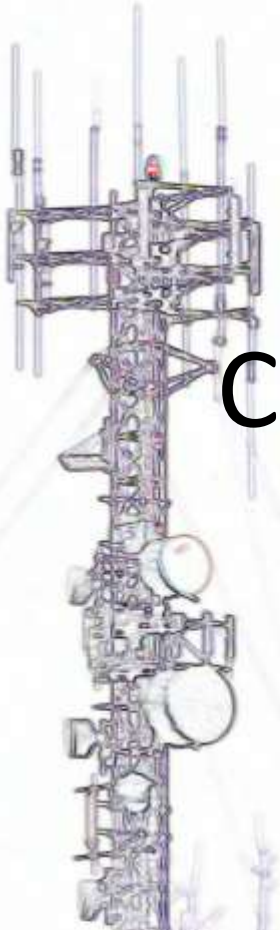


Challenges in profiles and architectures

Michael Mayer, Editor G.8275

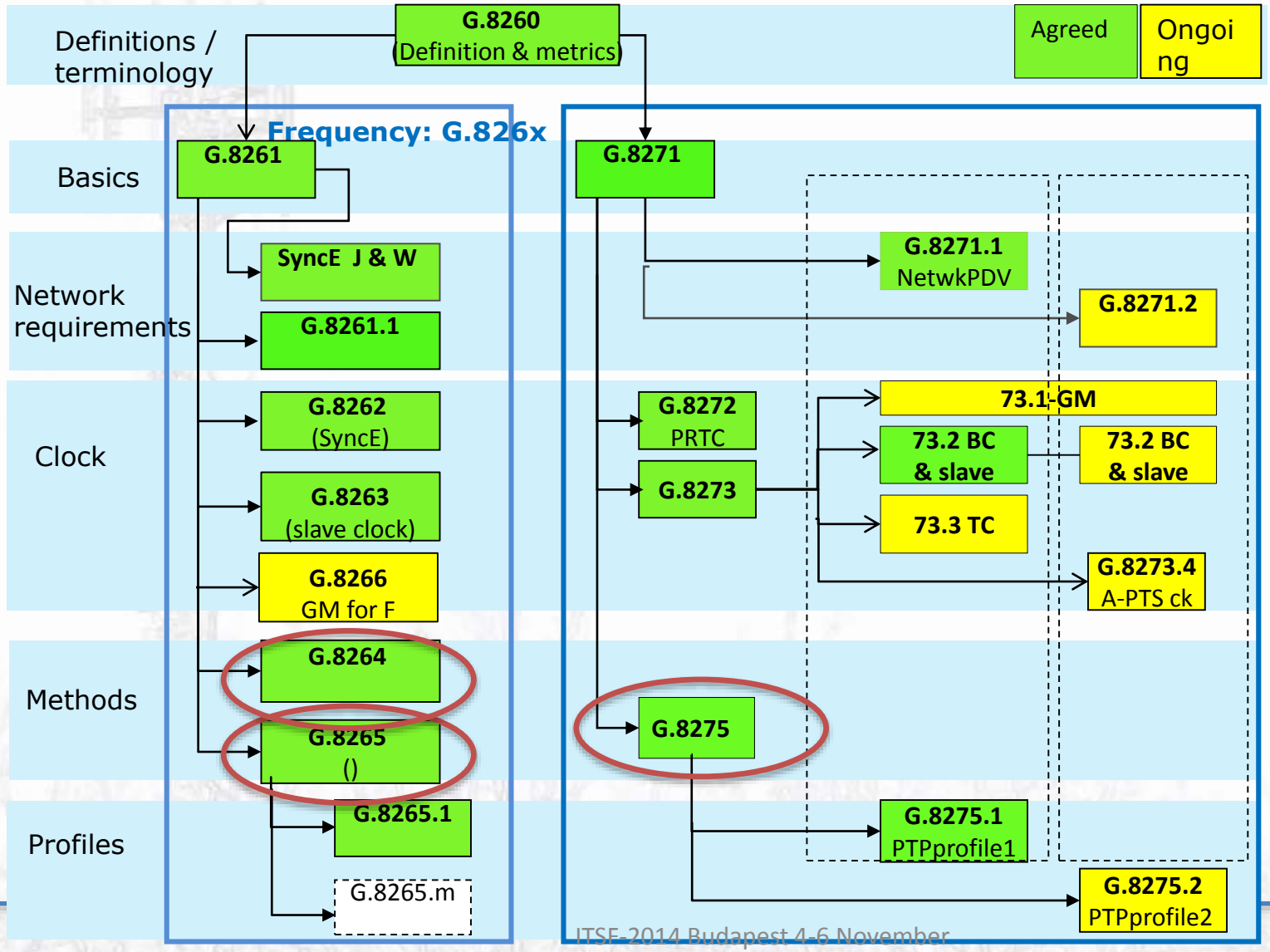
ITSF-2014 Budapest

Challenges in profiles and architectures

Outline

- The architecture recommendations
  - Relation to other Recommendations and status
- Brief overview of architecture methods
- G.8275 overview
- Future and challenges

The Architecture Recommendations



The Architecture Recommendations

Physical layer frequency:

- G.8264/Y.1364: Distribution of timing information through packet networks
  - G.8264/Y.1364 (05/14)
  - (first version 10/2008)

Packet Frequency

- G.8265/Y.1365 : Architecture and requirements for packet-based frequency delivery
  - **G.8265/Y.1365 (10/10)**
  - **G.8265/Y.1365 (2010) Amd. 1 (04/2011)**
  - **G.8265/Y.1365 (2010) Amd. 2 (10/2012)**

Packet time/phase

- G.8275: Architecture and requirements for packet-based time and phase delivery
  - **G.8275/Y.1369 (11/2013)**

Why architecture?

- A network is a distributed system
  - Purpose is to enable information transfer (flow)
- Necessary functions are specified in standards
- How do these functions fit together?
  - What restrictions exist?
- What is information required to manage the network?
  - how is the network controlled or managed
- How are functions specified by different organizations?

Formal “Architecture language” aids understanding

Example architectures

Example “languages”

- OSI Reference model (ISO, or X.200)
  - Used to describe computer networks
- ITU transport model (e.g. G.800, G.805)
  - Used to describe transport networks

Example architectures

- G.803: architecture of SDH
- G.872: architecture of OTN
- G.8010: Architecture of Ethernet…
- G.8121: MPLS

Time distribution over a network has to respect and be consistent with the underlying network architecture

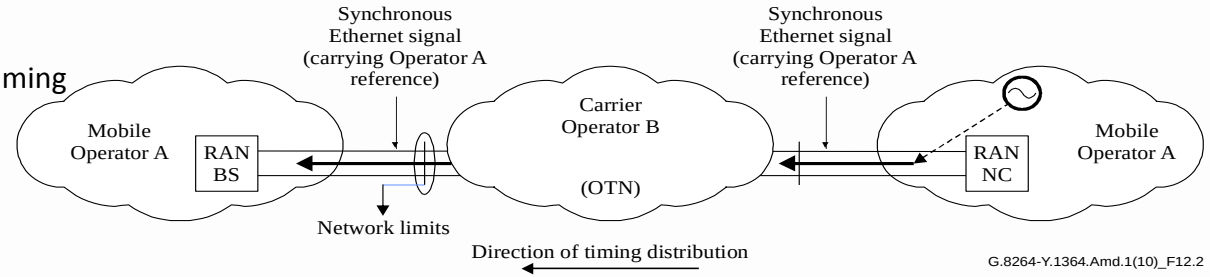
Except…

- High accuracy time/phase may not be supported over existing networks.
  - What aspects may be required *of the network* in order to support time/phase distribution?
  - What *additions are required* of the network?
    - Full path support may be required.
    - New network element type may be required (T-BC)
    - A different grouping of functions may be required
    - New functions may be required

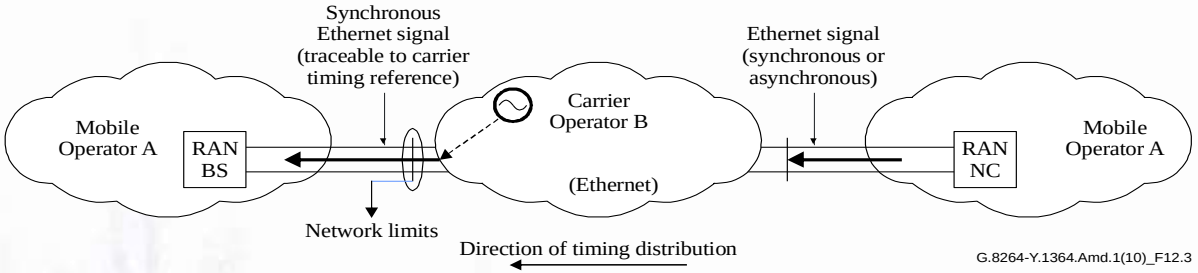
Architecture helps to clarify issues, leading to development of real solutions.

