NGN Standards

The 5th International Telecom Sync Forum, ITSF
London, November - 2007

Stefano Ruffini
Ericsson
stefano.ruffini@ericsson.com

ERICSSON
TAKING YOU FORWARD

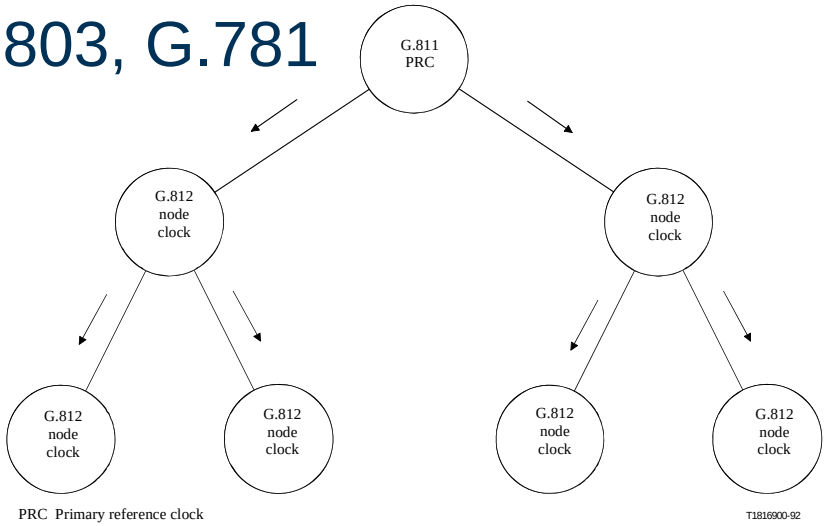
Presentation outline

- Synchronization in the Standards: from “Traditional Sync” to “NGN Sync”
- NGN Synchronization Aspects
- The NGN Standards: Status and Future

Sync Standards: Short history

Synchronization Standards: short history

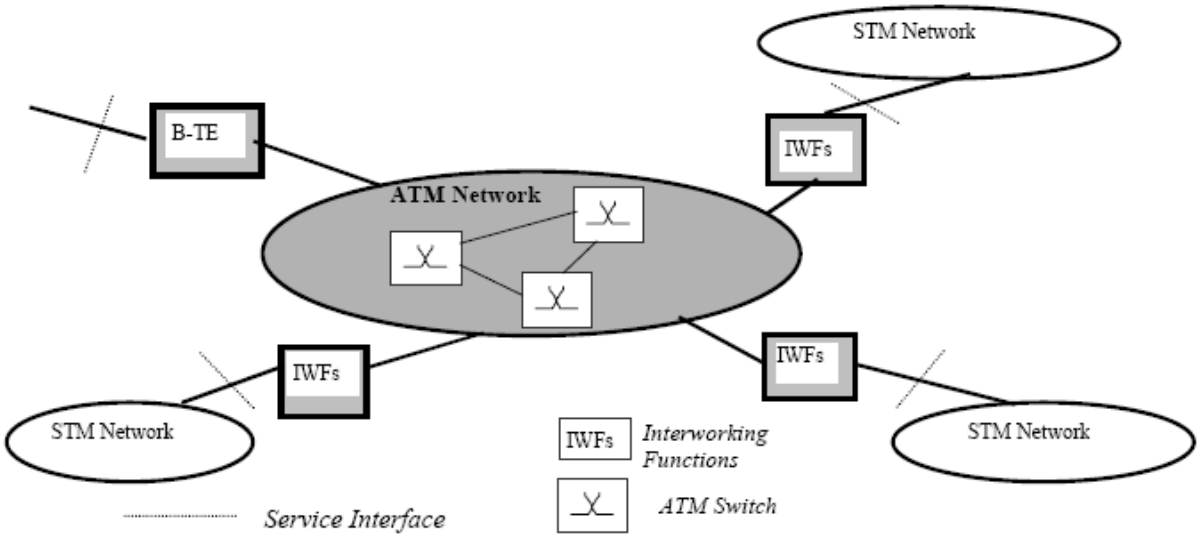
- The need for accurate synchronization in Telecom starts with digital switching (80s):
  ITU-T G.811 and G.812 blue book (1988)
- SDH / SONET (90s): new ITU-T G.811, G.812 , G.813, G.823, G.824, G.825, G.803, G.781



- TDMA / CDMA mobile technologies (90s):
  ETSI TS 145.010, TIA/EIA IS-95

Early “Packet Sync” Standards

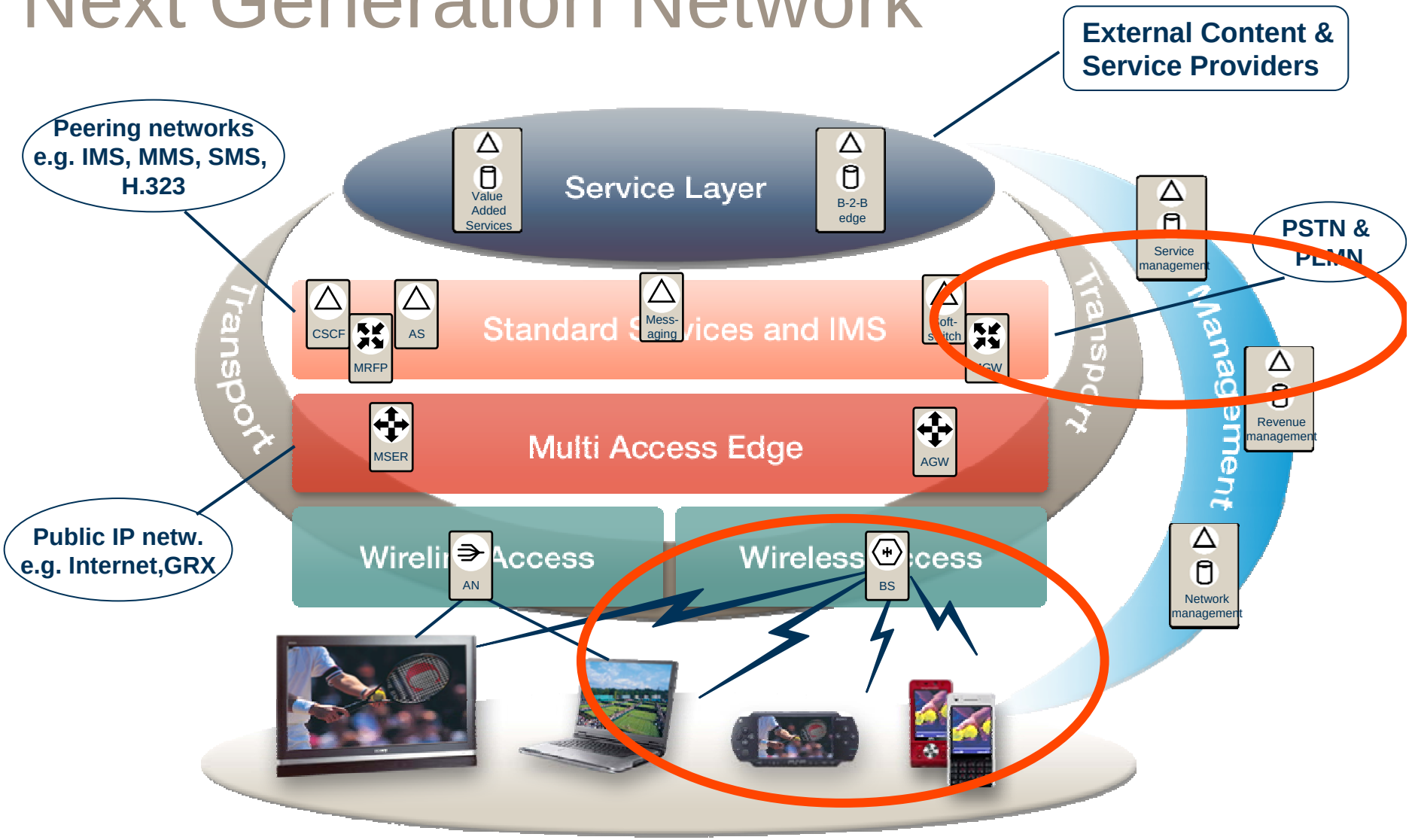
- ETSI TR 101 685 “Timing and Synchronization aspects of ATM Networks” (1999, developed by TM1 WP4)
- ANSI (T1X1.3) Draft Technical Report “Synchronization of Packet Networks” (now ATIS OPTXS-SYNC)
- Others: IETF (PWE3 sync related Drafts and RFCs)



