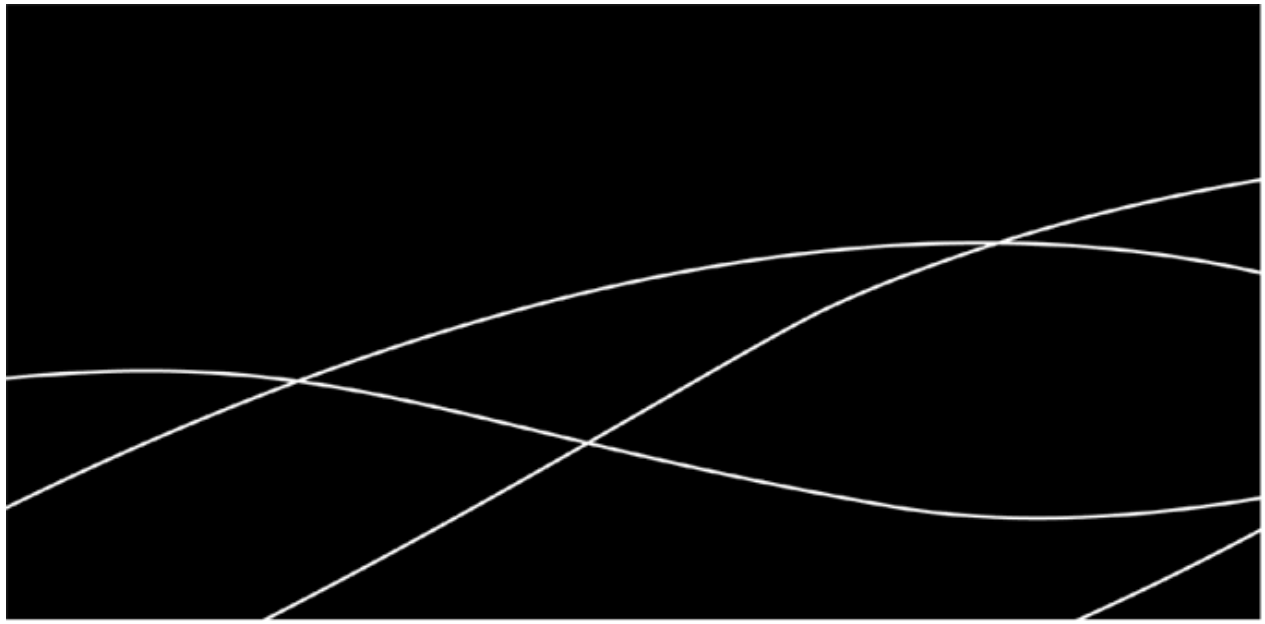

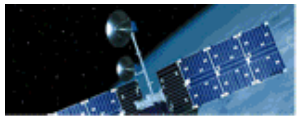

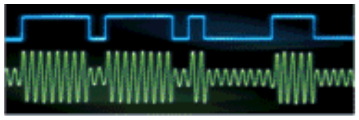

Intra-Node Synchronization NGN Perspective

Telecom's ITU G.tti (UTI), and Cable's DOCSIS 3.0 J.211 (DTI)

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Agenda

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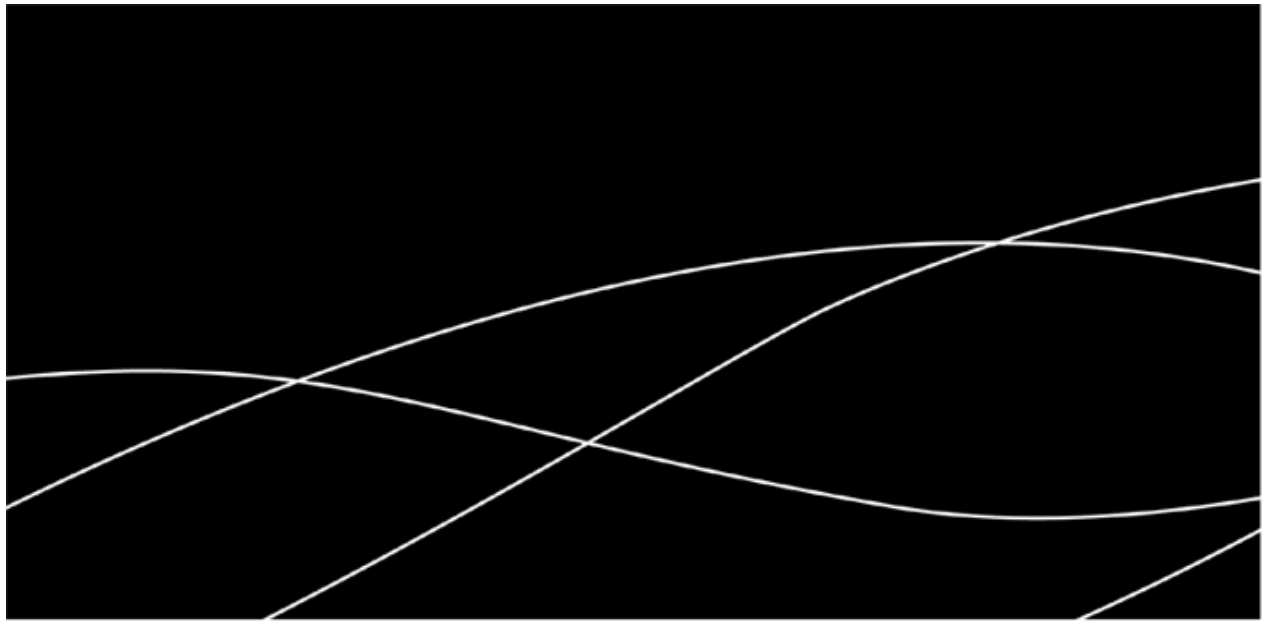
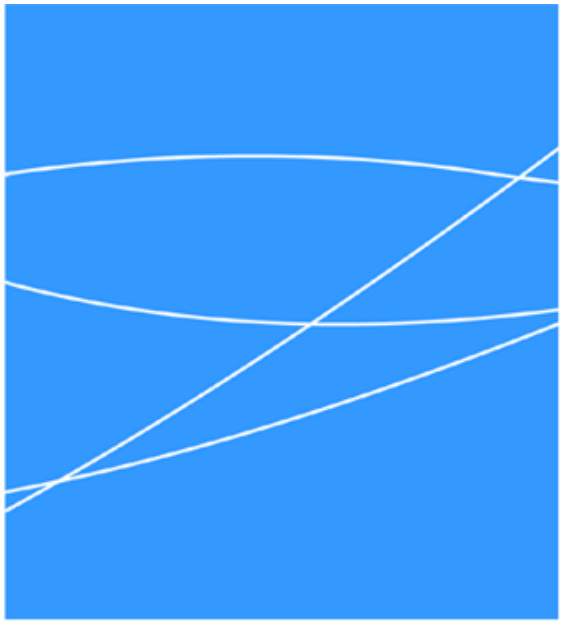
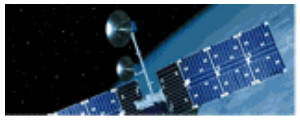
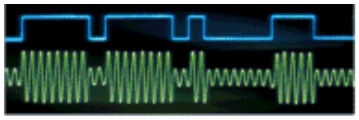
- Current Intra-node Synchronization Architectures
- Emerging NGN Synchronization Architectures
  - NGN Cable
  - NGN Wireline
- Summary









