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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Data over Transport – Generic aspects – Transport network control aspects

Data model of synchronization management

Recommendation ITU-T G.7721.1

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Recommendation ITU-T G.7721.1

Data model of synchronization management

Summary

Recommendation ITU-T G.7721.1 specifies the synchronization information models and data models for transport network elements (NEs) to support specific interface protocols and specific management and control (MC) functions.

The information models are interface protocol neutral and specified using the unified modelling language (UML).

The data models are interface protocol specific and are directly derived from these information models. The specific data models considered in this Recommendation include, but are not limited to, yet another next generation (YANG) data models.

The specific MC functions for synchronization covered by this Recommendation are specified in Recommendations ITU-T G.8265.1, ITU-T G.8275.1 and ITU-T G.8275.2.

The precision time protocol (PTP) telecom profile YANG module defined in this Recommendation augments the PTP YANG module defined in IETF RFC 8575 for the management of the precision time protocol (PTP) defined in IEEE 1588-2008.

The UML information model and YANG data model in this first version of the Recommendation covers the PTP telecom profiles defined in Recommendations ITU-T G.8265.1 (2014) Amd.1 (2019) (Edition 2.2), ITU-T G.8275.1 (2020) (Edition 3.0) and ITU-T G.8275.2 (2020) (Edition 2.0), which are based on IEEE 1588-2008.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.7721.1	2022-06-06	15	11.1002/1000/14915

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Data model, management, synchronization.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Electronic attachment: The UML information model and the YANG data model described in clauses 7 and 8, a ptp deviation example YANG module described Appendix I and a graphic with the PTP telecom profile. Available at: www.itu.int/ITU-T/formal-language/itu-t/g/g7721.1/2022/g7721.1-202206-Attachment.zip

Recommendation ITU-T G.7721.1

Data model of synchronization management[1]

1 Scope

This Recommendation specifies the synchronization information models and data models for transport network elements (NEs) to support specific interface protocols and specific management and control (MC) functions.

The specific MC functions for synchronization covered by this Recommendation are specified in [ITU-T G.8265.1], [ITU-T G.8275.1] and [ITU-T G.8275.2].

The information models are interface protocol neutral and specified using the unified modelling language (UML). The information models of this Recommendation are derived through pruning and refactoring from the [ITU-T G.7711] core information model and the [ITU-T G.7721] synchronization base information model.

The data models are interface protocol specific and are directly derived from these information models. The specific data models considered in this Recommendation include, but are not limited to, yet another next generation (YANG) data models.

The PTP telecom profile YANG module defined in this Recommendation augments the PTP YANG module defined in [IETF RFC 8575] for the management of the precision time protocol (PTP) defined in [IEEE 1588-2008].

The UML information model and YANG data model in this version of the Recommendation covers the PTP telecom profiles defined in Amendment 1 (2019) to [ITU-T G.8265.1] (Edition 2.2), [ITU-T G.8275.1] (Edition 3.0), and [ITU-T G.8275.2] Edition 2.0 (2021), which are based on [IEEE 1588-2008].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.7711] Recommendation ITU-T G.7711/Y.1702 (2018), *Generic protocol-neutral information model for transport resources*.

[ITU-T G.7721] Recommendation ITU-T G.7721 (2018), *Management requirement and information model for synchronization.*

[ITU-T G.8265.1] Recommendation ITU-T G.8265.1/Y.1365.1 (2014)[2], *Precision time protocol telecom profile for frequency synchronization*.

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[1] This Recommendation includes an electronic attachment containing the UML information model and the YANG data model described in clauses 7 and 8, as well as the ptp deviation example YANG module described Appendix I and a graphic with the PTP telecom profile.

[2] The UML information model and YANG data model in this first version of the Recommendation cover the PTP telecom profiles defined in Amendment 1 (2019) (Edition 2.2) to [ITU-T G.8265.1] and may not be compatible with subsequent editions of [ITU-T G.8265.1].

[ITU-T G.8275.1] Recommendation ITU-T G.8275.1 (2020)[3], *Precision time protocol telecom profile for phase/time synchronization with full timing support from*.