Architecture: Provides flexibility (Frequency distribution example)

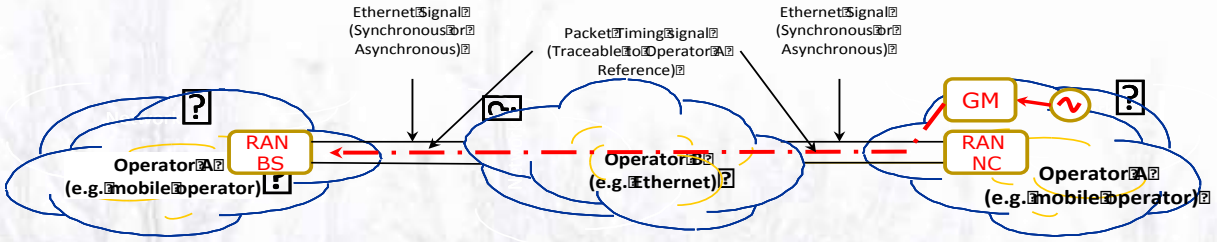
Physical layer:
Service owner provides timing



Physical layer:
Intermediate carrier provides timing



Packet layer:
Service owner provides timing



Architecture for time/phase?

- Architecture recommendations provide high level guidance to the development of other recommendations
- Act to coordinate other functions where necessary
  - Interface aspects,
  - Clock aspects,
  - Recommendations from other questions
  - Coordination similar functions over different technologies
- Time/phase distribution is new

A well defined architecture is needed to ensure that development of functionality is coordinated

Relationship to “Profiles”

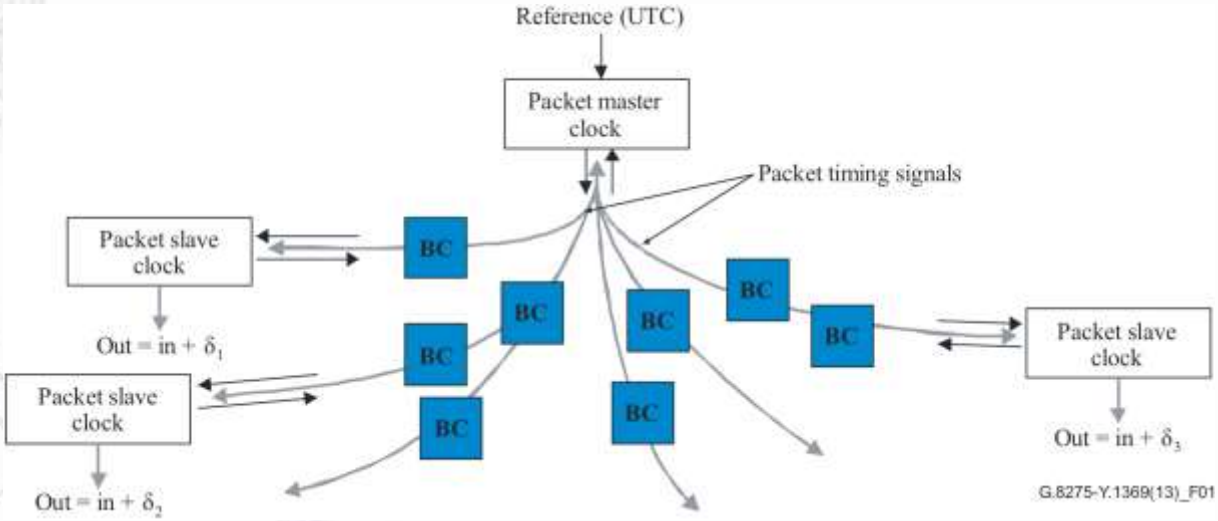
- Telecom timing distribution can occur over different technologies and with different mechanisms
  - SONET/SDH, Circuit Emulation, NTP, IEEE1588 (PTP)
  - Individual technology architecture documents are aligned with respect to requirements
  - Adhering to the architecture results in coordinated deployment
    - Example: SDH/SONET and Sync Ethernet are compatible
- IEEE-1588 profile mechanism to address different applications
  - Telecom is more than one application (e.g. frequency, phase/time) and may have existing technologies to consider
- The “Application” is defined by the architecture
  - Specific packet functionality (e.g. packet slave clocks) can be described within the architecture to ensure fit with other technologies
- The profile and the architecture must be considered together
  - The architecture Recommendations are normative reference in the Telecom profiles

Profile development and architecture are linked

G.8275 details

- First version consented in July 2013
  - Comments addressed October 2013
  - Published in November 2013.
- Aspects covered
  - High level requirements
  - General topology for time/phase distribution
  - High level protection concepts
    - Packet master protection
    - Packet slave protection
  - PRTC configurations
  - Initial functional models for time/phase
  - Partial timing support (currently non-normative in first version)

Time/phase distribution

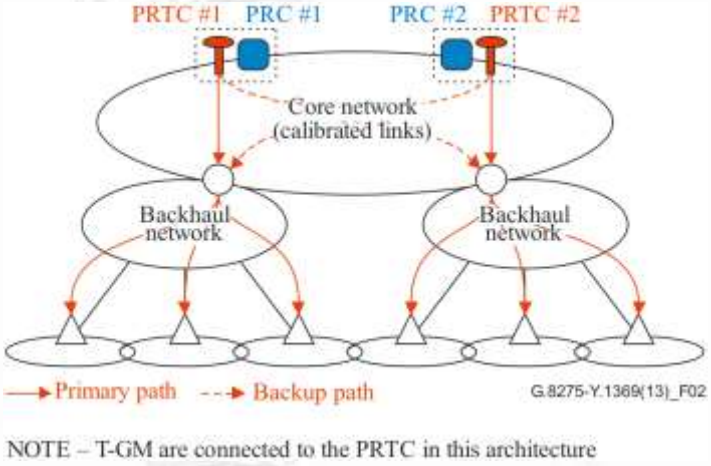


- High level distribution based on G.8265
  - Intermediate network elements are “PTP aware”
  - Restricted to boundary clocks in first version

High level protection

- Protection methods are needed for
  - Master protection
    - Provides guidance on deployment
    - Four scenario's considered
  - Slave protection
    - Provides guidance on mechanisms (e.g. how BMCA may work)
    - Three scenario's considered

Packet master protection



NOTE – T-GM are connected to the PRTC in this architecture

Scenario 1 (Case A)

Four scenarios considered

-Each case the PTC moves towards the edge of the network

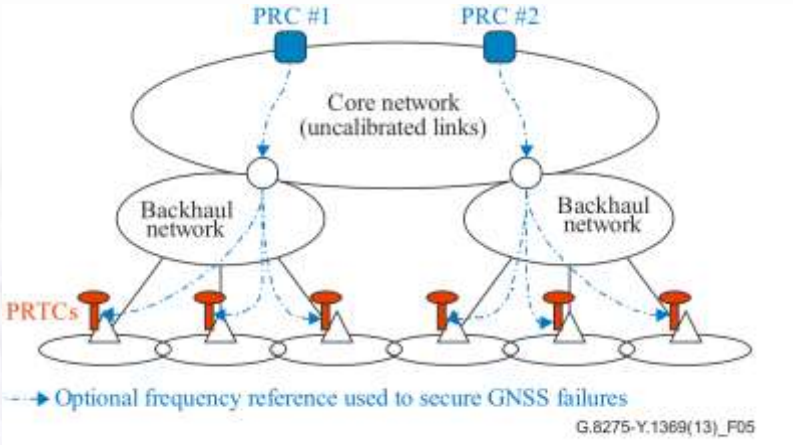
-may place different requirements on PTRC

Note: Scenarios 2 and 3 are not shown

2: Separates PRTC and PRC

3: Moves PRTC to head of backhaul

(refer to G.8275 Figures 3 and 4)



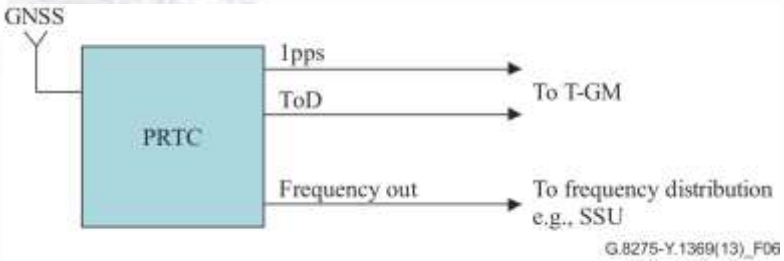
NOTE – There is normally no T-GM connected to the PRTC in this architecture