Current Intra-Node Synchronization Architecture

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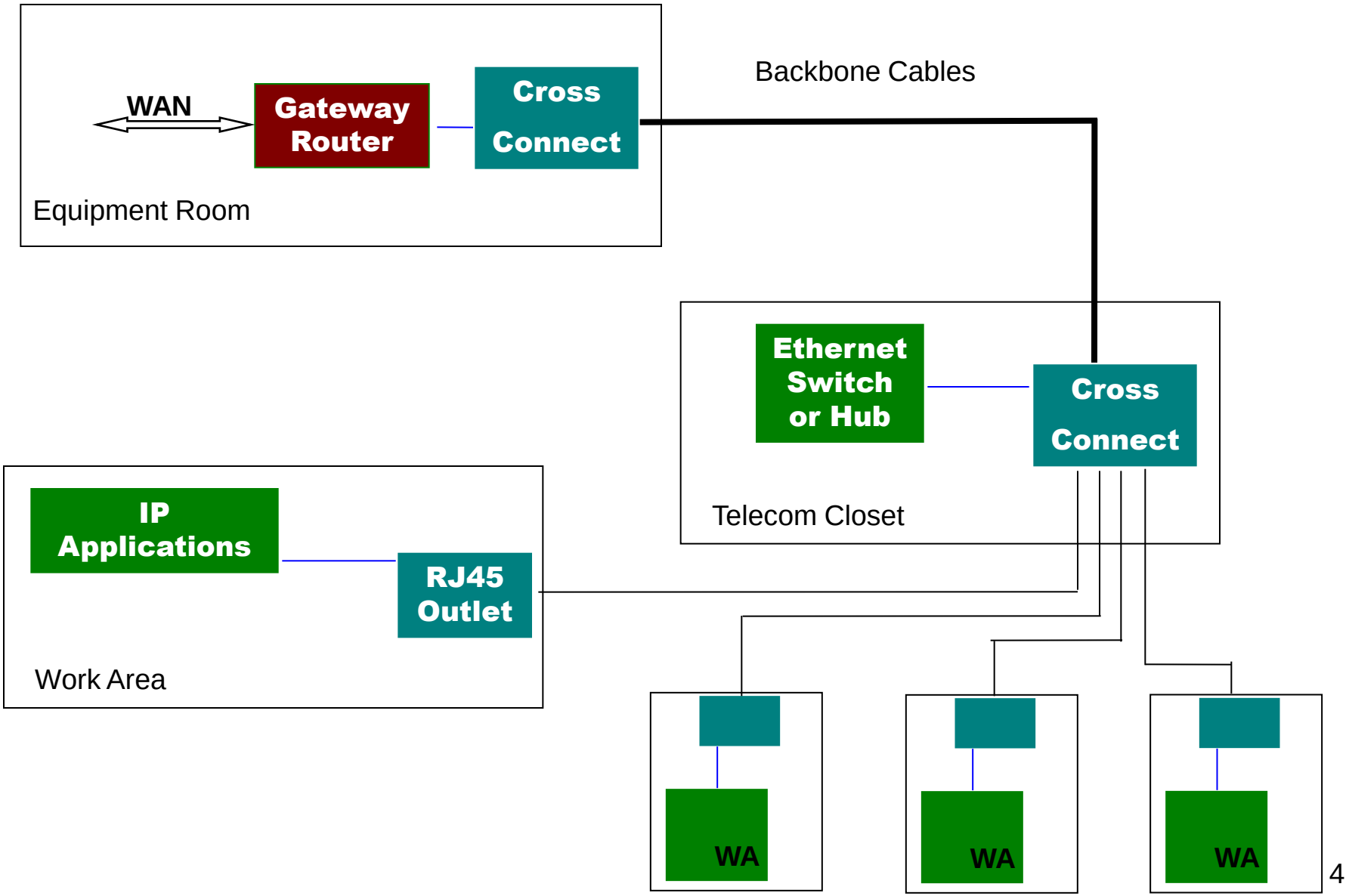
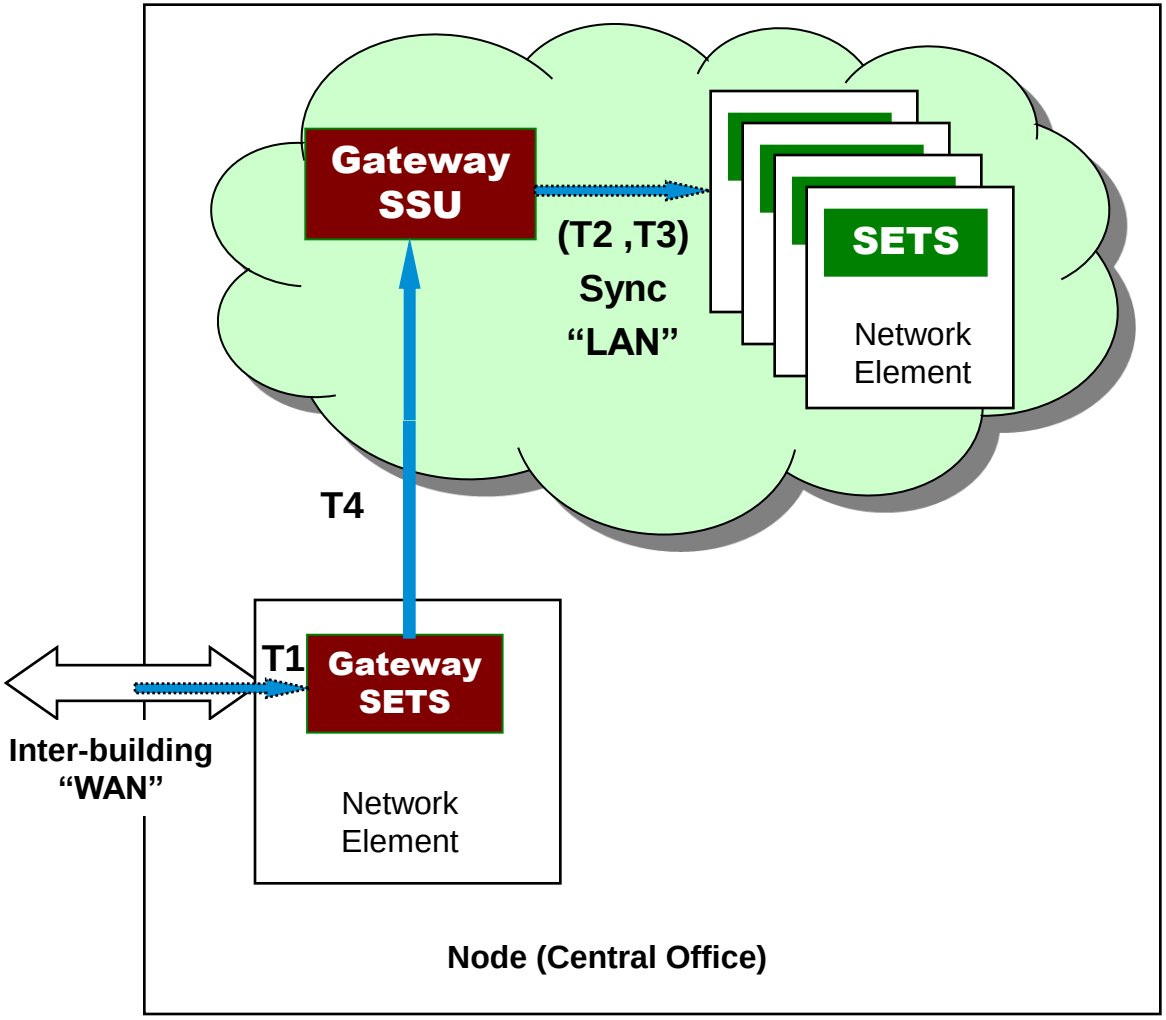
Ethernet LAN Background