[ITU-T G.8275.2] Recommendation ITU-T G.8275.2/Y.1369.1 (2020)[4], *Precision time protocol telecom profile for time/phase synchronization with partial timing support from the network*.

[IEEE 1588-2008] IEEE 1588-2008, *IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*.

[IEEE 1588-2019] IEEE 1588-2019, *IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*.

[IETF RFC 7950] RFC 7950 (2016), *The YANG 1.1 Data Modeling Language*.

[IETF RFC 8575] RFC 8575 (2019), *YANG Data Model for the Precision Time Protocol (PTP)*.

[IETF RFC 8340] RFC 8340 (2018), *YANG Tree Diagrams*.

[IETF RFC 8342] RFC 8342 (2018), *Network Management Datastore Architecture (NMDA)*.

[IETF RFC 8343] RFC 8343 (2018), *A YANG Data Model for Interface Management*.

3 Definitions

This Recommendation does not define any new terms.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CASC Configuration and Switch Control

LTP Logical Termination Point

NE Network Element

PTP Precision Time Protocol

UML Unified Modelling Language

YANG Yet Another Next Generation

5 Conventions

5.1 Information modelling conventions

UML modelling conventions

See [ITU-T G.7711] clause 5.1.

Model artefact lifecycle stereotypes conventions

See [ITU-T G.7711] clause 5.2.

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[3] The UML information model and YANG data model in this first version of the Recommendation covers the PTP telecom profiles defined in Edition 3.0 of [ITU-T G.8275.1], and may not be compatible with subsequent editions of [ITU-T G.8275.1].

[4] The UML information model and YANG data model in this first version of the Recommendation covers the PTP telecom profiles defined in Edition 2.0 of [ITU-T G.8275.2], and may not be compatible with subsequent editions of [ITU-T G.8275.2].

Forwarding entity terminology conventions

See clause 5.3 of [ITU-T G.7711].

Conditional package conventions

See clause 5.4 of [ITU-T G.7711].

Pictorial diagram conventions

See clause 5.5 of [ITU-T G.7711].

6 Synchronization functions

This clause identifies the synchronization functions that are modelled by the information model and data models of this Recommendation.

6.1 Precision time protocol (PTP) telecom profiles

The precision time protocol (PTP) is defined in [IEEE 1588-2008] and in [IEEE 1588-2019].

ITU-T has developed a set of PTP telecom profiles, as listed in Table 6-1.

Table 6-1 – ITU-T PTP telecom profiles

ITU-T PTP telecom profiles	Reference
Frequency synchronization	Amd.1 to [ITU-T G.8265.1]
Phase/time synchronization, with full timing support from the network	[ITU-T G.8275.1]
Phase/time synchronization, with partial timing support from the network	[ITU-T G.8275.2]

7 Synchronization management information models

This clause contains the unified modelling language (UML) information model of the synchronization functions identified in clause 6. The information model is derived through pruning and refactoring the [ITU-T G.7711] core information model and the [ITU-T G.7721] synchronization base information model.

7.1 Required object classes and relations

7.1.1 PTP telecom profile

The management of the precision time protocol (PTP), defined in [IEEE 1588-2008], is provided by the PTP YANG data model, defined in [IETF RFC 8575].

To assist the PTP telecom profile UML pruning and refactoring and to ensure that the translated PTP telecom profile YANG data model can augment seamlessly the PTP YANG data model, the PTP YANG data model, defined in [IETF RFC 8575], has been reverse-engineered into UML form.

Figure 7-1 provides an overview of the PTP UML model, reverse-engineered from the PTP YANG data model defined in [IETF RFC 8575], and of the Spec object classes of the PTP telecom profile UML model, defined in this Recommendation.

