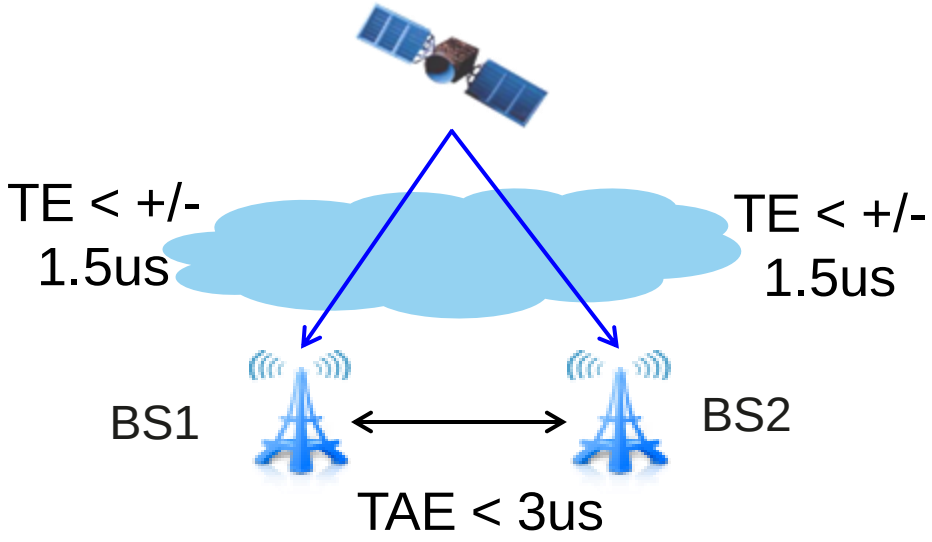
Outline

- Need for Synchronization monitoring in Telecom
- Use-cases of synchronization monitoring
- Using Network Management System for monitoring
- Summary

Need for Synchronization monitoring in Telecom

- Synchronization is vital for the operation of telecom networks
  - > 3GPP defines time requirements for the base stations
- Monitoring the network for sync failures is important to mitigate network outages
- Some Operators have Service Level Agreement (SLA) to offer synchronization as a service
  - > SLAs must be met



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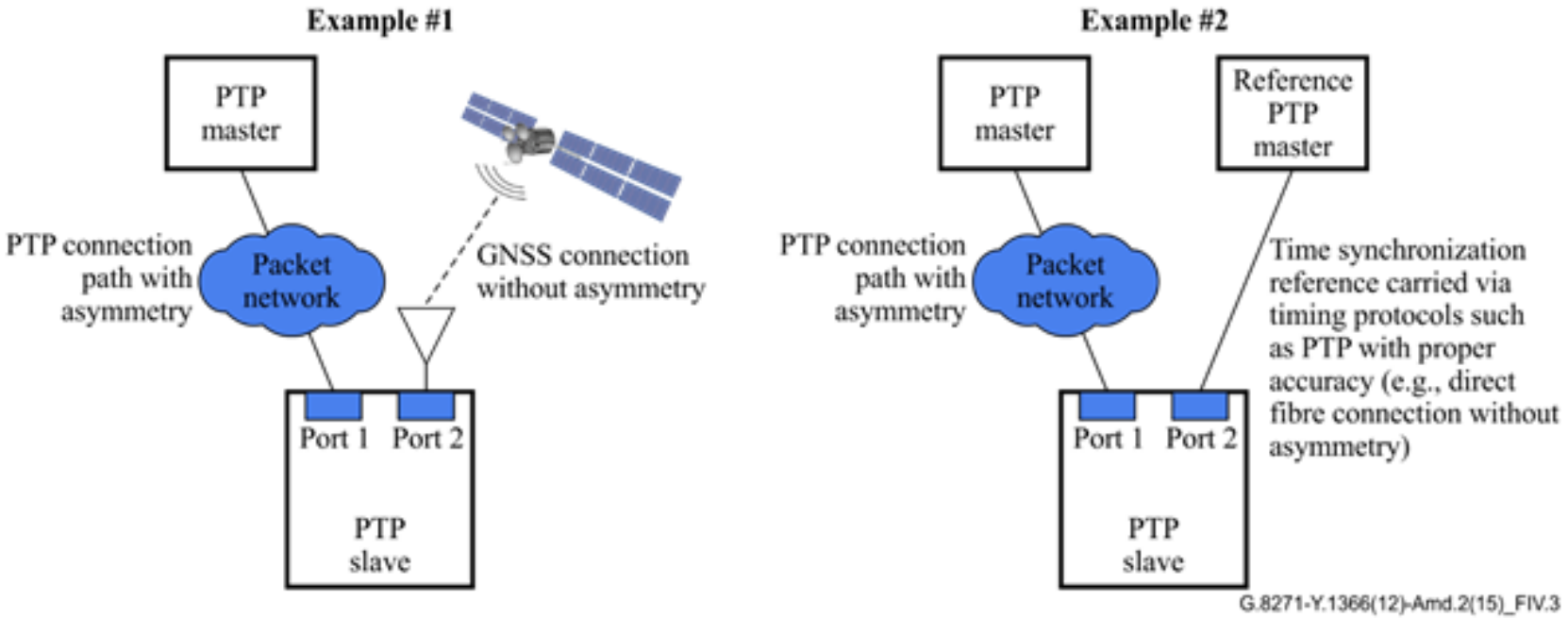
Use Case 1 – Asymmetry measurement