Intra-office sync “LAN”



Synchronization Architecture ETSI EN 300 462-2-1

Concepts

- Only one gateway for external sync into office.
- All other NE part of star topology “sync” LAN

Terms

SETS: SDH Equipment Timing Source

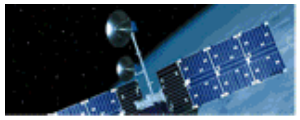
SSU: Sync. Supply Unit

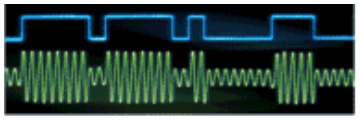
T1: Timing reference signal derived from STM-N input.

T2: Timing reference signal derived from 2 048 kbit/s input.

T3: Timing reference signal derived from 2 048 kHz or 2 048 kbit/s with SSM.

T4: External reference timing signal (2 048 kHz or 2 048 kbit/s with SSM).





NGN Cable
CMTS, M-CMTS & DOCSIS 3.0

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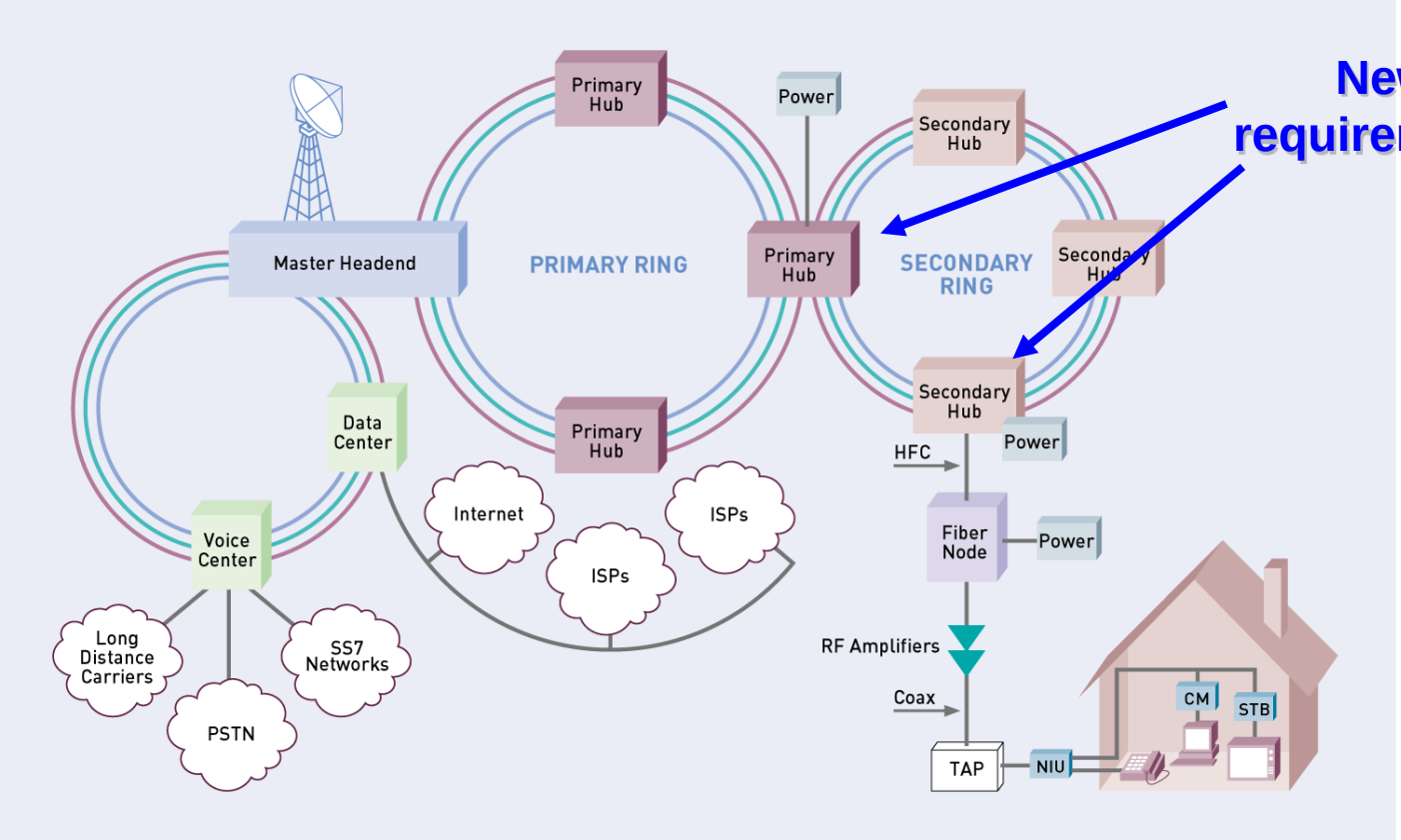
Cable Network Topology