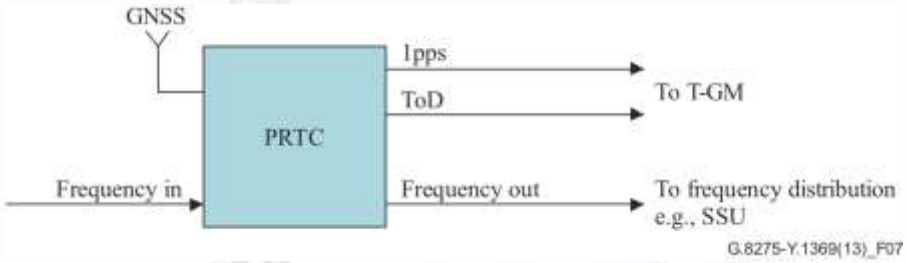
Scenario 4 (Case D)

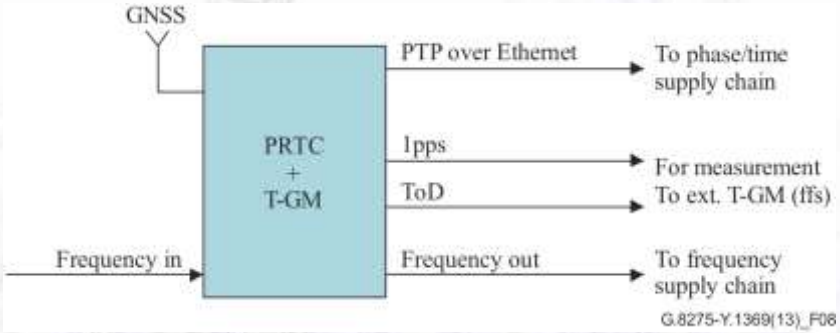
PRTC configurations

- Protection methods do not require the same PTRC configurations
- The architecture provides guidance for development of equipment specifications

PRTC configurations







PRTC (no physical reference)
-Frequency/phase/time all provided by single GNSS input
-Applies only to first scenario

PRTC with capability of input frequency reference for holdover
-Frequency/phase/time all provided by single GNSS input
-Can be used in all scenarios

PRTC functionality integrated with Telecom Grand Master
-PTP over Ethernet interface can also provide physical layer frequency synchronization

Packet slave protection

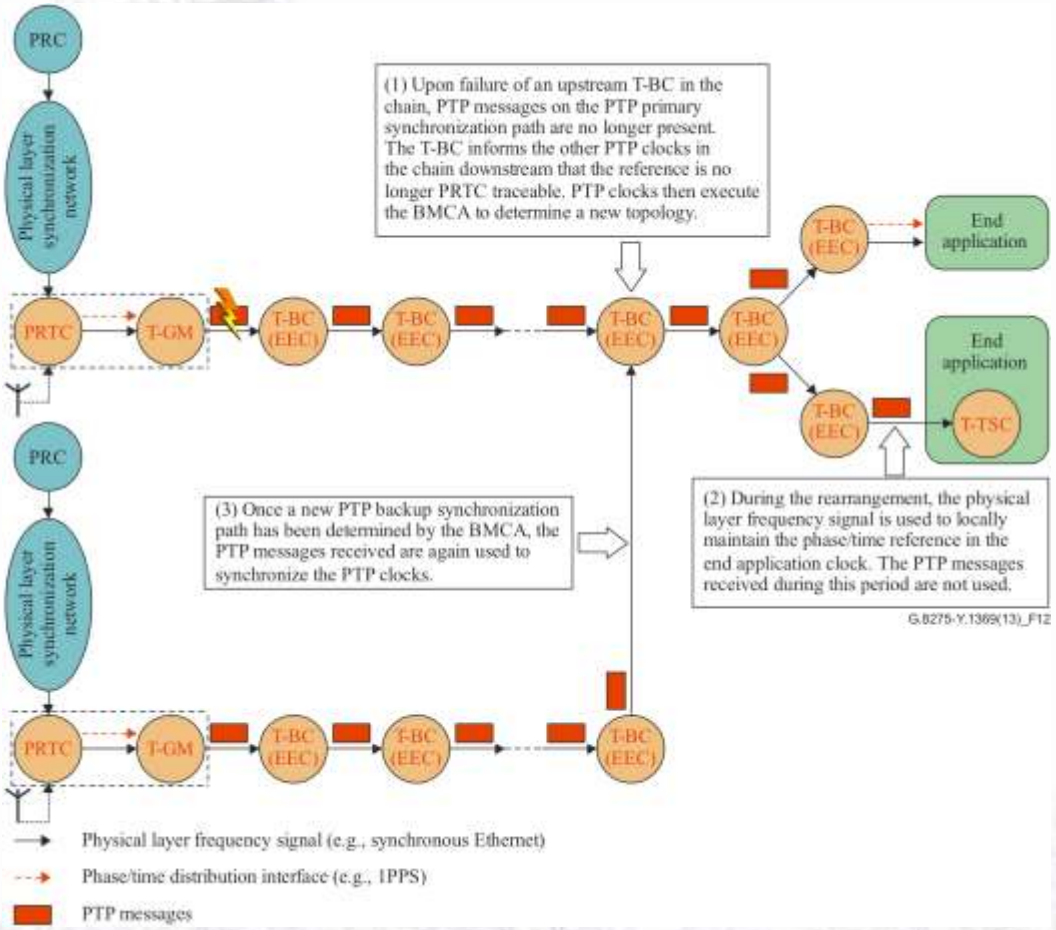
- Describes how redundant timing paths can be provided to the slave
- Three general cases:

  1: phase/time protection using physical layer frequency support

  2: Switching to a redundant reference with physical layer support (for frequency)

  3: switching to a redundant reference without physical layer support

Packet slave protection example



Packet slave protection

-Specific example is scenario 2: protection with support provided by physical layer frequency (holdover).

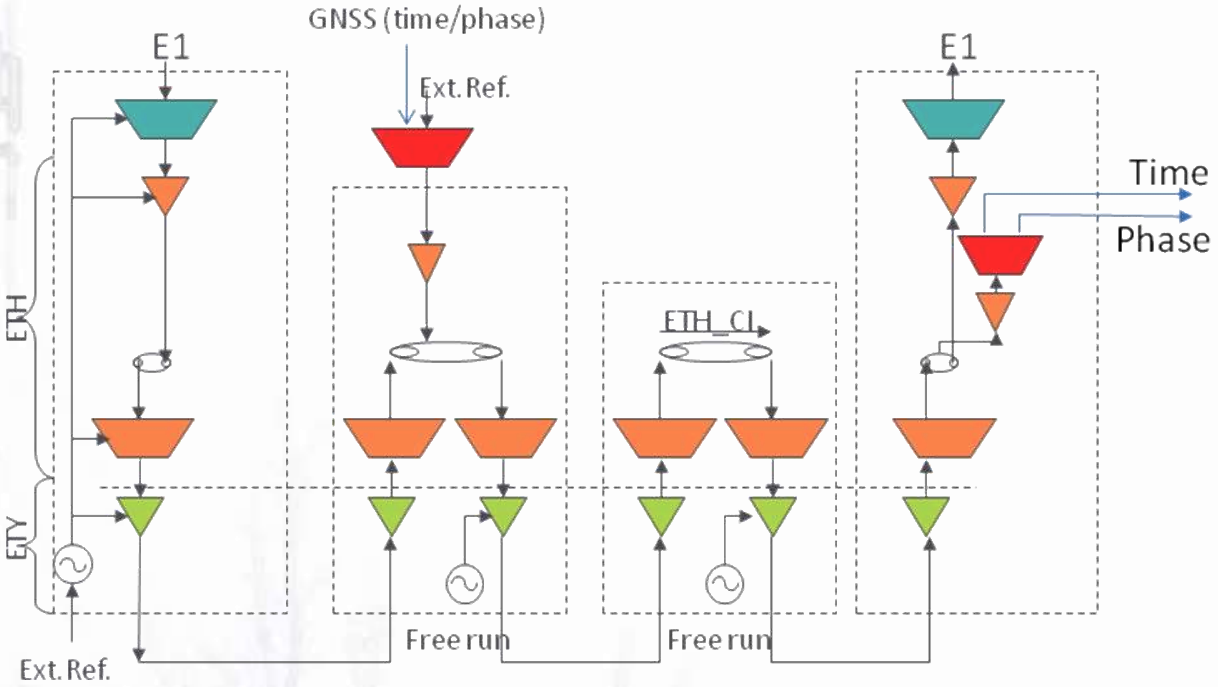
-Scenario 3 is similar (refer to G.8275)

-two types of end application are show, there the end application includes the end clock, or when the end application is driven by a stand-alone clock.

