Architecture standards for synchronization

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Editor - G.8264, G.8265, G.8275

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Overview

- Architecture in ITU
  - Why?
  - Relation to other Recommendations
- General aspects of architecture in ITU-T
  - The models
- Overview of key Synchronization recommendations
  - G.8264, Physical layer frequency (SyncE)
  - G.8265, Packet based frequency
  - G.8275, Packet based time/phase

Architecture

- Architecture means different things to different people.
  - The overall design of something (e.g. building)
  - How things are arranged (e.g. *"The chemical architecture of the human brain" –From Oxford dictionary*)
- Applying this to telecom:
  - How are networks designed and how are the individual components arranged

Architecture or design?

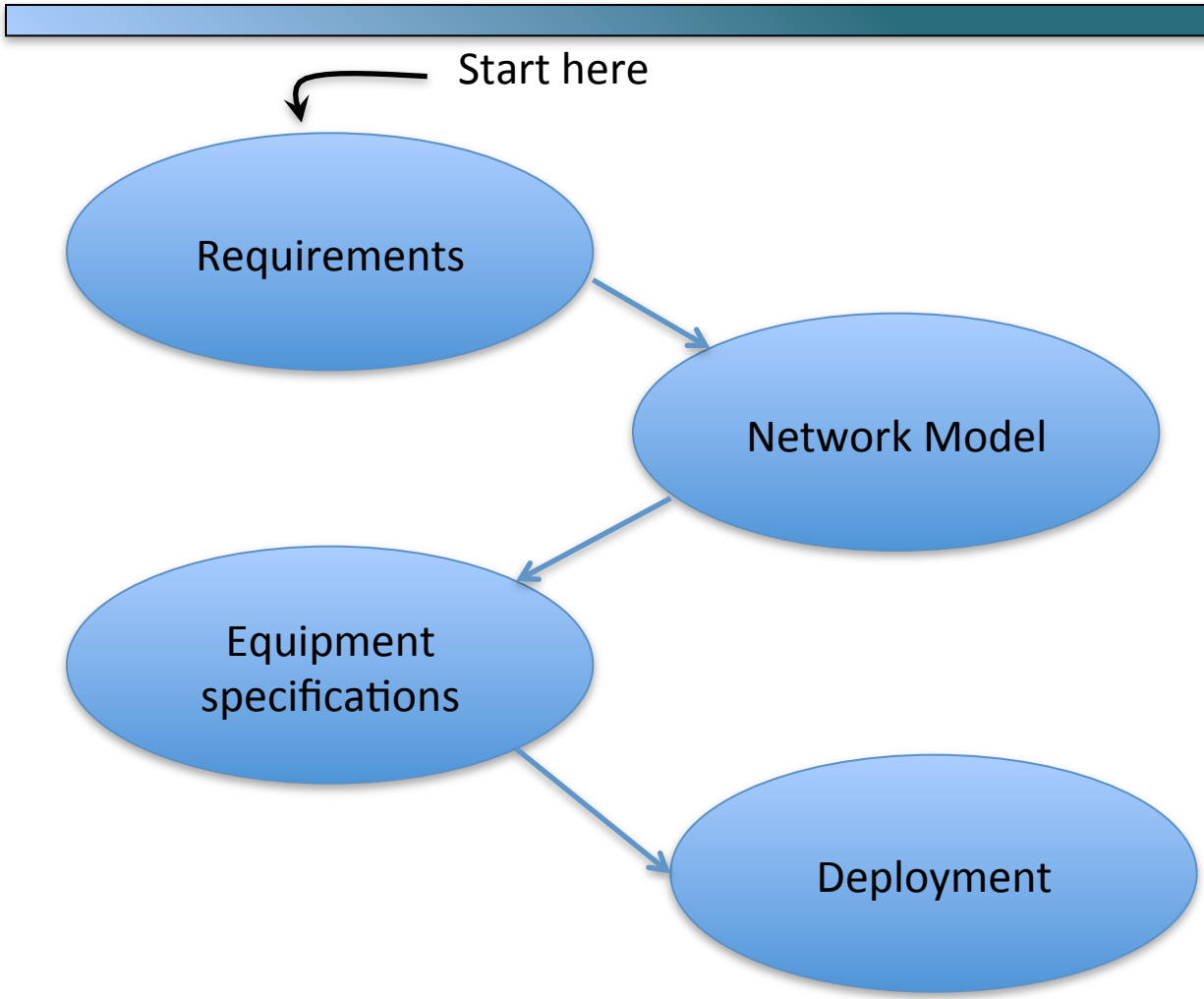
- Related, and are often used interchangeably
  - Design is how a specific implementation is produced
  - Architecture goes further in describing how things may be arranged
- Architecture in ITU-T describes how functions may be arranged in order to achieve a specific goal
  - The architecture provides guidance on how things should be designed
- We design networks based on an overall architecture

Examples of ITU-T architectures

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

- Note formal architectures are based on a fixed set of principles define in separate recommendations

Architecture development



Development of architecture starts with Requirements

A network model is then developed

Which constrains equipment specifications

Ensuring that deployed components meet all functional requirements for the network application