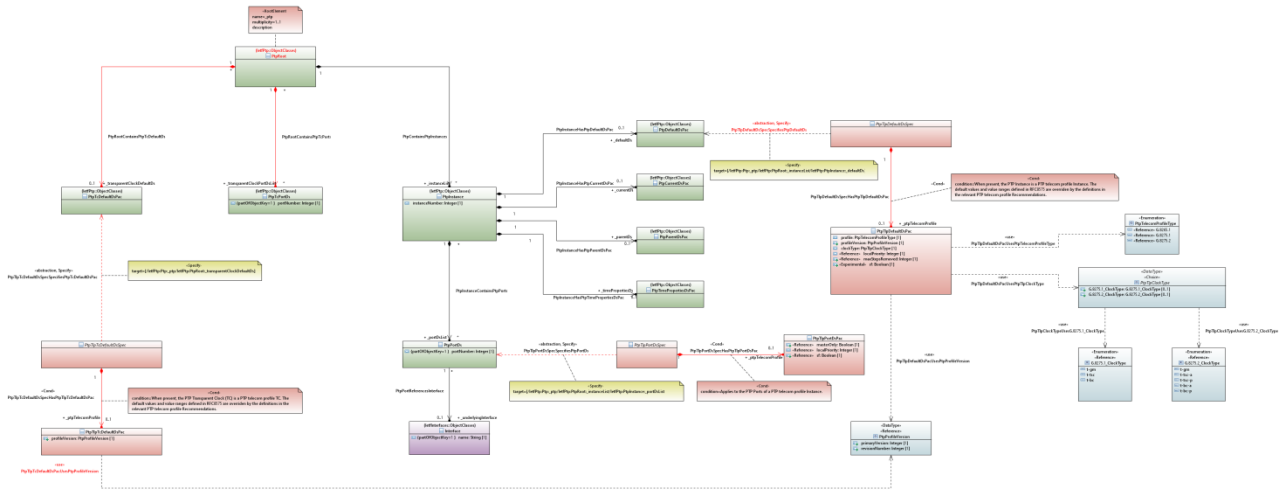

Figure 7-1 – PTP telecom profile UML overview[5]

NOTE – The green object classes are from the PTP UML model, reverse-engineered from the PTP YANG data model defined in [IETF RFC 8575]; the magenta object class is from the Interface UML model, reverse-engineered from the Interface YANG data model defined in [IETF RFC 8343], and the blue object classes are from the PTP telecom profile UML model, defined in this Recommendation.

A PTP instance supports one and only one PTP telecom profile; a network element (NE) may support one or multiple PTP instances, each of the instances can represent the same or different PTP profiles.

7.2 Required attributes and operations

7.2.1 PTP telecom profile

This clause shows how the required attributes and operations defined in [ITU-T G.7721] are pruned or refactored for the management of PTP telecom profiles.

In [ITU-T G.7721], PTP is modelled by the NeSync_Pac, PtpSync_Pac and Ptp_Pac object classes. Table 7-1 to Table 7-6 verify the the requirements of attributes and operations from [ITU-T G.7721] for the PTP telecom profile model.

Table 7-1 – PTP attributes for the NE Sync Pac (NE)

Attribute in [ITU-T G.7721]	Attribute in this Recommendation
packetFreqSyncSupportEnabledAndProfileSelector	Pruned out (Note)
syncSupportPacketFreq	Pruned out (Note)
timeSyncSupportEnabledAndProfileSelector	Pruned out (Note)
syncSupportTime	Pruned out (Note)
NOTE – Outside the scope of this version of the Recommendation.	

[5] This figure is also available in the electronic attachment to this Recommendation at www.itu.int/ITU-T/formal-language/itu-t/g/g7721.1/2022/g7721.1-202206-Attachment.zip .

Table 7-2 – PTP attributes for the PTP Sync Pac (PTP instance)

Attribute in [ITU-T G.7721]	Attribute in this Recommendation
ptpDomainNumber	Pruned out (Note 1)
ptpDeviceType	Refactored by the PtpTlpTcDefaultDsSpec:ptpTelecomProfile, PtpTlpDefaultDsSpec:ptpTelecomProfile, G.8275.1_Profile:clockType and G.8275.1_Profile:clockType attributes
ptpSlaveOnly	Pruned out (Note 1)
ptpSourceDataset	See Table 7-3
ptpDefaultDataset	See Table 7-4
ptpClockIdentity	Pruned out (Note 1)
ptpProfilesSupported	Pruned out (Note 2)
activeProfile	Refactored as PtpTlpDefaultDsSpec:ptpTelecomProfile and PtpTlpTcDefaultDsSpec:ptpTelecomProfile
ptpTransparentClockDefaultDataset	See Table 7-5
NOTE 1 – This attribute is already defined in [IETF RFC 8575]. NOTE 2 – No dataset member is defined in the ITU-T PTP telecom profiles Recommendations listed in clause 6.1.	

