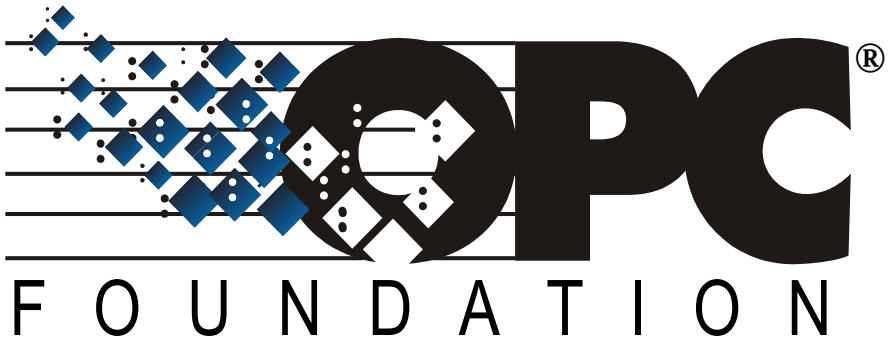

OPC 10000-22

OPC Unified Architecture

Part 22: Base Network Model

Release 1.05.04

2024-10-15

OPC UA Specification

Specification Type:	Industry Standard Specification	Comments:	
Document Number	**OPC 10000-22**		
Title:	OPC Unified Architecture Part 22 :Base Network Model	Date:	2024-10-1501
Version:	Release 1.05.04	Software:	MS-Word
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Author:	OPC Foundation	Status:	Release

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OPC FOUNDATION

UNIFIED ARCHITECTURE

FOREWORD

This specification is the specification for developers of OPC UA applications. The specification is a result of an analysis and design process to develop a standard interface to facilitate the development of applications by multiple vendors that shall inter-operate seamlessly together.

AGREEMENT OF USE

GENERAL PROVISIONS

Should any provision of this Agreement be held to be void, invalid, unenforceable or illegal by a court, the validity and enforceability of the other provisions shall not be affected thereby.

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This Agreement embodies the entire understanding between the parties with respect to, and supersedes any prior understanding or agreement (oral or written) relating to, this specification.

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The OPC Foundation strives to maintain the highest quality standards for its published specifications; hence they undergo constant review and refinement. Readers are encouraged to report any issues and view any existing errata here: http://www.opcfoundation.org/errata

Revision 1.05.04 Highlights

The following table includes the Mantis issues resolved with this revision.

Mantis ID	Scope	Summary	Resolution
9056	Feature	Part 22 needs to model LLDP neighbour information	Types were added model local and remote LLDP information
9834	Clarification	Missing external normative references	The Normative references section was updated with references to all RFCs and IEEE specifications referenced.

1 Scope

The Base Network Model (BNM) specifies an OPC UA *Information Model* for a basic set of network related components to be used in other *Information Models*.

The initial version of this document defines parameter sets for TSN Talkers and Listeners as well as network interfaces and ports as shown in Figure 1. A future version of this document is expected to have a broader scope of other network technologies than Ethernet only.

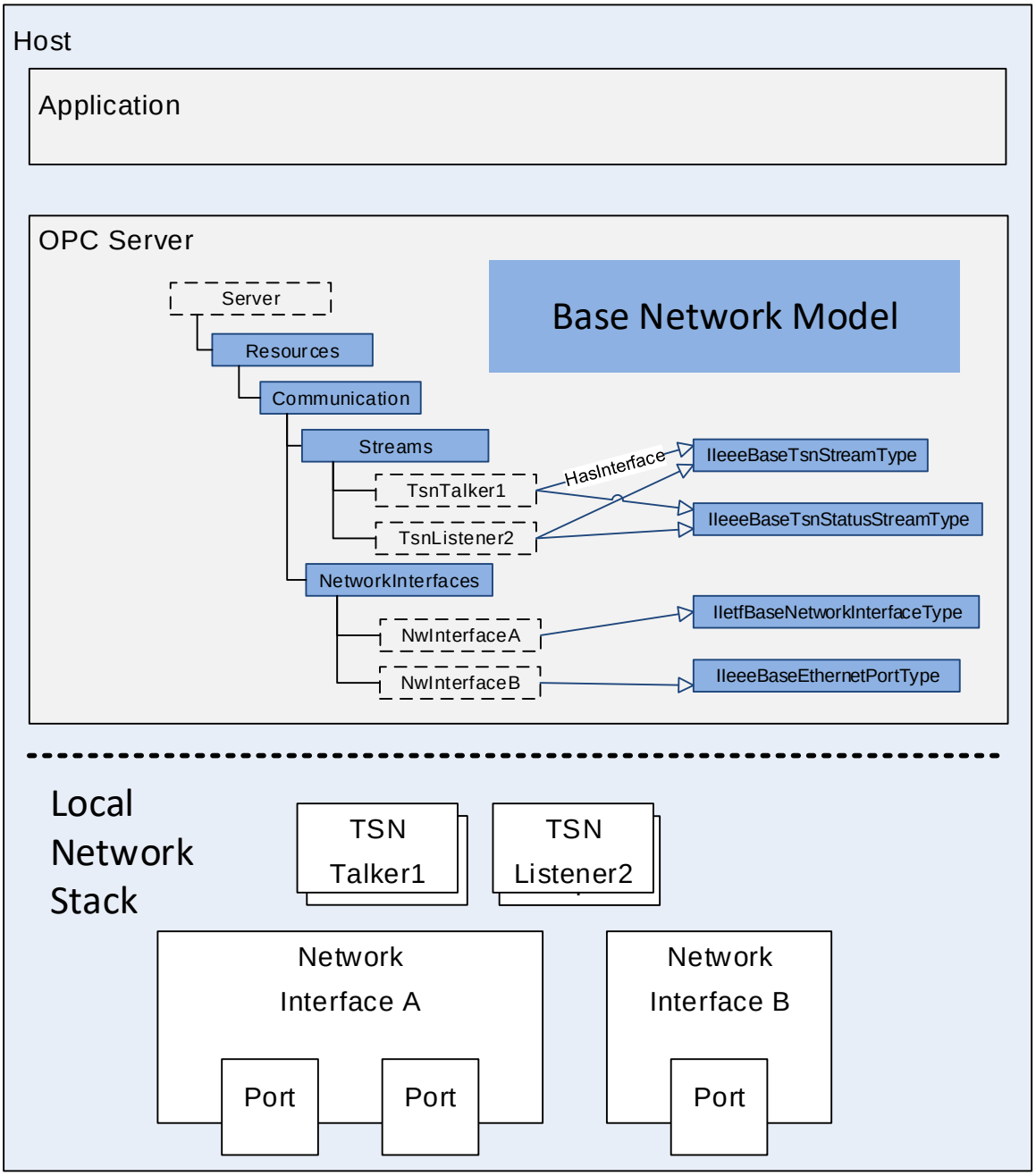


Figure 1 – Scope of Base Network Model

2 Normative references

The following referenced documents are indispensable for the application of this OPC UA part. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments and errata) applies.

OPC 10000-1, *OPC Unified Architecture - Part 1: Overview and Concepts*
http://www.opcfoundation.org/UA/Part1/

OPC 10000-3, *OPC Unified Architecture - Part 3: Address Space Model*
http://www.opcfoundation.org/UA/Part3/

OPC 10000-5, *OPC Unified Architecture - Part 5: Information Model*
http://www.opcfoundation.org/UA/Part5/

OPC 10000-8, *OPC Unified Architecture - Part 8: Data Access*
http://www.opcfoundation.org/UA/Part8/

IEEE 802.3-2022, *ETHERNET*
http://www.ieee802.org/3/

IEEE 802.1Q-2018, *IEEE Standard for Local and Metropolitan Area Networks Bridges and Bridged Networks*
http://www.ieee802.org/1/

IEEE 802.1Qcc-2018, *Bridges and Bridged Networks, Amendment: Stream Reservation Protocol (SRP) Enhancements and Performance Improvements*
http://www.ieee802.org/1/

IEEE 802-2014, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture
http://www.ieee802.org/1/

IEEE 802.1AB-2016, IEEE Standard for Local and metropolitan area networks - Station and Media Access Control Connectivity Discovery
http://www.ieee802.org/1/

IEEE 802.1ABcu-2021, IEEE Standard for Local and metropolitan networks--Station and Media Access Control Connectivity Discovery Amendment 1: YANG Data Model
http://www.ieee802.org/1/

IETF RFC 2021, *Remote Network Monitoring Management Information Base Version 2 using SMIv2*
https://tools.ietf.org/html/rfc2021

IETF RFC 2863, *The Interfaces Group MIB*
https://tools.ietf.org/html/rfc2863

IETF RFC 2737, *Entity MIB (Version 2)*
https://tools.ietf.org/html/rfc2737

IETF RFC 3046, *DHCP Relay Agent Information Option*
https://tools.ietf.org/html/rfc3046

IETF RFC 3232, *Assigned Numbers: RFC 1700 is Replaced by an On-line Database*
https://tools.ietf.org/html/rfc3232

IETF RFC 3418, Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)
https://tools.ietf.org/html/rfc3418

IETF RFC 4639, *Cable Device Management Information Base for Data-Over-Cable Service Interface Specification (DOCSIS) Compliant Cable Modems and Cable Modem Termination Systems*
https://tools.ietf.org/html/rfc4639

IETF RFC 8343, *A YANG Data Model for Interface Management*

https://tools.ietf.org/html/rfc8343

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in OPC 10000-1, OPC 10000-3, OPC 10000-5 and OPC 10000-8 apply.

All used terms are *italicized* in this document.

3.2 Abbreviated terms

AVB	Audio Video Bridging
BNM	Base Network Model
CNC	Centralized Network Configuration
CUC	Centralized User Configuration
DSCP	Differentiated services code point for packet classification purposes
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
MAU	Medium Attachment Units
MIB	Management Information Base
PCP	Priority Code Point for classifying and managing network traffic
TSN	Time Sensitive Networks
VLAN	Virtual Local Area Network
YANG	Yet Another Next Generation (Data modelling language for network management)

4 Concepts

4.1 Type and Naming Conventions

The BNM shall align its parameters to existing standards defined by IETF and the IEEE to allow an effortless mapping against existing network technologies. Therefore, selected *DataTypes* shall fit to the types used by the related managed objects of IEEE and IETF. *BrowseNames* of *Variables* and parameter sets (UA interface) are preferably derived from standardized IETF / IEEE YANG models. If no standardized YANG representation is available, MIB definitions are chosen.