Focus: ATM sync and Circuit Emulation

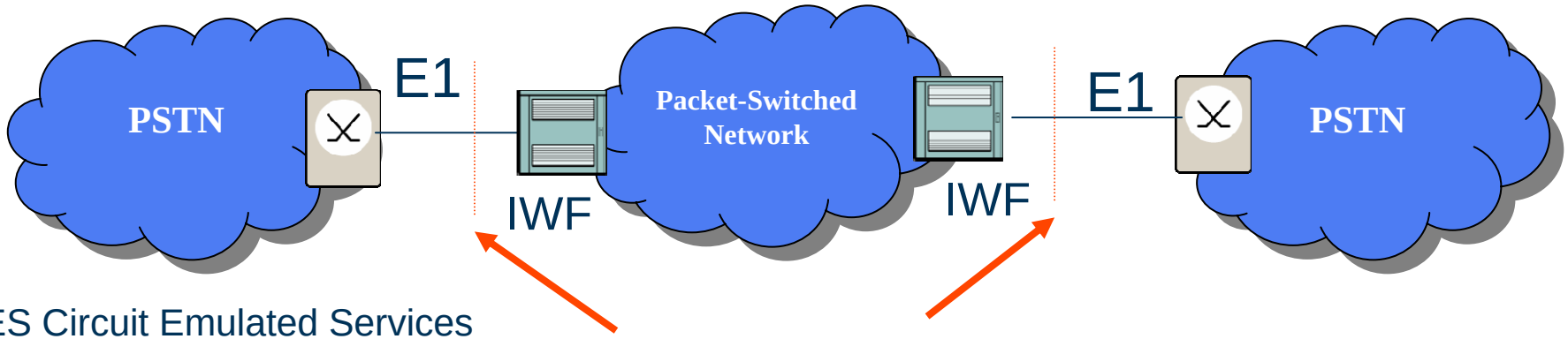
NGN Synchronization Aspects

Next Generation Network



Next Generation Network (ITU-T Y.2001, Y.2011): the service-related functions are independent from the underlying (packet based) transport technologies

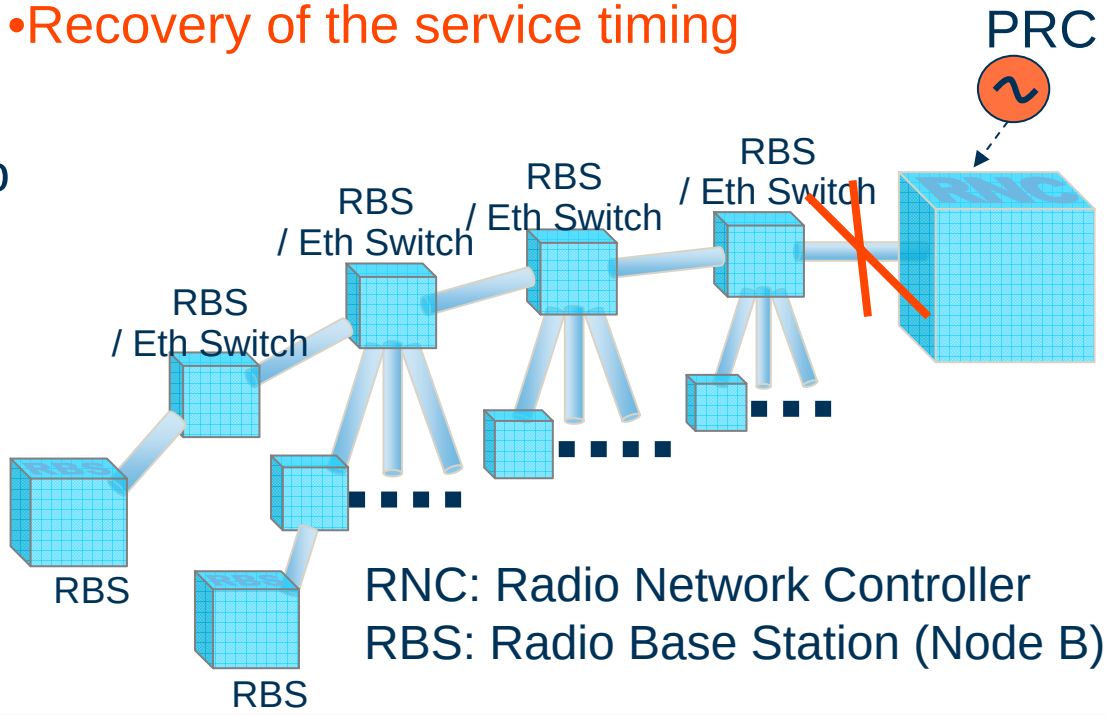
Synchronization issues: examples



CES Circuit Emulated Services
IWF InterWorking Function

- Network interface requirements
- Recovery of the service timing

- Packet technology in the radio access network: can synchronization be distributed over the physical layer ?
- Ethernet physical layer traditionally operates at up to +/- 100 ppm



Accurate Time and Phase Sync

- The need for distribution of Time and phase may increase in the future. Some examples are:
  - LTE TDD (Time Division Duplex)
  - Multimedia Broadcast and Multicast Service (MBMS)

- The use of GPS is the most deployed solution, however in some cases alternative solutions may be needed (e.g. when the view of the sky is not possible)

How to distribute accurate phase and time over packet networks ?

NGN Sync Standards

The need for new standards

- How can existing standards (e.g. ITU-T G.803, G.811, G.823, G.824) be applied in packet networks ?
- New methods may be required to distribute sync in a packet network environment (e.g. adaptive methods)
- Packet networks will degrade the synchronization: how can a network operator be confident that the network will correctly operate also in these scenarios ?

Work on G.Pactiming (G.8261) was initiated in 2004

ITU-T (SG15/Q13): the G.826x series

G.8261 (G.pactiming),
"Timing and Synchronization Aspects in Packet Networks"
First release: **2006**; Planned second release: **2008**

G.8262 (G.paclock)
"Timing characteristics of synchronous Ethernet equipment slave clock (EEC)"
First release: **2007**; planned updates: **2008**

Service and Network, Sync Requirements

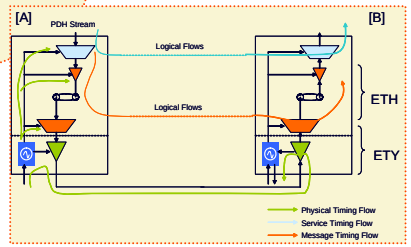
Clock Specification

In SDH:
G.803, G.810
G.823, G.824, G.825

In SDH:
G.812, G.813

G.8263 (G.paclock-bis)
"Timing characteristics of packet based clocks"
Planned first release:
during next study period?

Network Infrastructure
Functional Blocks
Timing Flow, SSM, Time of Day



In SDH:
G.783, G.781

G.8264 (G.pacmod)
"Distribution of Timing through Packet Networks"
Planned first release: **2008**
To be completed during next study period ?