ITU-T G.8271/Figure IV.3 – PTP slave evaluating PTP connection asymmetry

- PTP communication path may have asymmetry due to network configuration, loading, fiber lengths, etc.
  - > If the node has access to a secondary synchronization source, then these asymmetries can be measured and compensated

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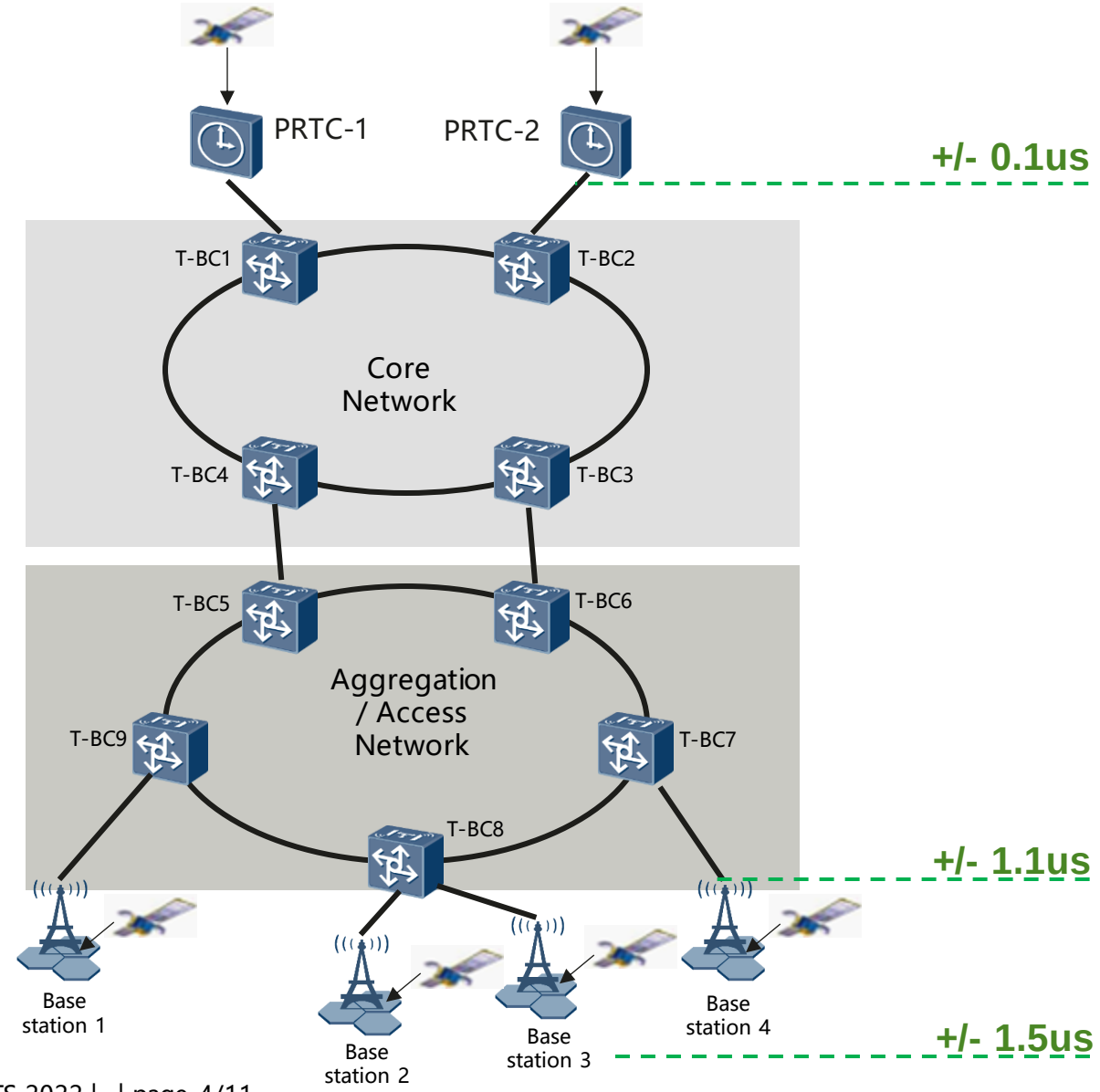
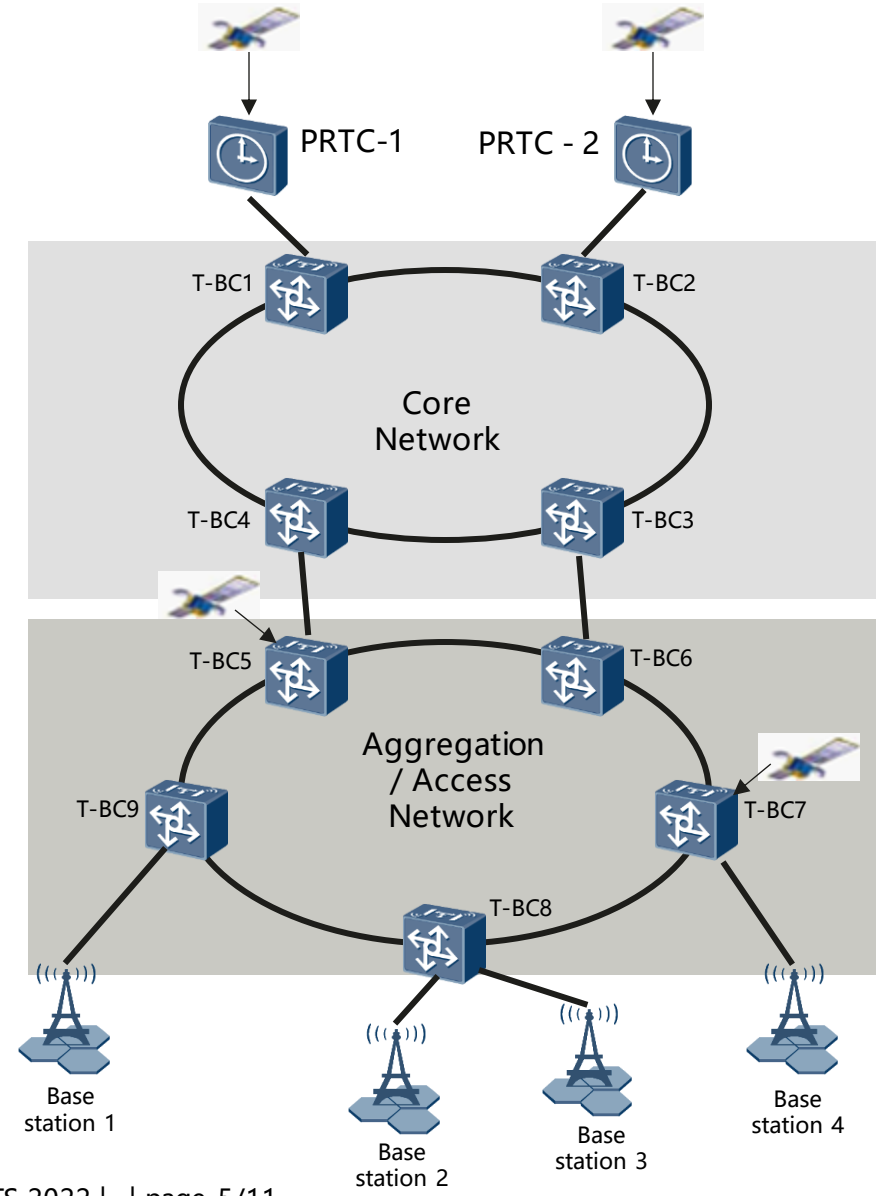
Use Case 2 – Operator's Networks with Assisted Full Time Support (AFTS)