4.2 Usage of OPC UA Interfaces

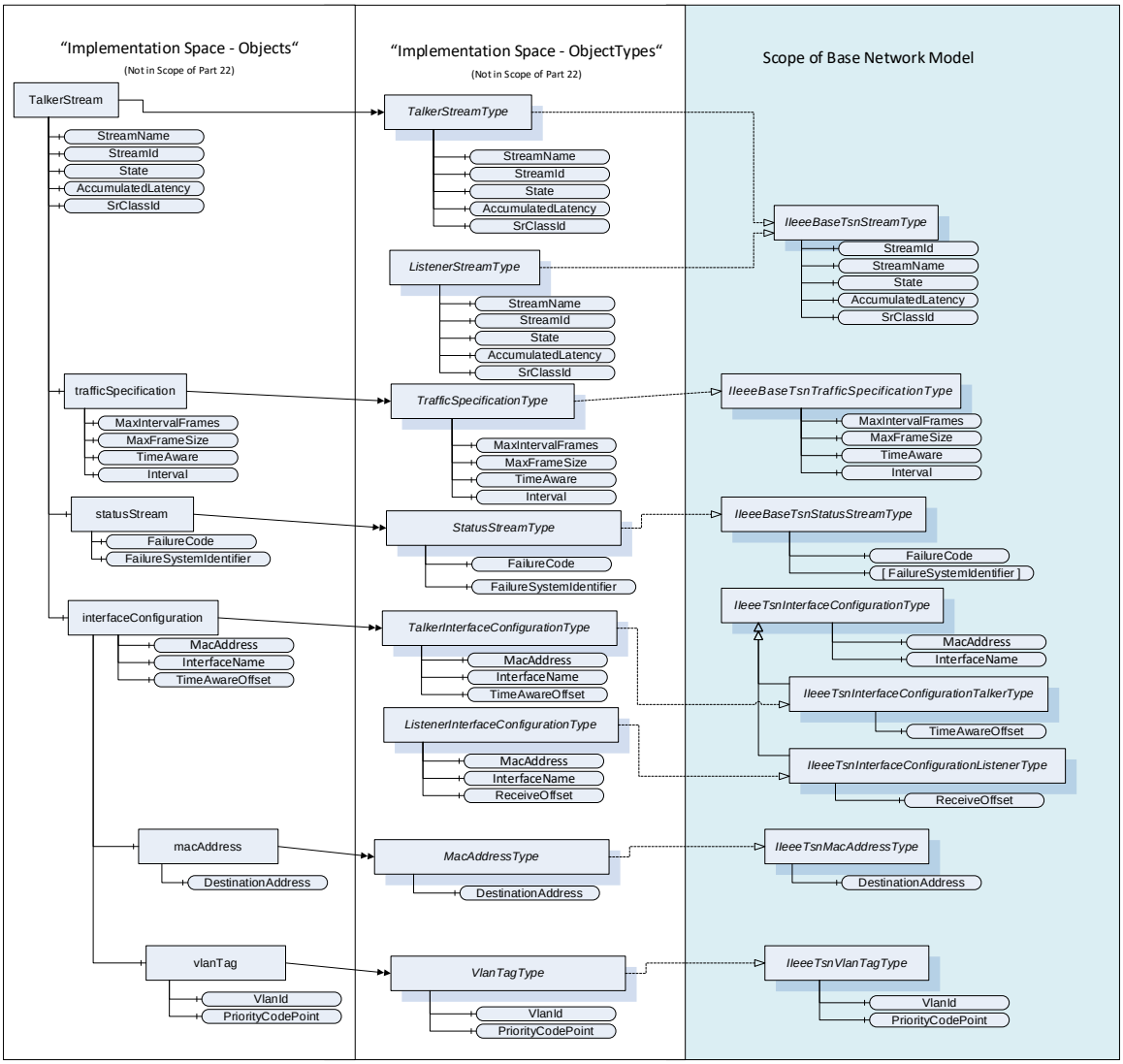
The parameters of the BNM are grouped in the form of OPC UA *Interfaces*. *Interfaces* have been chosen to define parameter sets independent of the implementation in future *ObjectType* hierarchies. This allows these grouped parameters to be used in other *Information Models* independent of *ObjectType* hierarchies that can be found in the BNM.

It is expected that a future version of the BNM will define a collection of network related *ObjectTypes*.

5 Base Network Model

5.1 Overview

The Base Network Model defined in this document is shown in Figure 2.


"Implementation Space - Objects"
(Not in Scope of Part 22)
"Implementation Space - ObjectTypes"
(Not in Scope of Part 22)
Scope of Base Network Model
TalkerStream
StreamName
StreamId
State
AccumulatedLatency
SrClassId
TalkerStreamType
StreamName
StreamId
State
AccumulatedLatency
SrClassId
IIeeeBaseTsnStreamType
StreamId
StreamName
State
AccumulatedLatency
SrClassId
ListenerStreamType
StreamName
StreamId
State
AccumulatedLatency
SrClassId
trafficSpecification
MaxIntervalFrames
MaxFrameSize
TimeAware
Interval
TrafficSpecificationType
MaxIntervalFrames
MaxFrameSize
TimeAware
Interval
IIeeeBaseTsnTrafficSpecificationType
MaxIntervalFrames
MaxFrameSize
TimeAware
Interval
statusStream
FailureCode
FailureSystemIdentifier
StatusStreamType
FailureCode
FailureSystemIdentifier
IIeeeBaseTsnStatusStreamType
FailureCode
[FailureSystemIdentifier]
interfaceConfiguration
MacAddress
InterfaceName
TimeAwareOffset
TalkerInterfaceConfigurationType
MacAddress
InterfaceName
TimeAwareOffset
ListenerInterfaceConfigurationType
MacAddress
InterfaceName
ReceiveOffset
IIeeeTsnInterfaceConfigurationType
MacAddress
InterfaceName
IIeeeTsnInterfaceConfigurationTalkerType
TimeAwareOffset
IIeeeTsnInterfaceConfigurationListenerType
ReceiveOffset
macAddress
DestinationAddress
MacAddressType
DestinationAddress
IIeeeTsnMacAddressType
DestinationAddress
vlanTag
VlanId
PriorityCodePoint
VlanTagType
VlanId
PriorityCodePoint
IIeeeTsnVlanTagType
VlanId
PriorityCodePoint

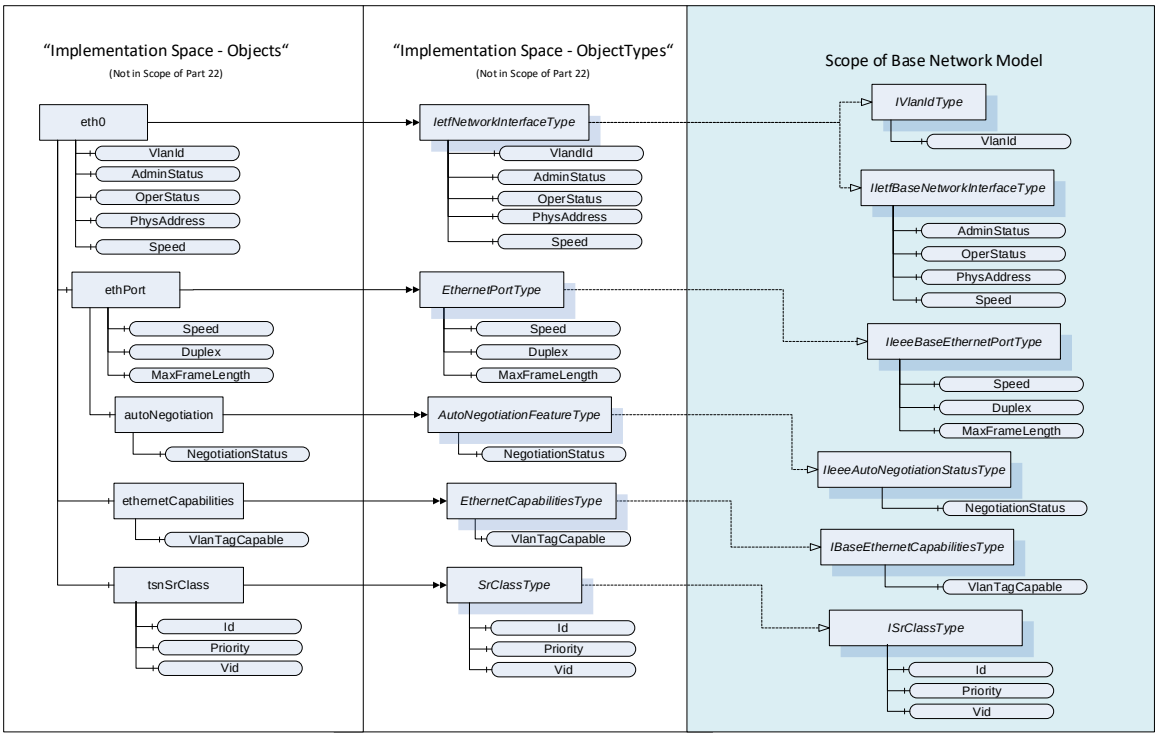

"Implementation Space - Objects"
(Not in Scope of Part 22)
"Implementation Space - ObjectTypes"
(Not in Scope of Part 22)
Scope of Base Network Model
eth0
VlanId
AdminStatus
OperStatus
PhysAddress
Speed
IetfNetworkInterfaceType
VlanId
AdminStatus
OperStatus
PhysAddress
Speed
IVlanIdType
VlanId
IIetfBaseNetworkInterfaceType
AdminStatus
OperStatus
PhysAddress
Speed
ethPort
Speed
Duplex
MaxFrameLength
EthernetPortType
Speed
Duplex
MaxFrameLength
IIeeeBaseEthernetPortType
Speed
Duplex
MaxFrameLength
autoNegotiation
NegotiationStatus
AutoNegotiationFeatureType
NegotiationStatus
IIeeeAutoNegotiationStatusType
NegotiationStatus
ethernetCapabilities
VlanTagCapable
EthernetCapabilitiesType
VlanTagCapable
IBaseEthernetCapabilitiesType
VlanTagCapable
tsnSrClass
Id
Priority
Vid
SrClassType
Id
Priority
Vid
ISrClassType
Id
Priority
Vid

Figure 2 – Overview of Base Network Model

5.2 OPC UA InterfaceTypes

5.2.1 IIetfBaseNetworkInterfaceType Interface

This OPC UA Interface defines the basis of an IETF network interface. The *IIetfBaseNetworkInterfaceType* is formally defined in Table 1.

Table 1 – IIetfBaseNetworkInterfaceType definition

Attribute	**Value**				
BrowseName	IIetfBaseNetworkInterfaceType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	AdminStatus	InterfaceAdminStatus	BaseDataVariableType	Mandatory
HasComponent	Variable	OperStatus	InterfaceOperStatus	BaseDataVariableType	Mandatory
HasComponent	Variable	PhysAddress	String	BaseDataVariableType	Optional
HasComponent	Variable	Speed	UInt64	AnalogUnitType	Mandatory
Conformance Units					
BNM Ethernet Base Info					

AdminStatus of *DataType InterfaceAdminStatus* specifies the desired state of the network interface. This *Variable* has the same read semantics as ifAdminStatus (ifAdminStatus is defined in IETF RFC 2863). The *InterfaceAdminStatus Enumeration* is defined in 5.3.1.2.

OperStatus of *DataType InterfaceOperStatus* specifies the current operational state of the network interface. This *Variable* has the same semantics as ifOperStatus (ifOperStatus is defined in IETF RFC 2863). The *InterfaceOperStatus Enumeration* is defined in 5.3.1.3.

PhysAddress of *DataType String* specifies the network interface's address at its protocol sub-layer. For example, for an 802.x network interface, this parameter normally contains a Media Access Control (MAC) address. The network interface's media-specific modules must define the bit and byte ordering and the format of the value of this object. For network interfaces that do not have such an address (e.g., a serial line), this node is not present (ifPhysAddress is defined in IETF RFC 2863).

Speed of *DataType UInt64* specifies an estimate of the network interface's current bandwidth in bits per second. For network interfaces that do not vary in bandwidth or for those where no accurate estimation can be made, this value should contain the nominal bandwidth (ifSpeed and ifHighSpeed are defined in IETF RFC 2863).

The component *Variables* of the *IIetfBaseNetworkInterfaceType* have the *Attribute* values defined in Table 2.

Table 2 – IIetfBaseNetworkInterfaceType Attribute values for child Nodes

Source Path	**Value Attribute**	**Description Attribute**
Speed EngineeringUnits	NamespaceUri: http://www.opcfoundation.org/UA/units/un/cefact UnitId: 4337968 DisplayName: bit/s Description: bit per second	-

5.2.2 IIeeeBaseEthernetPortType Interface

This OPC UA Interface defines capabilities of an Ethernet-based port. The *IIeeeBaseEthernetPortType* is formally defined in Table 3.

Table 3 – IIeeeBaseEthernetPortType definition

Attribute	**Value**				
BrowseName	IIeeeBaseEthernetPortType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	Speed	UInt64	AnalogUnitType	Mandatory
HasComponent	Variable	Duplex	Duplex	BaseDataVariableType	Mandatory
HasComponent	Variable	MaxFrameLength	UInt16	BaseDataVariableType	Mandatory
Conformance Units					
BNM Ethernet Base Info					

Speed of *DataType UInt64* specifies the configured, negotiated, or actual speed of an Ethernet port in entities of 1 Mb/s (data rate). The default value is implementation-dependent (Ethernet ports are defined in IEEE 802.3-2022).

Duplex of *DataType Duplex* represents the configured, negotiated, or actual duplex mode of an Ethernet port (aDuplexStatus is defined in IEEE 802.3-2022, clause 30.3.1.1.32, aDuplexStatus). The *Duplex DataType* is defined in 5.3.1.1.

MaxFrameLength of *DataType UInt16* indicates the MAC frame length (including FCS bytes) at which frames are dropped for being too long (aMaxFrameLength is defined in IEEE 802.3-2022, clause 30.3.1.1.37, aMaxFrameLength).

The component *Variables* of the *IIeeeBaseEthernetPortType* have the *Attribute* values defined in Table 4.

