6}
HS	≤ 100 ms (≤ 10 ms)		10^{-4} (10^{-6})
Non HS BE	≤ 50 ms (≤ 10 ms)	≤ 12 ms	10^{-4} (10^{-6})

- Service requirements: no additional requirement for the backhauling IP network compared to the "ATM over GbE" solution.

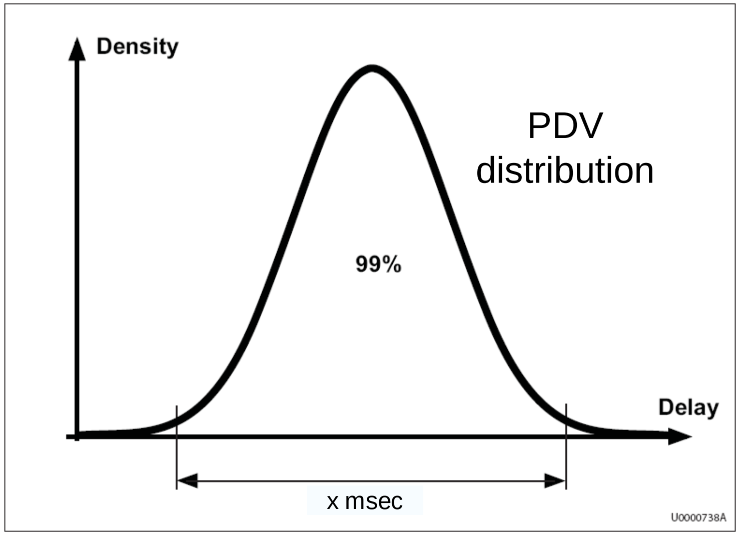
Backhauling requirements for Iub over IP

The max PDV is generally not a sufficient requirement for the purpose of qualifying a packet network as able to carry timing over packets.
This is especially true in the definition of the start up conditions: in this case the PDV statistics is fundamental (e.g. in order to select a suitable number of good packets)

- Current requirement in TIM network: when best 1% packets have less than 20 microseconds delay variation, locking happens quite fast (<16 minutes)

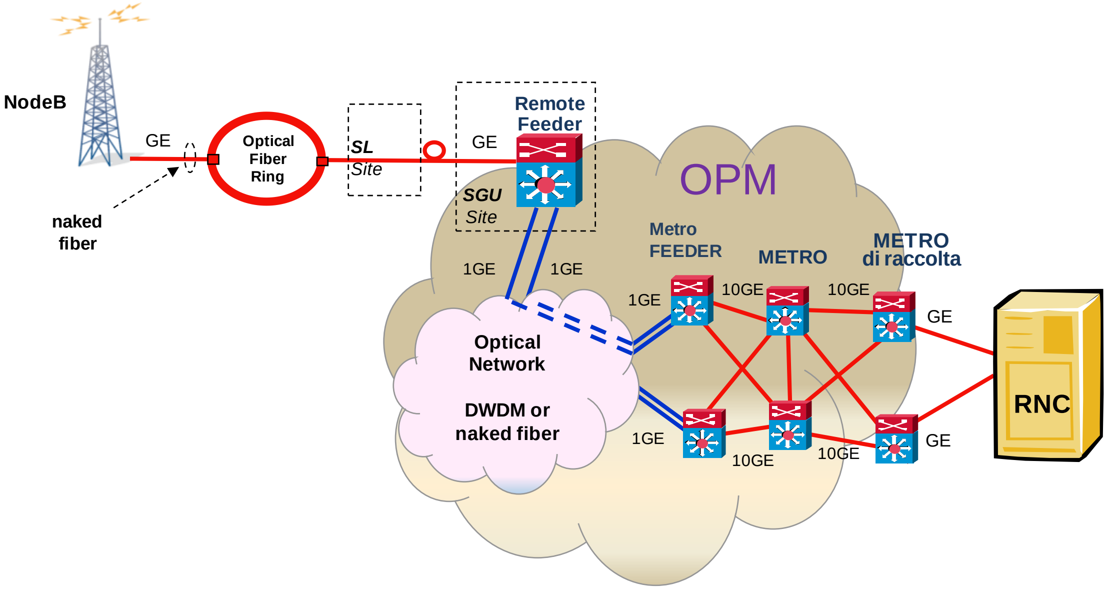


However when longer starting periods are acceptable, the limits might be expressed in terms of PDV (i.e. 99% of the packets below x ms depending on the actual acceptable start up period).
The assumption is also that changes in the PDV disitribution are detected.
After the clock has been locked, the PDV limits (e.g. 99% of packets < 10 ms) can also be considered sufficient thanks to OCXO stability (that can keep few ppb per day).



