Functional Modeling for Synchronization Networks

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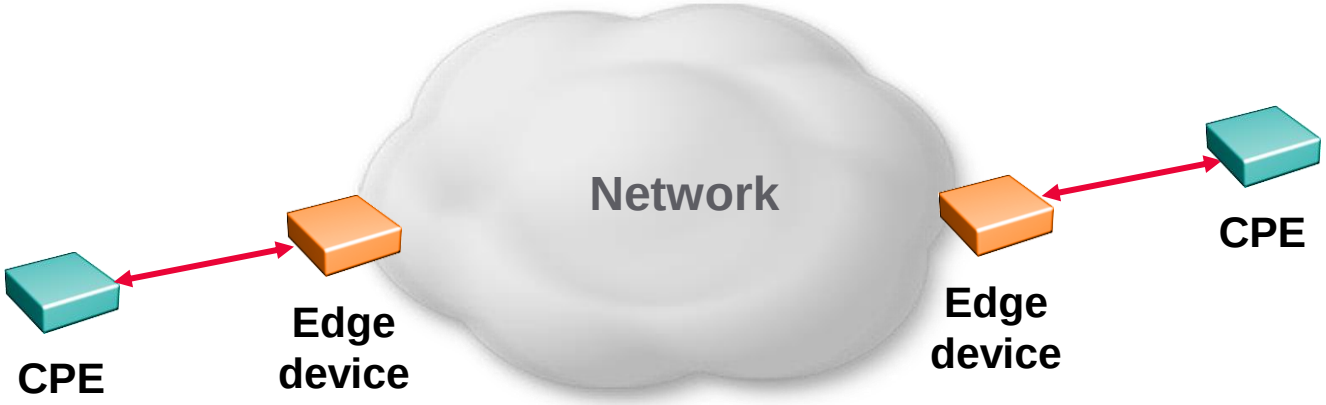
- Presentation intent:
  - Brief overview of current work in ITU-T to develop functional models for next generation synchronization networks
- Content:
  - Background of ITU-T modeling work
  - ITU-T Rec. G.805 modeling concepts
  - How functional modeling helps us study requirements for next generation synchronization networks
  - Examples of current standardization activities
  - What work remains to be done

Modeling Overview

- **What is a functional model?**
  - ITU-T method to describe transport networks
  - Method to formalize the “black box” diagram
  - Provides detail to specify interoperable networks and equipment
- **Modeling of synchronization networks lets us understand:**
  - The interactions of service level sync requirements
  - The impact of network level synchronization on services
  - Where, how and if we can distribute network timing
- **Use in synchronization networks:**
  - G.781 (synchronization layer functions)
  - G.8261 (CES)

Example: Network Model



- Common models look this way
  - Is this sufficient?
  - Can we start to specify the details?
- Development of interoperable standards requires considerable detail
  - ITU-T functional modeling is based on ITU-T Rec. G.805

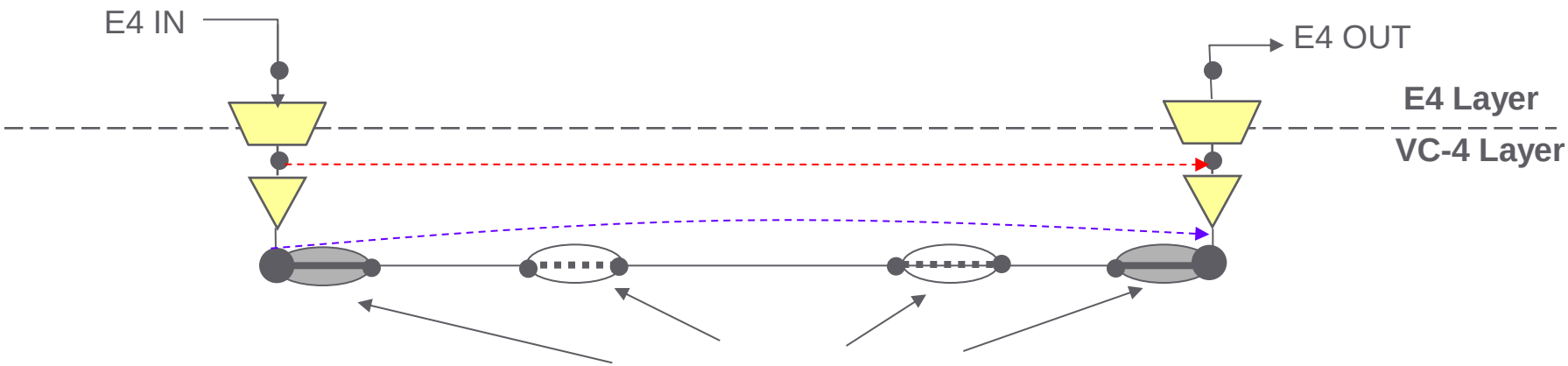
G.805 Modeling Concepts

- ITU-T G.805 provides the modeling language to describe transport networks
  - Describes functional blocks that form a transport network.
  - Defines “architecture”
- Defines transport “layers”
  - Networks are managed on a per-layer basis
  - Interactions between the layers follow client/server relationships
  - OAM is defined on a per-layer basis
- G.805 features
  - Well defined function interactions
  - Fully recursive: define as few or as many layers as necessary
  - Technology independent methodology
  - Does not restrict implementation