Table 4 – IIeeeBaseEthernetPortType Attribute values for child Nodes

Source Path	**Value Attribute**	**Description Attribute**
Speed EngineeringUnits	NamespaceUri: http://www.opcfoundation.org/UA/units/un/cefact UnitId: 4534832 DisplayName: Mbit/s Description: megabit per second	-

5.2.3 IIeeeAutoNegotiationStatusType Interface

This OPC UA Interface defines the auto negotiation status of an Ethernet-based port. The *IIeeeAutoNegotiationStatusType* is formally defined in Table 5.

Table 5 – IIeeeAutoNegotiationStatusType definition

Attribute	**Value**				
BrowseName	IIeeeAutoNegotiationStatusType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	NegotiationStatus	NegotiationStatus	BaseDataVariableType	Mandatory
Conformance Units					
BNM AutoNeg					

NegotiationStatus of *DataType NegotiationStatus* specifies the status of the auto-negotiation protocol (aAutoNegAutoConfig is defined in IEEE 802.3-2022, clause 30.6.1.1.4, aAutoNegAutoConfig). The *NegotiationStatus DataType* is defined in 5.3.1.4.

5.2.4 IBaseEthernetCapabilitiesType Interface

This OPC UA Interface defines if an Ethernet-based port is VLAN Tag capable. The *IBaseEthernetCapabilitiesType* is formally defined in Table 6.

Table 6 – IBaseEthernetCapabilitiesType definition

Attribute	**Value**				
BrowseName	IBaseEthernetCapabilitiesType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	VlanTagCapable	Boolean	BaseDataVariableType	Mandatory
Conformance Units					
BNM VLAN Capabilities					

When *VlanTagCapable* is true, the network interface supports the ability to tag/untag frames using a Customer VLAN Tag (C-TAG of clause 9) provided by the network (VLAN Tags are defined in IEEE 802.1Qcc-2018, clause 46.2.3.7.1).

5.2.5 IVlanIdType Interface

This OPC UA Interface specifies a VLAN Id to be associated with a network interface. The IVlanIdType is formally defined in Table 7.

Table 7 – IVlanIdType definition

Attribute	**Value**				
BrowseName	IVlanIdType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the BaseInterfaceType defined in OPC 10000-5					
HasComponent	Variable	VlanId	UInt16	BaseDataVariableType	Mandatory
Conformance Units					
BNM IETF Interface Vlan Info					

VlanId is an UInt16 and contains the Customer VLAN Tag (IEEE 802.1Q-2018 C-TAG of clause 9) that frames injected at this network interface will be tagged with (VlanId is defined in IEEE 802.1Qcc-2018 clause 46.2.3.7.1).

5.2.6 ISrClassType Interface

This OPC UA Interface defines the content of an SrClass. The *ISrClassType* is formally defined in Table 8.

Table 8 – ISrClassType definition

Attribute	**Value**				
BrowseName	ISrClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	Id	Byte	BaseDataVariableType	Mandatory
HasComponent	Variable	Priority	Byte	BaseDataVariableType	Mandatory
HasComponent	Variable	Vid	UInt16	BaseDataVariableType	Mandatory
Conformance Units					
BNM TSN Base Info					

Id is a Byte and specifies the SRclassID in a numeric representation of the SR classes which is supported by a particular Bridge Port (SRclassID is defined in IEEE 802.1Q-2018, clause 35.2.2.9.2, SRclassID). Only Values between 0 and 7 shall be used.

Priority is a *Byte* and holds the Data Frame Priority (item a in IEEE 802.1Q-2018 clause 35.2.2.8.5) value that will be used for streams that belong to the associated SR class. (SRclassPriority is defined in IEEE 802.1Q-2018, clause 35.2.2.9.3, SRclassPriority). Only Values between 0 and 7 shall be used.

Vid is an *UInt16* and contains the SR_PVID (item i) in IEEE 802.1Q-2018 clause 35.2.1.4) that the associated streams will be tagged with by the Talker (SRclassVID is defined in IEEE 802.1Q-2018, clause 35.2.2.9.4, SRclassVID).

5.2.7 IIeeeBaseTsnStreamType Interface

The *IIeeeBaseTsnStreamType* contains *Variables* which are common for both TSN talkers and TSN listeners. They represent the configuration properties and diagnostic values like reservation status and failure codes of a TSN stream. The *IIeeeBaseTsnStreamType* is formally defined Table 9.

Table 9 – IIeeeBaseTsnStreamType definition

Attribute	**Value**				
BrowseName	IIeeeBaseTsnStreamType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	StreamId	Byte[8]	BaseDataVariableType	Mandatory
HasComponent	Variable	StreamName	String	BaseDataVariableType	Mandatory
HasComponent	Variable	State	TsnStreamState	BaseDataVariableType	Mandatory
HasComponent	Variable	AccumulatedLatency	UInt32	BaseDataVariableType	Optional
HasComponent	Variable	SrClassId	Byte	BaseDataVariableType	Optional
Conformance Units					
BNM TSN Base Info					

StreamId is an array of 8 *Bytes* defined according to the StreamID in IEEE 802.1Qcc-2018 clause 35.2.2.8.2. The *StreamId* shall be unique in the scope of the related TSN Network. The mapping between the *StreamId Byte* array and the IEEE octet string StreamID is as follows: Entry[n] of *StreamId* is mapped to octet[n] of StreamID. The *StreamId* shall be provided in the TSN stream *Objects* for diagnostic reasons.

Note: In the distributed configuration model the StreamId is typically generated by the TSN control stack of the endstation. In the fully centralized configuration model the StreamId is typically generated by the CUC.

StreamName is a *String* identifying the related stream in the network. The format of the *String* is application specific. The uniqueness of the *StreamName* inside the network segment shall be guaranteed by the application. If multiple applications use the network segment, they need to agree on a naming scheme.

State represents the current state of the TSN configuration process of a TSN stream. The *TsnStreamState Enumeration* is defined in 5.3.1.6.

AccumulatedLatency of *DataType UInt32* is the maximum worst case propagation delay in nanoseconds calculated and guaranteed by the TSN Control Layer for this Listener. Once the stream reservation has succeeded the *AccumulatedLatency* is not expected to increase during the lifecycle of the TSN Stream (AccumulatedLatency is defined in IEEE 802.1Q-2018 clause 35.2.2.8.6).

SrClassId of *DataType Byte* contains the Stream Reservation Class that is used for this stream (as defined in IEEE 802.1Qcc-2018 clause 35.2.2.9.2).

5.2.8 IIeeeBaseTsnTrafficSpecificationType Interface

This OPC UA Interface is used to represent the traffic specification of a TSN stream. The *IIeeeBaseTsnTrafficSpecificationType* is formally defined in Table 10.

Table 10 – IIeeeBaseTsnTrafficSpecificationType definition

Attribute	**Value**				
BrowseName	IIeeeBaseTsnTrafficSpecificationType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	MaxIntervalFrames	UInt16	BaseDataVariableType	Mandatory
HasComponent	Variable	MaxFrameSize	UInt32	BaseDataVariableType	Mandatory
HasComponent	Variable	Interval	UnsignedRationalNumber	BaseDataVariableType	Mandatory
Conformance Units					
BNM TSN Config					

The *MaxFrameSize* of *DataType* UInt16 specifies the maximum size frame that will be sent by a Talker for this Stream (as defined in IEEE 802.1Q-2018 clause 35.2.2.8.4a).

Note: According to 802.1Q *MaxFrameSize* only counts the number of bytes of the Ethernet payload without the media specific framing bytes. (i.e. without 8-byte preamble, 14-byte IEEE 802.3 header, 4-byte IEEE 802.1Q priority/VID Tag, 4-byte CRC, 12-byte inter frame gap). Same rules apply for counting *MaxBytesPerInterval.*

The *MaxIntervalFrames* of *DataType* UInt16 Variable specifies the maximum number of frames that will be sent during an *Interval.* (as defined in IEEE 802.1Q-2018, clause 35.2.2.8.4b, “MaxIntervalFrames” or IEEE 802.1Qcc-2018, clause 35.2.2.10.6, “MaxFramesPerInterval”)

Interval of *DataType UnsignedRationalNumber* defines the time period of the TSN Stream in nanoseconds. In that interval a specified number of frames (MaxIntervalFrames) with a maximum payload size per frame (MaxFrameSize) and a maximum total number of bytes (MaxBytesPerInterval) will be transmitted. The *Interval* therefore shall either represent the “class measurement interval” as used for AVB based Streams (as defined in IEEE 802.1Q-2018 clause 35 or the “Interval” parameter used in the TrafficSpecification group in IEEE 802.1Qcc-2018 clause 46.2.3.5.1).

5.2.9 IIeeeBaseTsnStatusStreamType Interface

This OPC UA Interface is used to represent the status of a TSN stream. The *IIeeeBaseTsnStatusStreamType* is formally defined in Table 11.

Table 11 – IIeeeBaseTsnStatusStreamType definition

Attribute	**Value**				
BrowseName	IIeeeBaseTsnStatusStreamType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	TalkerStatus	TsnTalkerStatus	BaseDataVariableType	Optional
HasComponent	Variable	ListenerStatus	TsnListenerStatus	BaseDataVariableType	Optional
HasComponent	Variable	FailureCode	TsnFailureCode	BaseDataVariableType	Mandatory
HasComponent	Variable	FailureSystemIdentifier	Byte[][8]	BaseDataVariableType	Mandatory
Conformance Units					
BNM TSN Base Info					

TalkerStatus of *DataType TsnTalkerStatus* contains the Reservation Failure Code as defined in the “FailureInformation” in IEEE 802.1Qcc-2018 clause 46.2.5.1.1.

ListenerStatus of *DataType TsnListenerStatus* contains the Reservation Failure Code as defined in the “FailureInformation” in IEEE 802.1Qcc-2018 clause 46.2.5.1.2.

FailureCode of *DataType TsnFailureCode* contains the Reservation Failure Code as defined in the “FailureInformation” in IEEE 802.1Qcc-2018 clause 46.2.5.1.3.

FailureSystemIdentifier is an Array of Arrays of 8 Bytes and contains the System Identifiers representing the network nodes where the failure occurred (as defined in “System Identifier” in “FailureInformation” in IEEE 802.1Q-2018 clause 35.2.2.8.7).

5.2.10 IIeeeTsnInterfaceConfigurationType Interface

This OPC UA Interface is used to represent an interface configuration which is part of a TSN stream (on the end-device). The *IIeeeTsnInterfaceConfigurationType* is formally defined in Table 12.

Table 12 – IIeeeTsnInterfaceConfigurationType definition

Attribute	**Value**				
BrowseName	IIeeeTsnInterfaceConfigurationType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	MacAddress	String	BaseDataVariableType	Mandatory
HasComponent	Variable	InterfaceName	String	BaseDataVariableType	Optional
Conformance Units					
BNM TSN Config					

MacAddress of *DataType String* contains the MAC Address of the Interface the configuration will be applied to, as defined in IEEE 802.1Qcc-2018, clause 46.2.5.3.

InterfaceName of *DataType String* is optional and supports the identification of the Interface to be configured, as defined in IEEE 802.1Qcc-2018, clause 46.2.5.3.

5.2.11 IIeeeTsnInterfaceConfigurationTalkerType Interface

This OPC UA Interface is used to represent a talker (sender) interface configuration of a TSN stream. The *IIeeeTsnInterfaceConfigurationTalkerType* is formally defined in Table 13.

Table 13 – IIeeeTsnInterfaceConfigurationTalkerType definition

Attribute	**Value**				
BrowseName	IIeeeTsnInterfaceConfigurationTalkerType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *IIeeeTsnInterfaceConfigurationType* defined in 5.2.10					
HasComponent	Variable	TimeAwareOffset	UInt32	BaseDataVariableType	Optional
Conformance Units					
BNM TSN Config					

TimeAwareOffset of *DataType UInt32* specifies the time offset in nanoseconds relative to the start of the Interval that the Talker shall use for transmission (as defined in IEEE 802.1Qcc-2018 clause 46.2.5.3.5).

5.2.12 IIeeeTsnInterfaceConfigurationListenerType Interface

This OPC UA Interface is used to represent a listener (receiver) interface configuration of a TSN stream. The *IIeeeTsnInterfaceConfigurationListenerType* is formally defined in Table 14.

Table 14 – IIeeeTsnInterfaceConfigurationListenerType definition

Attribute	**Value**				
BrowseName	IIeeeTsnInterfaceConfigurationListenerType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *IIeeeTsnInterfaceConfigurationType* defined in 5.2.10					
HasComponent	Variable	ReceiveOffset	UInt32	BaseDataVariableType	Optional
Conformance Units					
BNM TSN Config					

ReceiveOffset of *DataType UInt32* specifies the offset in nanoseconds within the Interval at which the Listener will receive the first frame of the TSN Stream.