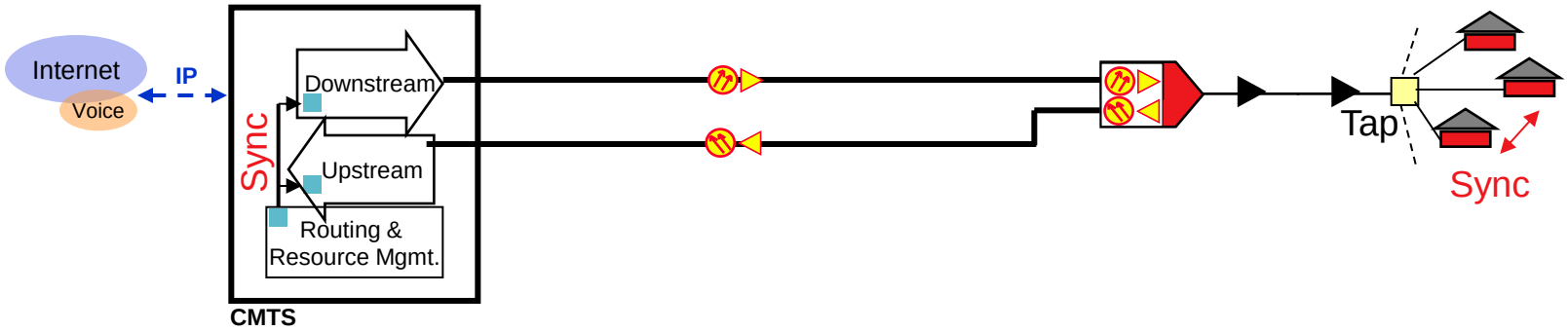


Source: Comcast

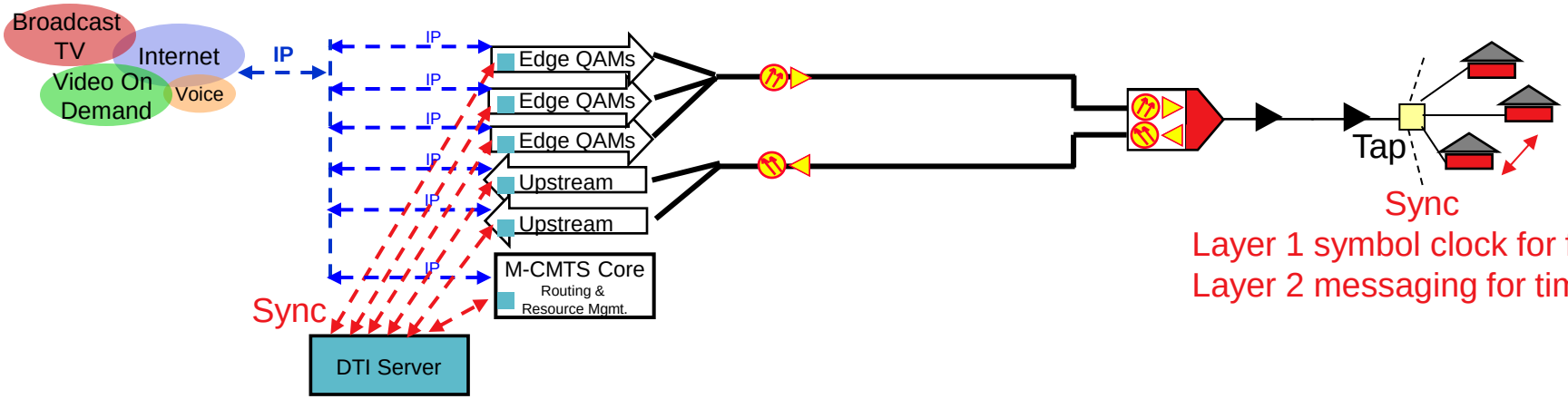
- Until recently the only external sync needed in Cable was for SONET or NTP
- The next generation Cable network is defined by two standards:
  DOCSIS 3.0 and M-CMTS

How Sync. Plays a Role

- In the old architecture a single CMTS communicated with a group of CMs. Sync was limited to the line cards in the single CMTS and the connected CMs



- In the new architecture multiple shelves must work all at the same time. Precise time & frequency sync is required to maintain sync with the CMs for ATDMA & SCDMA.



M-CMTS Goals

- Lower cost downstream for Quad Play
  - Converge all downstream traffic on a single “Converged EdgeQAM”
  - Leverage low cost, high capacity EdgeQAM from video
  - Lower cost of delivery for high data rates (DOCSIS 3.0)
- Scale routing, upstream & downstream independently
  - Flexible Bandwidth for Quad Play
  - Balance load across multiple channels
  - Flexible assignment of downstream & upstream channels
- Protect investment previous DOCSIS and VoD gear

DOCSIS 3.0 Goal

- Bandwidth!
  - DOCSIS 3.0 enables channel bonding (100MB min, 4TB possible)
  - Upstream or Downstream can be bonded
  - Competitive offering to FTTx for business or residential
- IP Multicast with QoS
- Enhanced Security
- Enhanced management & performance monitoring
- IPv6
- North American & European Convergence (upstream frequency now the same)
- Business Services over DOCSIS (T1/E1 CES & L2VPN)