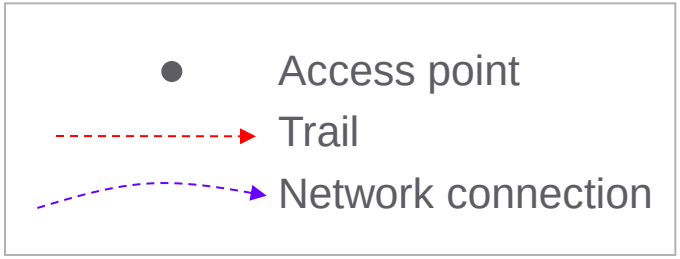
G.805 Modeling Concepts (cont'd)

- Commonly seen components in models:
  - Trails: support the end-to-end transfer of information
  - Adaptation, trail termination and connection functions
- Value:
  - Function interactions fully understood from the network level
  - Allows complete specification of equipment
  - The network is fully manageable
- Related ITU-T Recommendations:
  - Extensions for packet mechanisms (introduces flows)
  - Technology specific descriptions of architectures
  - Synchronization

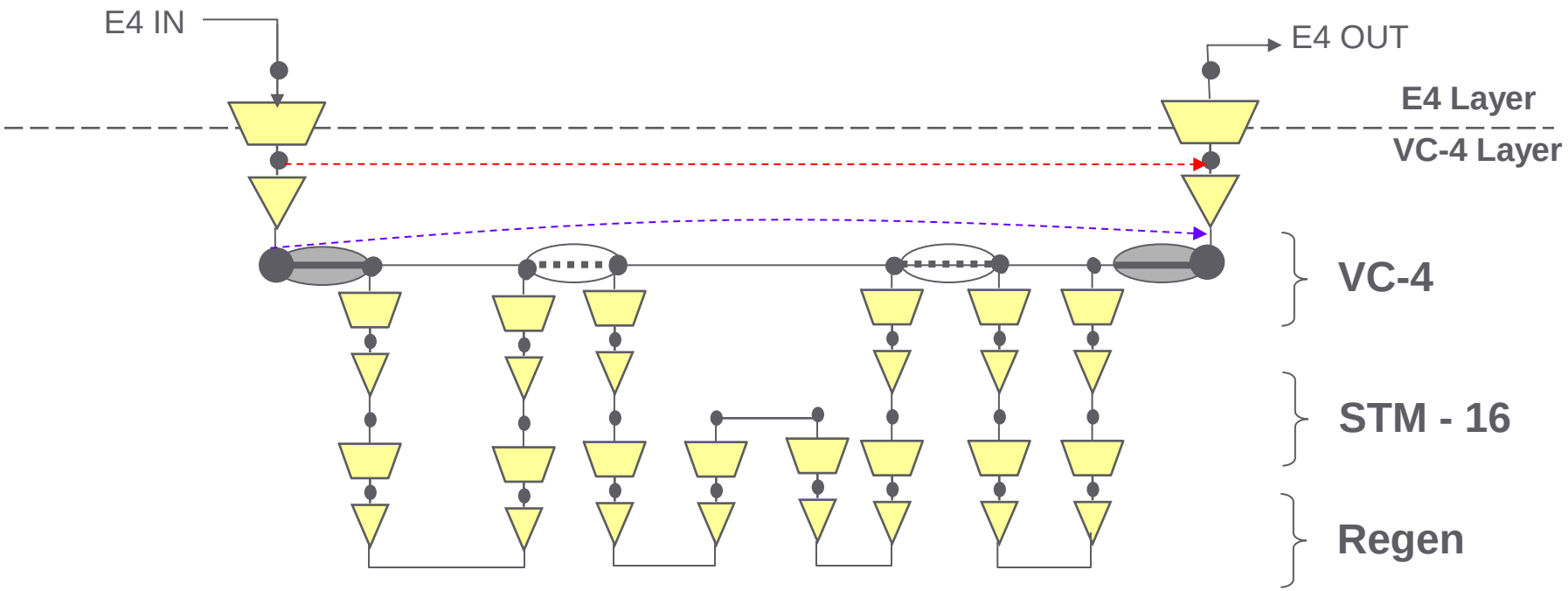
G.805 Layer Networks



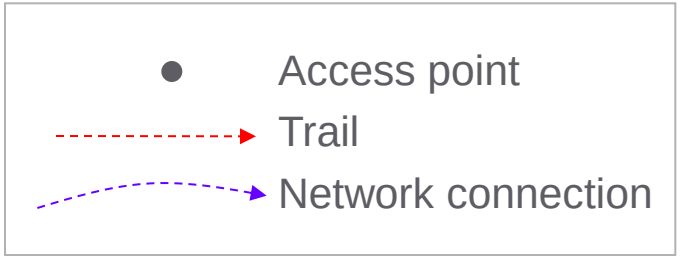
- ‘subnetwork connections’ signifying traversal across a switching matrix
- model allows us to hide lower layers so we can focus on how we manage a specific layer network