ITU-T G.8261, “Timing and Synchronization Aspects in Packet Networks”

“This ITU-T Recommendation defines synchronization aspects in packet networks”

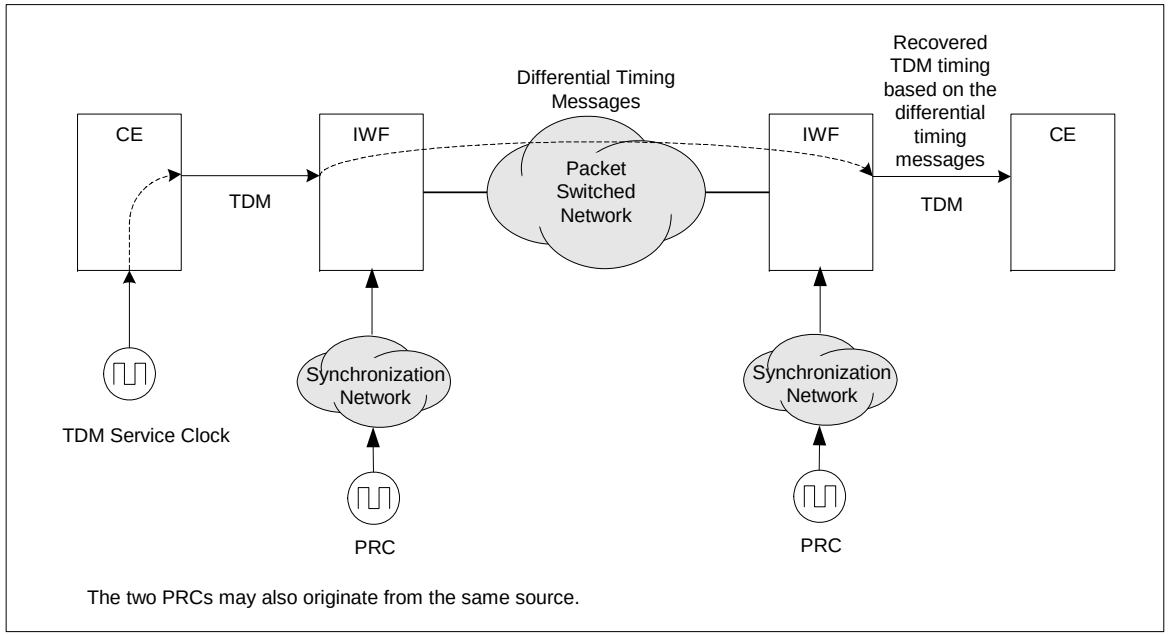
- First release in 2006:
  - Focus on TDM Circuit Emulated Services
  - Ethernet is the basic technology

- Deployment of synchronization networks over packet networks: introducing the synchronous Ethernet PHY (syncE) concept

- Enhanced version is planned to be released in 2008:
  - Distinction between Service (CES) and Network Clock Requirements (including Network Limits)
  - Packet Based methods
  - Extension to IP and MPLS

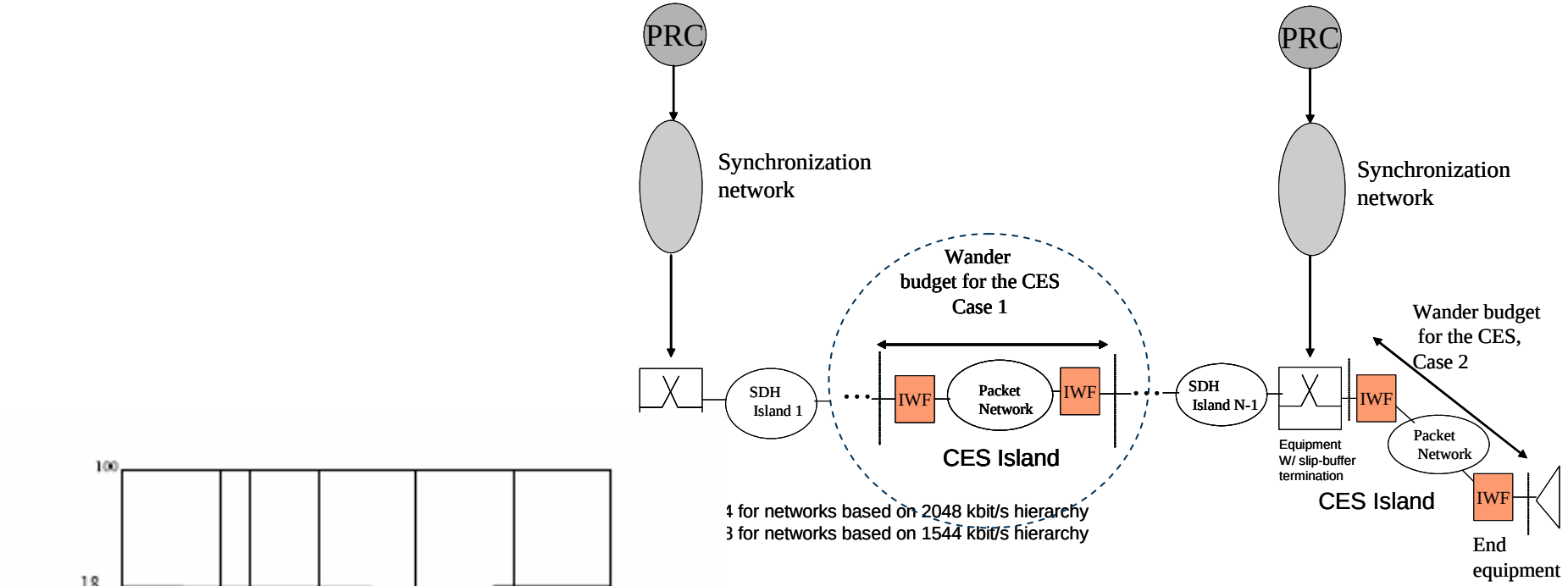
TDM Timing Recovery options

- The following operating methods are possible:
  - Network Synchronous operation
  - Differential Methods (shown in the picture below)
  - Adaptive Methods
  - Reference Clock available at the TDM end System



- Recommendations are provided for each of these methods
- The CES Network Limits are specified

CES Network Limits: CES is only part of a wider transport network



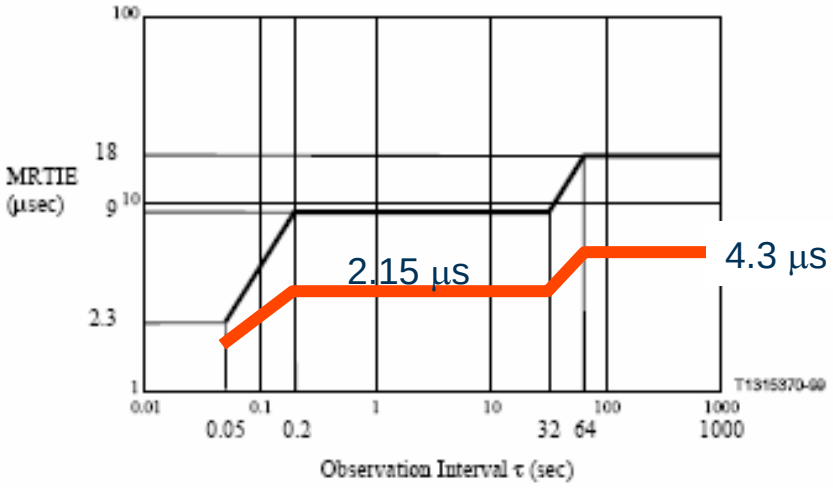
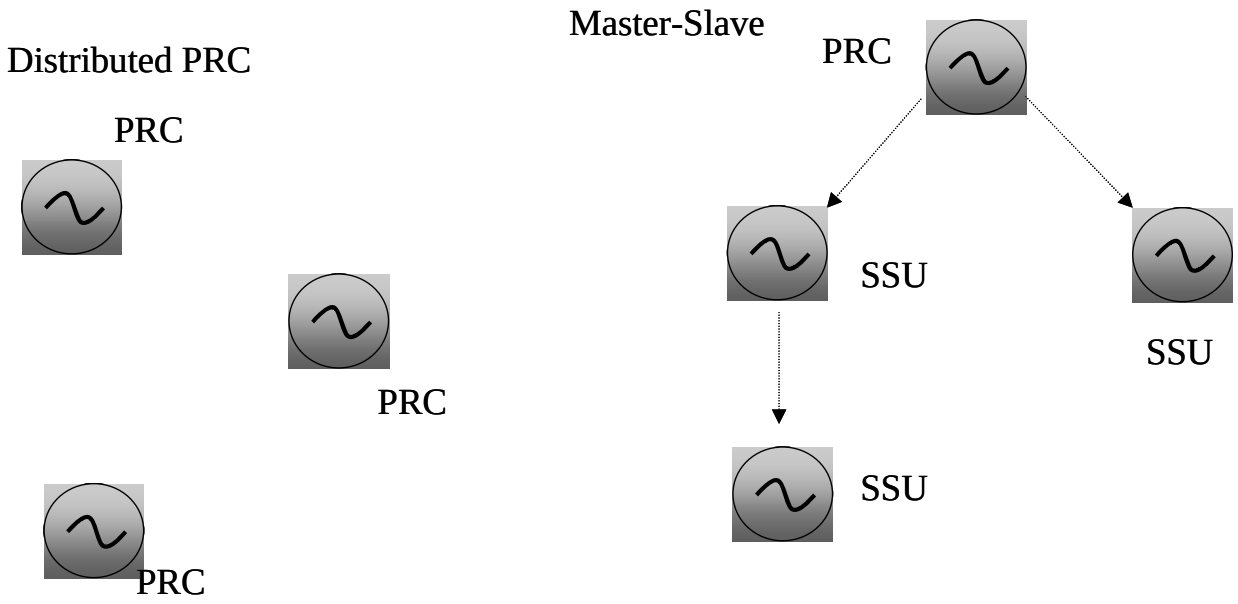