5.2.13 IIeeeTsnMacAddressType Interface

This OPC UA Interface is used to represent a MAC address based stream identification of a TSN stream. The *IIeeeTsnMacAddressType* is formally defined in Table 15.

Table 15 – IIeeeTsnMacAddressType definition

Attribute	Value				
BrowseName	IIeeeTsnMacAddressType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	DestinationAddress	Byte[6]	BaseDataVariableType	Mandatory
HasComponent	Variable	SourceAddress	Byte[6]	BaseDataVariableType	Optional
Conformance Units					
BNM TSN Config					

DestinationAddress is defined according to the destination_mac_address in IEEE 802.1Qcc-2018 clause 46.2.3.4.1, which represents the destination MAC address in the Ethernet header of the streamed data packets. Entry[n] of *DestinationAddress* is mapped to octet[n] of destination_mac_address.

SourceAddress is defined according to the source_mac_address in IEEE 802.1Qcc-2018 clause 46.2.3.4.1, which represents the source MAC address in the Ethernet header of the streamed data packets. Entry[n] of *SourceAddress* is mapped to octet[n] of source_mac_address.

5.2.14 IIeeeTsnVlanTagType Interface

This OPC UA Interface is used to represent the VLAN configuration of a TSN stream. The *IIeeeTsnVlanTagType* is formally defined in Table 16.

Table 16 – IIeeeTsnVlanTagType definition

Attribute	Value				
BrowseName	IIeeeTsnVlanTagType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	VlanId	UInt16	BaseDataVariableType	Mandatory
HasComponent	Variable	PriorityCodePoint	Byte	BaseDataVariableType	Mandatory
Conformance Units					
BNM TSN Config					

VlanId of *DataType UInt16* defines the 12-Bit VLAN-Identifier of the VLAN tag in the Ethernet header for the related stream. Only values between 0 and 4095 shall be used according to IEEE 802.1Q-2018 Table 9-2.

PriorityCodePoint of *DataType* Byte defines the 3 Bit priority code point inside the VLAN tag of the Ethernet header of the related stream. Only values between 0 and 7 are supported as defined by IEEE 802.1Q-2018, clause 35.2.2.8.5a, Data Frame Priority.

5.2.15 IPriorityMappingEntryType Interface

This OPC UA Interface is used to translate a priority label like PriorityLabel (defined in Part 14) to a concrete network priority value (e.g. DSCP or PCP).

Note: This UA Interface is typically used to form a mapping rule table containing a set of object entities implementing the *IPriorityMappingEntryType*. Each network interface supporting priority mapping can reference such a mapping table *Object*.

Table 17 – IPriorityMappingEntryType definition

Attribute	Value				
BrowseName	IPriorityMappingEntryType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseInterfaceType* defined in OPC 10000-5					
HasComponent	Variable	MappingUri	String	BaseDataVariableType	Mandatory
HasComponent	Variable	PriorityLabel	String	BaseDataVariableType	Mandatory
HasComponent	Variable	PriorityValue_PCP	Byte	BaseDataVariableType	Optional
HasComponent	Variable	PriorityValue_DSCP	UInt32	BaseDataVariableType	Optional
Conformance Units					
BNM Priority Mapping					

MappingUri of *DataType String* specifies a named identifier of a well-known predefined set of priority labels.

PriorityLabel of *DataType String* is a textual representation of the desired transport priority configured within the QoS settings of a communication relation, e.g. WriterGroup defined in Part14.

PriorityValue_PCP of *DataType Byte* is the Ethernet transport priority inside the VLAN-Tag associated with the *PriorityLabel*. The devices shall translate the defined priority label for each packet according to the communication relation (e.g. WriterGroup) and linked interface. Depending on the transport protocol mapping and if this *Variable* is supported, the PCP field inside a packet shall be set to the specified PCP value.

PriorityValue_DSCP of *DataType UInt32* is the IP transport priority associated with the *PriorityLabel*. The devices shall translate the defined priority label for each packet according to the communication relation (e.g. WriterGroup) and linked interface. Depending on the transport protocol mapping and if this *Variable* is supported, the DSCP field inside a packet shall be set to the specified DSCP value.

5.3 DataTypes

5.3.1 Enumeration DataTypes

5.3.1.1 Duplex Enumeration

The *Duplex* is an enumeration representing the configured, negotiated, or actual duplex mode of an Ethernet interface (aDuplexStatus is defined in IEEE 802.3-2022, 30.3.1.1.32, aDuplexStatus). The values of the *Duplex Enumeration* are defined in Table 18.

Table 18 – Duplex Values

Name	Value	Description
Full	0	Full duplex.
Half	1	Half duplex.
Unknown	2	Link is currently disconnected or initializing.

Its representation in the *AddressSpace* is defined in Table 19.

Table 19 – Duplex Definition

Attribute	Value				
BrowseName	Duplex				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM Ethernet Base Info					

5.3.1.2 InterfaceAdminStatus Enumeration

The *InterfaceAdminStatus* is an enumeration for the possible desired states of the network interface (ifAdminStatus is defined in IETF RFC 2863: The Interfaces Group MIB - ifAdminStatus). The values of the *InterfaceAdminStatus Enumeration* are defined in Table 20.

Table 20 – InterfaceAdminStatus Values

Name	Value	Description
Up	0	Ready to pass packets.
Down	1	Not ready to pass packets and not in some test mode.
Testing	2	In some test mode.

Its representation in the *AddressSpace* is defined in Table 21.

Table 21 – InterfaceAdminStatus Definition

Attribute	Value				
BrowseName	InterfaceAdminStatus				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM Ethernet Base Info					

5.3.1.3 InterfaceOperStatus Enumeration

The *InterfaceOperStatus* is an enumeration for the possible operational states of the network interface (ifOperStatus is defined in IETF RFC 2863: The Interfaces Group MIB - ifOperStatus). The values of the *InterfaceOperStatus Enumeration* are defined in Table 22.

Table 22 – InterfaceOperStatus Values

Name	Value	Description
Up	0	Ready to pass packets.
Down	1	The interface does not pass any packets.
Testing	2	In some test mode. No operational packets can be passed.
Unknown	3	Status cannot be determined for some reason.
Dormant	4	Waiting for some external event.
NotPresent	5	Some component (typically hardware) is missing.
LowerLayerDown	6	Down due to state of lower-layer interface(s).

Its representation in the *AddressSpace* is defined in Table 23.

Table 23 – InterfaceOperStatus Definition

Attribute	Value				
BrowseName	InterfaceOperStatus				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM Ethernet Base Info					

5.3.1.4 NegotiationStatus Enumeration

The *NegotiationStatus* is an enumeration representing the status of the auto-negotiation protocol (aAutoNegAutoConfig is defined in IEEE 802.3-2022, clause 30.6.1.1.4, aAutoNegAutoConfig). The values of the *NegotiationStatus Enumeration* are defined in Table 24.

Table 24 – NegotiationStatus Values

Name	Value	Description
InProgress	0	The auto-negotiation protocol is running and negotiation is currently in-progress.
Complete	1	The auto-negotiation protocol has completed successfully.
Failed	2	The auto-negotiation protocol has failed.
Unknown	3	The auto-negotiation status is not currently known, this could be because it is still negotiating or the protocol cannot run (e.g., if no medium is present).
NoNegotiation	4	No auto-negotiation is executed. The auto-negotiation function is either not supported on this interface or has not been enabled.

Its representation in the *AddressSpace* is defined in Table 25.

Table 25 – NegotiationStatus Definition

Attribute	Value				
BrowseName	NegotiationStatus				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM AutoNeg					

5.3.1.5 TsnFailureCode Enumeration

The *TsnFailureCode* is an *Enumeration* to provide detailed error information for failures occurring during TSN stream establishment (TSN Failure Codes are defined in IEEE 802.1Qcc-2018, Table 46-15, TSN Failure Codes). The *TsnFailureCode Enumeration* is defined in Table 26.

Table 26 – TsnFailureCode values

Name	Value	Description
NoFailure	0	No failure
InsufficientBandwidth	1	Insufficient bandwidth
InsufficientResources	2	Insufficient bridge resources
InsufficientTrafficClassBandwidth	3	Insufficient bandwidth for Traffic Class
StreamIdInUse	4	StreamID in use by another Talker
StreamDestinationAddressInUse	5	Stream destination address already in use
StreamPreemptedByHigherRank	6	Stream pre-empted by higher rank
LatencyHasChanged	7	Reported latency has changed
EgressPortNotAvbCapable	8	Egress port is not AVBCapable
UseDifferentDestinationAddress	9	Use a different destination address
OutOfMsrpResources	10	Out of MSRP resources
OutOfMmrpResources	11	Out of MMRP resources
CannotStoreDestinationAddress	12	Cannot store destination address
PriorityIsNotAnSrcClass	13	Requested priority is not an SR Class priority
MaxFrameSizeTooLarge	14	MaxFrameSize is too large for media
MaxFanInPortsLimitReached	15	MaxFanInPorts limit has been reached
FirstValueChangedForStreamId	16	Changes in FirstValue for a registered StreamID
VlanBlockedOnEgress	17	VLAN is blocked on this egress port (Registration Forbidden)
VlanTaggingDisabledOnEgress	18	VLAN tagging is disabled on this egress port (untagged set)
SrClassPriorityMismatch	19	SR class priority mismatch
FeatureNotPropagated	20	Enhanced feature cannot be propagated to original Port
MaxLatencyExceeded	21	MaxLatency exceeded
BridgeDoesNotProvideNetworkId	22	Nearest Bridge cannot provide network identification for stream transformation
StreamTransformNotSupported	23	Stream transformation not supported
StreamIdTypeNotSupported	24	Stream identification type not supported for stream transformation
FeatureNotSupported	25	Enhanced feature cannot be supported without a CNC

Its representation in the *AddressSpace* is defined in Table 27.

Table 27 – TsnFailureCode Definition

Attribute		Value			
BrowseName		TsnFailureCode			
IsAbstract		False			
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM TSN Base Info					

5.3.1.6 TsnStreamState Enumeration

The *TsnStreamState* is an enumeration representing the state of the configuration process of a TSN Talker or Listener.

The default value is *Disabled*. The *TsnStreamState Enumeration* is defined in Table 28.

Table 28 – TsnStreamState Values

Name	Value	Description
Disabled	0	The related TSN Stream is currently disabled.
Configuring	1	The related TSN Stream is in the process of receiving configuration parameters from the TSN Control Layer.
Ready	2	The related TSN Stream has successfully received and applied the configuration from the TSN Control Layer. The related TSN Stream is not fully operational as long as local preconditions (e.g. synchronization state) are not valid.
Operational	3	The related TSN Stream object is configured and all other required preconditions (e.g. synchronization state) for sending / receiving data are valid.
Error	4	The related TSN Stream object is in an error state.

Its representation in the *AddressSpace* is defined in Table 29.

Table 29 – TsnStreamState Definition

Attribute	Value				
BrowseName	TsnStreamState				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM TSN Base Info					

5.3.1.7 TsnTalkerStatus Enumeration

The *TsnTalkerStatus* is an enumeration representing the state of the TSN Talker configuration.

The default value is *None*. The *TsnTalkerStatus Enumeration* is defined in Table 30.

Table 30 – TsnTalkerStatus Values

Name	Value	Description
None	0	No Talker detected.
Ready	1	Talker ready (configured).
Failed	2	Talker failed.

Its representation in the *AddressSpace* is defined in Table 31.

Table 31 – TsnTalkerStatus Definition

Attribute	Value				
BrowseName	TsnTalkerStatus				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM TSN Base Info					

5.3.1.8 TsnListenerStatus Enumeration

The *TsnListenerStatus* is an enumeration representing the state of the TSN Listener configuration.

The default value is *None*. The *TsnListenerStatus Enumeration* is defined in Table 32.

Table 32 – TsnListenerStatus Values

Name	Value	Description
None	0	No Listener detected.
Ready	1	Listener ready (configured).
PartialFailed	2	One or more Listeners ready, and one or more Listeners failed.
Failed	3	Listener failed.

Its representation in the *AddressSpace* is defined in Table 33.