New Sync Role
DOCSIS Path Verification

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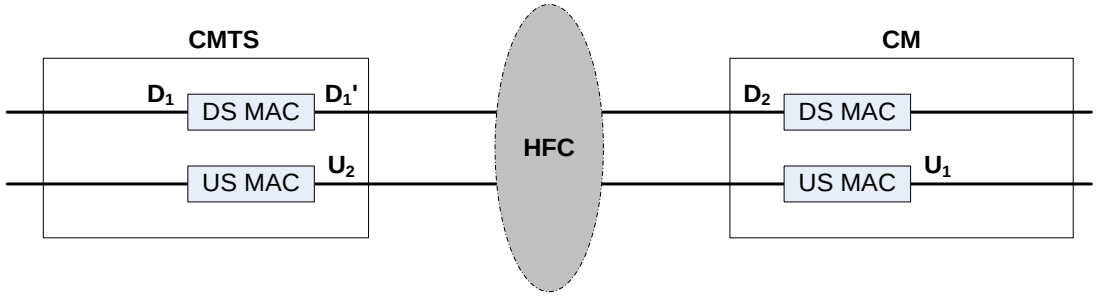
o Standardized in DOCSIS 3.0 **leveraging** the robust timing services of DTI

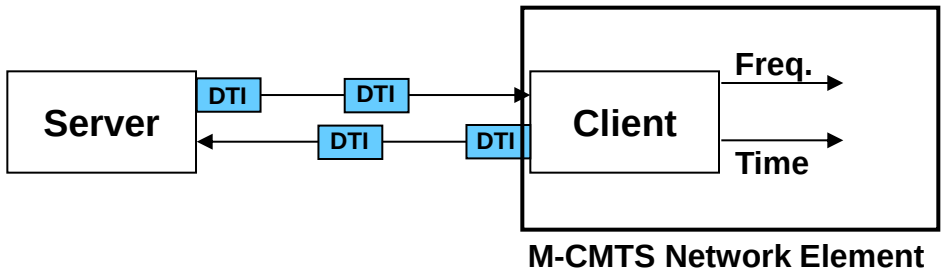
o Measures latency with respect to DTI delivered timestamps at critical reference points

o Ensures integrity of bonding groups and provides per path or per packet monitoring and resolution of problems



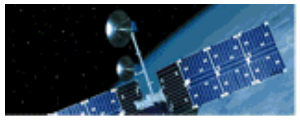
What is DTI?

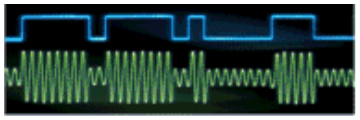
- **Status:**
  - Cable Labs M-CMTS standard http://www.cablemodem.com/downloads/specs/CM-SP-DTI-I03-060728.pdf
  - Emerging ITU Standard (J.211 Consented at last SG9 meeting in last call waiting period)
  - Active in SG15 as part of "G.TTI initiative"
- **Objective**
  - Replicate and Assure Frequency (10.24MHz Master Clock at each DTI client)
  - Replicate and Assure Time (Both TOD and DOCSIS Timestamp at each DTI client)
  - Enable Next Generation services on a converged network
- **How?**
  - Dedicated star topology local sync network
  - Uses existing Ethernet Cat5 wiring (200m max length)
  - Digital Isochronous layer 2 frames over Manchester encoded physical layer
  - 2-Way – Ping-Pong operation 10K a second over single wire pair
  - Transfers Time, Frequency & Position
  - 5ns Accuracy across all DTI Clients in a hub/headend
  - Intelligent Server, simple inexpensive client
  - Server can monitor heath of clients



“Sync LAN” Distribution Comparison

Characteristic	Ethernet 10BT	G.TTI (DTI)	G.TTI (mode 1)
Media	UTP	UTP Cat 5	G.703
Transmission Mode	Current practice Full Duplex 4 wire	Ping-pong (single wire pair or coax)	Ping-pong (single wire pair or coax)
Local Network Topology	Star (Tree with hub/switch)	Star (Tree with sub. Servers)	Star (Tree with sub. Servers)
Maximum Segment Length	100 Meters	200 Meters	200 Meters
Data Rate (Mbps)	10	5.12	2.048
Modulation	Manchester	Manchester	Manchester