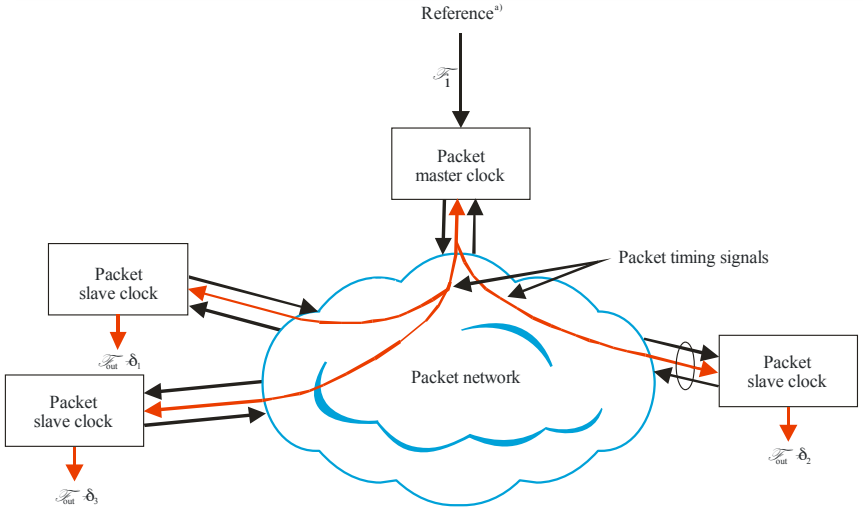
Coordination with other technology standards

- Network model may become complex when considering transport technology choices
  - SDH, OTN, MPLS, IP, Ethernet
  - Synchronization functions are only a small part of a network element (but an important part)
- Formalized method becomes invaluable for coordination
  - Simplify and separate issues
  - Individual standards (e.g. for components) can be developed separately with high degree of success of interoperability

Next generation synchronization

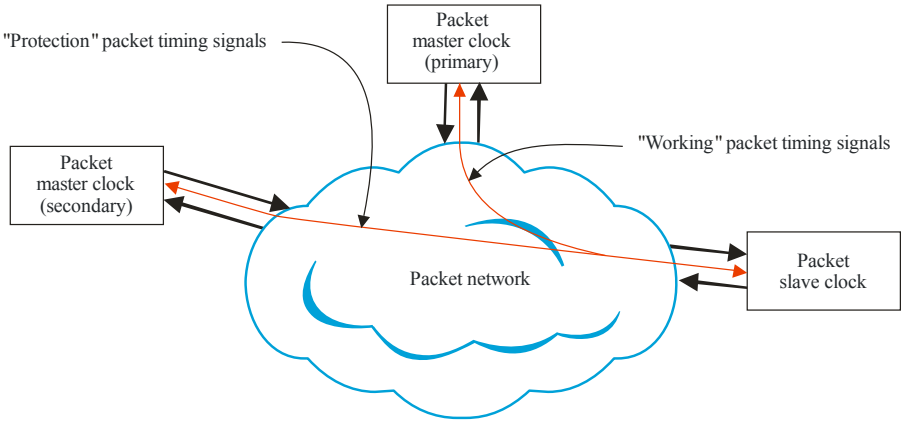
- Key aspects of NGN synchronization
  - Packet network infrastructure
    - Moving away from SDH
    - But can't throw out existing network
  - New wireless backhaul requirements
    - Air interface
  - New methods
    - CES, PTP, Synchronous Ethernet
  - New clocks
    - BC, TC, GM
  - Architecture helps see how all pieces fit together

The sync architecture



a) The reference may be from a PRC directly, from a GNSS or via a synchronization network