Table 33 – TsnListenerStatus Definition

Attribute	Value				
BrowseName	TsnListenerStatus				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM TSN Base Info					

5.3.1.9 ChassisIdSubtype Enumeration

The *ChassisIdSubtype* is an enumeration representing different types of chassis identifier as defined in IEEE 802.1AB-2016, Table 8-2, chassis ID subtype.

The *ChassisIdSubtype Enumeration* is defined in Table 34.

Table 34 – ChassisIdSubtype Values

Name	Value	Description
ChassisComponent	1	Represents a chassis identifier based on the value of entPhysicalAlias object (defined in IETF RFC 2737) for a chassis component (i.e., an entPhysicalClass value of chassis(3))
InterfaceAlias	2	Represents a chassis identifier based on the value of ifAlias object (defined in IETF RFC 2863) for an interface on the containing chassis.
PortComponent	3	Represents a chassis identifier based on the value of entPhysicalAlias object (defined in IETF RFC 2737) for a port or backplane component (i.e., entPhysicalClass has a value of port(10), or backplane(4)), within the containing chassis.
MacAddress	4	Represents a chassis identifier based on the value of a unicast source address (encoded in network byte order and IEEE 802.3 canonical bit order) of a port on the containing chassis as defined in IEEE Std 802-2014.
NetworkAddress	5	Represents a chassis identifier based on a network address associated with a particular chassis. The encoded address is actually composed of two fields. The first field is a single octet, representing the IANA AddressFamilyNumbers value for the specific address type, and the second field is the network address value.
InterfaceName	6	Represents a chassis identifier based on the value of ifName object (defined in IETF RFC 2863) for an interface on the containing chassis.
Local	7	Represents a chassis identifier based on a locally defined value.

Its representation in the *AddressSpace* is defined in Table 35.

Table 35 – ChassisIdSubtype Definition

Attribute	Value				
BrowseName	ChassisIdSubtype				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM IEEE LLDP Info					

5.3.1.10 PortIdSubtype Enumeration

The *PortIdSubtype* is an enumeration representing different types of port identifier as defined in IEEE 802.1AB-2016, Table 8-3, port ID subtype.

The *PortIdSubtype Enumeration* is defined in Table 36.

Table 36 – PortIdSubtype Values

Name	Value	Description
InterfaceAlias	1	Represents a port identifier based on the ifAlias MIB object defined in IETF RFC 2863.
PortComponent	2	Represents a port identifier based on the value of entPhysicalAlias (defined in IETF RFC 2737) for a port component (i.e., entPhysicalClass value of port(10) or backplane(4)), within the containing chassis.
MacAddress	3	Represents a port identifier based on a unicast source address (encoded in network byte order and IEEE 802.3 canonical bit order) which has been detected by the agent and associated with a particular port (IEEE Std 802-2014).
NetworkAddress	4	Represents a port identifier based on a network address, detected by the agent and associated with a particular port.
InterfaceName	5	Represents a port identifier based on the ifName MIB object, defined in IETF RFC 2863.
AgentCircuitId	6	Represents a port identifier based on the agent-local identifier of the circuit (defined in IETF RFC 3046), detected by the agent and associated with a particular port.
Local	7	Represents a port identifier based on a value locally assigned.

Its representation in the *AddressSpace* is defined in Table 37.

Table 37 – PortIdSubtype Definition

Attribute					
BrowseName	PortIdSubtype				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM IEEE LLDP Info					

5.3.1.11 ManAddrIfSubtype Enumeration

The *ManAddrIfSubtype* is an enumeration representing different types of management address interface as defined in IEEE 802.1AB-2016, Section 8.5.9.5, interface numbering subtype.

The *ManAddrIfSubtype Enumeration* is defined in Table 38.

Table 38 – ManAddrIfSubtype Values

Name	Value	Description
None	0	Optional variable is not set.
Unknown	1	Interface is not known.
PortRef	2	Interface based on the port-ref MIB object.
SystemPortNumber	3	Interface based on the system port number.

Its representation in the *AddressSpace* is defined in Table 39.

Table 39 – ManAddrIfSubtype Definition

Attribute	Value				
BrowseName	ManAddrIfSubtype				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Enumeration type defined in OPC 10000-5					
HasProperty	Variable	EnumValues	EnumValueType[]	PropertyType	
Conformance Units					
BNM IEEE LLDP Info					

5.3.2 Structure DataTypes

5.3.2.1 PriorityMappingEntryType

This *Structure DataType* is used to represent an entry in the *PriorityMappingTableType*. The *PriorityMappingEntryType* is formally defined in Table 40.

Table 40 – PriorityMappingEntryType structure

Name	Type	Description
PriorityMappingEntryType	Structure	
MappingUri	String	Named identifier of a well-known predefined set of priority labels.
PriorityLabel	String	Textual representation of the desired transport priority.
PriorityValue_PCP	Byte	VLAN Tag based priority value. *PriorityValue_PCP* shall be a value between 0 and 7, or 0xFF. The value 0xFF indicates the *PriorityValue_PCP* is not used.
PriorityValue_DSCP	UInt32	IP header based priority value. *PriorityValue_DSCP* shall be a value between 0 and 63, or 0xFFFFFFFF. The value 0xFFFFFFFF indicates the *PriorityValue_PCP* is not used.

Its representation in the *AddressSpace* is defined in Table 41.

Table 41 – PriorityMappingEntryType Definition

Attribute	Value				
BrowseName	PriorityMappingEntryType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Structure DataType defined in OPC 10000-5					
Conformance Units					
BNM Priority Mapping 2					

5.3.2.2 LldpManagementAddressTxPortType

This *Structure DataType* represents the YANG list *management-address-tx-port* as defined in IEEE 802.1ABcu-2021. The *LldpManagementAddressTxPortType* is formally defined in Table 42.

Table 42 – LldpManagementAddressTxPortType structure

Name	Type	Description
LldpManagementAddressTxPortType	Structure	
AddressSubtype	UInt32	Type of address (8.5.9.3 of IEEE Std 802.1AB-2016, enumeration based on ianaAddressFamilyNumbers IETF RFC 3232)
ManAddress	String	Management address associated with this TLV (8.5.9.4 of IEEE Std 802.1AB-2016)
TxEnable	Boolean	Transmission enabled status (9.1.2.1 of IEEE Std 802.1AB-2016)
AddrLen	UInt32	Length of the management address subtype and the management address fields in LLDPDUs transmitted by the local LLDP agent (8.5.9.2 of IEEE Std 802.1AB-2016)
IfSubtype	ManAddrIfSubtype	Interface numbering method used for defining the interface number, associated with the local system (8.5.9.5 of IEEE Std 802.1AB-2016)
IfId	UInt32	Interface number for the management address component associated with the local system (8.5.9.6 of IEEE Std 802.1AB-2016)

The *AddressSubtype* and *ManAddress* are mandatory. The *TxEnable* has the default value *false*. The *AddrLen* is an optional element and shall be set to *0* if this variable is unititialized. The *IfSubtype* is an optional *Enumeration* element and shall be set to *None* if this variable is uninitialized. The *IfId* is an optional element and shall be set to *0* if this element is uninitialized or unknown.

Its representation in the *AddressSpace* is defined in Table 43.

Table 43 – LldpManagementAddressTxPortType Definition

Attribute	Value				
BrowseName	LldpManagementAddressTxPortType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Structure DataType defined in OPC 10000-5					
Conformance Units					
BNM IEEE LLDP Info					

5.3.2.3 LldpManagementAddressType

This *Structure DataType* is used to represent the YANG list management-address as defined in IEEE 802.1ABcu-2021. The *LldpManagementAddressType* is formally defined in Table 44.

Table 44 – LldpManagementAddressType structure

Name	Type	Description
LldpManagementAddressType	Structure	
AddressSubtype	UInt32	Type of address (8.5.9.3 of IEEE Std 802.1AB-2016), enumeration based on ianaAddressFamilyNumbers IETF RFC 3232)
Address	String	Management address associated with this TLV. (8.5.9.4 of IEEE Std 802.1AB-2016)
IfSubtype	ManAddrIfSubtype	Interface numbering method used for defining the interface number, associated with the local system. (8.5.9.5 of IEEE Std 802.1AB-2016)
IfId	UInt32	Interface number for the management address component associated with the local system. (8.5.9.6 of IEEE Std 802.1AB-2016)

The *AddressSubtype* and *Address* are mandatory. The *IfSubtype* is an optional variable and shall be set to *None* if this variable is unset. The *IfId* is an optional variable and shall be set to *0* if this variable is not set or unknown.

Its representation in the *AddressSpace* is defined in Table 45.

Table 45 – LldpManagementAddressType Definition

Attribute	Value				
BrowseName	LldpManagementAddressType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Structure DataType defined in OPC 10000-5					
Conformance Units					
BNM IEEE LLDP Info					

5.3.2.4 LldpTlvType

This *Structure DataType* is used to represent the YANG list remote-unknown-tlv as defined in IEEE 802.1ABcu-2021. The *LldpTlvType* is formally defined in Table 46.

Table 46 – LldpTlvType structure

Name	Type	Description
LldpTlvType	Structure	
TlvType	UInt32	Type of TLV (9.2.7.7.1 of IEEE Std 802.1AB-2016)
TlvInfo	ByteString	Value extracted from TLV. (9.2.7.7.1 of IEEE Std 802.1AB-2016)

The *TlvType* and *TlvInfo* are mandatory.

Its representation in the *AddressSpace* is defined in Table 47.

Table 47 – LldpTlvType Definition

Attribute	Value				
BrowseName	LldpTlvType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the Structure DataType defined in OPC 10000-5					
Conformance Units					
BNM IEEE LLDP Info					

5.3.3 OptionSets

5.3.3.1 LldpSystemCapabilitiesMap

The *LldpSystemCapabilitiesMap OptionSet* is based on UInt32. It is used to represent the bitmap for the capabilities of a system as defined in IEEE 802.1AB-2016. All possible options for the *LldpSystemCapabilitiesMap* are formally defined in Table 48.

Table 48 – LldpSystemCapabilitiesMap OptionSet

Value	Bit No.	Description
Other	0	System has capabilities other than those listed below
Repeater	1	System has repeater capability
Bridge	2	System has bridge capability
WlanAccessPoint	3	System has WLAN access point capability
Router	4	System has router capability
Telephone	5	System has telephone capability
DocsisCableDevice	6	System has DOCSIS cable device capability (IETF RFC 4639)
StationOnly	7	System has only station capability
CvlanComponent	8	System has C-VLAN component functionality
SvlanComponent	9	System has S-VLAN component functionality
TwoPortMacRelay	10	System has Two-port MAC Relay (TPMR) functionality.

All variables in the *LldpSystemCapabilitiesMap OptionSet* are per default set to *False*. The variable *Other* indicates that the system has capabilities, which are not specified in the *OptionSet*. All other variables shall only be set to *True*, if they are applicable for this device.

Its representation in the *AddressSpace* is defined in Table 49.

Table 49 – LldpSystemCapabilitiesMap OptionSet Definition

Attribute	Value				
BrowseName	LldpSystemCapabilitiesMap				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of 0:UInt32 defined in OPC 10000-5					
0:HasProperty	Variable	OptionSetValues	0:LocalizedText[]	0:PropertyType	
Conformance Units					
BNM IEEE LLDP Info					

5.4 Instance Entry Points

Overview and location of the instance entry points are shown in Figure 3.