Time/phase functional models

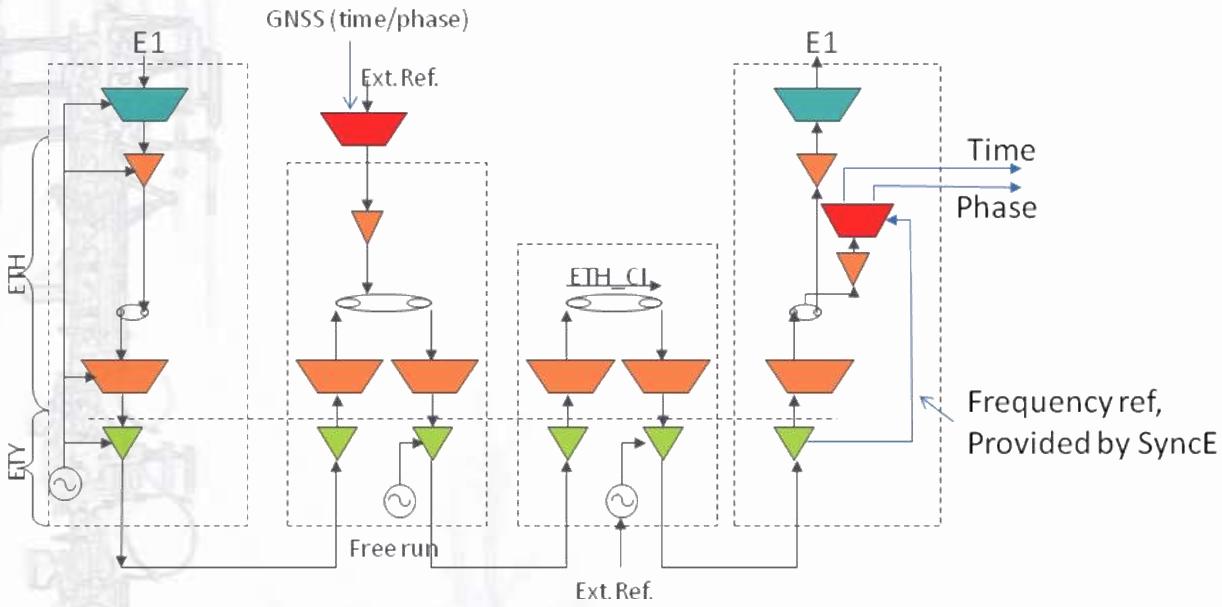
- Extensions of G.8264 models to describe time/phase with support from physical layer (SyncE) have been included as Annex.
- Provides guidance to other questions in developing appropriate equipment specifications

Extension for Packet timing



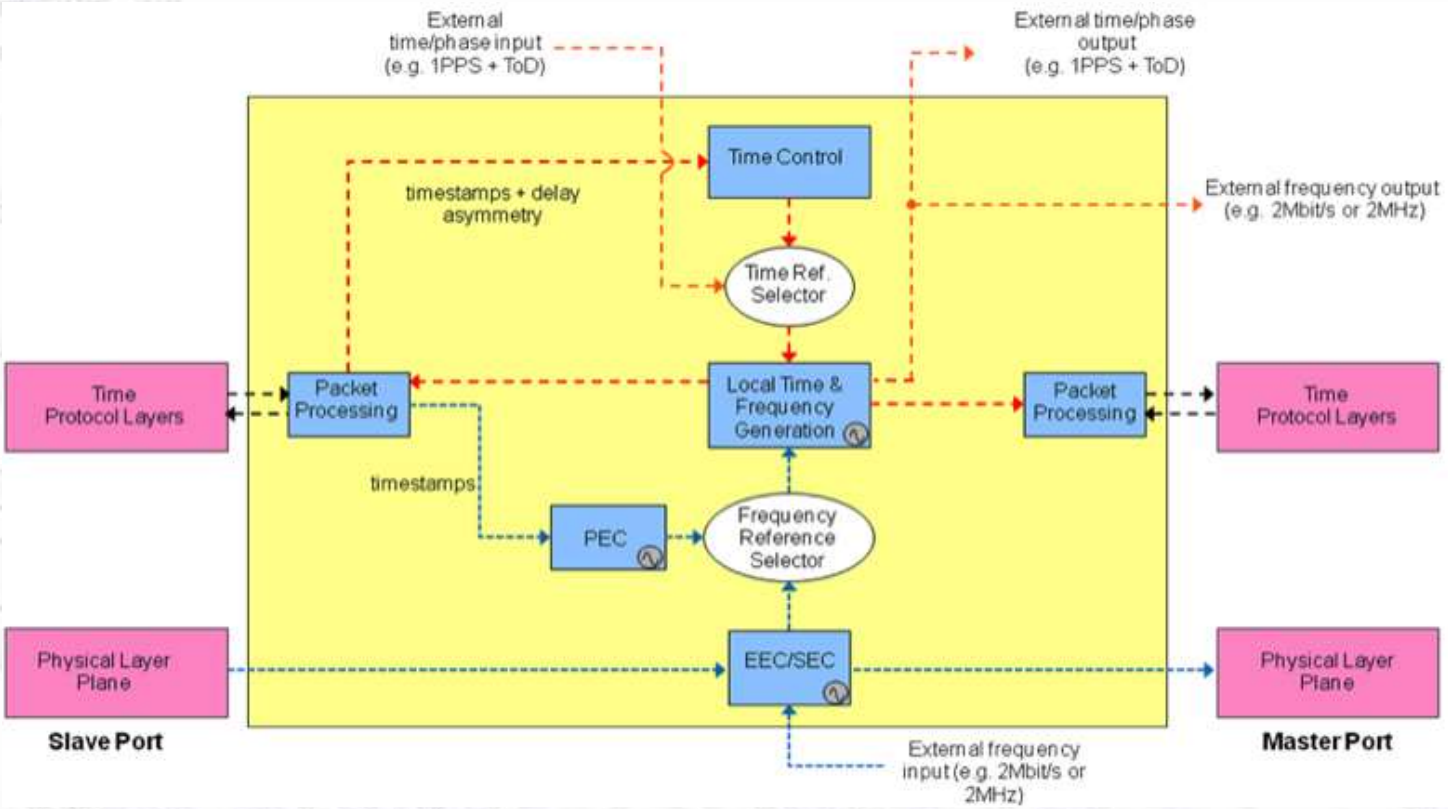
- Specific functions needed for Time distribution can be added to the basic model
  - Network may remain unchanged

Going further: Frequency assist



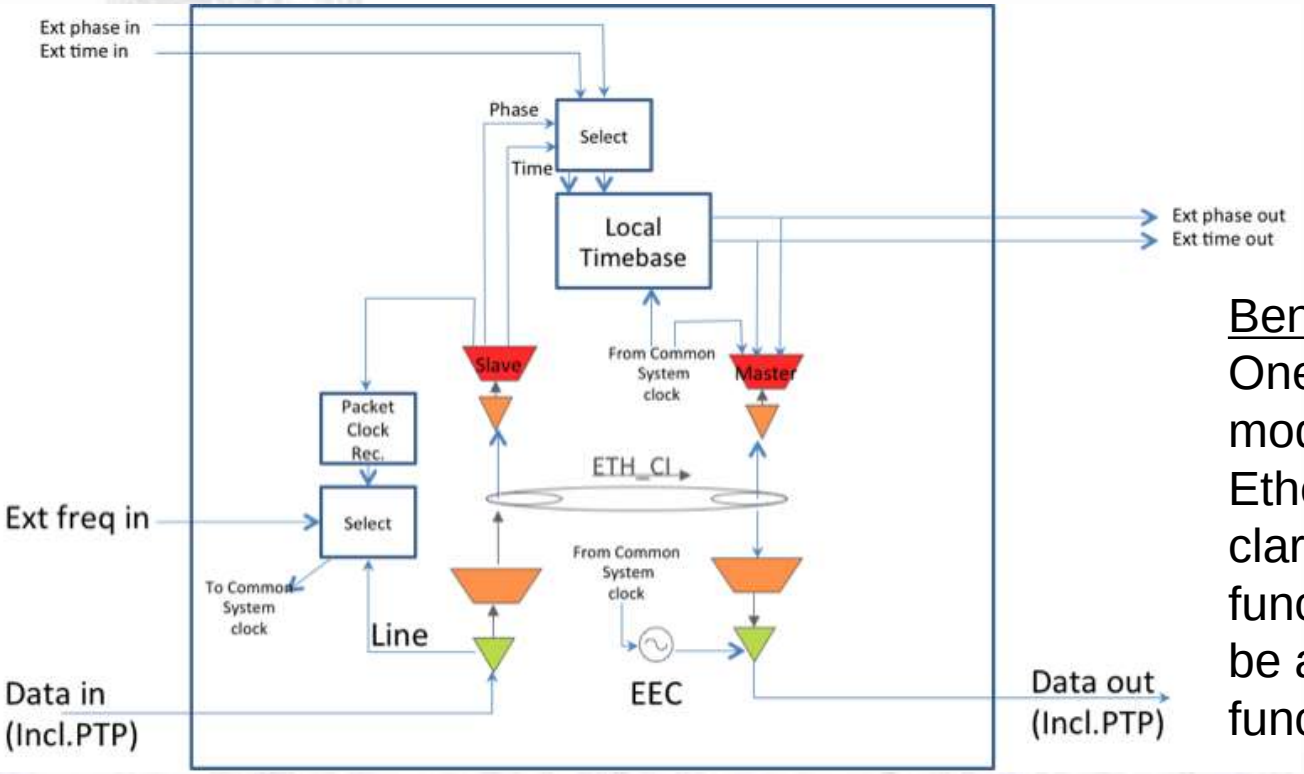
- Physical layer synchronization model is that of SDH/SyncE.
  - Boundary clock function starts to appear