- All the equipment deployed in the network supports IEEE 1588 (full time support), and GNSS is deployed at the end application
- Base station (BS) can compare the time error of its local GNSS with the time error of PTP
- BS can generate an alarm if the time difference exceeds a pre-set threshold
- Maintenance personnel can check the network and fix issues in advance avoiding network outages

Use Case 3 – The use of Probes in the Network



- Probes can be used in key points throughout the network to monitor performance
- YANG model can be used by NMS to monitor time error in the network
- Maintenance personnel can check the network and fix issues in advance avoiding network outages

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IEEE 1588 Performance Monitoring

- Annex J of IEEE 1588 defines performance monitoring options that can be used to monitor PTP,
  - It defines two types of datasets: performanceMonitoringDS (per PTP Instance) and performanceMonitoringPortDS (per port)
- The definition of performanceMonitoringDS includes average, minimum, maximum, and standard deviation for its dataset members
  - The device can report data periodically for each 15 minutes and 24 hours interval.
- The definition of performanceMonitoringPortDS includes:
  - For peer-to-peer delay mechanism, average, minimum, maximum, and standard deviation of MeanLinkDelay are reported
  - Additional parameters use counters indicating the number of messages that have been transmitted and received for each 15 minutes and 24 hours for different types of messages (e.g. sync)
- A dataset member called “PMTime" is also defined to indicate the starting times of the measurement periods being utilized for monitoring
- Network Management System (NMS) can be used to retrieve and analyze the data