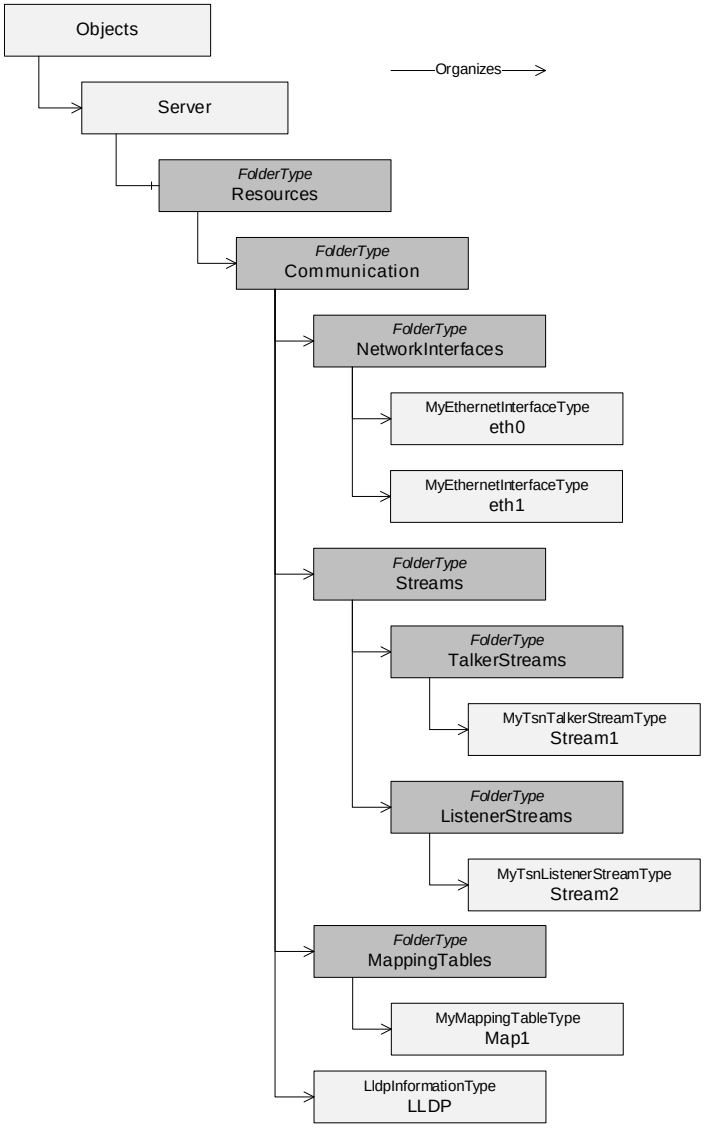


Figure 3 – Instance Entry Points for Network Interfaces, Streams, Mapping Tables and LLDP information

5.4.1 Resources Folder

The *Resources Object* shall be used as the browse entry point for physical and logical resources of the device the *Server* is running on. It shall reside in the *Server Object* defined in OPC 10000-5. It can contain a set of *Organizes* References that point to other *Objects* representing specific resources. It is formally defined in Table 50.

Table 50 – Resources definition

Attribute	**Value**		
BrowseName	Resources		
References	**NodeClass**	**BrowseName**	**Comment**
ComponentOf of the Server Object defined in Part 5.			
HasTypeDefinition	ObjectType	FolderType	
Organizes	Object	Communication	Defined in 5.4.2
Conformance Units			
BNM Entry Points			

5.4.2 Communication Folder

The *Communication Object* shall be used as the browse entry point for communication related resources of the physical device the *Server* is running on. It is formally defined in Table 51.

The *Communication Object* is referenced by an *Organizes Reference* from the *Resources Object* defined in 5.4.1.

The *Communication Object* can include the following subfolders:

- MappingTables
- NetworkInterfaces
- Streams

Additionally, the *Communication Object* may include the LLDP instance.

It is recommended to keep TSN-Streams and possible future (DetNet-)Flows separated in specific folders.

Table 51 – Communication definition

Attribute	**Value**		
BrowseName	Communication		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	FolderType	
Organizes	Object	MappingTables	Defined in 5.4.3
Organizes	Object	NetworkInterfaces	Defined in 5.4.4
Organizes	Object	Streams	Defined in 5.4.5
Organizes	Object	LLDP	Defined in 5.4.8
Conformance Units			
BNM Entry Points			

5.4.3 MappingTables Folder

The *MappingTables Object* shall be used as the browse entry point for mapping tables of priority values and their application labels. It is formally defined in Table 52 – MappingTables definition. All instances of the *PriorityMappingTableType* shall be referenced from this *Object*, either directly or indirectly, following hierarchical References.

Table 52 – MappingTables definition

Attribute	**Value**		
BrowseName	MappingTables		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	FolderType	
Conformance Units			
BNM Mapping Entry Points			

5.4.4 NetworkInterfaces Folder

The *NetworkInterfaces Object* shall be used as the browse entry point for network interfaces of the device the *Server* is running on. It is formally defined in Table 53.

Table 53 – NetworkInterfaces definition

Attribute	**Value**		
BrowseName	NetworkInterfaces		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	FolderType	
Conformance Units			
BNM Entry Points			

The *NetworkInterfaces* folder is intended to hold instances, which are of *IetfBaseNetworkInterfaceType* or a subtype of it. However other *Objects* can be stored within this folder that implement the UA Interface *IIetfBaseNetworkInterfaceType*.

All *Objects* of Type *IetfBaseNetworkInterfaceType* within the *NetworkInterfaces* folder shall represent either a physical or virtual network interface.

5.4.5 Streams Folder

The *Streams Object* shall be used as the browse entry point for network streams of the device the *Server* is running on. It is formally defined in Table 54.

Table 54 – Streams definition

Attribute	**Value**		
BrowseName	Streams		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	FolderType	
Organizes	Object	TalkerStreams	Defined in 5.4.6
Organizes	Object	ListenerStreams	Defined in 5.4.7
Conformance Units			
BNM TSN Entry Points			

5.4.6 TalkerStreams Folder

The *TalkerStreams Object* shall be used as the browse entry point for sending network streams of the device the *Server* is running on. It is formally defined in Table 55.

Table 55 – TalkerStreams definition

Attribute	**Value**		
BrowseName	TalkerStreams		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	FolderType	
Conformance Units			
BNM TSN Entry Points			

5.4.7 ListenerStreams Folder

The *ListenerStreams Object* shall be used as the browse entry point for receiving network streams of the device the *Server* is running on. It is formally defined in Table 56.

Table 56 – ListenerStreams definition

Attribute	**Value**		
BrowseName	ListenerStreams		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	FolderType	
Conformance Units			
BNM TSN Entry Points			

5.4.8 LLDP Information Object

The *LLDP Information Object* shall be used as the single browse entry point for all LLDP information represented in the *Server* running on the device. It is formally defined in Table 57.

Table 57 – LLDP definition

Attribute	Value		
BrowseName	LLDP		
References	**NodeClass**	**BrowseName**	**Comment**
HasTypeDefinition	ObjectType	LldpInformationType	
Conformance Units			
BNM IEEE LLDP Info			

The *LLDP Object* is an instance of Type *LldpInformationType* and represents the same structure as the YANG container lldp defined in the IEEE 802.1ABcu-2021. This object shall be read-only. The content is filled by the LLDP agent, based on the current configuration and operation. This LLDP agent behaves according to IEEE 802.1AB-2016 and is configured via mechanisms defined in IEEE 802.1AB-2016.

Note: The behaviour of an LLDP agent can be further specified and limited by profiles (either IEEE or OPC). This specification only represents data received and transmitted by this agent and is independent of the agent configuration.

Annex A.4 shows an example for the topology discovery using the information models of two neighbour *OPC UA Servers.*

5.5 ObjectTypes

5.5.1 IetfBaseNetworkInterfaceType

5.5.1.1 Overview

The *IetfBaseNetworkInterfaceType* defines the core set of properties needed to model a network interface based on the definition provided by IETF. Figure 4 illustrates the structure of the *IetfBaseNetworkInterfaceType*.

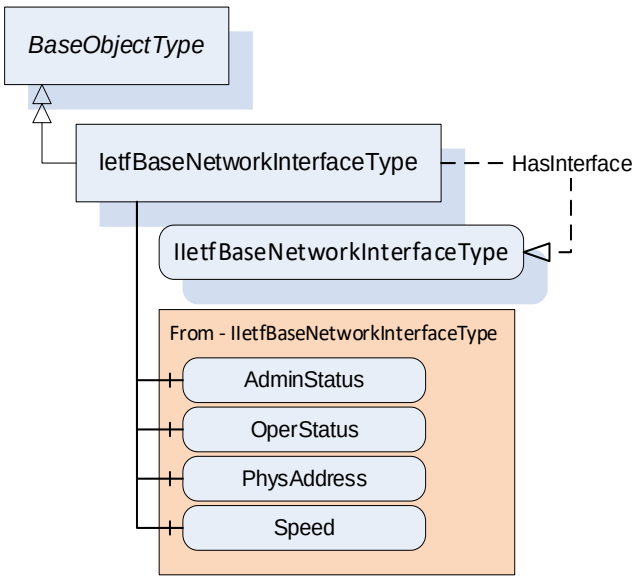


Figure 4 – IetfBaseNetworkInterfaceType

5.5.1.2 IetfBaseNetworkInterfaceType definition

The *IetfBaseNetworkInterfaceType* is formally defined in Table 58.

Table 58 – IetfBaseNetworkInterfaceType definition

Attribute	Value				
BrowseName	IetfBaseNetworkInterfaceType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType					
HasInterface	ObjectType	IIetfBaseNetwork-InterfaceType			
Applied from IIetfBaseNetworkInterfaceType (see 5.2.1)					
HasComponent	Variable	AdminStatus	InterfaceAdminStatus	BaseDataVariableType	M
HasComponent	Variable	OperStatus	InterfaceOperStatus	BaseDataVariableType	M
HasComponent	Variable	PhysAddress	String	BaseDataVariableType	O
HasComponent	Variable	Speed	UInt64	AnalogUnitType	M
HasLowerLayerInterface	Object	<InterfaceName>		BaseObjectType	OP
Conformance Units					
BNM IETF Interface Base Info					

The *BrowseName* of this *Object* shall be the same as the ifName of the corresponding IETF object (ifName is defined in IETF RFC 2863: The Interfaces Group MIB).

For the formal definition of *AdminStatus, OperStatus, PhysAddress* and *Speed* please refer to 5.2.1.

The *HasLowerLayerInterface Reference* points to an *Object* implementing the *IIetfBaseNetworkInterfaceType* used to indicate a hierarchical connection of network interfaces. This is used to indicate the relation e.g. between a VLAN interface and the actual physical interface. A VLAN interface shall additionally implement *IVlanIdType*.

Each instance of the *IetfBaseNetworkInterfaceType* shall point to zero or one instance of *PriorityMappingTableType* or a subtype using a *UsesProrityMappingTable Reference* or a subtype. The referenced PriorityMappingTable is used for the prioritisation of network messages injected to the network using this network interface. If an instance of type *IetfBaseNetworkInterfaceType* has no reference to a PriorityMappingTable, the PriorityMappingTable of the next lower layer interface of type *IetfBaseNetworkInterfaceType* shall be used. An example for this is shown in Annex A.2 for “eth0.100”.

It is recommended that within one network domain that all interfaces should have consistent MappingTables assigned. This ensures consistent use of Quality of Service features within the network.

A network interface is linked for transmission or reception via the *BrowseName* of the object of type *IetfBaseNetworkInterfaceType.*

Note: An example for a simplified PubSub connection is shown in Annex A.2.

The components of the *IetfBaseNetworkInterfaceType* have the *Attribute* values defined in Table 59.

Table 59 – IetfBaseNetworkInterfaceType Attribute values for child Nodes

Source Path	Value Attribute	Description Attribute
Speed EngineeringUnits	NamespaceUri: http://www.opcfoundation.org/UA/units/un/cefact UnitId: 4337968 DisplayName: bit/s Description: bit per second	-

The components of the *IetfBaseNetworkInterfaceType* have additional *References* which are defined in Table 60.

Table 60 – IetfBaseNetworkInterfaceType Additional References

SourceBrowsePath	Reference Type	Is Forward	TargetBrowsePath
<InterfaceName>	HasInterface	True	IIetfBaseNetworkInterfaceType

5.5.2 PriorityMappingTableType

5.5.2.1 Overview

Instances of the PriorityMappingTableType contains priority mapping information. Figure 5 illustrates the structure of the *PriorityMappingTableType*.

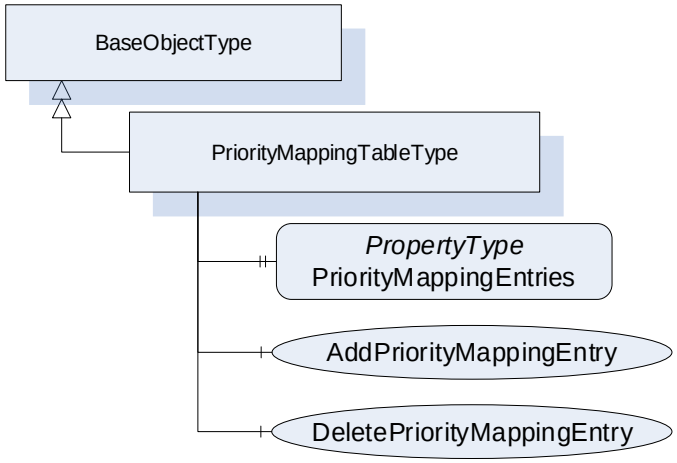


Figure 5 – PriorityMappingTableType

5.5.2.2 PriorityMappingTableType definition

The *PriorityMappingTableType* is formally defined in Table 61.