Applying the architecture



Boundary clock block diagram under development in Q13/15

Possible functional Model of BC

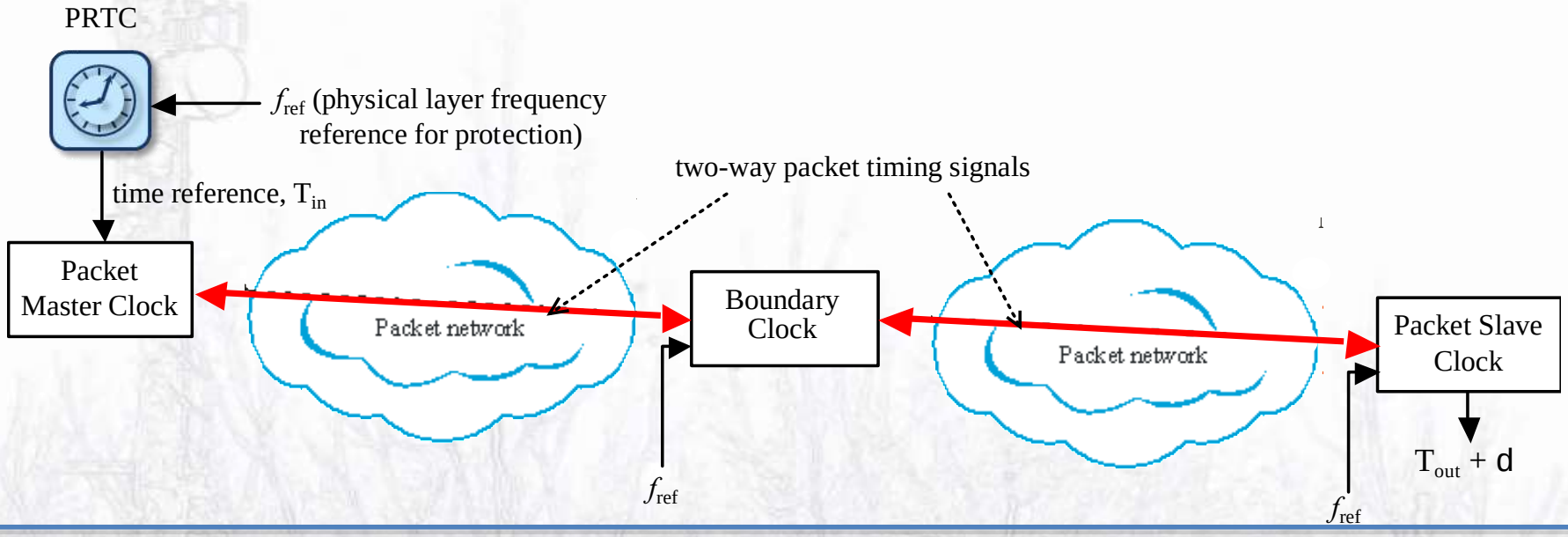


Benefit of functional model:
One can compare the model with existing Ethernet switch models to clarify the additional functionality that needs to be added to support the BC function.

Figure taken from "Synchronous Ethernet and IEEE 1588 in Telecoms"
J.L. Ferrant, et al, ISTE/Wiley, ISBN 978-1-84821-443-9

Partial timing support

- Evolution from G.8265 (Frequency) to provide time/phase
- Currently non-normative in G.8275
- Not all network elements are BC
- Architecture begins to define functional requirements

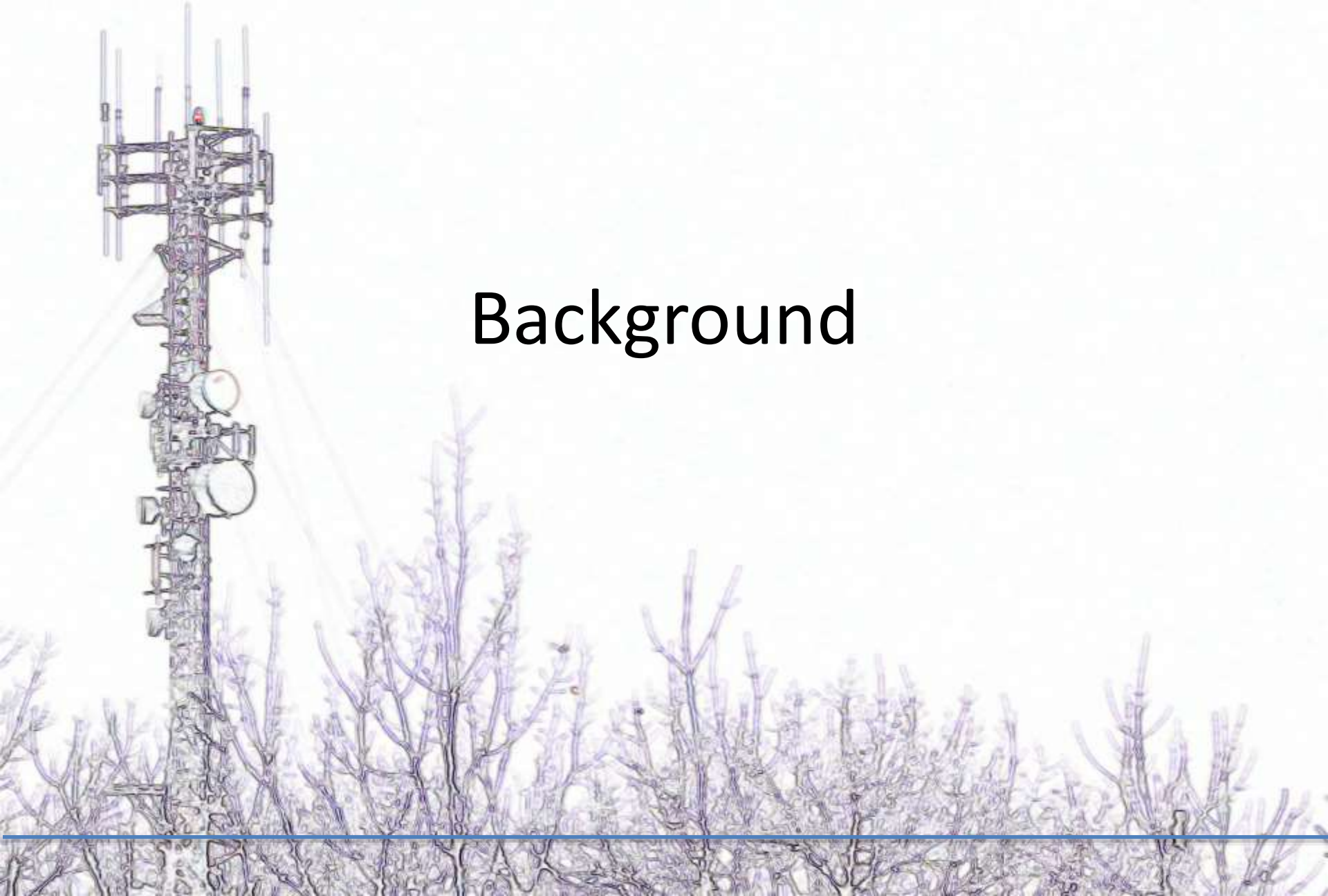


Challenges

- First version approved 2013
- Areas for further work will be captured in amendments
  - G.8275AM1 due 12/2014
- Further work expected
  - Partial support
  - Enhancements to architecture PTP layer models
  - Small cell time distribution in a building
  - Deployment cases and applicability to the various use cases
  - Link asymmetry
  - PTP over OTN proposed some aspects should be noted in the architecture to define expected applications

Conclusion

- Architecture recommendations are important to understand the relationships between the various components in the network
- Development of the architecture, when progressed with other recommendations, results in realizable networks and networks that make full use of existing capabilities



Background

Time/phase requirements

- Packet-based mechanisms for time and phase distribution must meet the following requirements:

  1) Mechanisms must be specified to allow interoperability between the various phase/time clocks defined in this architecture.

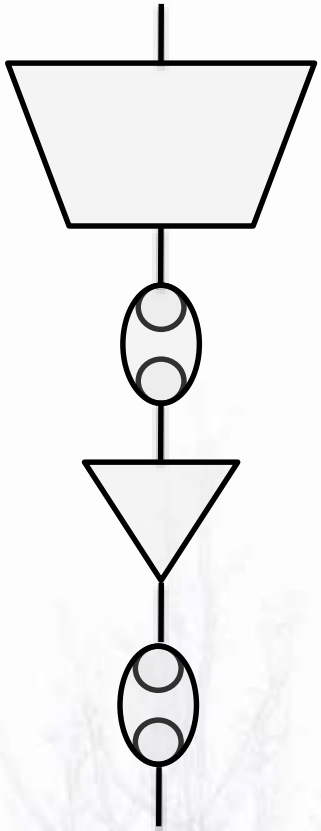
  2) Mechanisms must permit consistent operation over managed wide area telecom networks.