Figure 1/G.823 – 2048 kbit/s interface output wander limit

CES island budget
in “Case 1” < G.823 / G.824

Timing reference signal distribution options

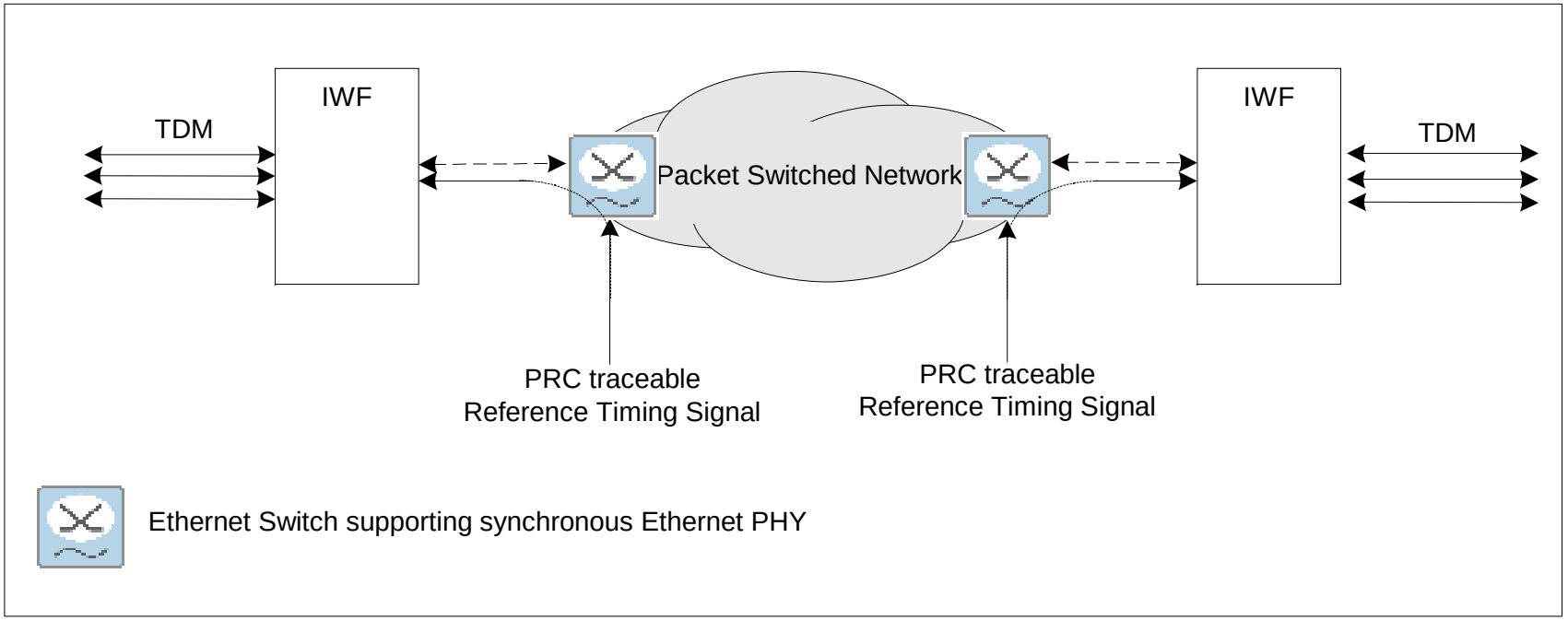


PRC: Primary Reference Clock
SSU: Synchronization Supply Unit

The “traditional” solutions: Distributed PRCs (e.g. GPS) or Master-Slave architecture with timing distribution over the synchronous Physical layer; traditionally SDH or PDH.

SyncE: a new concept

- Timing (frequency synchronization) carried over the Ethernet physical layer to distribute timing towards end application (Note: the timing is not needed by the network itself)
- Example of application: support of CES Network Synchronous operation (or differential methods) via syncE



Network Limits for syncE

Same Network limits as for the SEC Interfaces

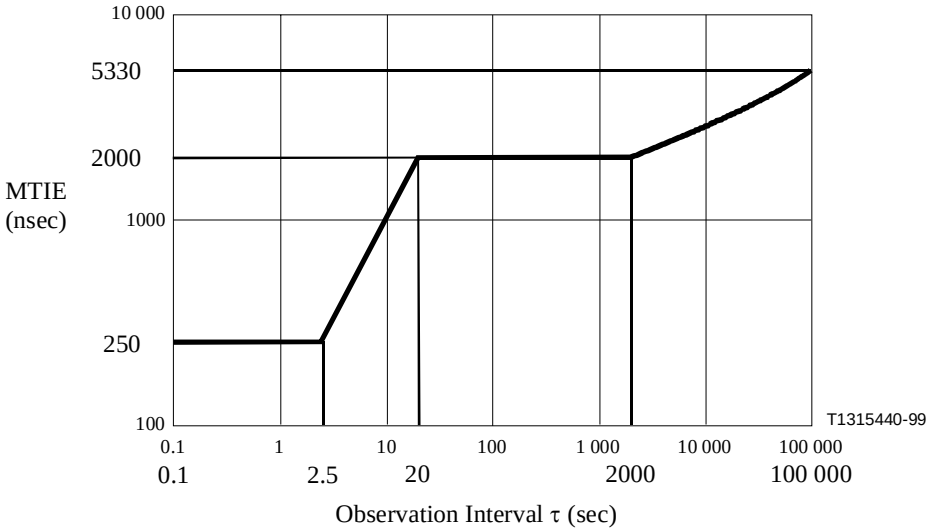
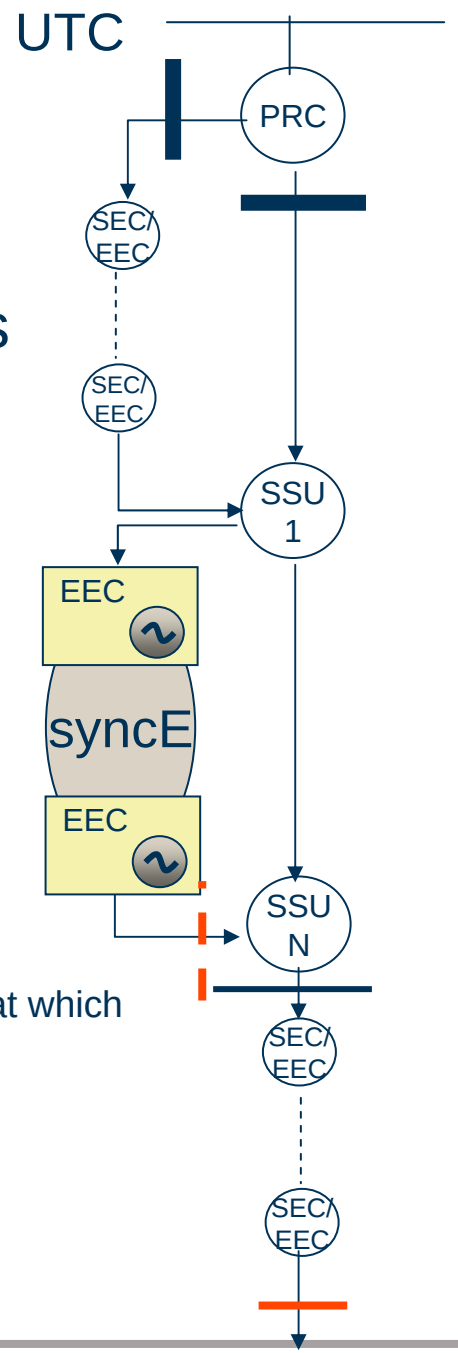