Table 7-3 – PTP attributes for the PTP source dataset (PTP instance)

Attribute in [ITU-T G.7721]	Attribute in this Recommendation
_grandMasterIdentity	Pruned out (Note 1)
_parentClock	Pruned out (Note 2)
priority1	Pruned out (Note 1)
priority2	Pruned out (Note 1)
clockClass	Pruned out (Note 1)
clockAccuracy	Pruned out (Note 1)
offsetScaledLogVariance	Pruned out (Note 1)
timeSource	Pruned out (Note 1)
stepsRemoved	Pruned out (Note 1)
currentUtcOffset	Pruned out (Note 1)
ptpTimeScale	Pruned out (Note 1)
timeTraceable	Pruned out (Note 1)
frequencyTraceable	Pruned out (Note 1)
1588ProtocolVersion	Pruned out (Note 2)
currentAbsoluteTime	Pruned out (Note 2)
isMasterOnly	Pruned out (Note 2)
localPriority	Pruned out (Note 2)
isSf	Refactored as ptpTlpPortSpec:sf and PtpTlpDefaultDsSpec:sf
NOTE 1 – This attribute is already defined in [IETF RFC 8575]. NOTE 2 – No dataset member is defined in the ITU-T PTP telecom profiles Recommendations listed in clause 6.1.	

Table 7-4 – PTP attributes for the default dataset (PTP instance)

Attribute in [ITU-T G.7721]	Attribute in this Recommendation
_clock	Pruned out (Note 2)
priority1	Pruned out (Note 1)
priority2	Pruned out (Note 1)
clockClass	Pruned out (Note 1)
accuracy	Pruned out (Note 1)
offsetScaledLogVariance	Pruned out (Note 1)
timeSource	Pruned out (Note 1)
stepsRemoved	Pruned out (Note 1)
1588ProtocolVersion	Pruned out (Note 2)
localPriority	Refactored as PtpTlpDefaultDsSpec:localPriority
NOTE 1 – This attribute is already defined in [IETF RFC 8575]. NOTE 2 – No dataset member is defined in the ITU-T PTP telecom profiles Recommendations listed in clause 6.1	

Table 7-5 – PTP attributes for the TC default dataset (PTP instance)

Attribute in [ITU-T G.7721]	Attribute in this Recommendation
primaryDomain	Pruned out (Note)
NOTE – This attribute is already defined in [IETF RFC 8575].	

Table 7-6 – PTP attributes for the PTP Pac (Port)

Attribute in [ITU-T G.7721]	Attribute in this Recommendation
ptpPortEnableStatus	Pruned out (Note 3)
ptpPortState	Pruned out (Note 1)
ptpAsymmetryCorrection	Pruned out (Note 3)
ptpTwoStepFlag	Pruned out (Note 3)
ptpUdpEgressConfiguration	Pruned out (Note 2)
ptpMacEgressConfiguration	Pruned out (Note 2)
ptpAnnounceInterval	Pruned out (Note 1)
ptpAnnounceReceiptTimeout	Pruned out (Note 1)
ptpSyncInterval	Pruned out (Note 1)
ptpMinDelayReqInterval	Pruned out (Note 1)
ptpLocalPriority	Refactored as PtpTlpPortSpec:localPriority
ptpMasterOnly	Refactored as PtpTlpPortSpec:masterOnly
NOTE 1 – This attribute is already defined in [IETF RFC 8575]. NOTE 2 – No dataset member is defined in the ITU-T PTP telecom profiles Recommendations listed in clause 6.1. NOTE 3 – This dataset member is defined in [IEEE 1588-2019] but not in [IEEE 1588-2008].	