  3) Packet-based mechanisms must allow the synchronization network to be designed and configured in a fixed arrangement.

  4) Protection schemes used by packet-based systems must be based on standard telecom operational practice and allow telecom time slave clocks (T-TSC) the ability to take phase and time from multiple geographically separate telecom grand master (T-GM) clocks.

  5) Phase/time reference source selection based on received phase/time traceability and local priority should be permitted. Automatic establishment of the phase/time synchronization network topology may also be possible.

Architecture blocks



Adaptation function

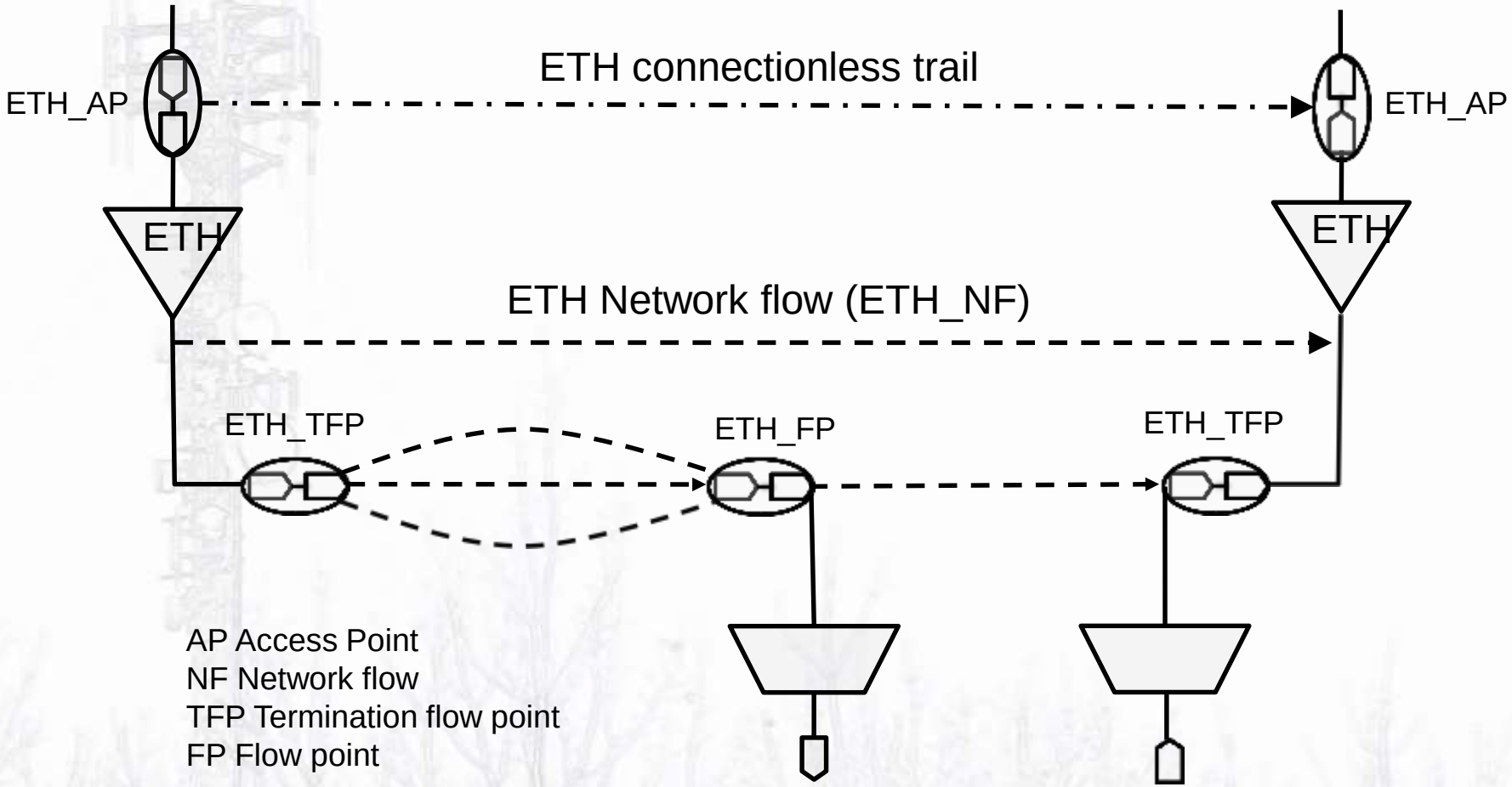
Access point

Trail termination function

Termination connection point

Figure taken from “Synchronous Ethernet and IEEE 1588 in Telecoms”
J.L. Ferrant, et al, ISTE/Wiley, ISBN 978-1-84821-443-9

Ethernet networks



Equipment example

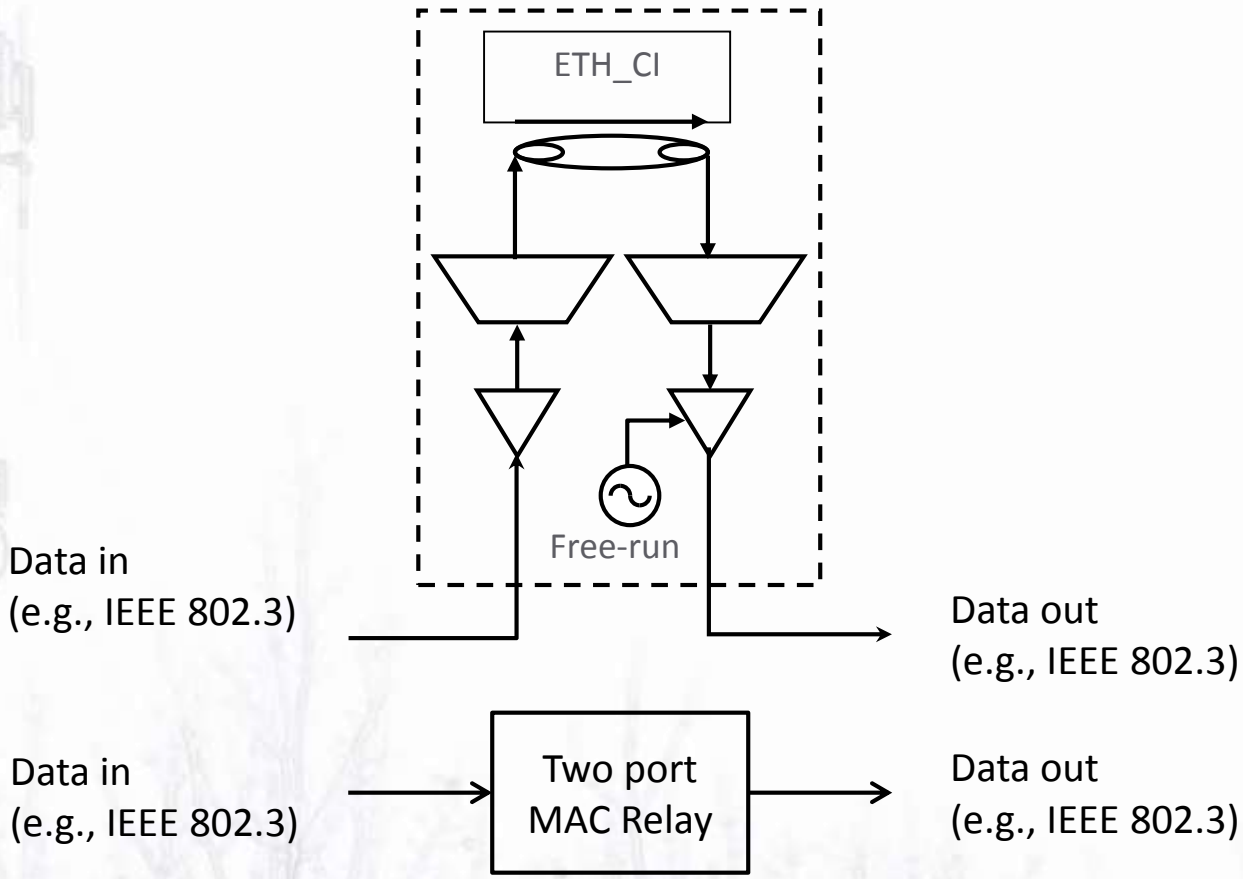
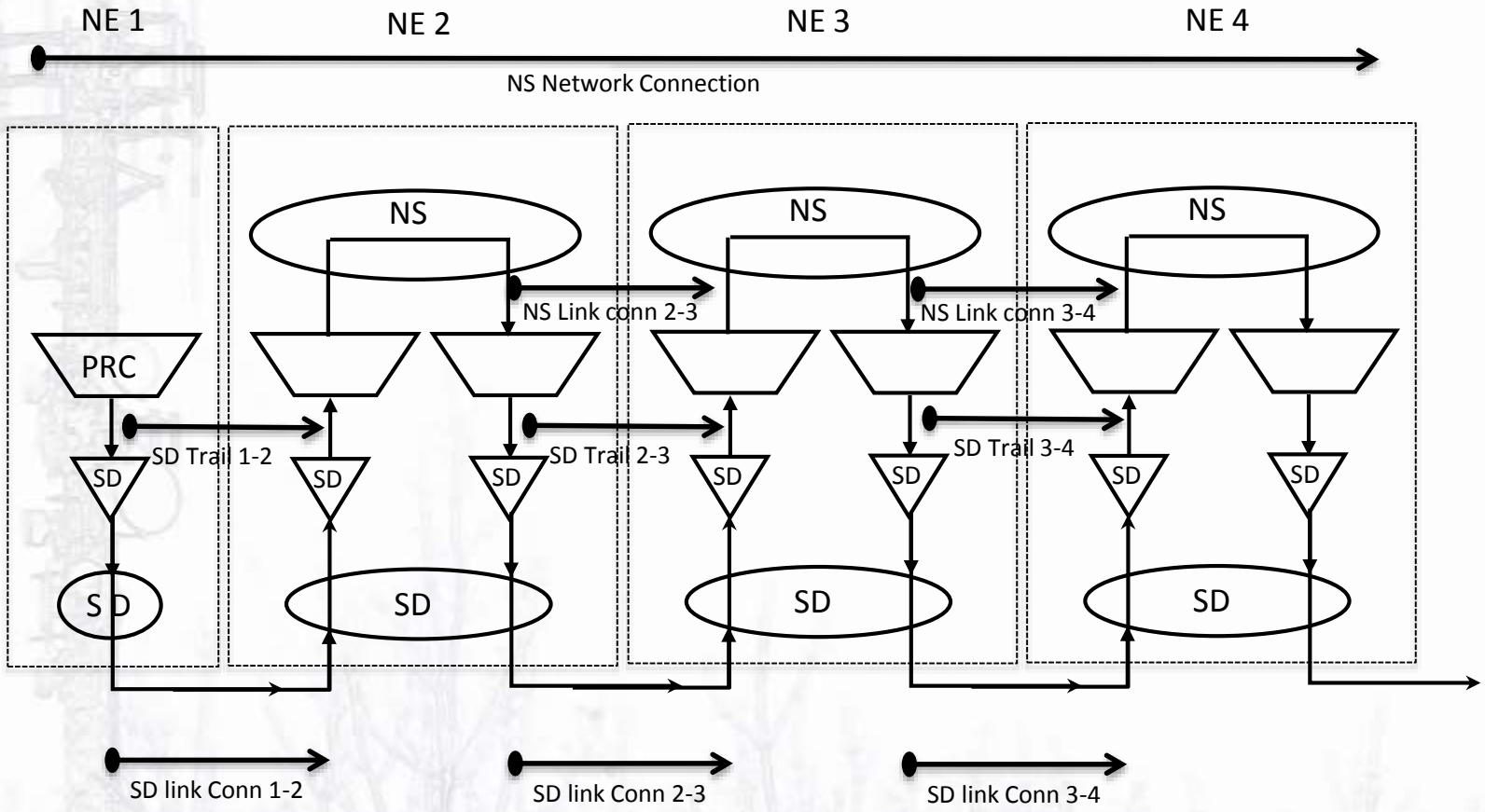