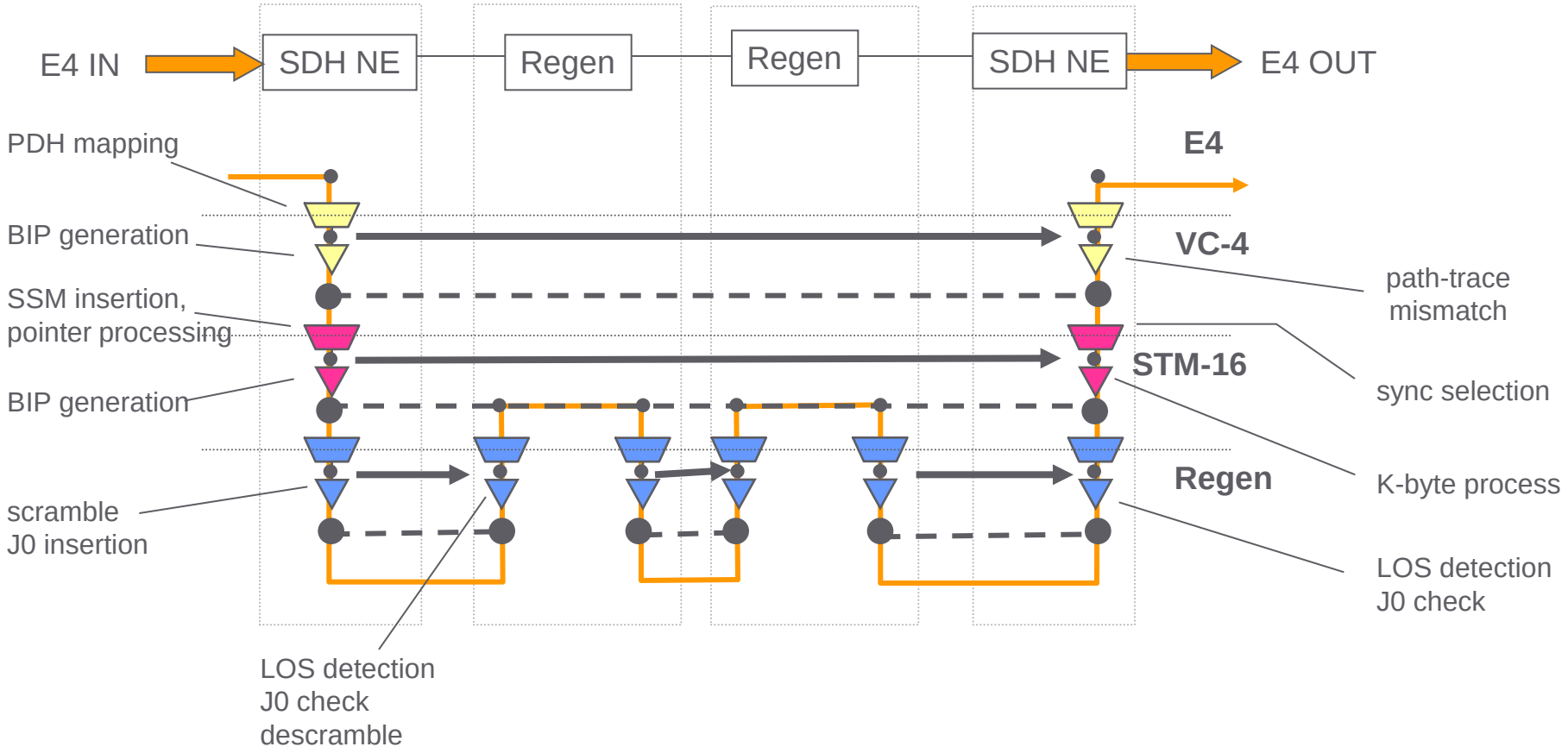
G.805 Layer Networks



Full details can be revealed if we need the big picture



Example: SDH Overhead Detail Revealed



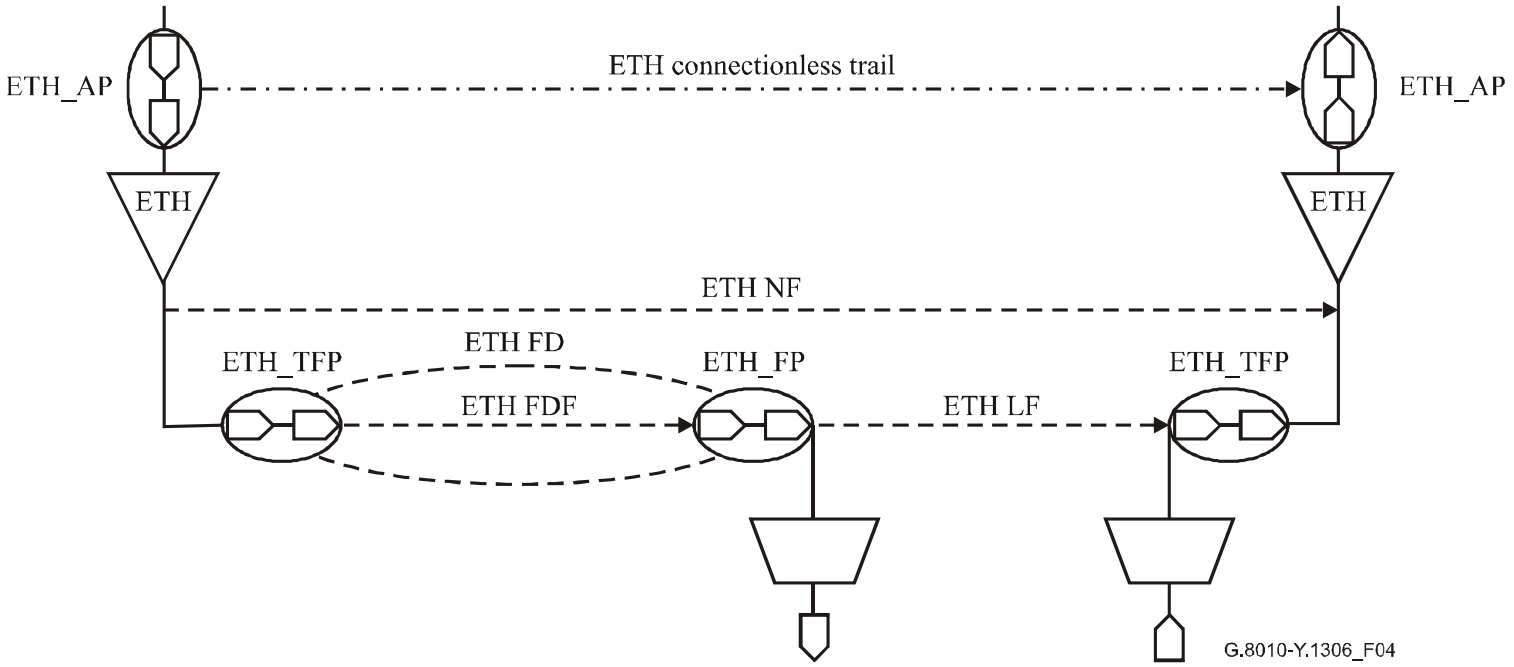
NOTE: For simplicity, not All function types that may be present in NE are shown in this figure.