NGN Wireline

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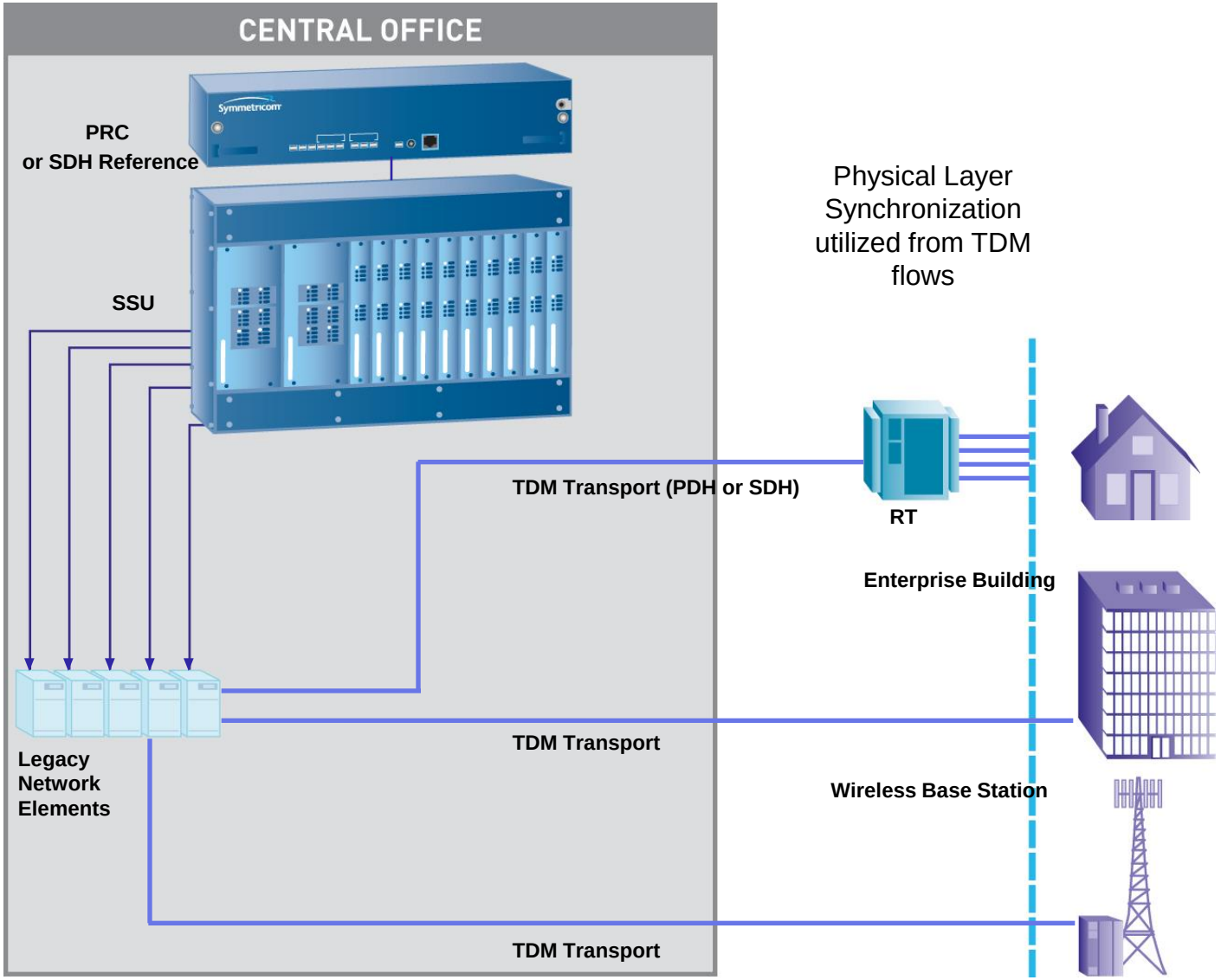
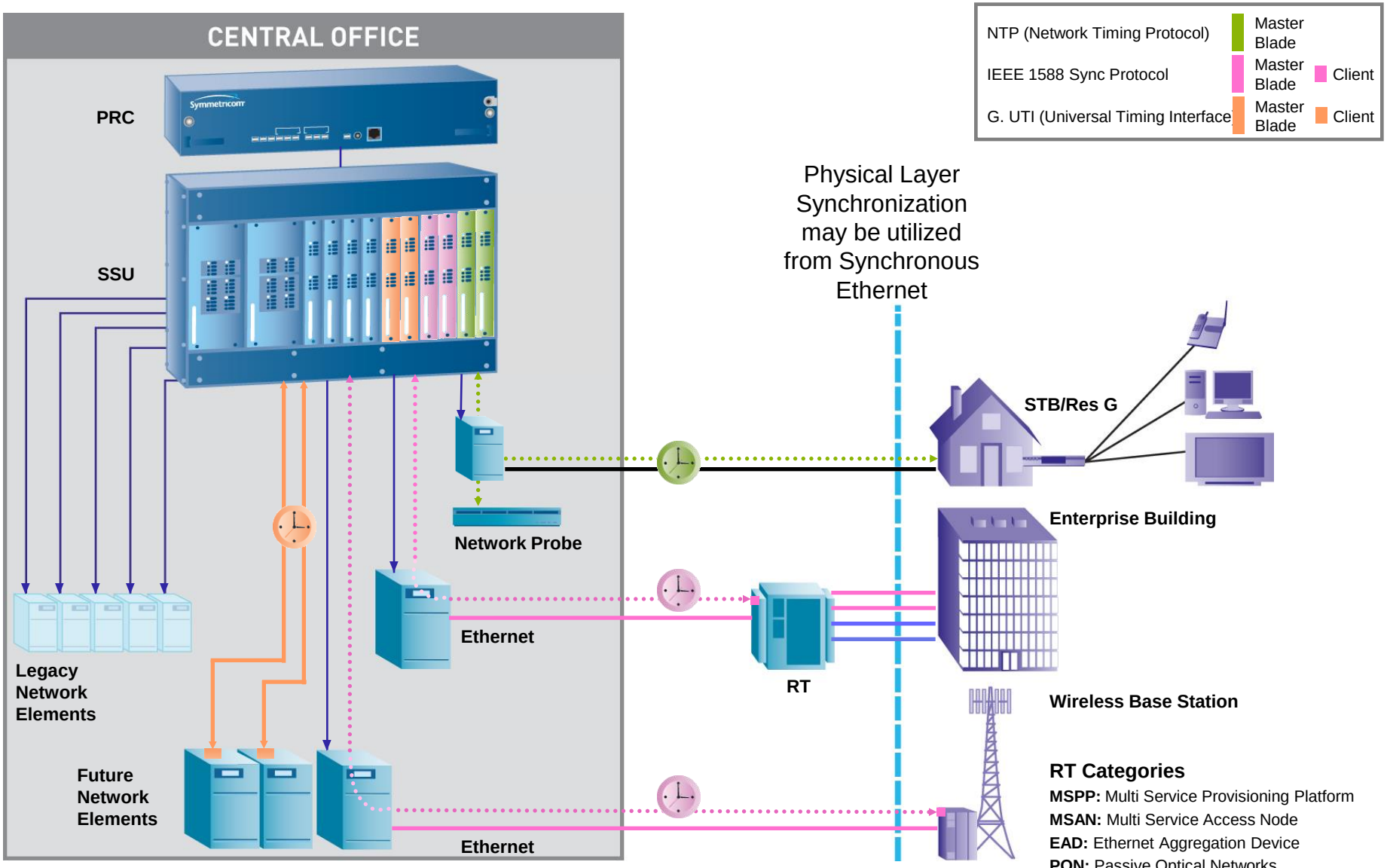
Present Edge (WAN) Timing Architecture