Figure taken from "Synchronous Ethernet and IEEE 1588 in Telecoms"
J.L. Ferrant, et al, ISTE/Wiley, ISBN 978-1-84821-443-9

G.781 sync network



OSI model example

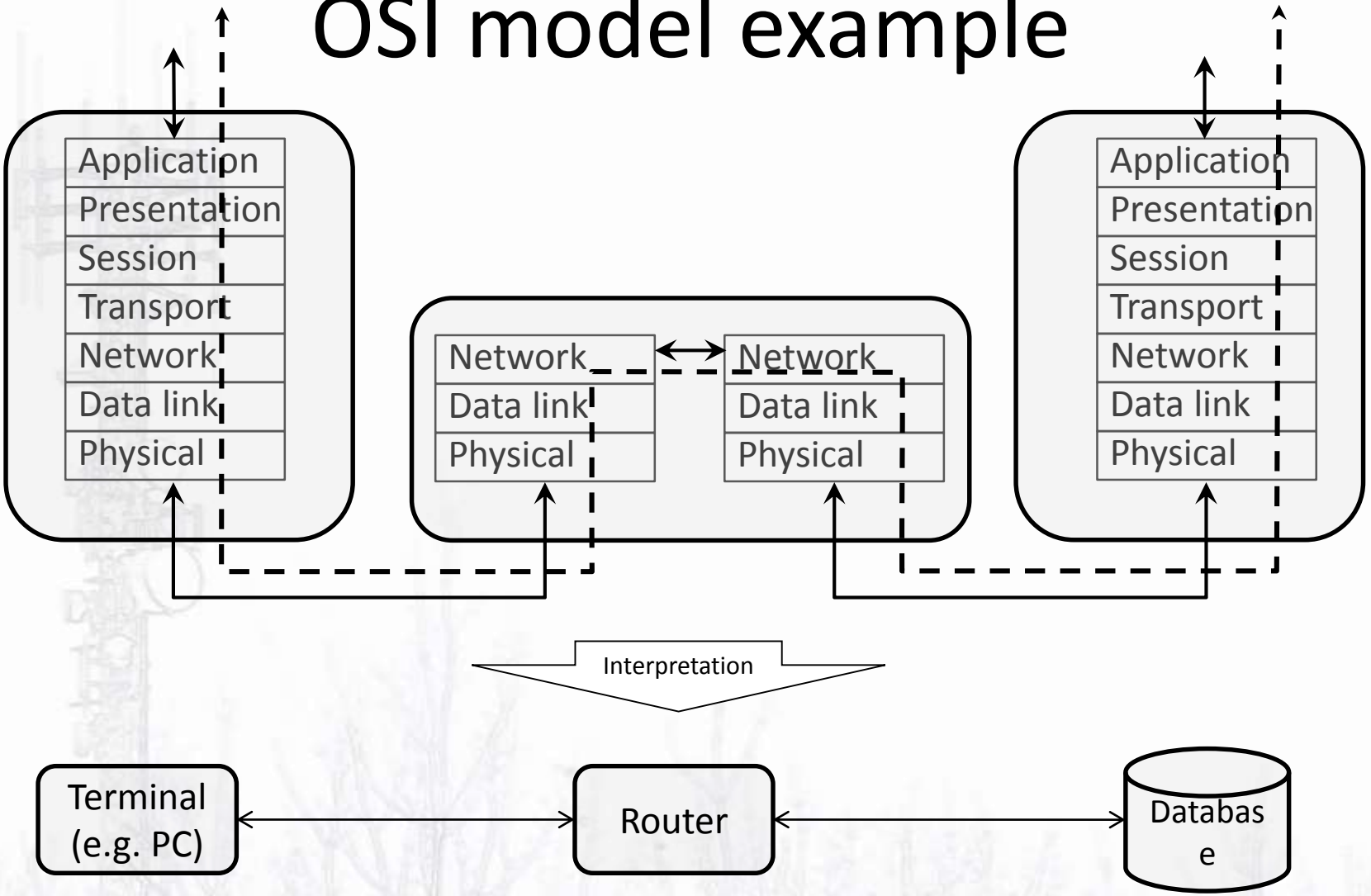
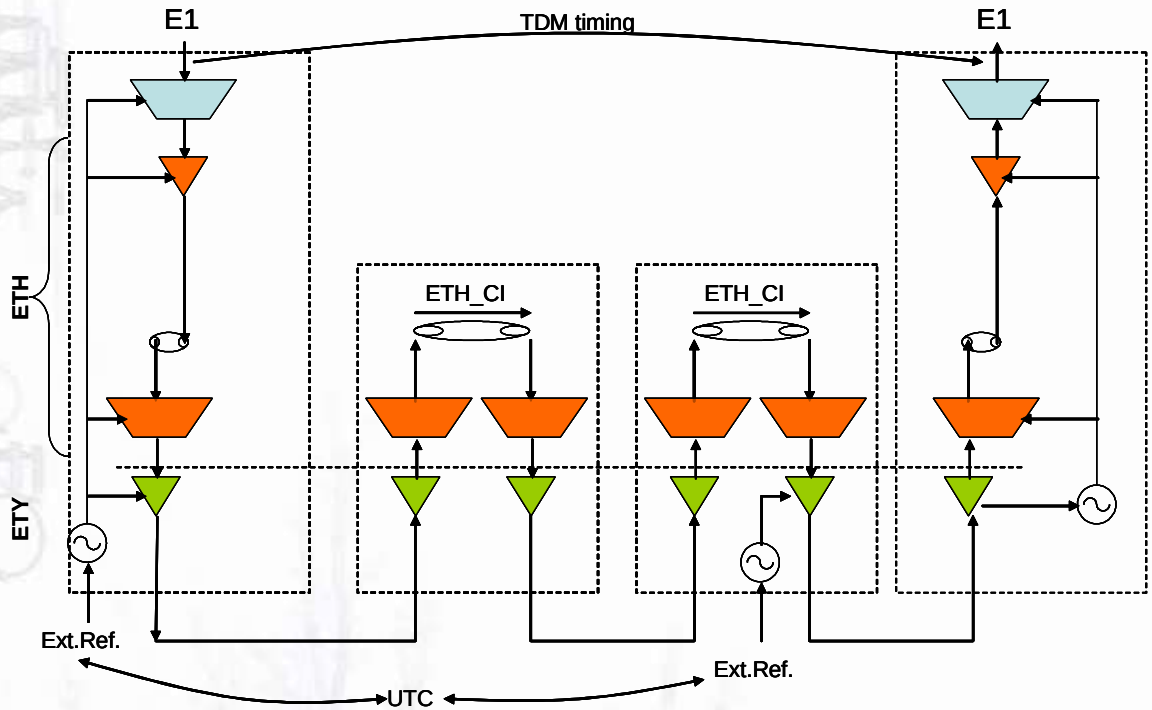
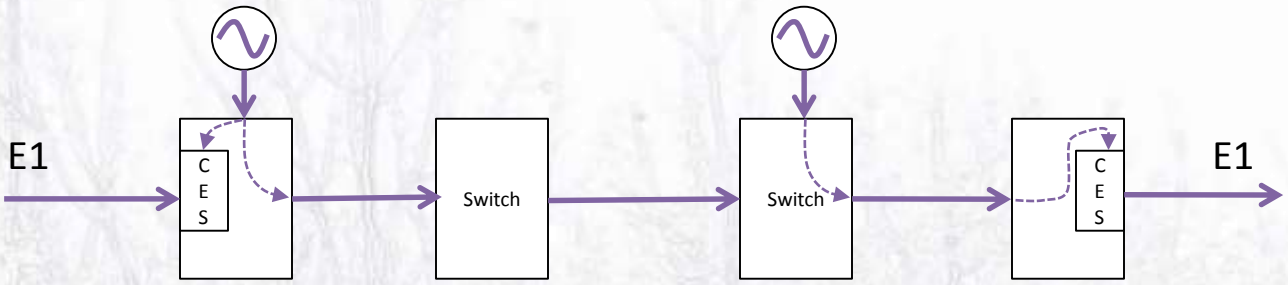