Next Generation Synchronization

- Packet technology key to next generation networks
  - Some services will require synchronization support.
- Specific synchronization areas currently under study in standards:
  - Current sync distribution
  - Synchronous Ethernet
  - IEEE1588 timing distribution
  - Circuit emulation (CES)
- Open questions:
  - How do synchronization aspects inter-relate?
  - What functionality is needed to implement synchronization functions:
    - at the network level?
    - at the equipment level?
  - What are the timing distribution requirements:
    - at the network level?
    - at the equipment level?
  - How do we manage it all?
- Starting point: look at the network architecture (model) first.

Background: ITU-T Ethernet Model

- The ITU-T Ethernet network model (G.8010) describes Ethernet as two layers: ETH and ETY



Packet support of PDH services

- Use IWF to carry PDH over packet networks
- Key questions:
  - What timing support do we need?
  - Where do we get it?

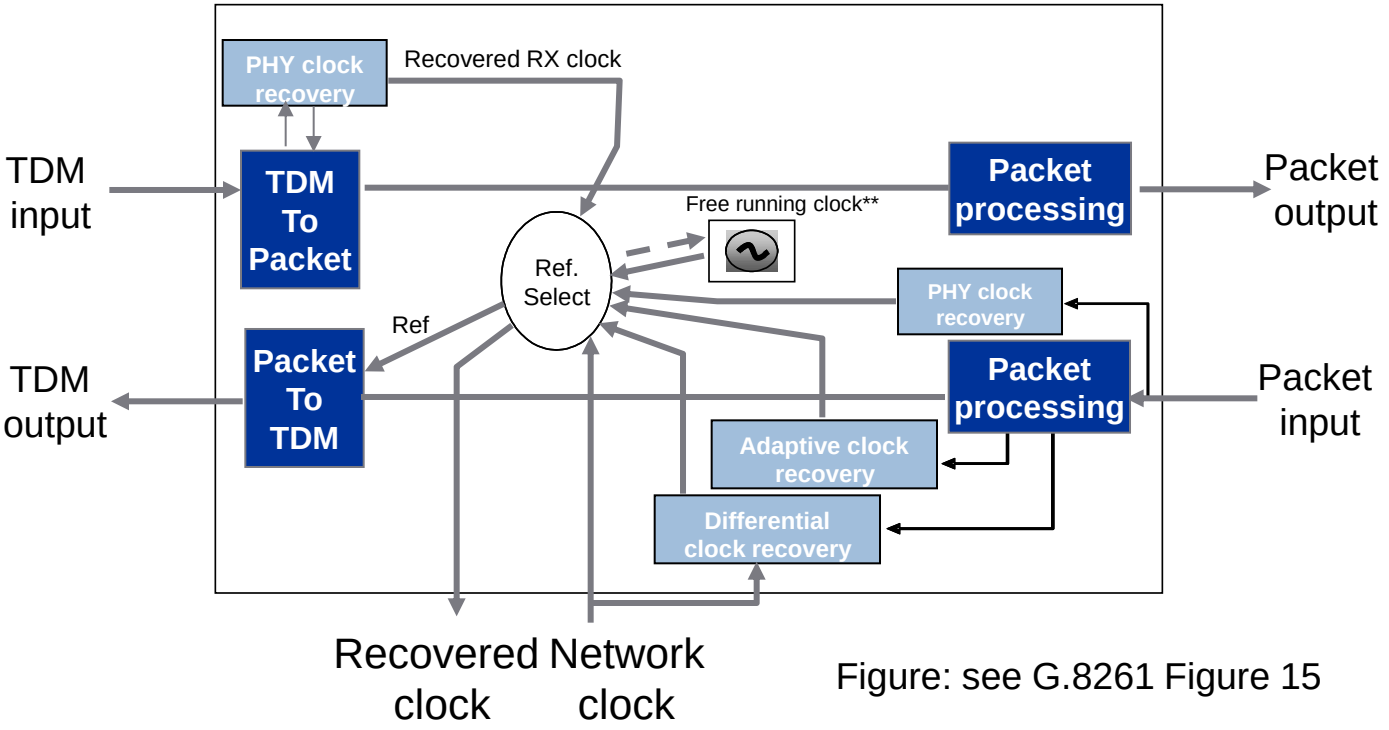
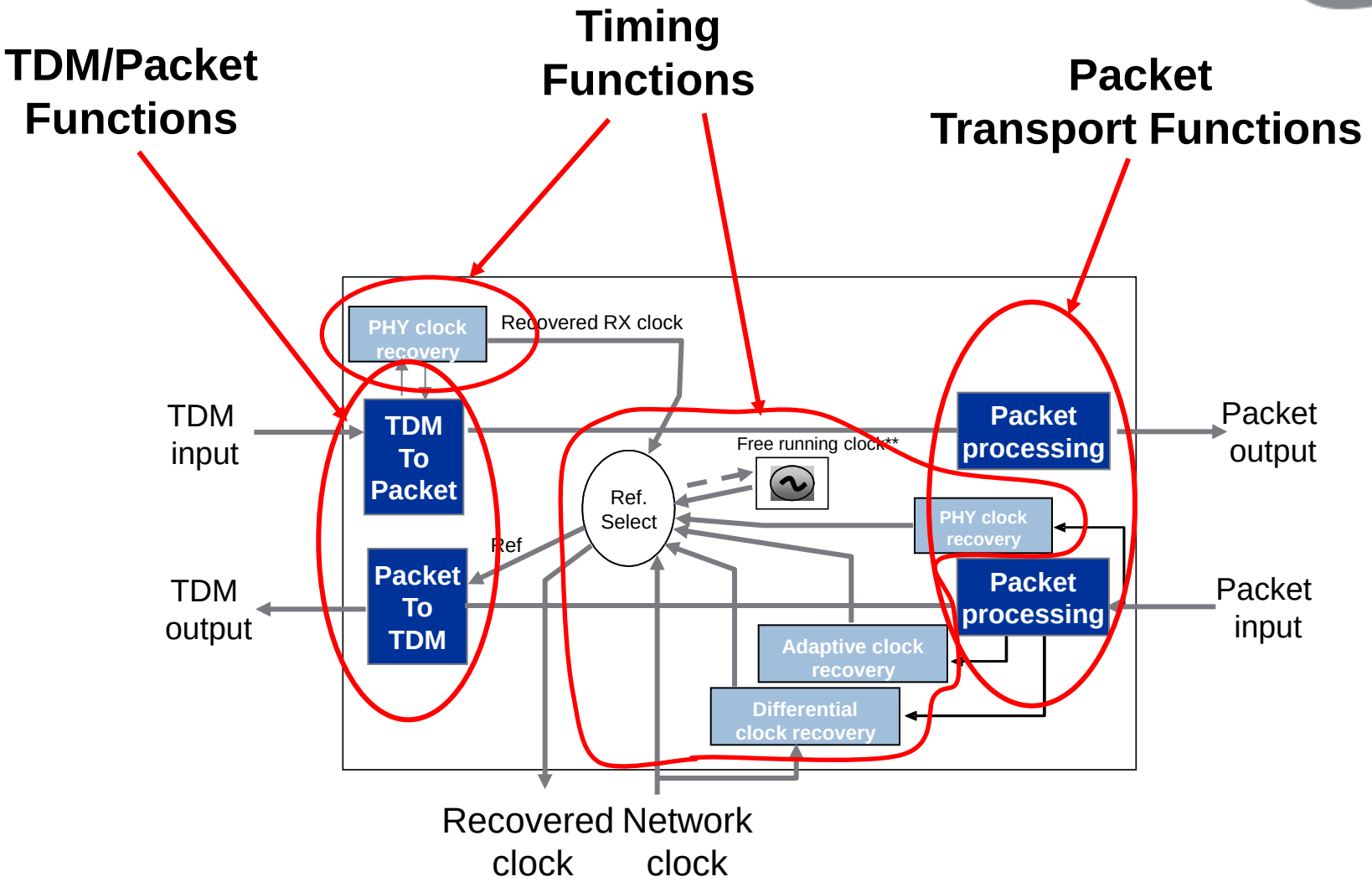
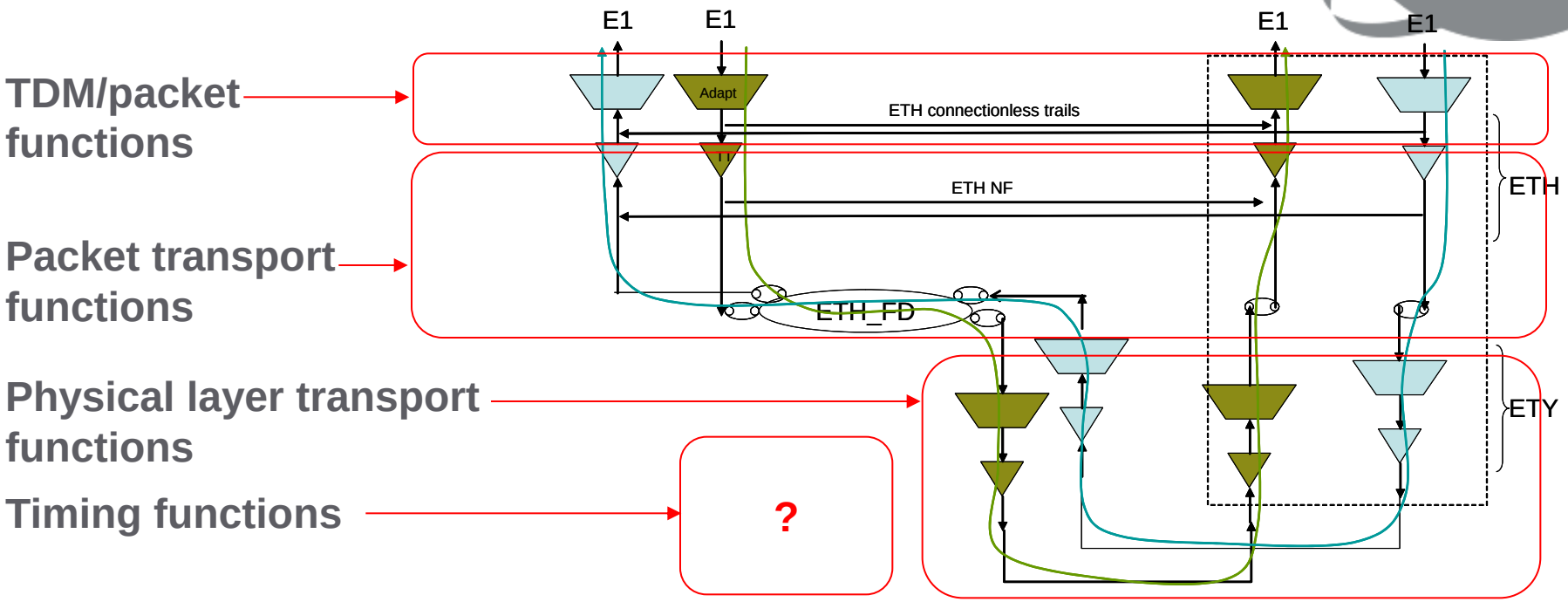