7.3 UML model files

A zip file that contains the UML model for this Recommendation developed using the Papyrus open-source modelling tool (G.7721.1_v0.0.05@2022-03-04) can be downloaded from www.itu.int/ITU-T/formal-language/itu-t/g/g7721.1/2022/g7721.1-202206-Attachment.zip:

This zip file contains the following:

- The UML model consisting of the following files:
  - The Papyrus project file;
    - .project;
  - The .di, .notation, and .uml files of the itut-ptp-telecom-profiles module:
    - itut-ptp-telecom-profiles.di;
    - itut-ptp-telecom-profiles.notation;
    - itut-ptp-telecom-profiles.uml;
- The UML profiles that determine the properties of the UML artefact.
  - The OpenModelProfile folder, which contains the .di, .notation, and uml of the open model profile.
  - The OpenInterfaceModelProfile folder, which contains the .di, .notation, and uml of the open model interface profile.
  - The ProfileLifecycleProfile folder, which contains the .di, .notation, and uml of the profile lifecycle profile.
  - The ClassDiagramStyleSheet.css style sheet.
- The UML models that are needed (i.e., imported) by this model.
  - ITU-T G.7711 core information model;
  - ITU-T G.7721 base synchronization information model;
  - IETF model, i.e., the UML models that are reverse-engineered from the IETF YANG data models imported by ITU-T YANG Recommendations.

8 Synchronization data models

This clause contains the interface-protocol-specific data models of the synchronization functions identified in clause 6. These data models are translated from the interface-protocol-neutral UML information specified in clause 7.

8.1 Synchronization YANG data models

This clause contains the YANG data models for synchronization management.

The YANG data models specified in this Recommendation use the YANG 1.1 language specified in [IETF RFC 7950]. The tree format specified in [IETF RFC 8340] is used for the YANG data model tree representation. The YANG data models specified in this Recommendation conform to the network management datastore architecture specified in [IETF RFC 8342].

8.1.1 PTP telecom profile YANG data model

The PTP telecom profile YANG data model is translated from the PTP telecom profile UML information model provided in clause 7.3. The translation is done manually. The YANG (itut-ptp-telecom-profile@2021-12-08) can also be downloaded from www.itu.int/ITU-T/formal-language/itu-t/g/g7721.1/2022/g7721.1-202206-Attachment.zip.

The PTP telecom profile YANG data model, as defined in this clause, augments the PTP YANG data model, as defined in [IETF RFC 8575], to manage PTP instances which are compliant with the ITU-T telecom profiles, as outlined in clause 6.1.

Since the PTP YANG data model defined in [IETF RFC 8575] supports only the management of the PTP implementations based on the [IEEE 1588-2008] version, the PTP telecom profile YANG data model, defined in this Recommendation, supports only the management of the PTP telecom profile implementations which are based on the [IEEE 1588-2008] version.

Since the PTP YANG data model, as defined in [IETF RFC 8575], has a broader scope than the management of the ITU-T PTP telecom profile instances, Annex A provides some guidelines on how the PTP YANG data model shall be used to manage the ITU-T PTP telecom profile instances.

Annex A

Using the IETF PTP YANG data model for ITU-T PTP Telecom Profiles

(This annex forms an integral part of this Recommendation.)

The PTP YANG data model, as defined in [IETF RFC 8575], has a broader scope than the management of the ITU-T telecom profile PTP instances.

For example, some attributes defined in the PTP YANG data model correspond to PTP dataset members which are not applicable to ITU-T telecom profiles.

Moreover, the PTP YANG data model supports the write operation for some attributes which corresponds to PTP dataset members which are defined as static or dynamic in [IEEE 1588-2008] as well as in the ITU-T PTP telecom profile Recommendations, listed in clause 6.1.

This annex provides some guidelines on how the PTP YANG data model, defined in [IETF RFC 8575], shall be used to manage the PTP telecom profile instances which are based on the PTP protocol version defined in [IEEE 1588-2008].

A.1 Default values

The ITU-T PTP telecom profiles Recommendations, which are listed in the clause 6.1, define the default values for various PTP datasets which may be different from the default values defined in [IEEE 1588-2008] and in [IEEE 1588-2019].

When required, the system shall apply, within the operational datastore, the default values which are defined by the relevant ITU-T PTP telecom profile Recommendation (i.e., the ITU-T Recommendation, as listed in clause 6.1, which specifies the configured type of PTP telecomprofile for a given PTP instance).