Note: an alternative approach often used is to specify the requirements in terms of G.8261 (i,e, test cases 12 to 17 in Appendix VI.5.2 with traffic model 2 according to Appendix VI.2.2). However this is sometimes not practical.

TI Optical Packet Metro



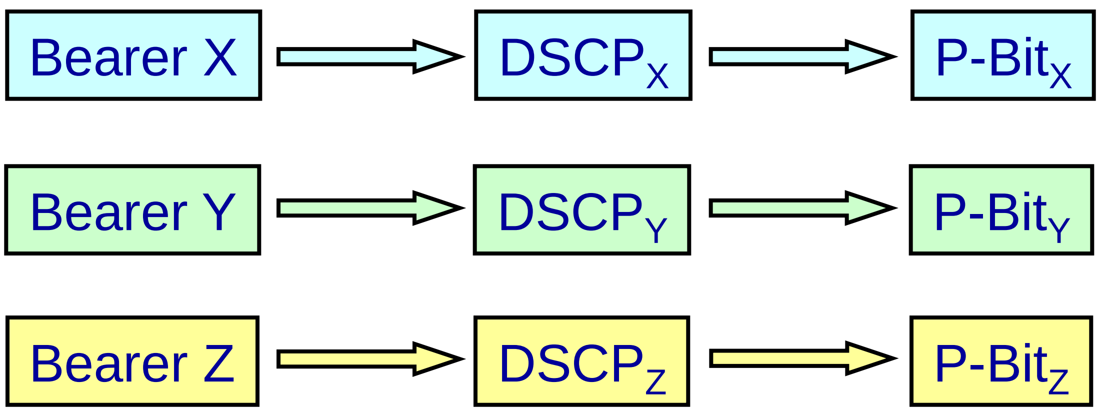
- 100 Node Bs active today using Iub over IP and optical fiber
- FTTB with dedicated naked fiber (no GPON)
- Project started in 1H 2008
- Hundreds of Nobe B over IP planned for 2009-2010
- Very stable solution
- No synchronization problems

- 24 MdR (Metro di Raccolta)
- 60 Metro 30 sites
- 70 Metro Feeder
- 180 Remote Feeder (180 SGU sites)
- OPM Load between Feeder and Metro: 5%-10%
- Number of nodes between Node B and RNC: 4 (Remote Feeder, Metro Feeder, Metro, MdR)
- OPM Traffic Handling: QoS priority (3 queues)

QoS for Iub over IP

- QoS separation at IP level, using DSCP (Differentiated Services Code Points). [0...63].

- QoS separation at Ethernet level by using the Priority Bits (L2 Ethernet priority 802.1p). P-bit [0..7]



QoS Mapping – TIM choices

3 QoS Priority Levels

- Maximum: **Network Synchronization** and Conversational/Streaming traffic
- Medium: PS R99 DCHs and NBAP signaling
- Best effort: HSDPA/HSUPA

	Layer 3: DSCP	Layer 2: P-bit
High Priority	46 **Sync** 18 CS & Stream	5 Sync, CS, Stream
Medium Priority	22 PS R99, NBAP	3 PS R99, NBAP
Best Effort	0 HSxPA	0 HSxPA

Our Optical Packed Metro is a Layer 2 network working with 3 P-bit values (5, 3, 0), so we had to adapt the mapping of DSCP to P-bit to the existing situation.