G.8265/Y.1365(10)_F01

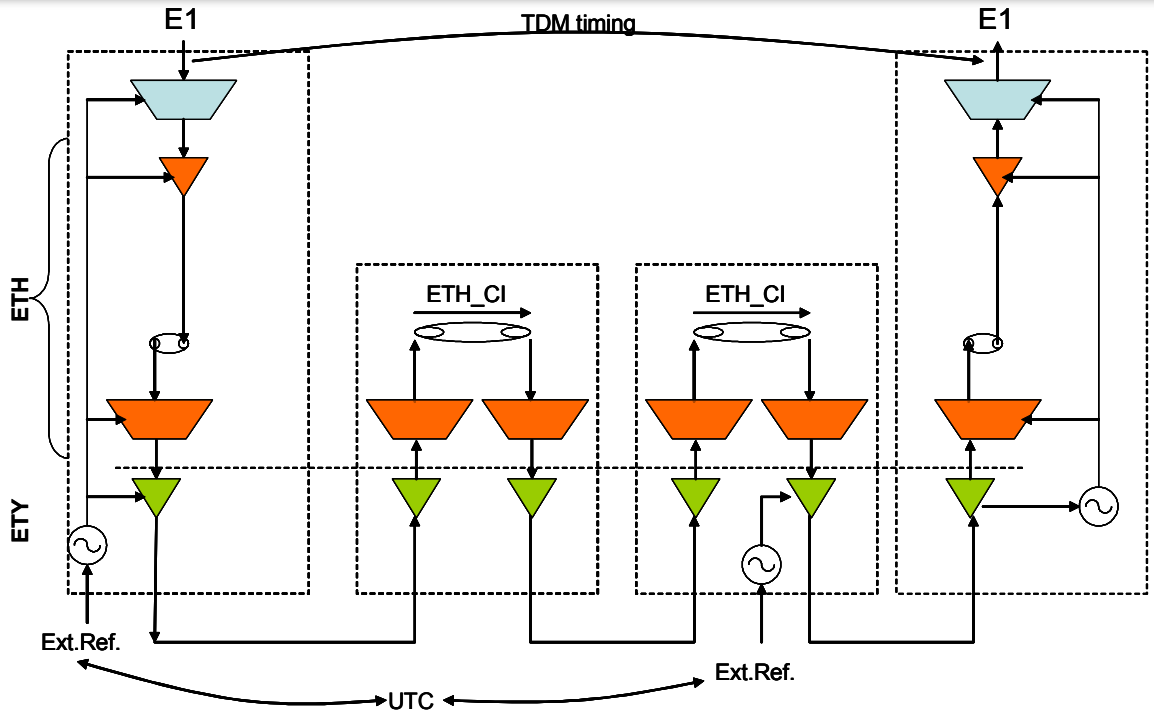


NOTE – For clarity, the network reference signals to masters are not shown.

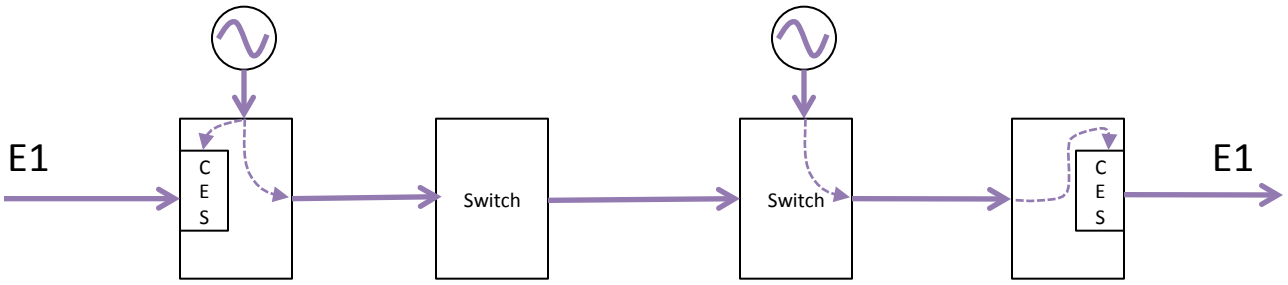
G.8265/Y.1365(10)_F02

- Requirements start with basic principles
  - Example above shows basic protection
  - This had significant effect on first Telecom profile

What does the architecture look like?