Figure 10/G.8261 – Network limit for wander (MTIE) at EEC-Option 1 interfaces

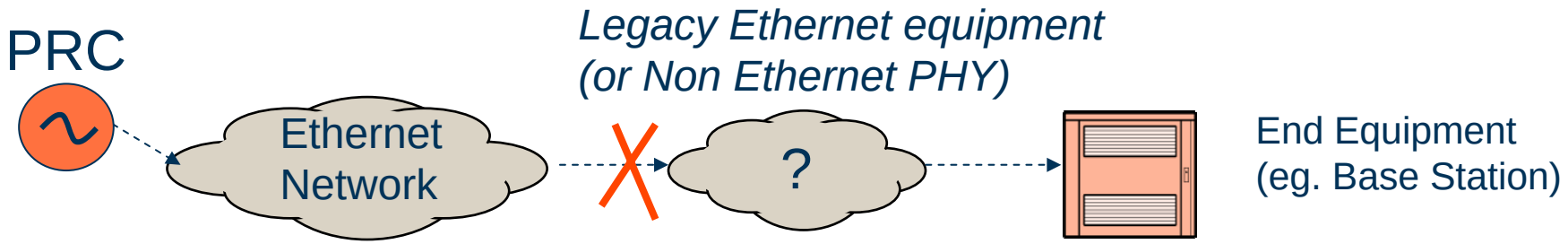


Synchronization Interface at which the network limits apply:

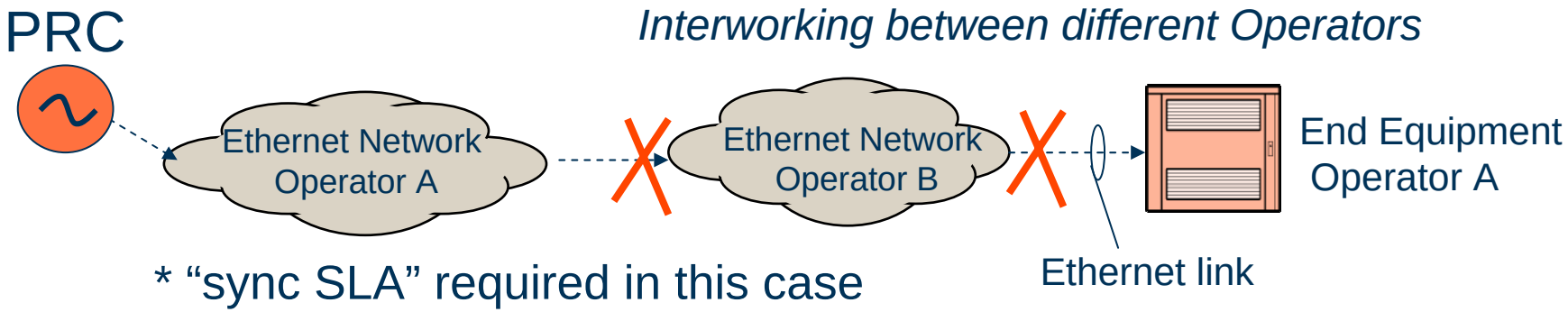
EEC Output
SEC Output
SSU Output
PRC Output

SyncE Applicability Issues

- Packet networks implementing legacy Ethernet equipment (or not (fully) based on Ethernet physical layer).



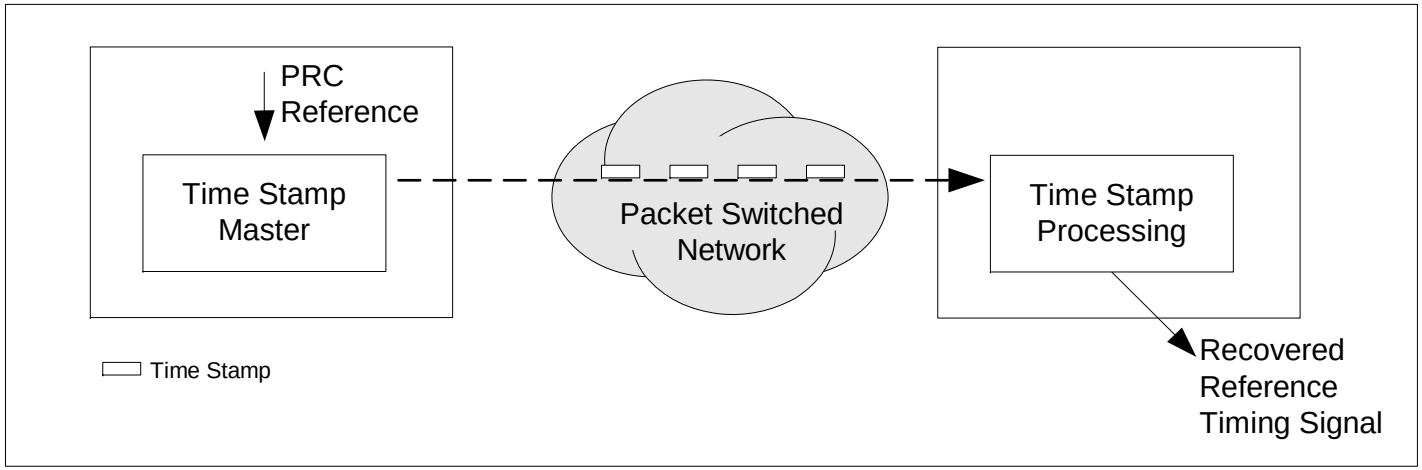
- Use of physical layer suitable within one operator domain but critical when timing is to be carried between different operators*



- New Technologies and services requiring accurate phase/time

Packet Based Methods

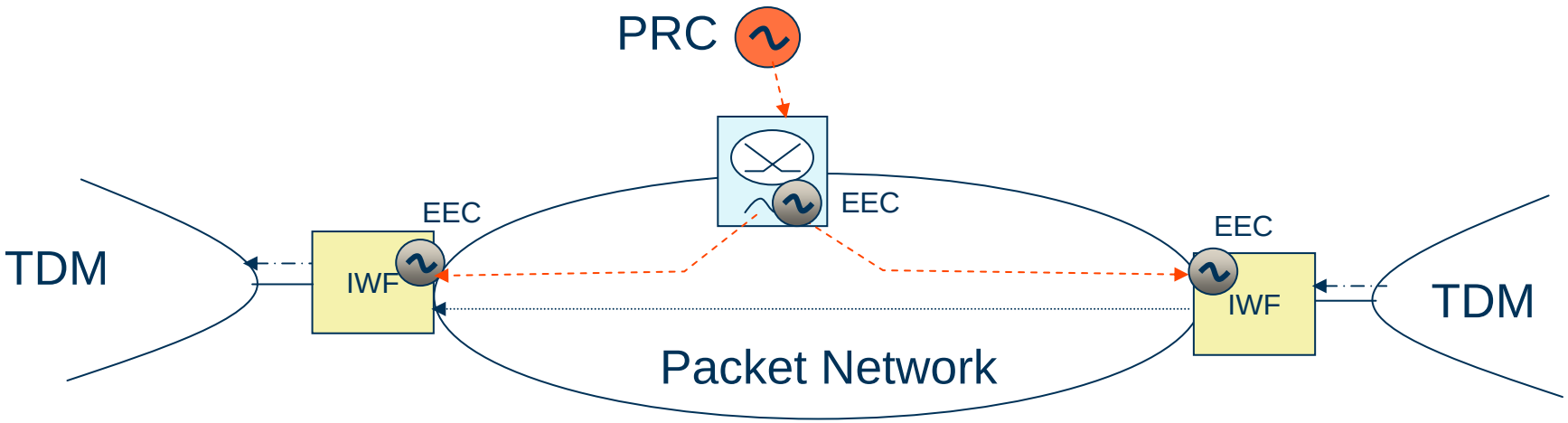
- The G.8261 addresses also the timing distribution via dedicated packets (“packet based methods”); examples of protocols are NTP and PTP