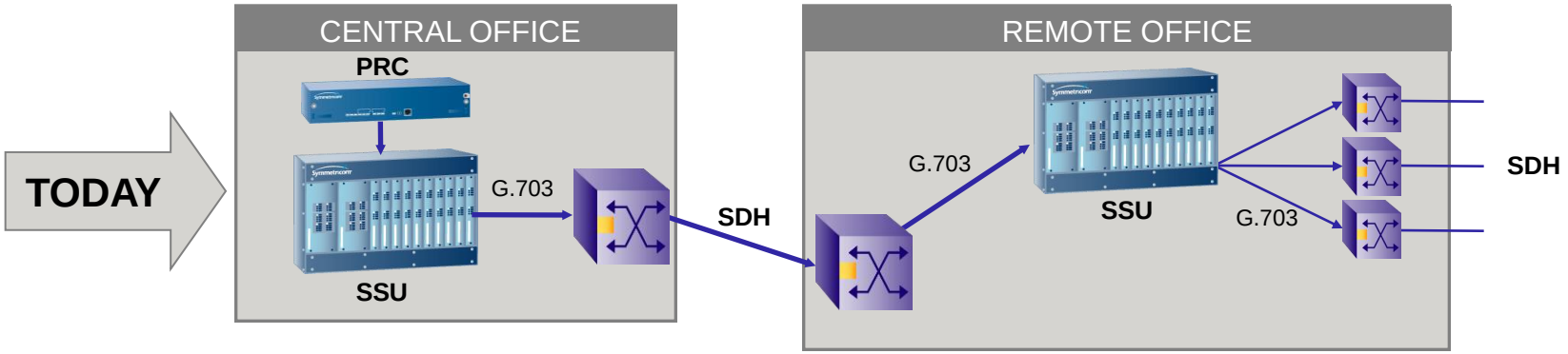
NGN Edge (WAN) Timing Architecture



RT Categories

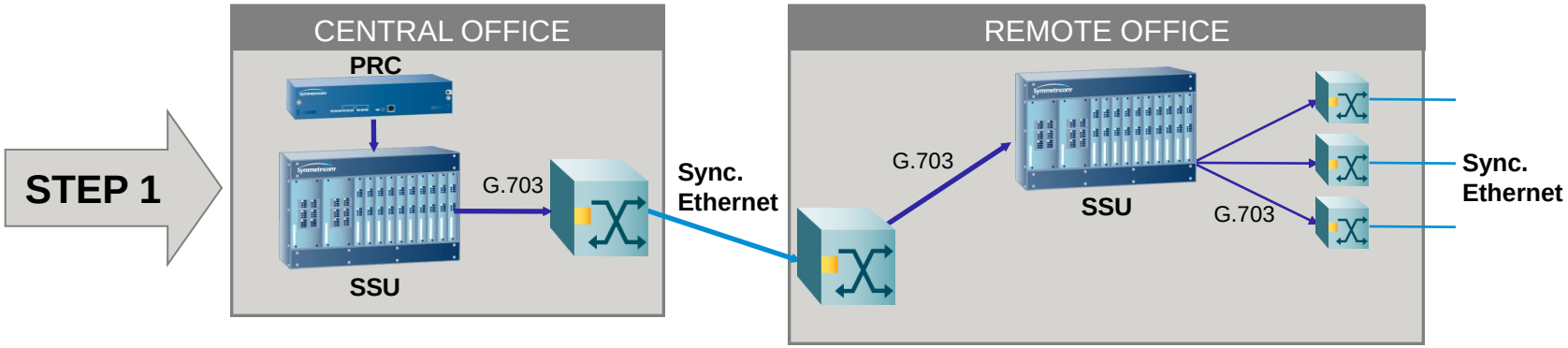
MSPP: Multi Service Provisioning Platform
MSAN: Multi Service Access Node
EAD: Ethernet Aggregation Device
PON: Passive Optical Networks
IP DSLAM

Core Network Synchronization



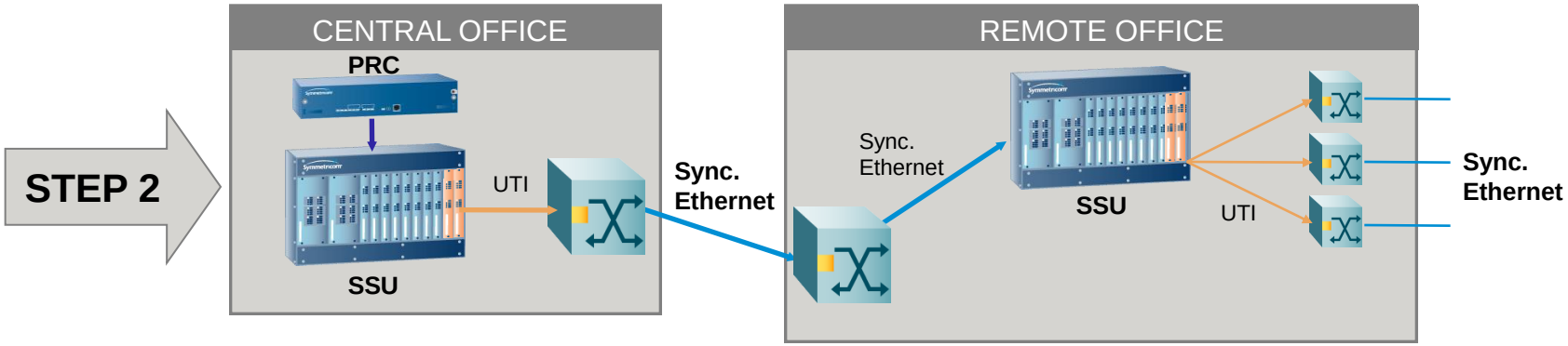
- Existing Synchronization Distribution
  - Central Office
    - PRC provides Stratum 1 source for SSU
    - G.703 frequency reference to SDH equipment
  - Remote Office
    - SDH equipment receives timing from the network
    - SDH provides G.703 timing to SSU
    - SSU filters, manages, and provides holdover of sync for the Remote Office
    - SSU distributes stable reference to SDH
  - Issues
    - No management between SSU and SDH equipment
    - No performance monitoring
    - Multiple layers of holdover (expensive, but necessary due to lack of mgmt.)

Core Network Synchronization Migration



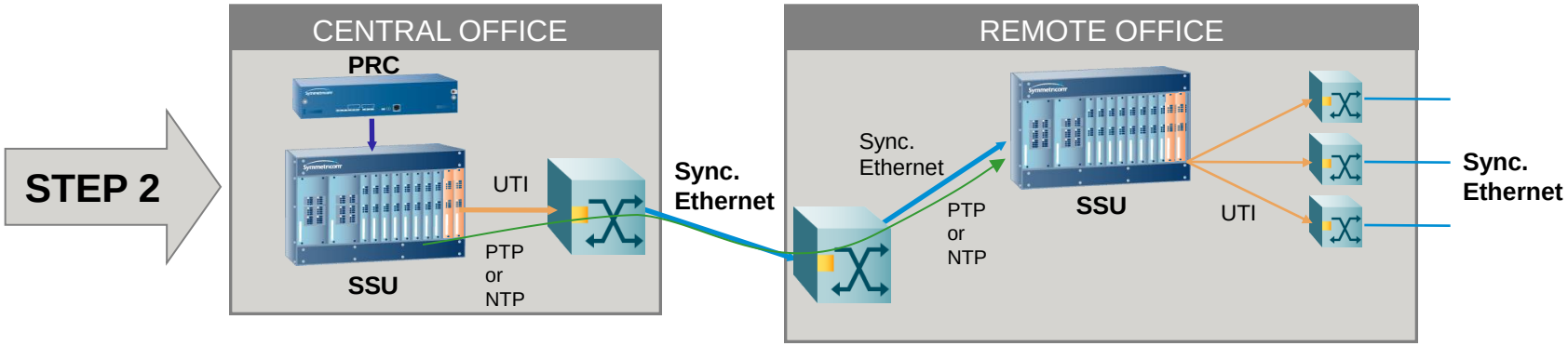
- Synchronization Distribution Migration - First Step
  - Central Office
    - G.703 used as reference to Sync. Ethernet equipment
      - Sync. Ethernet will first be deployed as an upgrade to SDH equipment
      - SDH equipment already has G.703 frequency available
      - New protocols will likely only be implemented in new equipment
  - Remote Office
    - Same distribution as existing architecture