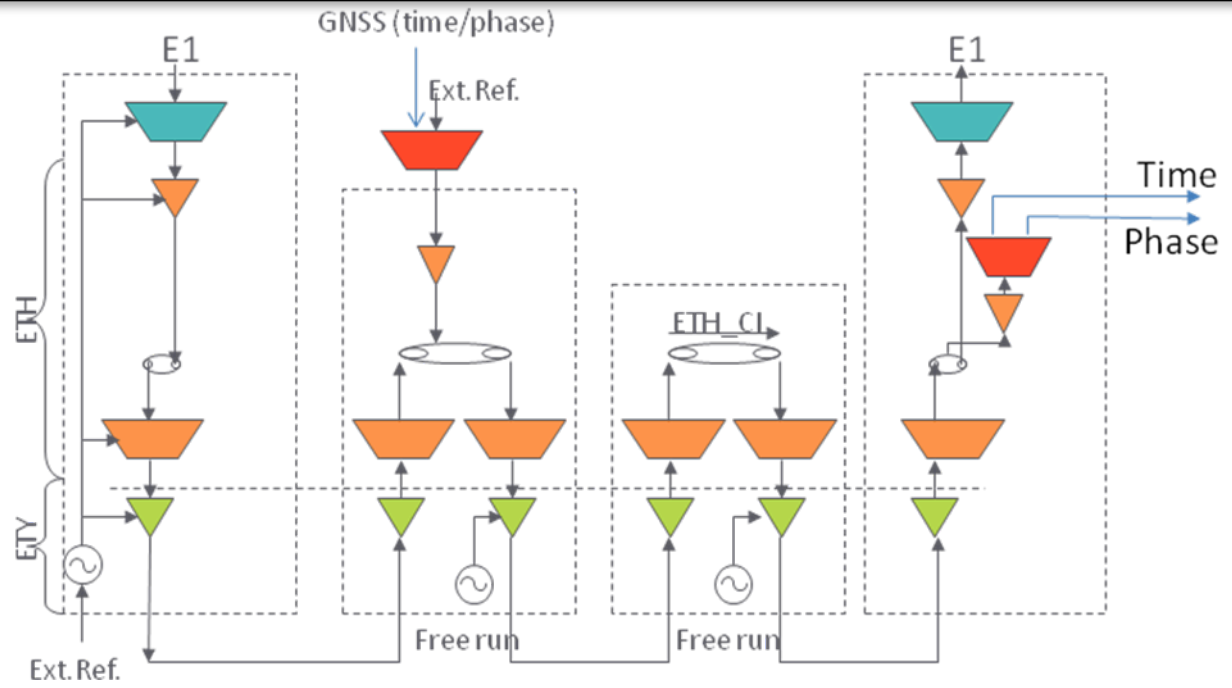


G.805 Functional Model for CES



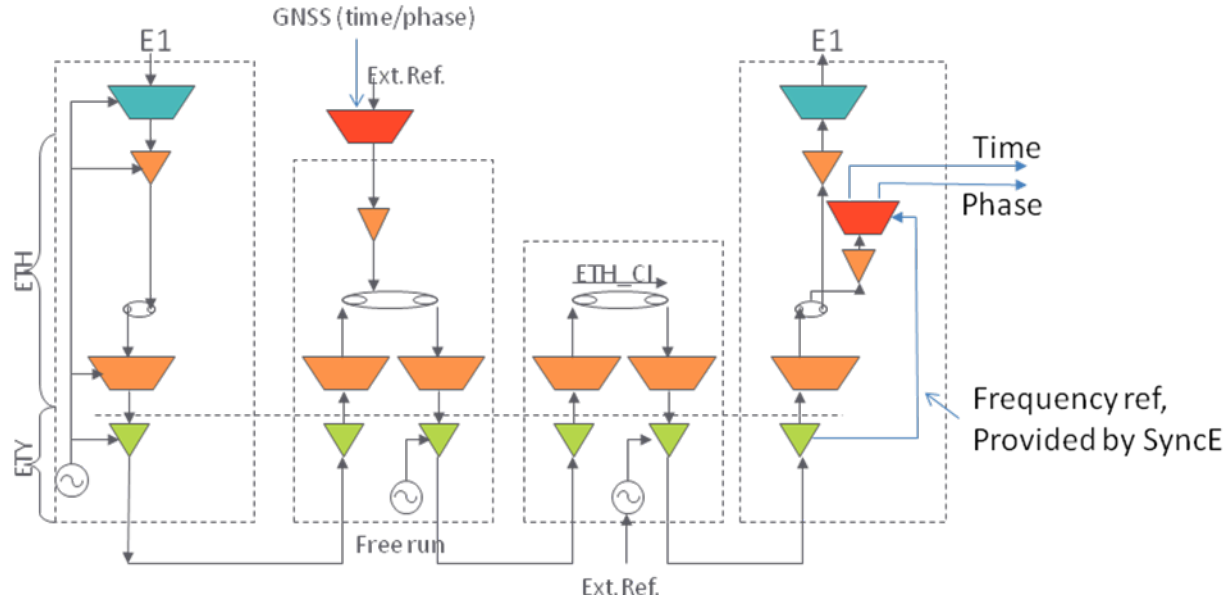
Network Element Model

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

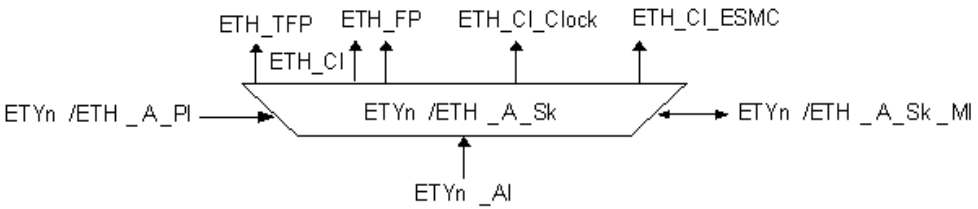


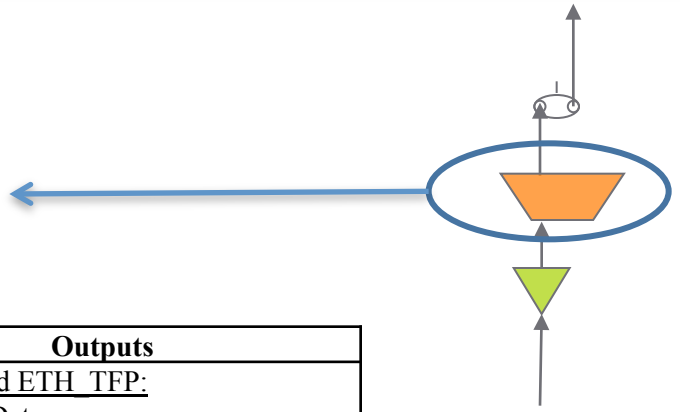
- Physical layer synchronization model is that of SDH/SyncE.
  - Boundary clock function starts to appear

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)