Table 61 – PriorityMappingTableType definition

Attribute	Value				
BrowseName	PriorityMappingTableType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType defined in OPC 10000-5					
HasProperty	Variable	PriorityMapppingEntries	PriorityMappingEntryType[]	PropertyType	M
HasComponent	Method	AddPriorityMappingEntry	Defined in 5.5.2.3		O
HasComponent	Method	DeletePriorityMappingEntry	Defined in 5.5.2.4		O
Conformance Units					
BNM Priority Mapping 2					

PriorityMappingEntries represents a list of all instances of *PriorityMappingEntryType*. For a formal definition see 5.3.2.1. The order of the elements in the array does not have any influence, as elements are indexed via the *MappingUri* and *PriorityLabel*.

The combination of *QosCategory* and *PriorityLabel* are used as indices into the referenced *PriorityMappingTable* to look up the priority values. The reference from an *IetfBaseNetworkInterface* is described in Section 5.5.1. For the sender, the priority values shall be included within the frame, if the according fields are available, i.e., VLAN Tag to use the PCP value and IP header to use the DSCP value. The receiver can use the priority values for internal packet processing.

Note: An example for a simplified PubSub connection is shown in Annex A.2. Within the *PubSubConnection*, each *WriterGroup* can contain a *QosCategory* and *DatagramQos* structure with a *PriorityLabel*. For the subscriber side these values are specified on the *DataSetReader* level.

AddPriorityMappingEntry allows to add an entry to this instance of *PriorityMappingTableType*.

DeletePriorityMappingEntry allows to delete an entry from this instance of *PriorityMappingTableType*.

5.5.2.3 AddPriorityMappingEntry method

This optional *Method* allows to add an entry to this instance of *PriorityMappingTableType*. If the combination of *MappingUri* and *PriorityLabel* does not exist yet, the element will be added to the Variable *PriorityMappingEntries*.

The signature of this *Method* is specified below. Table 62 and Table 64 specify the *Arguments* and *AddressSpace* representation, respectively.

Signature

```
AddPriorityMappingEntry(
  [in]  String MappingUri,
  [in]  String PriorityLabel,
  [in]  Byte PriorityValue_PCP,
  [in]  UInt32 PriorityValue_DSCP
);
```

Table 62 – AddPriorityMappingEntry Method arguments

Argument	Description
MappingUri	Named identifier of a well-known predefined set of priority labels.
PriorityLabel	Textual representation of the desired transport priority.
PriorityValue_PCP	*PriorityValue_PCP* shall be a value between 0 and 7. The value 0xFF indicates to omit the *PriorityValue_PCP* from the entry.
PriorityValue_DSCP	*PriorityValue_DSCP* shall be a value between 0 and 63. The value 0xFFFFFFFF indicates to omit the *PriorityValue_PCP* from the entry.

The possible *Method* result codes are defined in Table 63.

Table 63 – AddPriorityMappingEntry Method result codes

ResultCode	Description
Bad_UserAccessDenied	The caller is not allowed to add a priority mapping rule.
Bad_InvalidArgument	One of the arguments is invalid.
Bad_IndexRangeInvalid	A mapping table entry with *MappingUri* and *PriorityLabel* already exists.

Table 64 – AddPriorityMappingEntry Method AddressSpace definition

Attribute	Value				
BrowseName	**AddPriorityMappingEntry**				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
HasProperty	Variable	InputArguments	Argument[]	PropertyType	M

5.5.2.4 DeletePriorityMappingEntry method

This optional *Method* allows to delete an entry from this instance of PriorityMappingTableType.

The signature of this *Method* is specified below. Table 65 and Table 67 specify the *Arguments* and *AddressSpace* representation, respectively.

Signature

```
DeletePriorityMappingEntry(
  [in]  String MappingUri,
  [in]  String PriorityLabel
);
```

Table 65 – DeletePriorityMappingEntry Method arguments

Argument	Description
MappingUri	Named identifier of a well-known predefined set of priority labels.
PriorityLabel	Textual representation of the desired transport priority.

The possible *Method* result codes are defined in Table 66.

Table 66 – DeletePriorityMappingEntry Method result codes

ResultCode	Description
Bad_UserAccessDenied	The caller is not allowed to delete the priority mapping rule.
Bad_InvalidState	The state of this *ConnectionConfigurationSetType* instance is "Processing".
Bad_BrowseNameInvalid	The *BrowseName* for the mapping entry is invalid.

Table 67 – DeletePriorityMappingEntry Method AddressSpace definition

Attribute	Value				
BrowseName	**DeletePriorityMappingEntry**				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
HasProperty	Variable	InputArguments	Argument[]	PropertyType	M

5.5.3 LldpInformationType definition

An instance of the *LldpInformationType* contains LLDP information collected by an independent LLDP agent. Figure 6 illustrates the structure of the *LldpInformationType*.

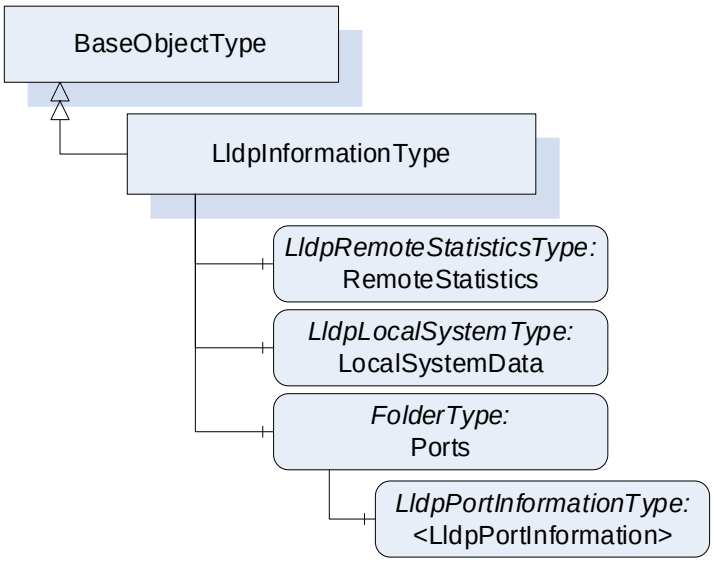


Figure 6 – LldpInformationType

The *LldpInformationType* is formally defined in Table 68.

Table 68 – LldpInformationType definition

Attribute	Value				
BrowseName	LldpInformationType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType					
HasComponent	Object	RemoteStatistics		LldpRemoteStatisticsType	O
HasComponent	Object	LocalSystemData		LldpLocalSystemType	M
HasComponent	Object	Ports		FolderType	M
Conformance Units					
BNM IEEE LLDP Info					

LldpInformationType represents the schema of the YANG container lldp in IEEE 802.1ABcu-2021. It models the two entry points for subsequent structures *LocalSystemData* for all device-related identification and *Ports* for the port-specific identification and information on neighbour devices.

RemoteStatistics contains a collection of statistics indicating activity and events occurring on neighbour devices.

LocalSystemData represents all device-related identification properties.

Ports is a folder containing one or more instances of *LldpPortInformationType* that contains information about neighbouring devices seen through that port. The content of *Ports* is limited to instances of Type *LldpPortInformationType*.

The components of the *LldpInformationType* have additional subcomponents, which are defined in Table 69.

Table 69 - LldpInformationType Addtional Components

Browse Path	References	NodeClass	BrowseName	Data Type	TypeDefinition	Other
Ports	Organizes	Object	<LldpPortInformation>		LldpPortInformationType	OP

5.5.4 LldpRemoteStatisticsType definition

The *LldpRemoteStatisticsType* is formally defined in Table 70.

Table 70 – LldpRemoteStatisticsType definition

Attribute	Value				
BrowseName	LldpRemoteStatisticsType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType					
HasComponent	Variable	LastChangeTime	UInt32	BaseDataVariableType	M
HasComponent	Variable	RemoteInserts	UInt32	BaseDataVariableType	M
HasComponent	Variable	RemoteDeletes	UInt32	BaseDataVariableType	M
HasComponent	Variable	RemoteDrops	UInt32	BaseDataVariableType	M
HasComponent	Variable	RemoteAgeouts	UInt32	BaseDataVariableType	M
Conformance Units					
BNM IEEE LLDP Info					

LldpRemoteStatisticsType represents the schema of the YANG container *remote-statistics* in IEEE 802.1ABcu-2021.

LastChangeTime defines the time any remote info changed in the scale of the uptime of the system, as defined in clause 11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesLastChangeTime. The uptime of the system is specified by IETF RFC 3418 in the unit of hundreths of a second.

RemoteInserts defines the number of times new information was inserted into the *LldpRemoteSystemsType* array, as defined in clause 11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesInserts. When this counter reaches the end of its range, it rolls over to 0.

RemoteDeletes defines the number of times information was deleted from the *LldpRemoteSystemsType* array, as defined in clause 11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesDeletes. When this counter reaches the end of its range, it rolls over to 0.

RemoteDrops defines the number of times new information could not be inserted into the *LldpRemoteSystemsType* array because of insufficient resources, as defined in clause 11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesDrops. When this counter reaches the end of its range, it rolls over to 0.

RemoteAgeouts defines the number of times information aged out from the *LldpRemoteSystemsType* array because the information timeliness interval has expired, as defined in clause 11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesAgeouts. When this counter reaches the end of its range, it rolls over to 0.

LldpLocalSystemType definition

The *LldpLocalSystemType* is formally defined in Table 71.

Table 71 – LldpLocalSystemType definition

Attribute	Value				
BrowseName	LldpLocalSystemType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType					
HasProperty	Variable	ChassisIdSubtype	ChassisIdSubtype	PropertyType	M
HasProperty	Variable	ChassisId	String	PropertyType	M
HasProperty	Variable	SystemName	String	PropertyType	M
HasProperty	Variable	SystemDescription	String	PropertyType	M
HasProperty	Variable	SystemCapabilitiesSupported	LldpSystemCapabilities Map	PropertyType	O
HasProperty	Variable	SystemCapabilitiesEnabled	LldpSystemCapabilities Map	PropertyType	O
Conformance Units					
BNM IEEE LLDP Info					

LldpLocalSystemType represents the schema of the YANG container *local-system-data* in IEEE 802.1ABcu-2021.

ChassisIdSubtype defines type of encoding used to identify the chassis associated with the local system, as defined in clause 8.5.2.2 of IEEE Std 802.1AB-2016.

ChassisId defines the chassis component associated with the local system, as defined in clause 8.5.2.3 of IEEE Std 802.1AB-2016.

SystemName defines the system name of the local system, as defined in clause 8.5.6.2 of IEEE Std 802.1AB-2016.

SystemDescription defines the system description of the local system, as defined in clause 8.5.7.2 of IEEE Std 802.1AB-2016.

SystemCapabilitiesSupported defines the system capabilities that are supported on the local system, as defined in clause 8.5.8.1 of IEEE Std 802.1AB-2016.

SystemCapabilitiesEnabled defines the system capabilities that are enabled on the local system, as defined in clause 8.5.8.2 of IEEE Std 802.1AB-2016.

5.5.5 LldpPortInformationType definition

The *LldpPortInformationType* is formally defined in Table 72.

Table 72 – LldpPortInformationType definition

Attribute	Value				
BrowseName	LldpPortInformationType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType					
HasProperty	Variable	IetfBaseNetworkInterfaceName	String	PropertyType	M
HasProperty	Variable	DestMacAddress	Byte[6]	PropertyType	M
HasProperty	Variable	PortIdSubtype	PortIdSubtype	PropertyType	M
HasProperty	Variable	PortId	String	PropertyType	M
HasProperty	Variable	PortDescription	String	PropertyType	O
HasProperty	Variable	ManagementAddressTxPort	LldpManagementAddressTxPortType[]	PropertyType	O
HasComponent	Object	RemoteSystemsData		FolderType	O
Conformance Units					
BNM IEEE LLDP Info					

LldpPortInformationType represents the schema of the YANG list *port* in IEEE 802.1Abcu-2021.

IetfBaseNetworkInterfaceName points to an object of type *IetfBaseNetworkInterfaceType* organized in the *NetworkInterfaces* folder with the value of the *String*. This link is needed to identify the port component (contained in the local chassis with the LLDP agent) associated with this entry. Annex A.3 visualizes this reference.