- G.8261 provides general recommendations and Network Limits
- Note: the distribution of Time of Day is planned to be addressed by the G.8264

Service Clock and Network Clock (1)

Example: Differential method



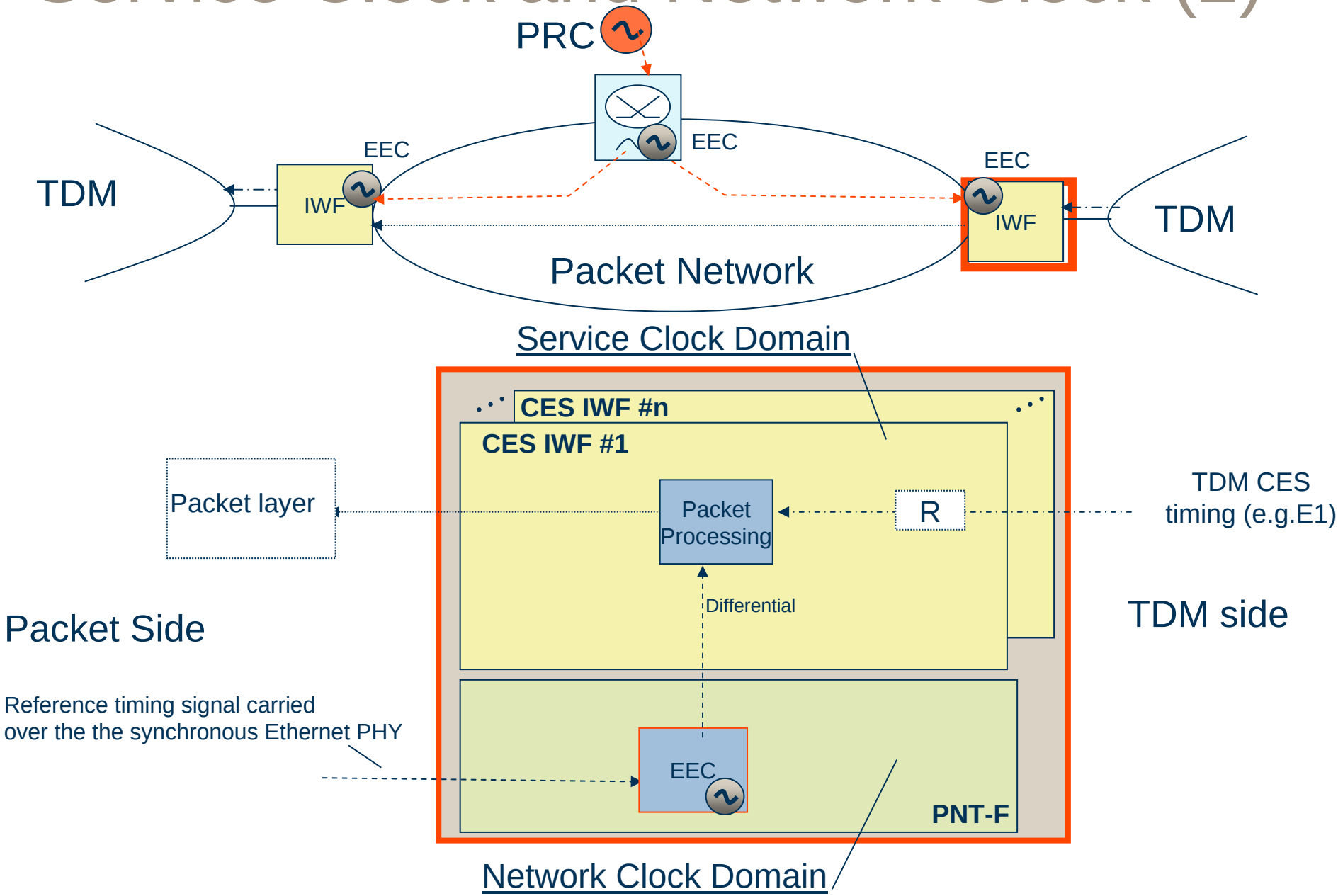
Network Clock Timing flow

Service Clock Timing flow

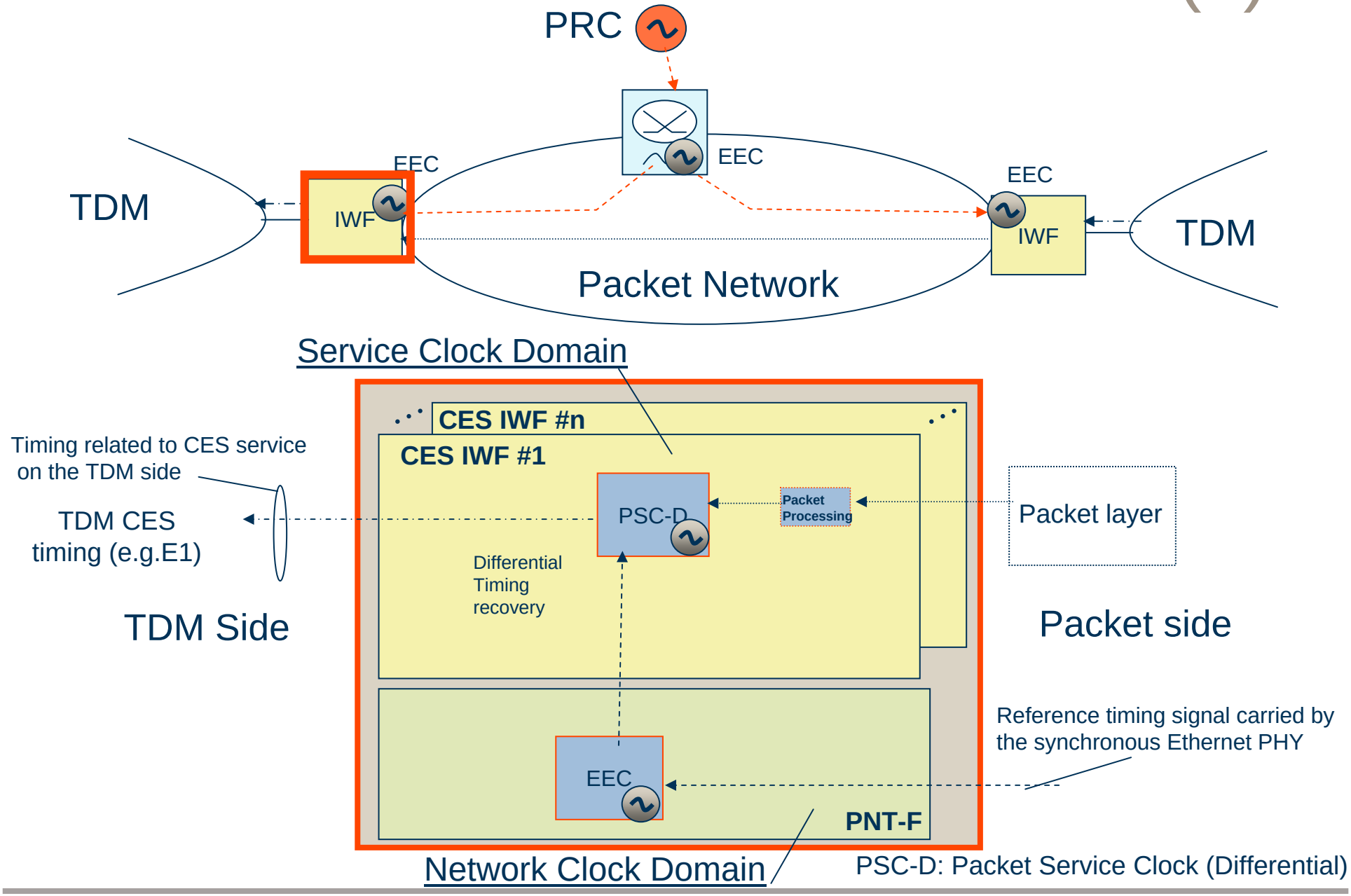
Timing messages supporting the differential method