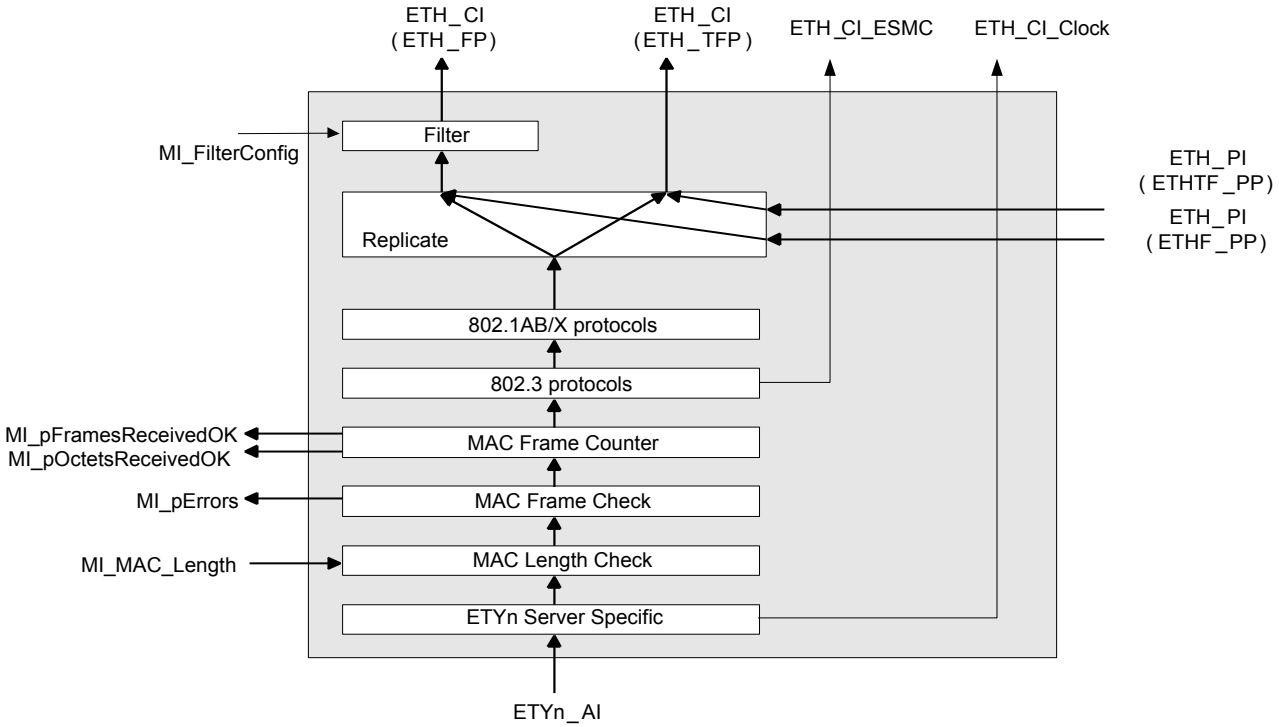
Ethernet detail example





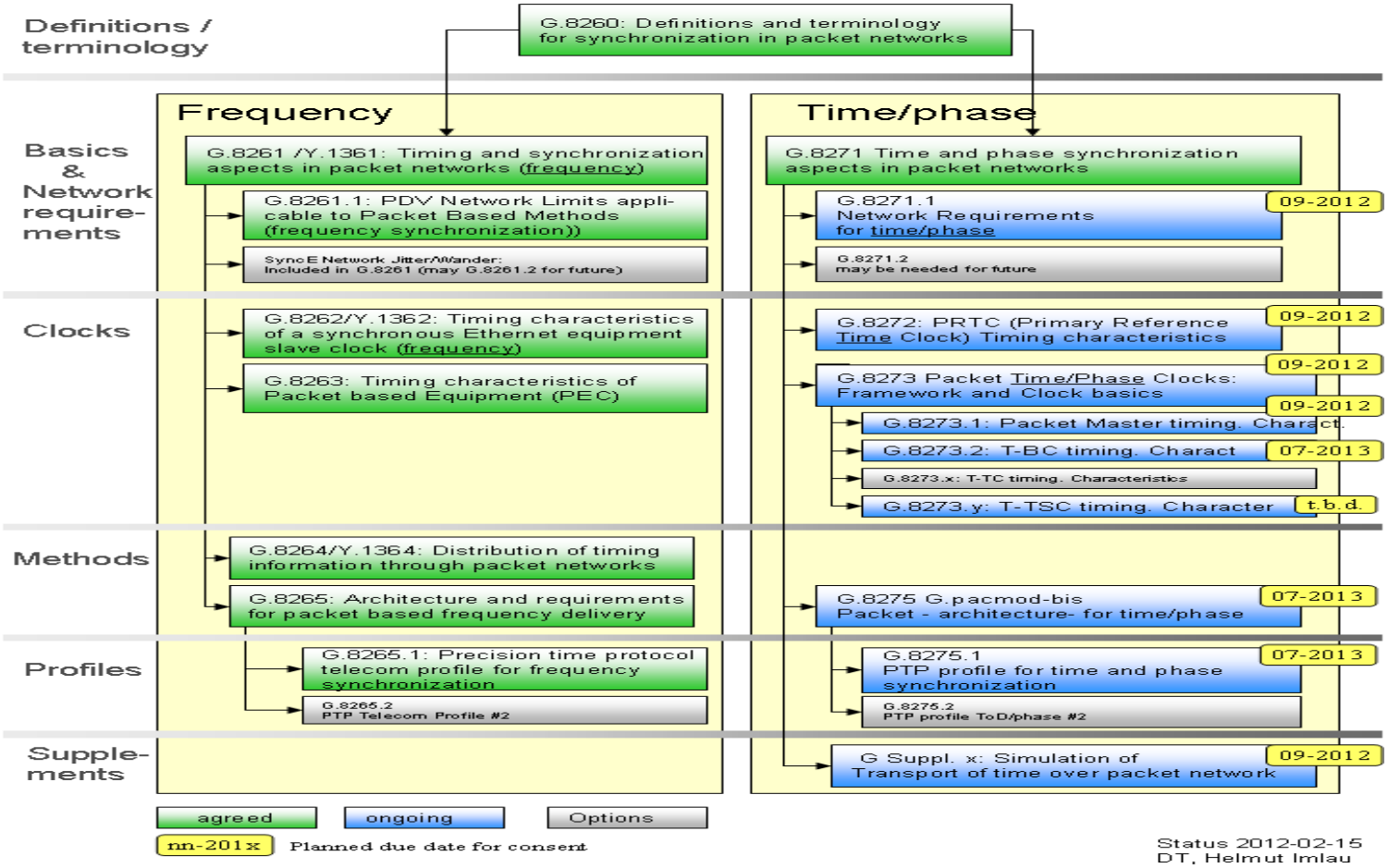
Inputs	Outputs
ETYn_AP: ETYn_AI_Data ETYn_AI_Clock ETYn_AI_TSF ETYn_AI_TSFrdi ETYn_AI_TSFfdi ETH_PP: ETH_PI_Data ETYn/ETH_A_Sk_MP: ETYn/ ETH_A_Sk_MI_FilterConfig ETYn/ ETH_A_Sk_MI_MAC_Length Holdover control MI	ETH_FP and ETH_TFP: ETH_CI_Data ETH_CI_Clock ETH_CI_SSF ETH_CI_SSFrdi ETH_CI_SSFfdi ETH_FP: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