Figure: see G.8261 Figure 15

Identifying IWF Functionality



Mapping The CES IWF to Ethernet



- Mapping IWF functions to architecture show interactions needed.
- Some functions are now seen to be distributed across a network.
- Additional functions may be required.

Recall how we need to time the IWF?

- Timing reference is needed at each IWF (Differential timing case)

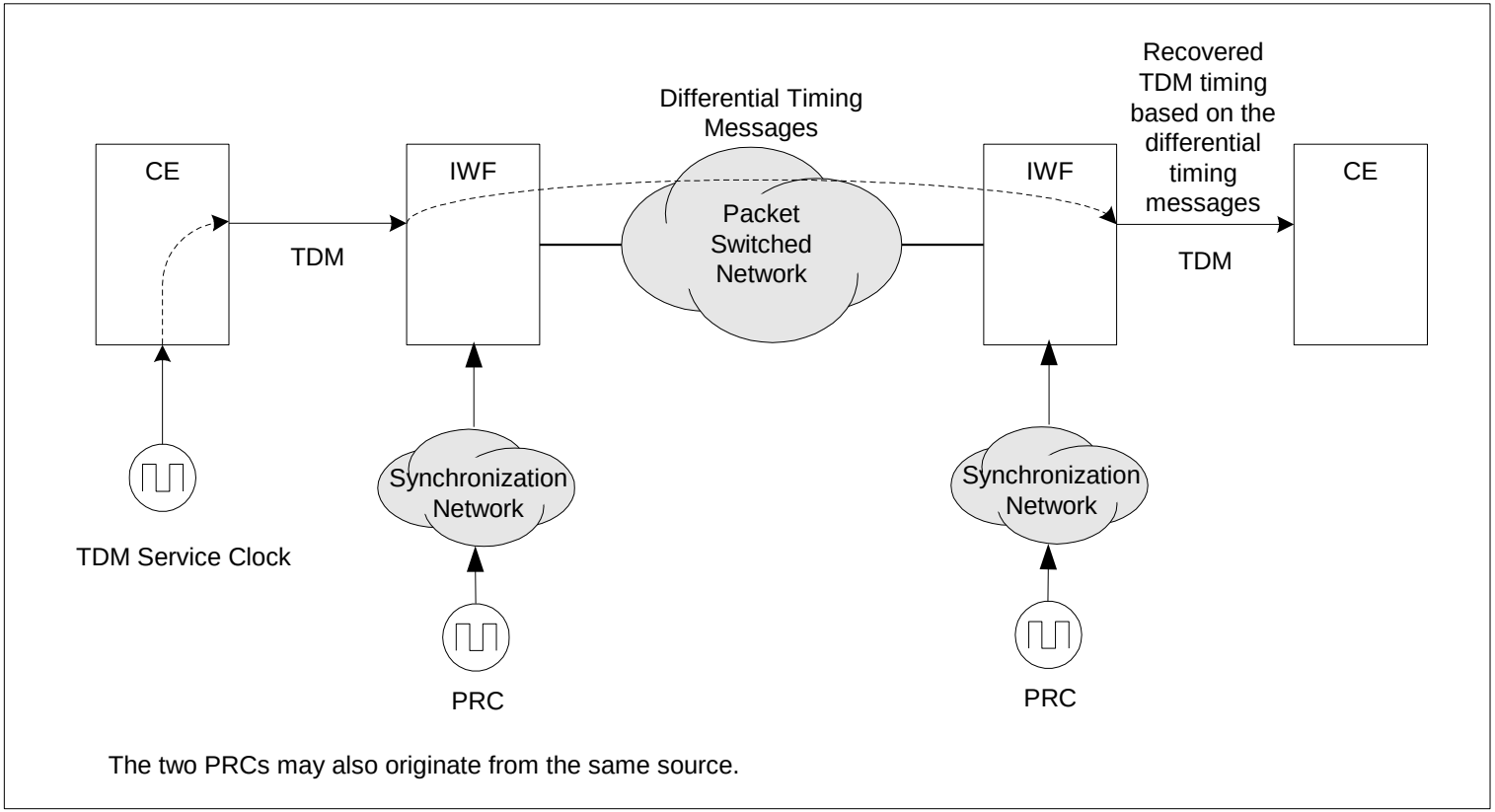
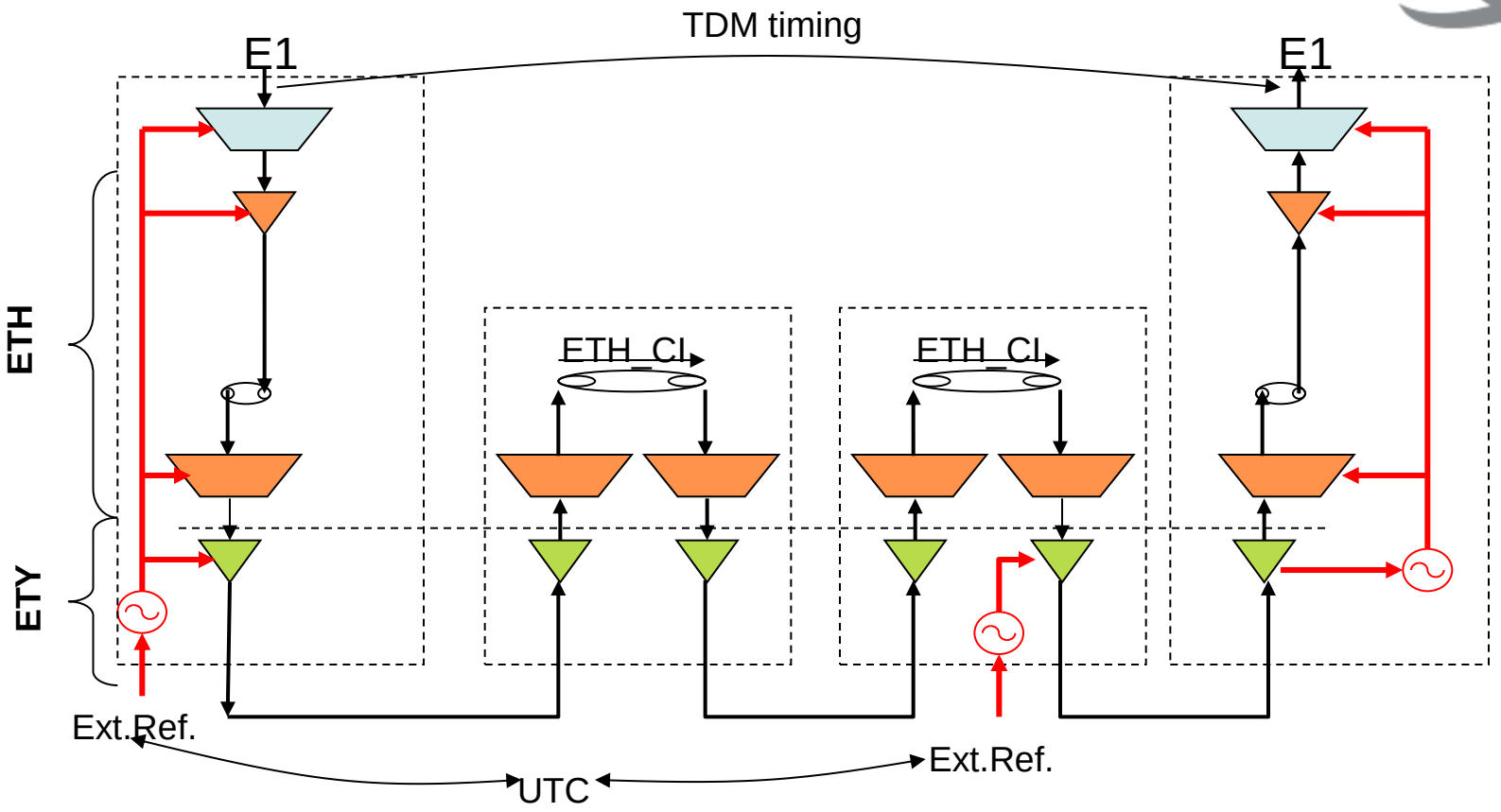