PNT: Packet Network Timing
CES: Circuit Emulation Services
EEC: Ethernet Equipment Clock

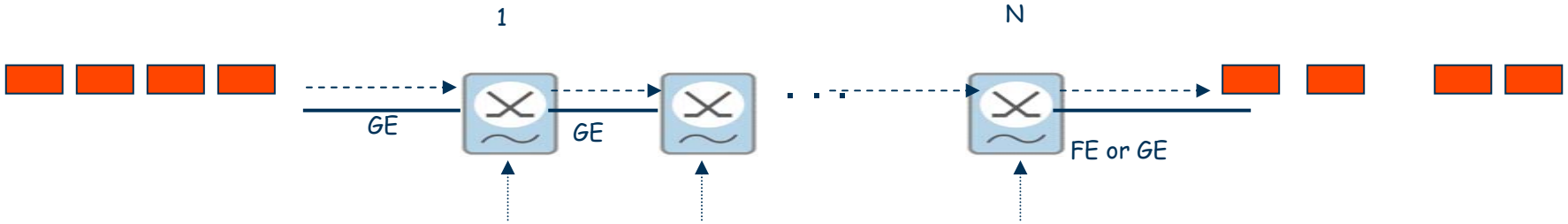
Service Clock and Network Clock (2)



Service Clock and Network Clock (3)



Network and Traffic Models



Input traffic according to traffic models

Flow of interest

Ethernet Switches

N = 10

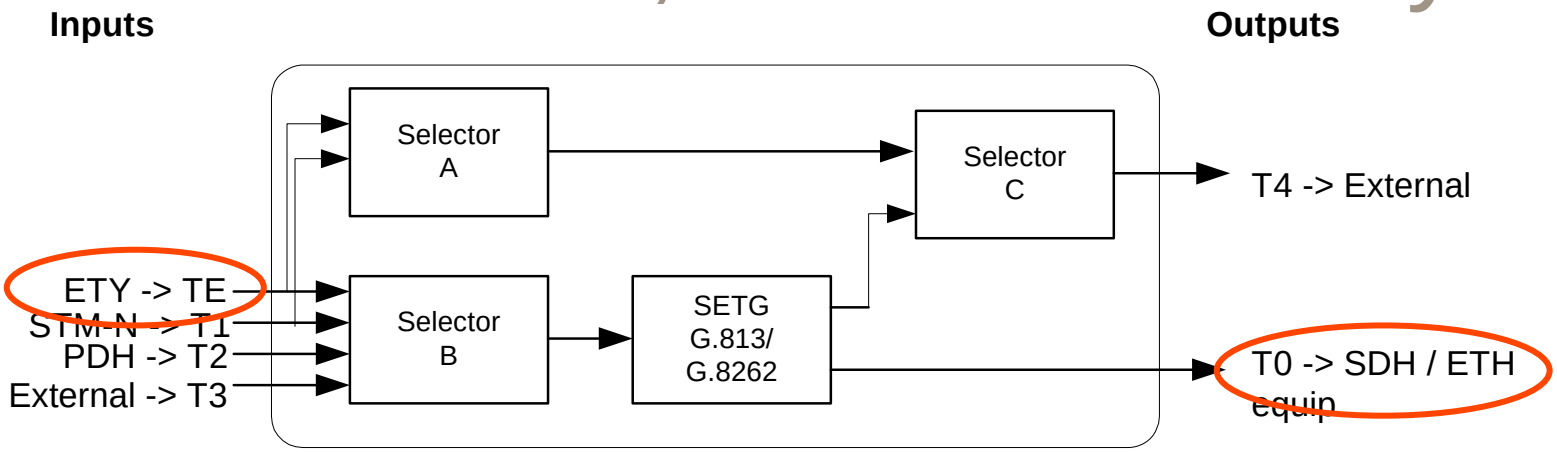
GE = 1 Gbps Ethernet

FE = 100 Mbps Ethernet

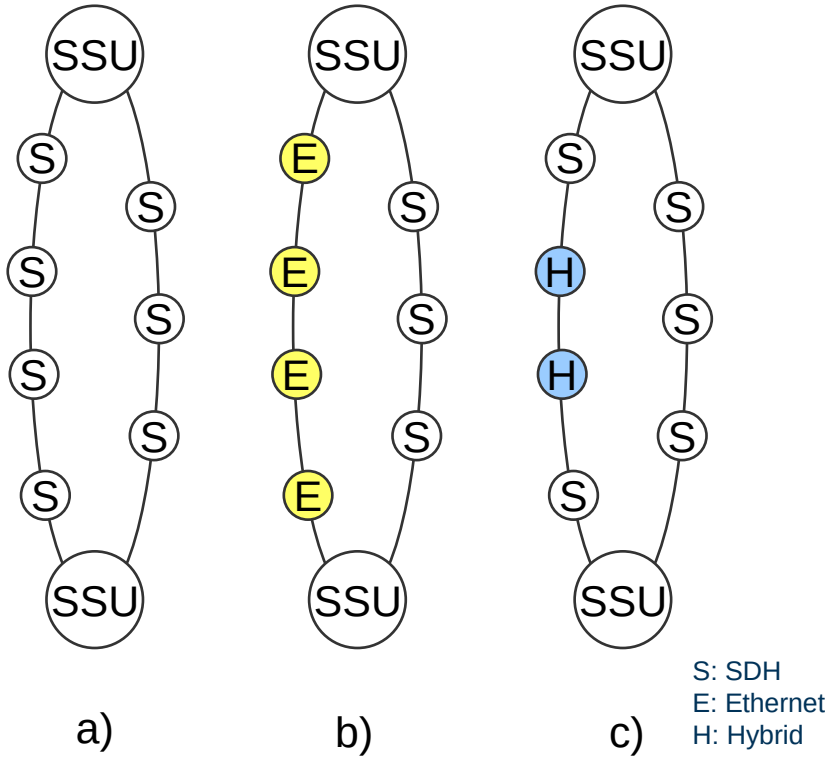
The “reference packet” is a packet with fixed length sent at typical packet rates, from 1 packets /s to1000 packets/s)

- G.8261 Appendix includes also some Measuring Guidelines: although not exhaustive, it provides hints on how the clock algorithms can be tested