Ethernet Detail example, continued



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

General NGN sync Rec. structure



Sync Architecture Recommendations

- G.8264/Y.1364: Distribution of timing information through packet networks
  - G.8264/Y.1364 (10/2008)
  - G.8264/Y.1364 (2008) Amd. 1 (09/2010)
  - G.8264/Y.1364 (2008) Cor. 1 (11/2009)
  - G.8264/Y.1364 (2008) Amd. 2 (02/2012)
  - G.8264/Y.1364 (2008) Cor. 2 (02/2012)
- G.8265/Y.1365 : Architecture and requirements for packet-based frequency delivery
  - **G.8265/Y.1365 (10/10)**
- G.8275: Architecture and requirements for packet-based time and phase delivery
  - Under development

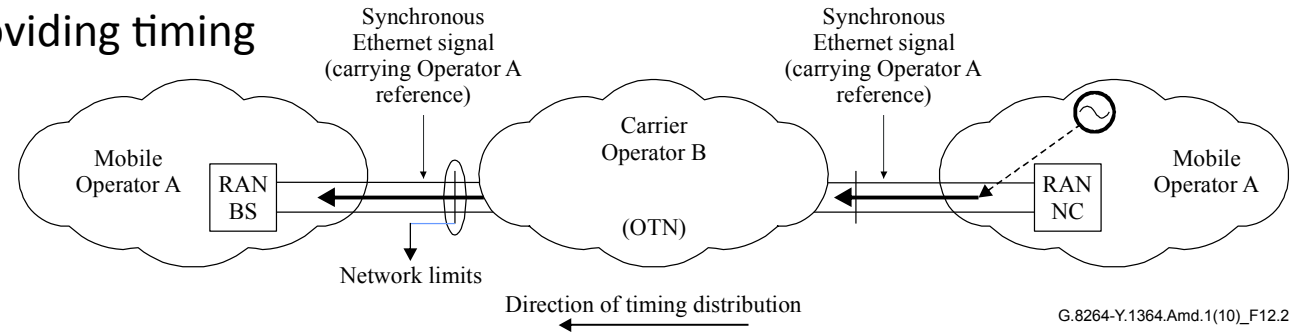
G.8264: Distribution of timing through packet networks

- Main aspects:
  - NGN sync concepts
    - Evolution of network to packet based network and use of CES to support PDH services
    - Describes Sync Ethernet concepts in coordination with G.8261 and G.8262
  - Synchronous Ethernet Sync status message channel
    - ESMC
    - Based on IEEE802.3 slow protocol, using Organization Specific Slow Protocol (OSSP)
    - Defines PDU format
  - Sync Selection based on SSM QL
  - Use of Synchronous Ethernet in Multi-operator context
  - Supporting functional models