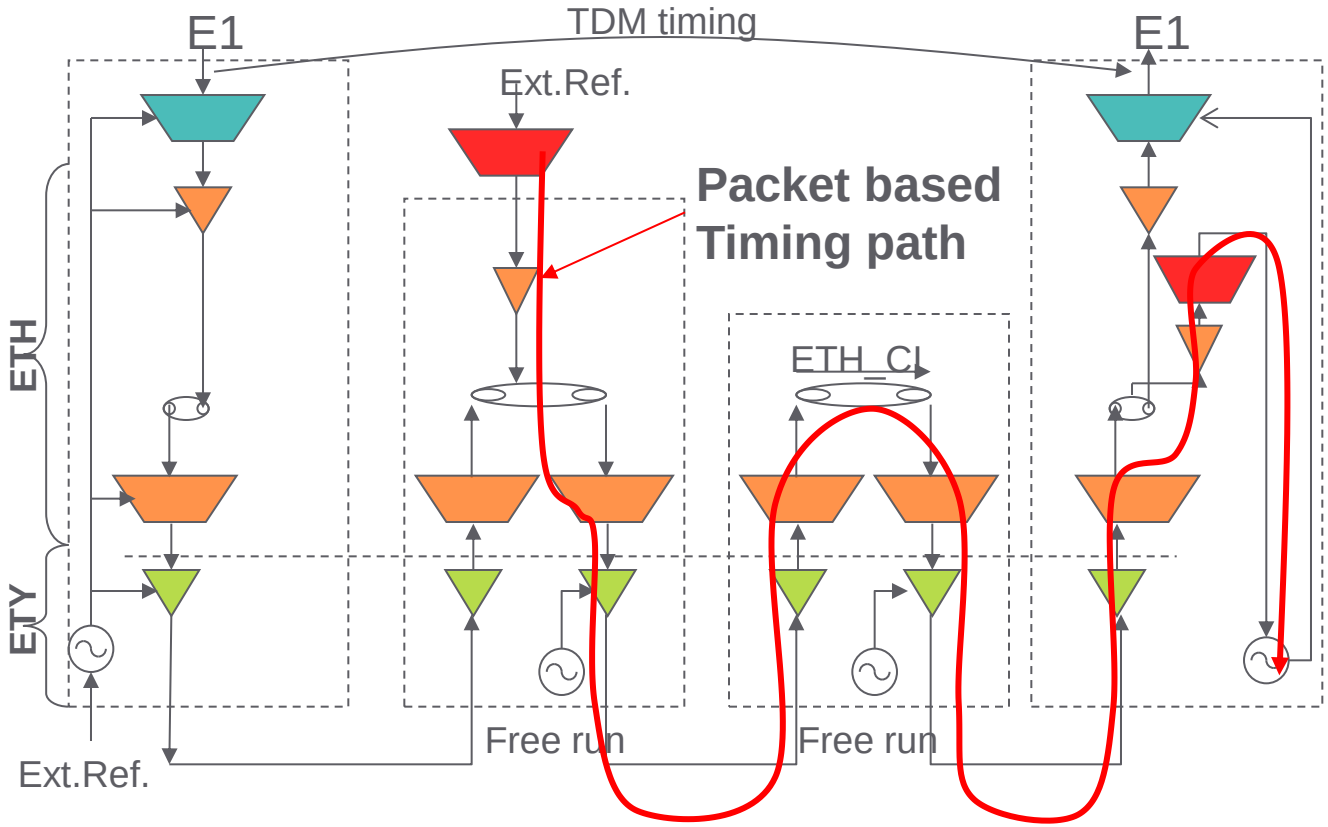
Figure 7/G.8261 – Example of Timing Recovery operation based on Differential Methods