G.8262: EEC, the Clock for SyncE

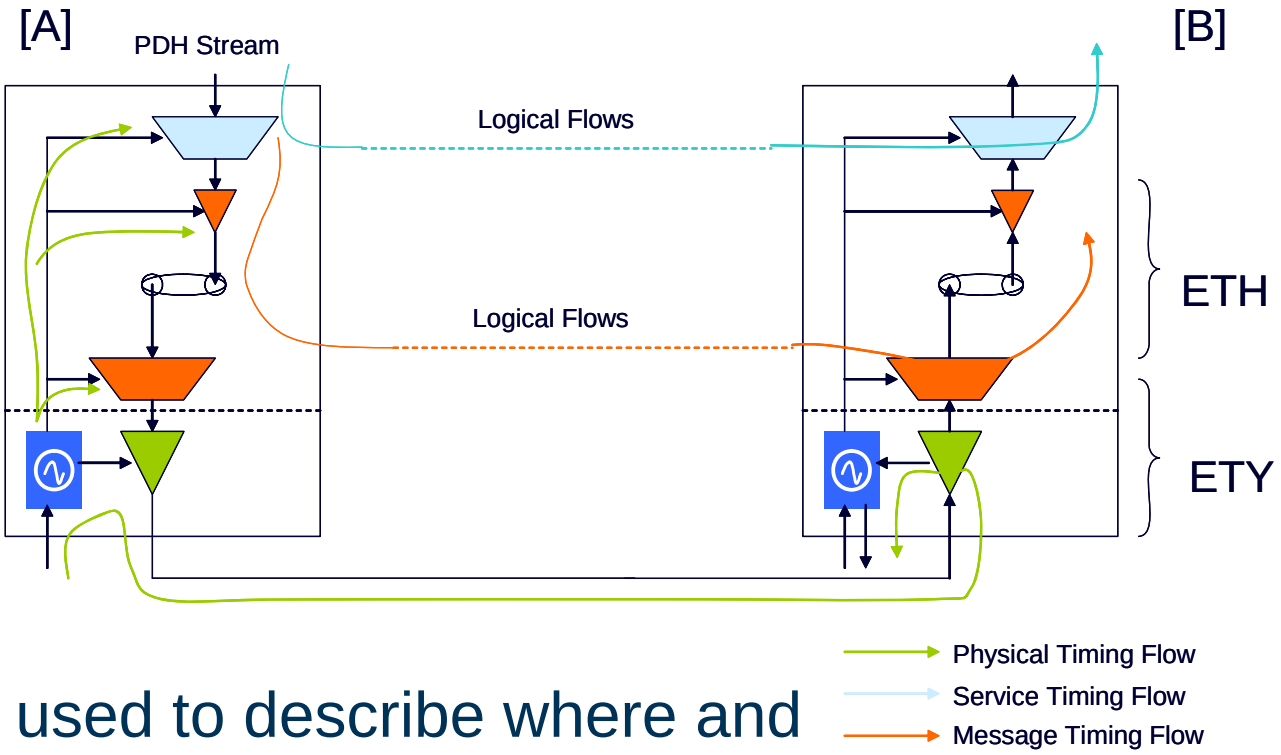


- G.8262 specifies the EEC, Ethernet Equipment Clock, to support SyncE
- The G.8262 is based on the SDH standards (characteristics similar to the G.813 clocks)



G.8264 (G.pacmod)

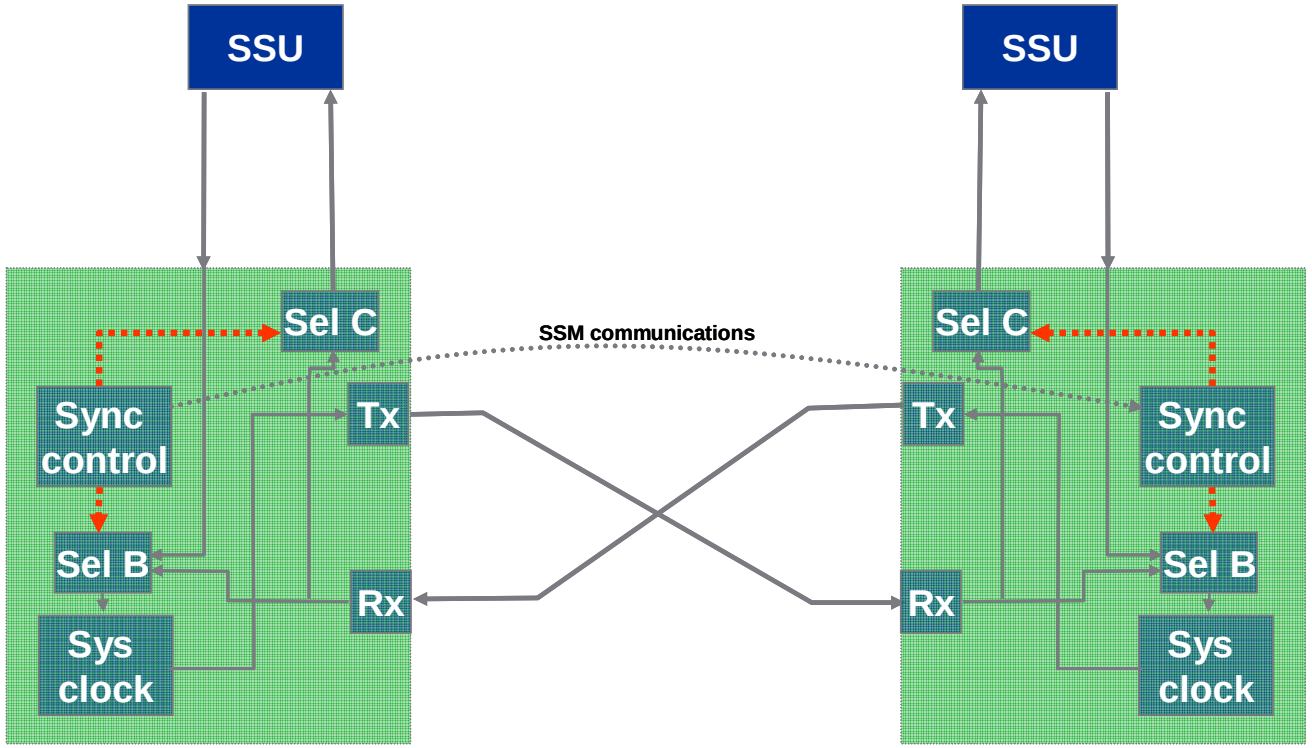
- G.8264 outlines the requirements on Ethernet Transport networks with respect to Time and Timing and details the required architecture in formal modelling language.



- Timing flows are used to describe where and how time and timing will flow through the architecture.
- Time of Day is one of the aspects to be covered in G.8264

SSM in G.8264

- The SSM is one of the main building blocks of the Synchronous Ethernet based synchronization methods



G.8263 (G.paclock-bis)

- This recommendations shall address the specification of the packet based clocks.
  To be released during next study period ?
- Service Clock (CES) domain:
  - PSC-A (Packed Service Clock-Adaptive)
  - PSC-D (Packet Service Clock-Differential)
- These clock shall recover the service clock signal (e.g. the timing of circuit emulated E1 carried over a packet network)
- Network Clock Domain:
  - PEC (Packet based Equipment Clock)
- The PEC is the clock that recovers (frequency) timing from dedicated timing packets (e.g. timestamps)

Network Time Protocol: NTP

- NTP is the most deployed time protocol. RFC 1305 (NTP V3) also describes the algorithms to recover the “time” at the client side. NTP v4 draft is available.
- The target accuracy has traditionally been in the order of ms (e.g. to support billing and alarming). Also widely used over the public internet.

- In a well engineered network better accuracy is expected (“HW time-stamping” can also be used by NTP, see RFC 1305); resolution of the NTP packets is 200 ps.
- The long-term accuracy (10^{-11}) of the NTP Time Servers can be used to distribute frequency (e.g. towards Base Stations); Packet Delay Variation filtering is needed on the client side.

Precision Time Protocol: PTP

- IEEE1588 V2, Precision Time Protocol (PTP), about to be released (beginning 2008 ?).
- Targeting accurate time/phase distribution (sub-microsecond level). This can be guaranteed when all nodes in the network implement Transparent or Boundary Clocks.
- PTP packets can be used in an end-to-end arrangement as any other protocol (NTP, RTP, etc.);
  PDV filtering is needed at the end equipment (not defined by the IEEE1588).
- ITU-T is starting to investigate the applicability of IEEE1588 into Telecom applications: the G.826x documents may address the related aspects (during next study period ?).
- Some of the aspects that may be part of the study:
  - Network Architecture
  - Clock Implementation

Others

- ATIS (OPTXS): Technical Report *Synchronization of Packet networks (*OPTXS-SYNC-2007-007R6).
- MEF: Ongoing project on Mobile Backhauling IA (based on ITU-T Recommendations); CESoETH (MEF 8); etc.
- Other ITU-T synch over packet related recc.:, *TDM-MPLS network interworking – User plane interworking*, (Y.1413);
- IETF: *Requirements for Edge-to-Edge Emulation of Time Division Multiplexed (TDM) Circuits over Packet Switching Networks*, (RFC 4197); *Structure-aware TDM Circuit Emulation Service over Packet Switched Network* (PWE3-CESoPSN)

Conclusions

- The Next Generation Networks have introduced new challenges in the synchronization area which is again a key area for study
- Within ITU-T two new standards have been released recently: the G.8261 and G.8262.
  G.8264 and updated G.8261 and G.8262 will soon be available
- The standardization of synchronous Ethernet is almost completed.
  Additional solutions will be needed: Packet based methods are under study (to deliver frequency and/or Time)
- Protocols such as PTP and NTP, are now among those mostly debated for use in Telecom. Both can carry frequency in addition to time.
- Some work is required in the standards in order to take advantage of the PTP potentialities

THANK YOU

QUESTIONS ?