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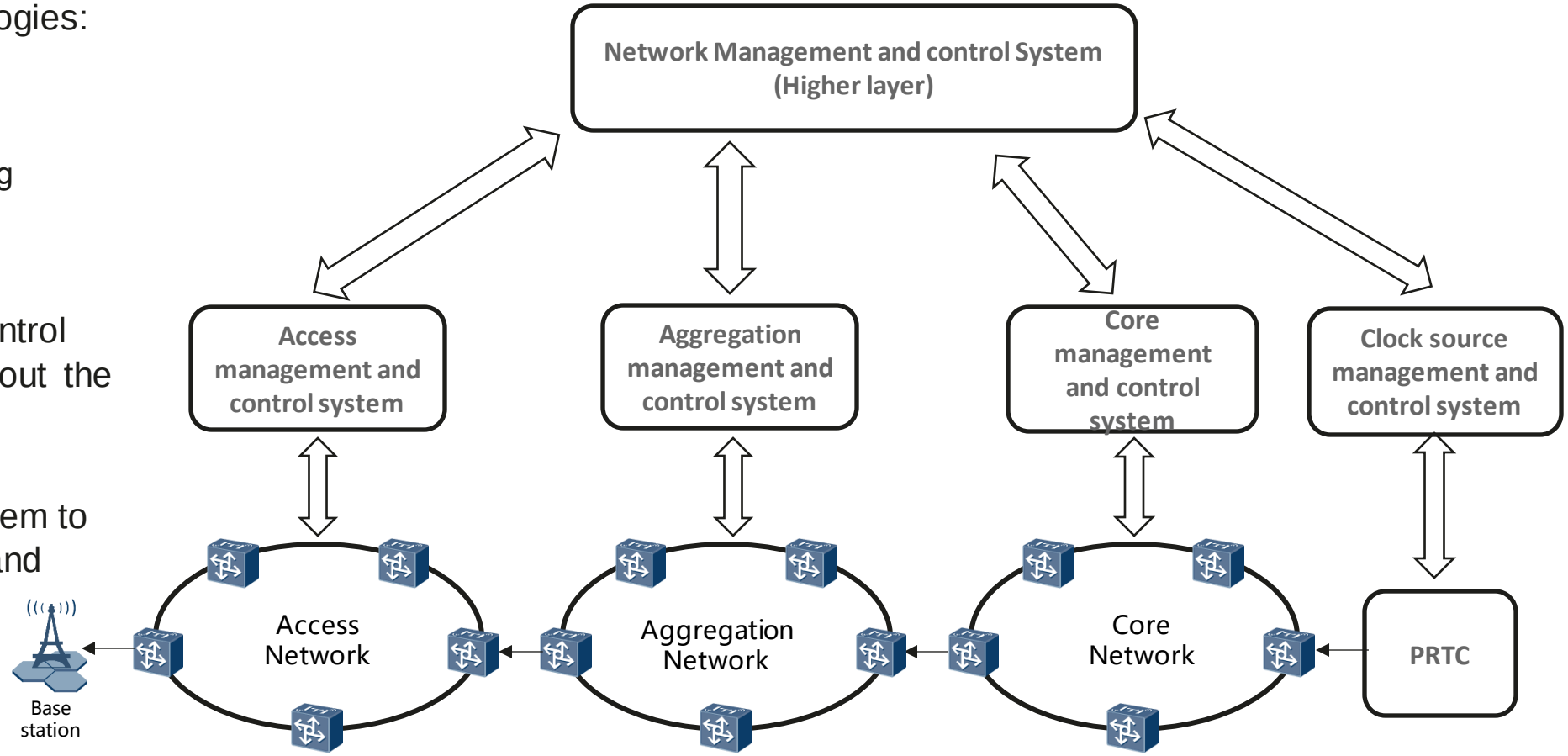
Network Management and Control System

- Transport Network may be comprised of different technologies:
  - Packet Transport Network
  - Optical Transport Network
  - Wavelength Division Multiplexing
  - Passive Optical Network
  - Etc...
- Different management and control systems may be used throughout the network
- Need to have a higher layer management and control system to coordinate the management and control of the whole network



Synchronization is an end-to-end feature, synchronization management and control also need to be end-to-end

Sync Management Protocol

- Management protocol between the equipment and Network management system (NMS) are important to be standardized to allow NMS to manage equipment from different vendors
- NetConf (IETF RFC 6241) + YANG (IETF RFC 6020) are suggested as management protocol.
- IEEE 1588 is working on an amendment (P1588e) to specifies MIB and YANG data models based on the data sets of IEEE Std 1588-2019
- IEEE 802.1 TSN is working on an amendment for IEEE 802.1AS to specify a YANG data model
  - It augments the YANG model for P1588e
- ITU-T is developing YANG model (G.7721, G.7721.1) for the Telecom profiles