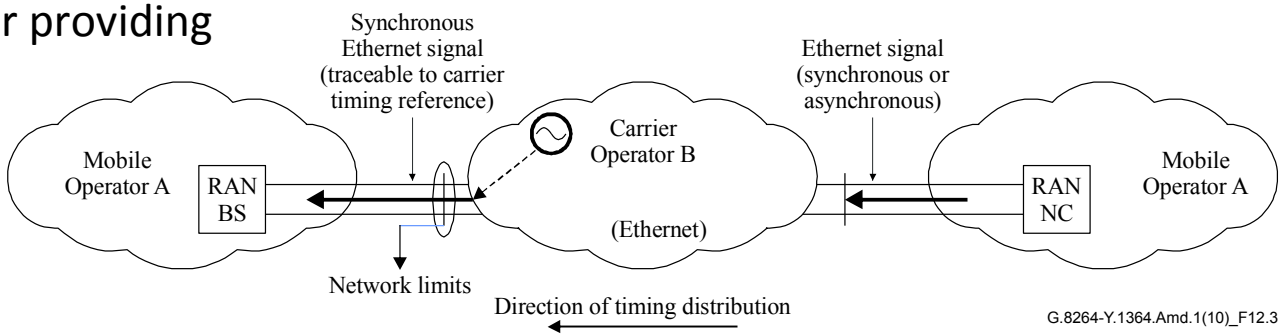
G.8264: Multi-Carrier operation

- G.8264 starts to address physical sync as a service
  - Distribution of sync moving to the edge
  - Multi-carrier situations now part of standards

Service owner providing timing



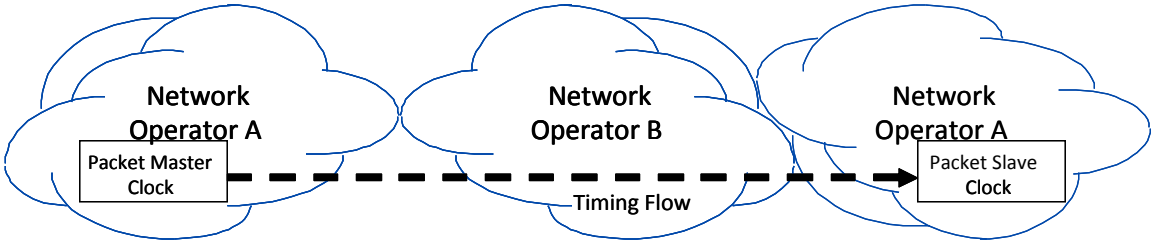
Intermediate carrier providing timing

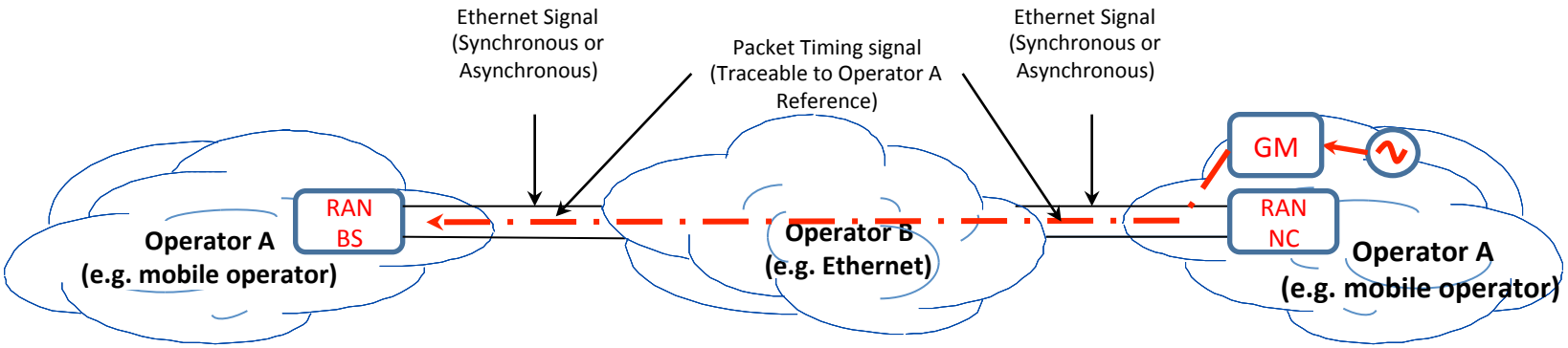


G.8265: Architecture and requirements for packet based frequency delivery

- Evolution of synchronization distribution is based on packet techniques such as PTP.
- G.8265 described basic requirements for frequency distribution
  - Necessary in order to define operation of a packet system within overall synchronization distribution network.
  - Although not mandated, a network could have mixed technology
    - SDH
    - Sync Ethernet
    - Packet
  - Frequency only
    - Applicable to both NTP and PTP
  - Addresses protection aspects
    - IEEE1588 Profile development based on architecture
    - Telecom slave clock defined