QoS Mapping – TIM choices (2)

Traffic classes	QoS sensitivity	Type of flow	3 Priorities supported	Layer 3: DSCP	Layer 2: P-bit
Network sync	1	Rigid	Peak Allocation	46 **Sync** 18 CS & Stream	5 Sync, CS, Stream
CCH + Node sync	2	Rigid			
R99/GBR (CS and PS)	3	Rigid			
NBAP	4	Rigid	Elastic dimensioning (*) + NBAP	22 PS R99, NBAP	3 PS R99, NBAP
DCH BE	5	Elastic – FC			
Interactive 1	6	Elastic – FC	Elastic dimensioning (*) + O&M	0 HSxPA	0 HSxPA
O&M	7	Elastic – TCP FC			
Interactive 2	8	Elastic –FC			
Interactive 3	9	Elastic -FC			
Background	10	Elastic -FC			

Conclusions

- Iub over IP is the solution for:
  - the transport bottlenecks removal
  - the evolution of the network towards new services:
    - HSDPA Evolution 64QAM (up to 21 Mbps)
    - HSDPA Evolution MIMO (up to 28 Mbps)
    - HSDPA Evolution MultiCarrier (up to 42 Mbps)
    - LTE (150/300 Mbps)

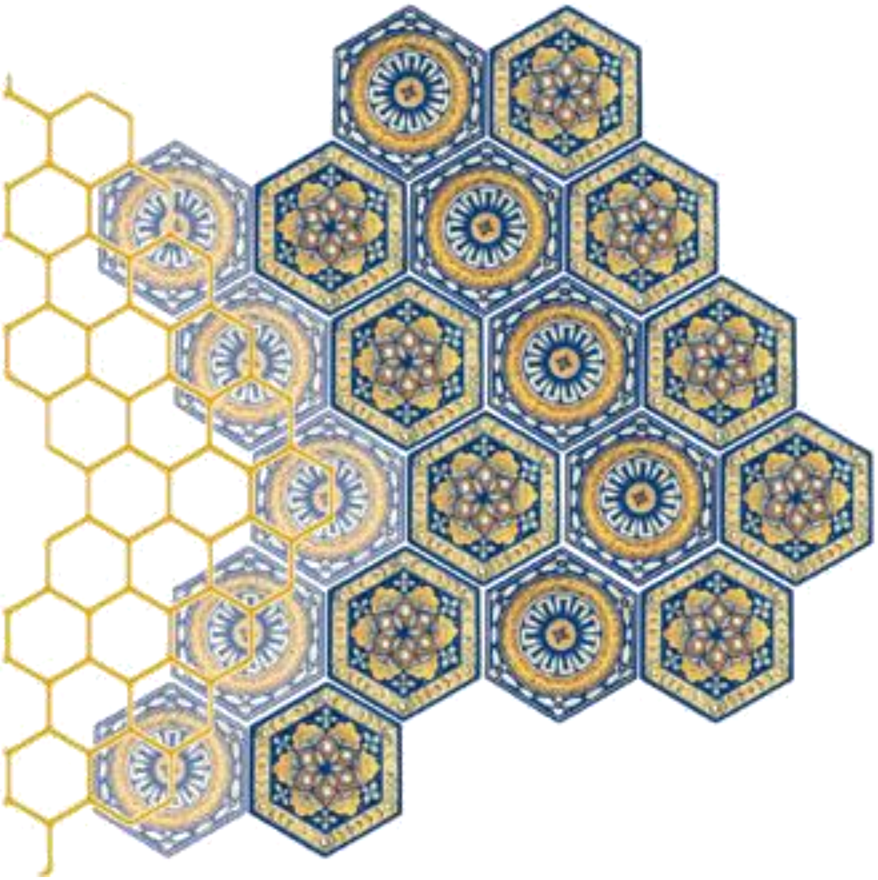
- Live traffic shows good performance and no quality, reliability or throughput variations.
- Iub over IP (optical fiber) deployment started in 1H 2008
- 100 Node Bs active today using Iub over IP and optical fiber
- Hundreds of Nobe B over IP planned for 2009-2010 in the TIM Radio Access Network

- Iub over IP (with sync based on NTP over IP) is a very stable solution: no synchronization problems in real network (18 months)

Acknowledgements:

Lorella Parmeggiani

(TI Opical Packet Metro Engeniering)



Thanks for

Your Attention

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