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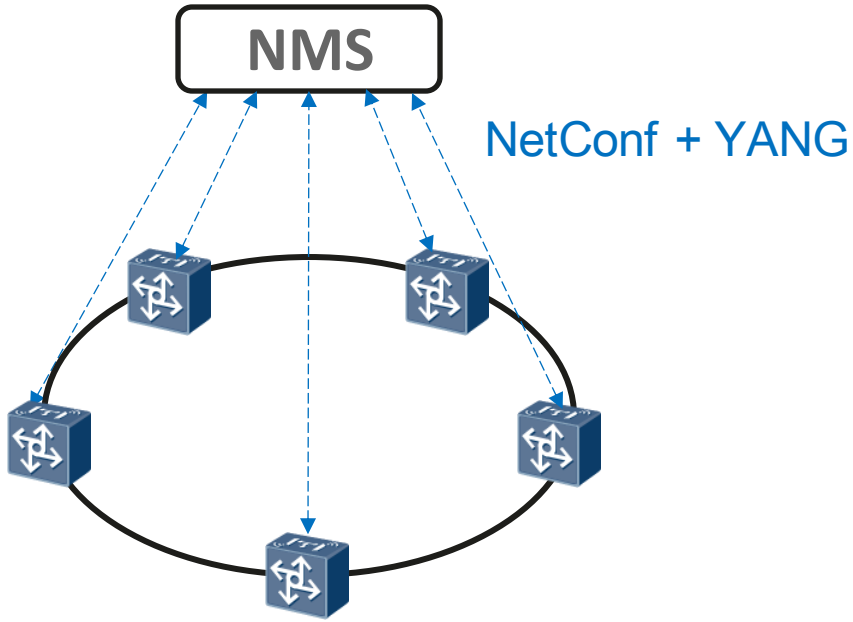

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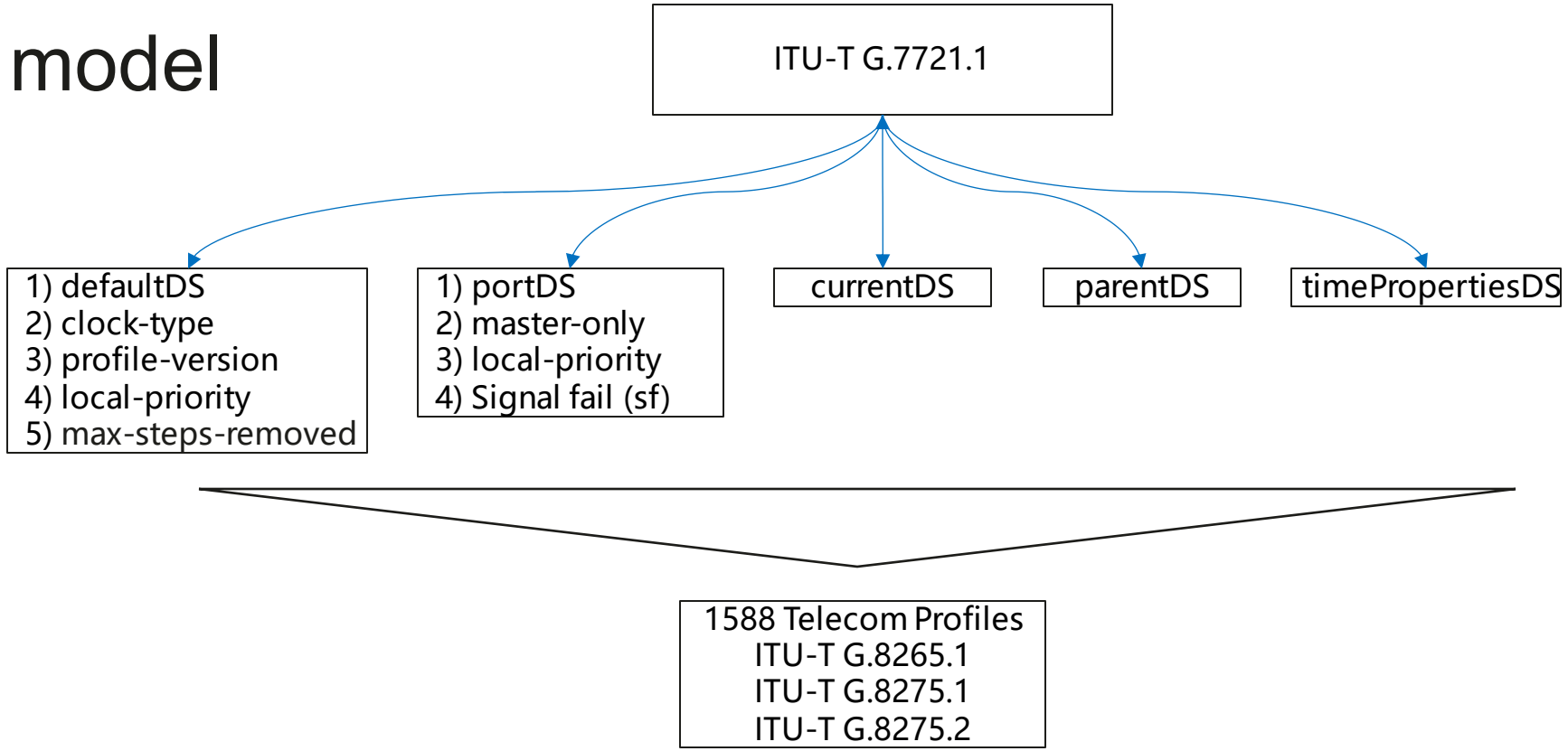
YANG model for Telecom