Core Network Synchronization Migration



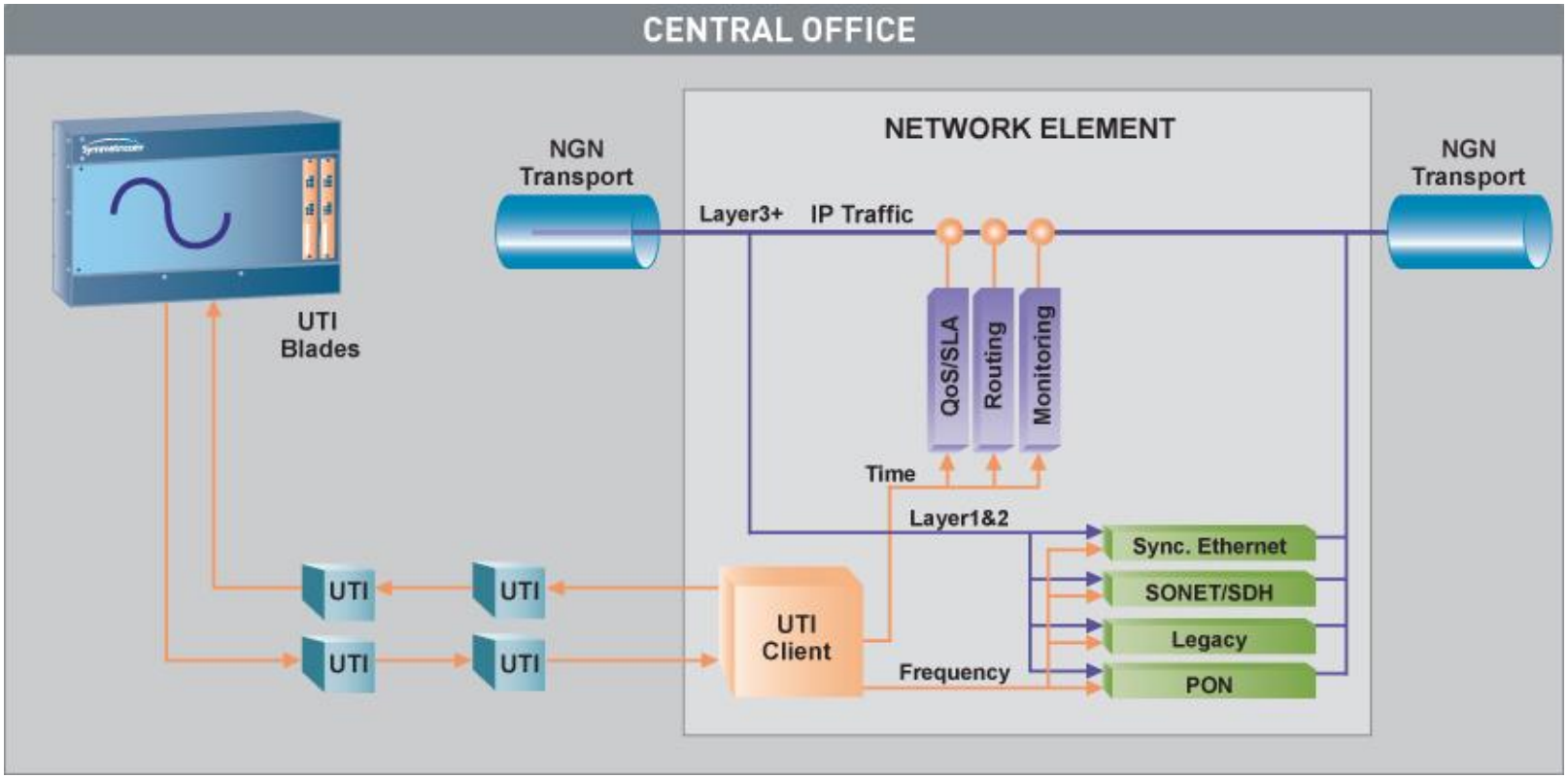
- Synchronization Distribution Migration - Second Step
  - Central Office
    - UTI used as reference to Sync. Ethernet equipment
      - Enables communication of configuration, performance and telemetry between SSU and Sync. Ethernet Equipment
      - Lessens the need for holdover
      - Provides ultra-precise local time for distributed applications & architectures
      - Provides Time-Of-Day (UTC) time for IP applications & one-way delay measurements
  - Remote Office
    - Sync. Ethernet equipment receives frequency from the network
    - Sync. Ethernet equipment provides frequency to SSU via Sync. Ethernet
    - SSU filters, manages, and provides holdover of sync for the Remote Office
    - SSU distributes stable reference to Sync. Ethernet equipment
    - What about time?

Core Network Synchronization Migration



- What about time in the Remote Office?
  - PTP or NTP is forwarded over a managed IP network between SSUs
    - Ensures that time offsets are not created between local equipment in the RO
      - Local time >100ns
    - Time-Of-Day traceability maintained in UTI local distribution.
    - Time Authentication handled by the SSUs
    - Filtering and expense centralized in the SSU

NGN Intra-office Timing Technology: UTI



Summary

- UTI is emerging as a key intra-building synchronization technology
- UTI complements NTP,PTP and Synchronous Ethernet providing a complete NGN Synchronization Architecture
- NGN Cable intra-building will be DTI
- NGN Wireline can migrate to first improve robustness and manageability and later established time services as needed.