Adding Timing Functions



- We can now see where we need to provide timing to the functional blocks to fully support a specific service or network architecture.

Alternative Approach to Timing Distribution in Packet Networks



- Functional modeling allows us to look at alternatives.
- Above figure shows a situation where a timing reference is passed via packet means (e.g. IEEE1588 or similar)

Adding Additional Details

- Functional modeling provides a separation of concerns;
  - Focus on only the necessary details
  - Example: PDH/ETH adaptation functions is independent of reference timing distribution
- G.8261 Appendix B contains some initial models for circuit emulation

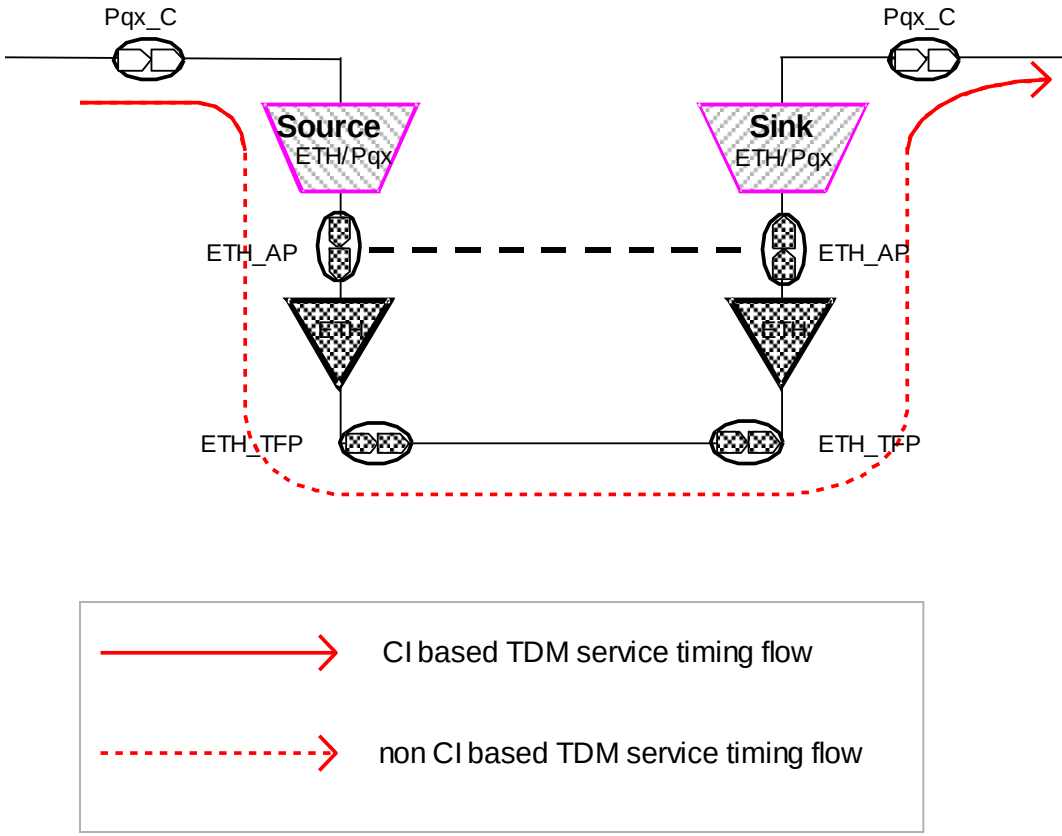


Figure III.5/G.8261: Functional models for Adaptive timing

Future work

- ITU-T Q13/15 is continuing to define synchronization aspects of next generation networks
  - Extension of G.8261
  - New Recommendations G.paclock, G.pacmod
- Functional modeling work will be used by other groups responsible for development of equipment and architecture standards.

ITU-T References

- General architecture/models
  - G.805: Generic functional architecture of transport networks
  - G.809: Functional architecture of connectionless layer networks
- Technology specific descriptions of architectures,
  - G.803: Architecture of transport networks based on the synchronous digital hierarchy (SDH)
  - I.326: Functional architecture of transport networks based on ATM
  - G.872: Architecture of optical transport networks
  - G.8010: Architecture of Ethernet layer networks
  - G.8110: MPLS layer network architecture
- Synchronization:
  - G.781: Synchronization layer functions
  - G.8261: Timing and Synchronization aspects in Packet Networks

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