- ITU-T G.7721 –“Management requirement and information model for synchronization”
  - Specifies management requirements and a protocol-neutral management information model for managing synchronization network
- ITU-T G.7721.1 –“Data model of Synchronization management”
  - Specifies the synchronization information models and data models for Transport Network Element (NE) to support specific interface protocols and specific management and control (MC) functions.
  - Specifies the information models using the Unified Modelling Language (UML).
  - Specifies YANG data models that augments the PTP YANG module defined in IETF RFC 8575 for IEEE 1588-2008
  - UML information model and YANG data model cover the ITU-T profiles (ITU-T G.8265.1, G.8275.1, and G.8275.2)

G.7721.1 YANG model



- IEEE Std 1588-2008 default DS
  - twoStepFlag, clockIdentity, numberPorts, clockQuality, priority1, priority2, domainNumber, and slaveOnly
- IEEE Std 1588-2008 portDS
  - portIdentity,portState, logMinDelayReqInterval, peerMeanPathDelay, logAnnounceInterval, .announceReceiptTimeout, logSyncInterval, delayMechanism, portDS.logMinPdelayReqInterval, and portDS.versionNumber
- IEEE Std 1588-2008 currentDS
  - stepsRemoved, offsetFromMaster, and meanPathDelay

- IEEE Std 1588-2008 parentDS:
  - parentStats, observedParentOffsetScaledLogVariance, observedParentClockPhaseChangeRate, grandmasterIdentity, grandmasterClockQuality, grandmasterPriority1, and grandmasterPriority2
- IEEE Std 1588-2008 timePropertiesDS
  - currentUtcOffset, currentUtcOffsetValid, leap59, leap61, timeTraceable, frequencyTraceable, ptpTimescale, and timeSource
- IEEE Std 1588-2008 transparentClockDefaultDS
  - clockIdentity, numberPorts, delayMechanism, and primaryDomain
- SyncE data sets are being defined at ITU-T

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Summary

- Synchronization monitoring is important to avoid network outages
- It is important to use a common network management protocol (e.g., NetConf + YANG) for synchronization
- On-going development of MIB and YANG models for IEEE 1588, Telecom, and 802.1 TSN profiles.

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