NOTE – As required in section 5.3 of [IETF RFC 8342], the system always reports, within the operational datastore, the values in use, regardless of the default value definition.

It is not appropriate to allow the system to override the default values defined by YANG default statements. It is therefore recommended that an implementation of the PTP telecom profile YANG data model does not implement the YANG default statements within the PTP YANG data model, defined in [IETF RFC 8575], and reports this using the YANG deviation statements, as defined in section 5.6.3 of [IETF RFC 7950].

Since section 7.20.3 of [IETF RFC 7950] does not allow including YANG deviation statements in standard YANG modules, the definition of these YANG deviation statements is implementation specific. Appendix I provides some guidelines on how deviation statements could be written to report that the YANG default statements in the PTP YANG data model, defined in [IETF RFC 8575], are not implemented.

A.2 Value ranges

ITU-T PTP telecom profile Recommendations, listed in clause 6.1, define the value ranges for various PTP datasets which may be narrower than the value ranges defined in [IEEE 1588-2008] and in [IEEE 1588-2019].

The system shall reject the configuration of values outside of the range allowed by the relevant ITU-T PTP telecom profile Recommendation and shall reply with an error message.

As required in section 5.3 of [IETF RFC 8342], the system shall always report, within the operational datastore, the values in use. The values allowed to be in use by the system are defined by the relevant ITU-T PTP telecom profile Recommendation.

A.3 Dataset members not used

The ITU-T PTP telecom profile Recommendations, which are listed in clause 6.1, specify some PTP datasets, defined in [IEEE 1588-2008] and in [IEEE 1588-2019], as not to be used for the given profile, and therefore they are not required to be supported.

A system that does not support the configuration of an attribute representing a dataset member not being used by the configured profile shall reject the configuration and reply with an error message.

A system that supports the configuration of an attribute representing a dataset member not being used by the configured profile shall accept the configuration, not use (i.e., ignore) the configured value and reply with a warning message.

The warning or the error message shall notify the client that the configured attribute is not used by the configured PTP profile.

As required in section 5.3 of [IETF RFC 8342], the system, regardless of whether the dataset member is supported or not, shall never report, within the operational datastore, attributes that are not in use.

The attributes that are not used by the configured profile are defined by the relevant ITU-T PTP telecom profile Recommendation.

A.4 Static dataset members

The ITU-T PTP telecom profiles Recommendations, which are listed in the clause 6.1, define that some PTP datasets are static.

In general, static dataset members should not be configurable. Therefore, the system should reject the configuration and reply with an error message.

The twoStepFlag dataset member has been deprecated in [IEEE 1588-2019]. However, PTP telecom profile implementations based on [IEEE 1588-2008] can support it as a configurable dataset member.

The system shall accept the configuration of the twoStepFlag if it can support it.

A.5 Dynamic dataset members

ITU-T PTP telecom profiles Recommendations, listed in clause 6.1, define that some PTP datasets are dynamic.

In general, dynamic dataset members are not expected to be configurable as they will change dynamically depending on the protocol operations. Therefore, the system should reject the configuration and reply with an error message.

Appendix I

YANG deviation example for the PTP YANG data model

(This appendix does not form an integral part of this Recommendation.)

Clause A.1 recommends that an implementation of the PTP telecom profile YANG data model, as defined in clause 8.1.1, also reports, using YANG deviation statements, that the YANG default statement of the PTP YANG data model, defined in [IETF RFC 8575], are not implemented.

Since section 7.20.3 of [IETF RFC 7950] does not allow including YANG deviation statements in standard YANG modules, the definition of these YANG deviation statements is implementation specific.

This appendix provides some guidelines on how these deviation statements could be written by providing, as an example, the itut-ptp-deviation-example YANG module which only declares that the YANG default statements of the PTP YANG data model, defined in [IETF RFC 8575] are not supported.

The itut-ptp-deviation-example YANG module example (itut-ptp-deviation-example@2021-09-30.yang) can be downloaded from www.itu.int/ITU-T/formal-language/itu-t/g/g7721.1/2022/g7721.1-202206-Attachment.zip.

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