Figure taken from "Synchronous Ethernet and IEEE 1588 in Telecoms"
J.L. Ferrant, et al, ISTE/Wiley, ISBN 978-1-84821-443-9

Architectural models vs network elements



G.805 Functional Model for CES

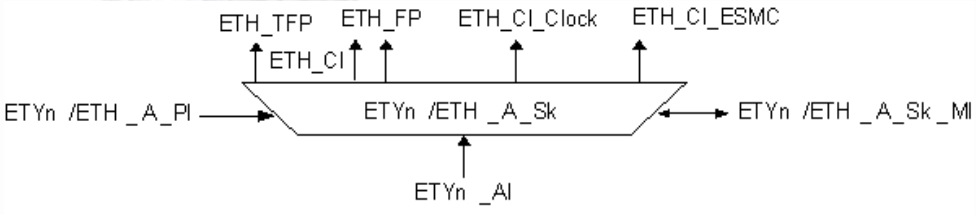


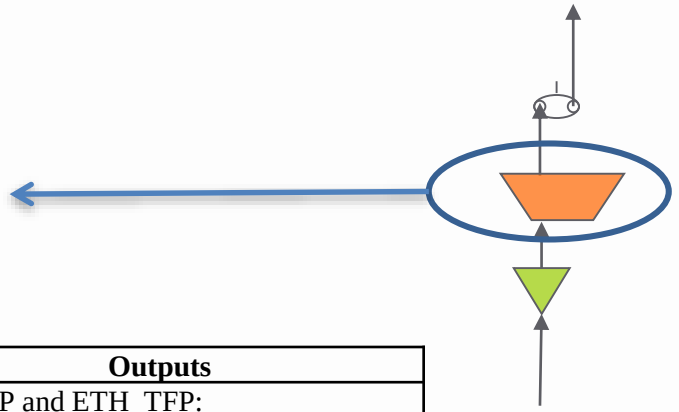
Network Element Model

Details of functions

- Individual functions may be specified in different recommendations
- May include other aspects related to basic transport, in addition to synchronization
- Some blocks may contain significant detail
  - Sync functions in G.781
  - Clocks in G.8262 (e.g. EEC)
  - Transport functions in G.8021 (Ethernet)

Ethernet detail example

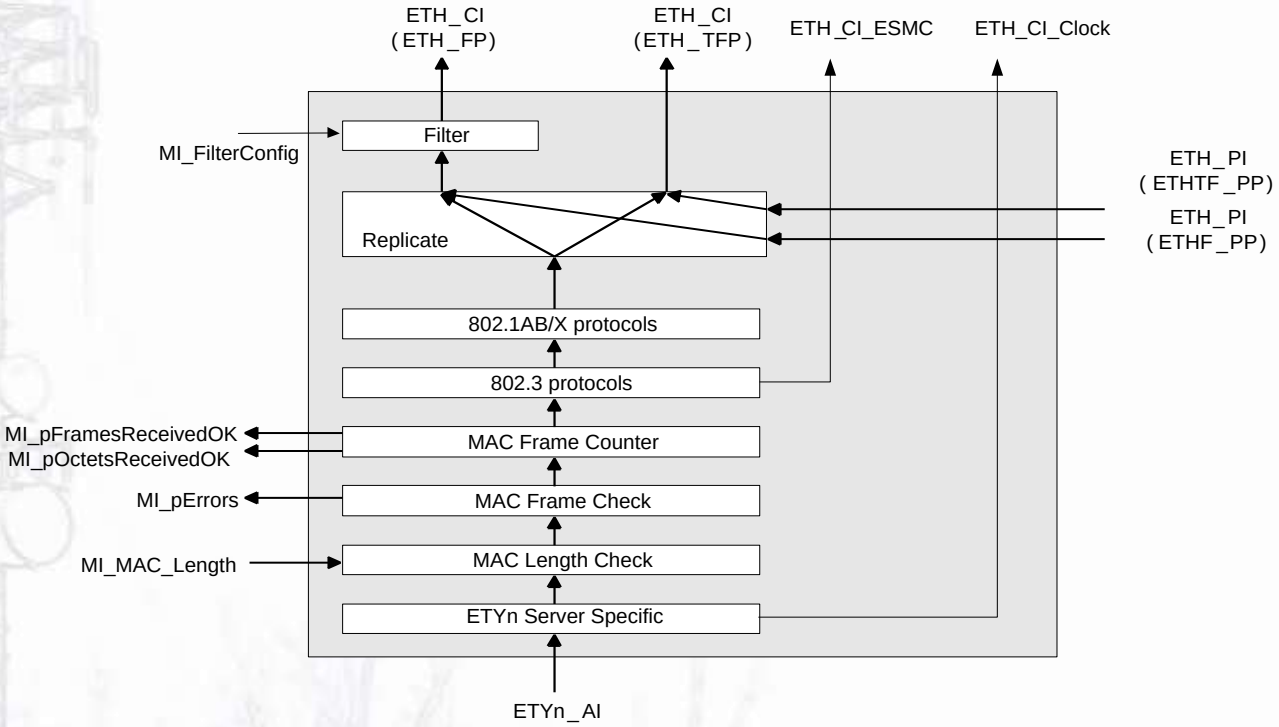




Inputs	Outputs
ETYn_AP: ETYn_AI_Data ETYn_AI_Clock ETYn_AI_TSF ETYn_AI_TSFrdi ETYn_AI_TSFfdi ETH_PP: ETH_PI_Data ETYn/ETH_A_Sk_MP: ETYn/ETH_A_Sk_MI_FilterConfig ETYn/ETH_A_Sk_MI_MAC_Length Holdover control MI	ETH_FP and ETH_TFP: ETH_CI_Data ETH_CI_Clock ETH_CI_SSF ETH_CI_SSFrdi ETH_CI_SSFfdi ETH_FP: ETH_CI_ESMC ETYn/ETH_A_Sk_MP: ETYn/ETH_A_Sk_MI_pErrors ETYn/ETH_A_Sk_MI_pFramesReceivedOK ETYn/ETH_A_Sk_MI_pOctetsReceivedOK

From Ethernet equipment specification: G.8021

More detail can be illustrated



- Description of functional block will specify as much detail as necessary to define implementation requirements
  - Note: references IEEE802

Functional model showing Time reference distribution