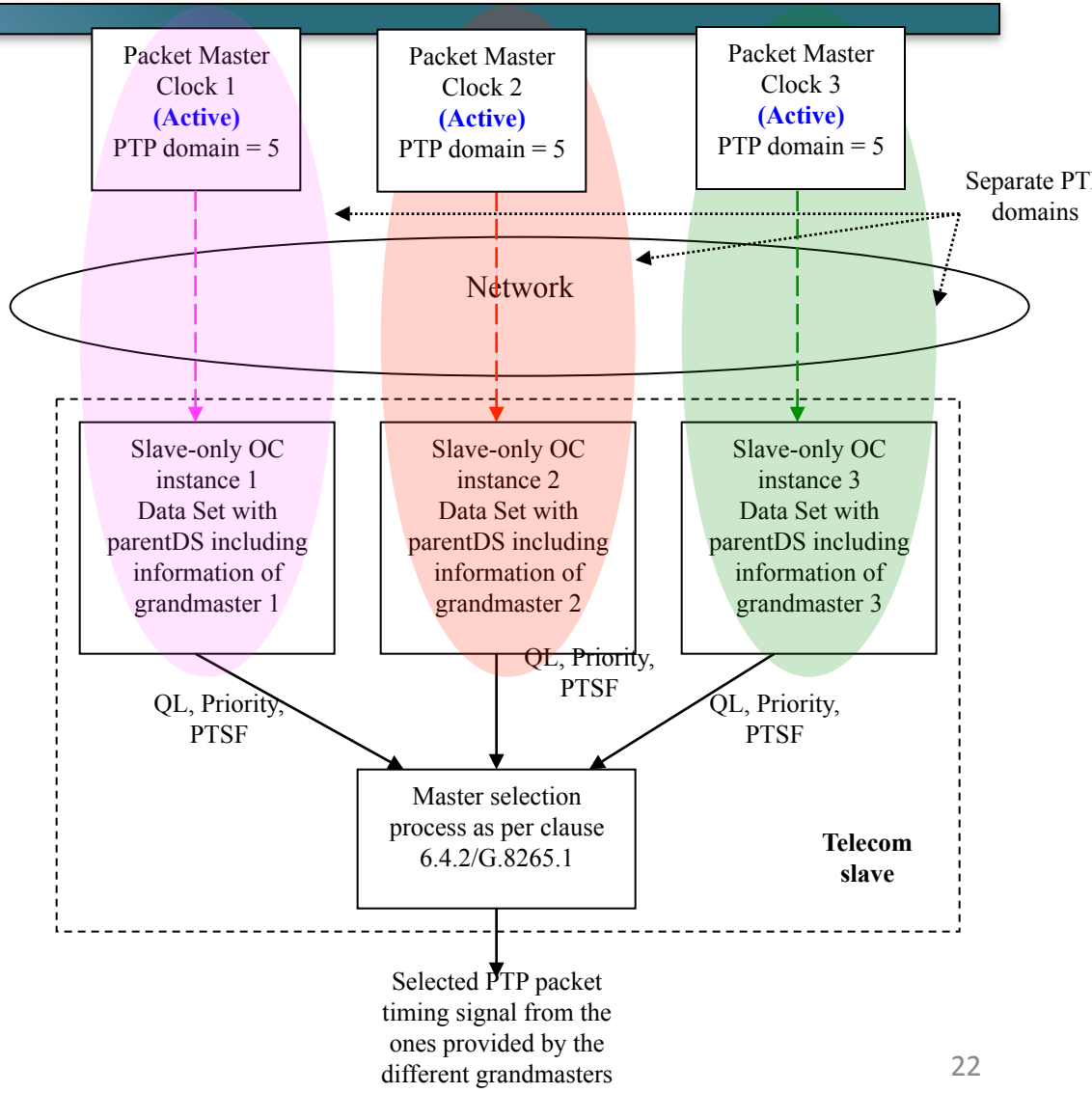
G.8265: timing as a service now with packet timing





G.8265 architecture details

- Telecom slave construct
  - Required to meet telecom protection requirements
  - Default BMCA could not support telecom requirements
  - Telecom slave for frequency allows G.781 protection to be implemented with PTP based networks
  - Clock requirement has been driven by architecture



G.8275: Architecture and requirements for packet based time/phase delivery

- Recommendation under development (planned completion in July 2013)
- Focus on network based on time/phase distribution using IEEE1588
  - Time/phase requirements are a substantially different paradigm
- Architectural aspects
  - How do the multiple types of network clocks interact
    - Boundary and Transparent clocks
    - Slave clocks
    - Grand Master clocks
    - Packet Reference Time Clock (PRTC)
  - Protection aspects
    - Best Master clock
    - Fit with BMCA with telecom practices (e.g. automatic vs provisioned)
  - Syntonization provided by Synchronous Ethernet
  - Information aspects (information across time interface)

Summary

- Architecture recommendations are important
  - Developed to provide an overall framework for how technology can be deployed in a network
  - Provide a framework for controlled technology evolution
  - Synchronization related architecture documents
    - Provide controlled evolution of technology
    - Ensure high degree of interoperability of different synchronization technologies
    - Guidance for developing equipment recommendations
    - Synchronization solutions fit with traffic functions of NEs
    - Strong linkage to Hypothetical Reference Model (HRM) development
    - Provide guidance to other SDO's