DestMacAddress defines the MAC address of this network interface.

PortIdSubtype defines type of encoding used to identify the associated *PortId*, as defined in clause 8.5.3.2 of IEEE Std 802.1AB-2016.

PortId defines the port component associated with a given port in the local system, as defined in clause 8.5.3.3 of IEEE Std 802.1AB-2016.

PortDescription defines the port description associated with the local system, as defined in clause 8.5.5.2 of IEEE Std 802.1AB-2016.

ManagementAddressTxPort defines the set of ports (represented as a List of *Type LldpManagementAddressTxPortType*) on which the local system management address instance will be transmitted.

RemoteSystemsData defines the data received on this particular physical network connection. It is a folder containing instances of type *LldpRemoteSystemType.*

The components of the *LldpInformationType* have additional subcomponents, which are defined in Table 73.

Table 73 - LldpPortInformationType additional subcomponents

BrowsePath	References	NodeClass	BrowseName	DataType	TypeDefinition	Other
RemoteSystemsData	Organizes	Object	*<LldpRemoteSystem>*		*LldpRemoteSystemType*	OP

5.5.6 LldpRemoteSystemType definition

The *LldpRemoteSystemType* is formally defined in Table 74.

Table 74 – LldpRemoteSystemType definition

Attribute	Value				
BrowseName	LldpRemoteSystemType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the BaseObjectType					
HasComponent	Variable	TimeMark	UInt32	BaseDataVariableType	M
HasComponent	Variable	RemoteIndex	UInt32	BaseDataVariableType	M
HasComponent	Variable	ChassisIdSubtype	ChassisIdSubtype	BaseDataVariableType	M
HasComponent	Variable	ChassisId	String	BaseDataVariableType	M
HasComponent	Variable	PortIdSubtype	PortIdSubtype	BaseDataVariableType	M
HasComponent	Variable	PortId	String	BaseDataVariableType	M
HasComponent	Variable	PortDescription	String	BaseDataVariableType	O
HasComponent	Variable	SystemName	String	BaseDataVariableType	O
HasComponent	Variable	SystemDescription	String	BaseDataVariableType	O
HasComponent	Variable	SystemCapabilitiesSupported	LldpSystemCapabilitiesMap	BaseDataVariableType	O
HasComponent	Variable	SystemCapabilitiesEnabled	LldpSystemCapabilitiesMap	BaseDataVariableType	O
HasComponent	Variable	RemoteChanges	Boolean	BaseDataVariableType	O
HasComponent	Variable	RemoteTooManyNeighbors	Boolean	BaseDataVariableType	O
HasComponent	Variable	ManagementAddress	LldpManagementAddressType[]	BaseDataVariableType	O
HasComponent	Variable	RemoteUnknownTlv	LldpTlvType[]	BaseDataVariableType	O
Conformance Units					
BNM IEEE LLDP Info					

LldpRemoteSystemType represents the schema of the YANG list *remote-systems-data* in IEEE 802.1ABcu-2021. These instances are populated based on received LLDP TLVs.

TimeMark defines a TimeFilter for this entry, as defined in IETF RFC 2021 section 6. The units for this time are hundredths of seconds.

RemoteIndex defines an arbitrary local integer value used to identify a remote system, as defined in clause 11.5.1 of IEEE Std 802.1AB-2016: lldpV2RemIndex.

ChassisIdSubtype defines type of encoding used to identify the chassis associated with the remote system, as defined in clause 8.5.2.2 of IEEE Std 802.1AB-2016.

ChassisId defines the chassis component associated with the remote system, as defined in clause 8.5.2.3 of IEEE Std 802.1AB-2016.

PortIdSubtype defines type of encoding used to identify the associated *PortId*, as defined in clause 8.5.3.2 of IEEE Std 802.1AB-2016.

PortId defines the port component associated with a given port in the remote system, as defined in clause 8.5.3.3 of IEEE Std 802.1AB-2016.

PortDescription defines the port description associated with the remote system, as defined in clause 8.5.5.2 of IEEE Std 802.1AB-2016.

SystemName defines the system name of the remote system, as defined in clause 8.5.6.2 of IEEE Std 802.1AB-2016.

SystemDescription defines the system description of the remote system, as defined in clause 8.5.7.2 of IEEE Std 802.1AB-2016.

SystemCapabilitiesSupported defines the system capabilities are supported on the remote system, as defined in clause 8.5.8.1 of IEEE Std 802.1AB-2016.

SystemCapabilitiesEnabled defines the system capabilities are enabled on the remote system, as defined in clause 8.5.8.2 of IEEE Std 802.1AB-2016.

RemoteChanges Indicates that there are changes in the remote system's data, as determined by the variable remoteChanges, as defined in clause 9.2.5.11 of IEEE Std 802.1AB-2016.

RemoteTooManyNeighbors Indicates that there are too many neighbors as determined by the variable tooManyNeighbors, as defined in clause 9.2.5.15 of IEEE Std 802.1AB-2016.

ManagementAddress defines the Management address information about a particular chassis component (represented as a List of *Type* LldpManagementAddressType).

RemoteUnknownTlv defines Information about an unrecognized TLV received from a physical network connection.

All values get initialized from the LLDP stack based on received TLVs. If mandatory variables are not initialized due to a non-conforming LLDP stack, the return value for Browse action shall be *Bad_NoValue*, as defined in OPC 10000-4.

5.6 ReferenceTypes

5.6.1 UsesPriorityMappingTable ReferenceType

The *UsesPriorityMappingTable ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *NonHierarchicalReferences ReferenceType*.

The *SourceNode* of this *ReferenceType* shall be an *Object* implementing the *IIetfBaseNetworkInterfaceType* or an Object of Type *IetfBaseNetworkInterfaceType*. Each *Node* shall be the *SourceNode* of at most one *UsesPriorityMappingTable Reference*.

The *TargetNode* of this *ReferenceType* shall be an instance of *PriorityMappingTableType*.

The *UsesPriorityMappingTable ReferenceType* is formally defined in Table 75.

Table 75 – UsesPriorityMappingTable definition

Attributes	**Value**		
BrowseName	UsesPriorityMappingTable		
InverseName	UsedByNetworkInterface		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
Subtype of the NonHierarchicalReferences ReferenceType defined in OPC 10000-5			
Conformance Units			
BNM Priority Mapping 2			

5.6.2 HasLowerLayerInterface ReferenceType

The *HasLowerLayerInterface ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *HierarchicalReferences ReferenceType*.

The usage of the References is following the YANG modelling approach which is using reference pointers in the YANG-interface nodes to point to other interface nodes in lower or higher layers (“lower-layer-if”, “higher-layer-if”). The YANG Data Model for Interface Management is defined in IETF RFC 8343.

Virtual interfaces shall reference their physical interfaces with the *HasLowerLayerInterfaceReferenceType*. Annex A contains examples for such hierarchical references.

The *SourceNode* of this *ReferenceType* shall be an *Object* organized in the *NetworkInterfaces* folder.

The *TargetNode* of this *ReferenceType* shall be an *Object* organized in the *NetworkInterfaces* folder.

The *HasLowerLayerInterface ReferenceType* is formally defined in Table 76.

Table 76 – HasLowerLayerInterface definition

Attributes	**Value**		
BrowseName	HasLowerLayerInterface		
InverseName	HasHigherLayerInterface		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
Subtype of the HierarchicalReferences ReferenceType defined in OPC 10000-5			
Conformance Units			
BNM IETF Interface Base Info			

Annex A Modelling Examples (informative)

A.1 Modelling Examples for Network Interfaces

A.1.1 Virtual Network Interfaces

A virtual interfaces configuration can be represented by *Objects* representing the virtual and the physical network interface instances. *HasLowerLayerInterface References* point from the *Object(s)* representing the virtual interface(s) to the *Object* representing the physical interface. All *Objects* are of *ObjectType IetfBaseNetworkInterfaceType*. An example is shown in Figure A-1.

Note: The usage of the *References* is following the YANG modelling approach which is using reference pointers in the YANG-interface nodes to point to other interface nodes in lower or higher layers (“higher-layer-if”, “lower-layer-if”).

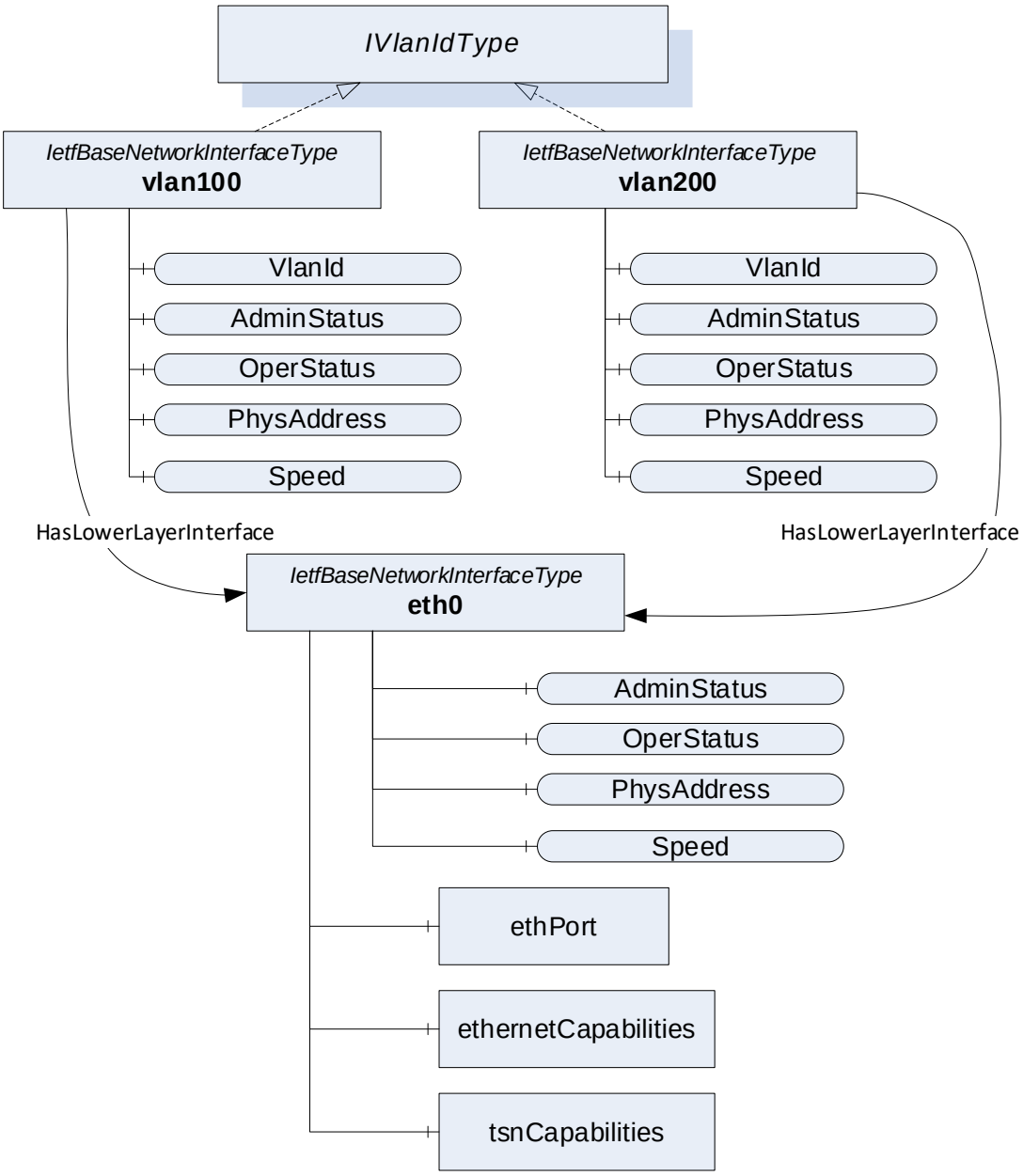


Figure A-1 – Modelling Example for virtual network interfaces

A.1.2 Link Aggregation

A link aggregation configuration can be represented by *Objects* representing the logical aggregation and the particular physical interface instances. *HasLowerLayerInterface References* point from the *Object(s)* representing the aggregation interface to the *Objects* representing the physical interfaces. All *Objects* implement the *IIetfBaseNetworkInterfaceType*. An example is shown in Figure A-2.

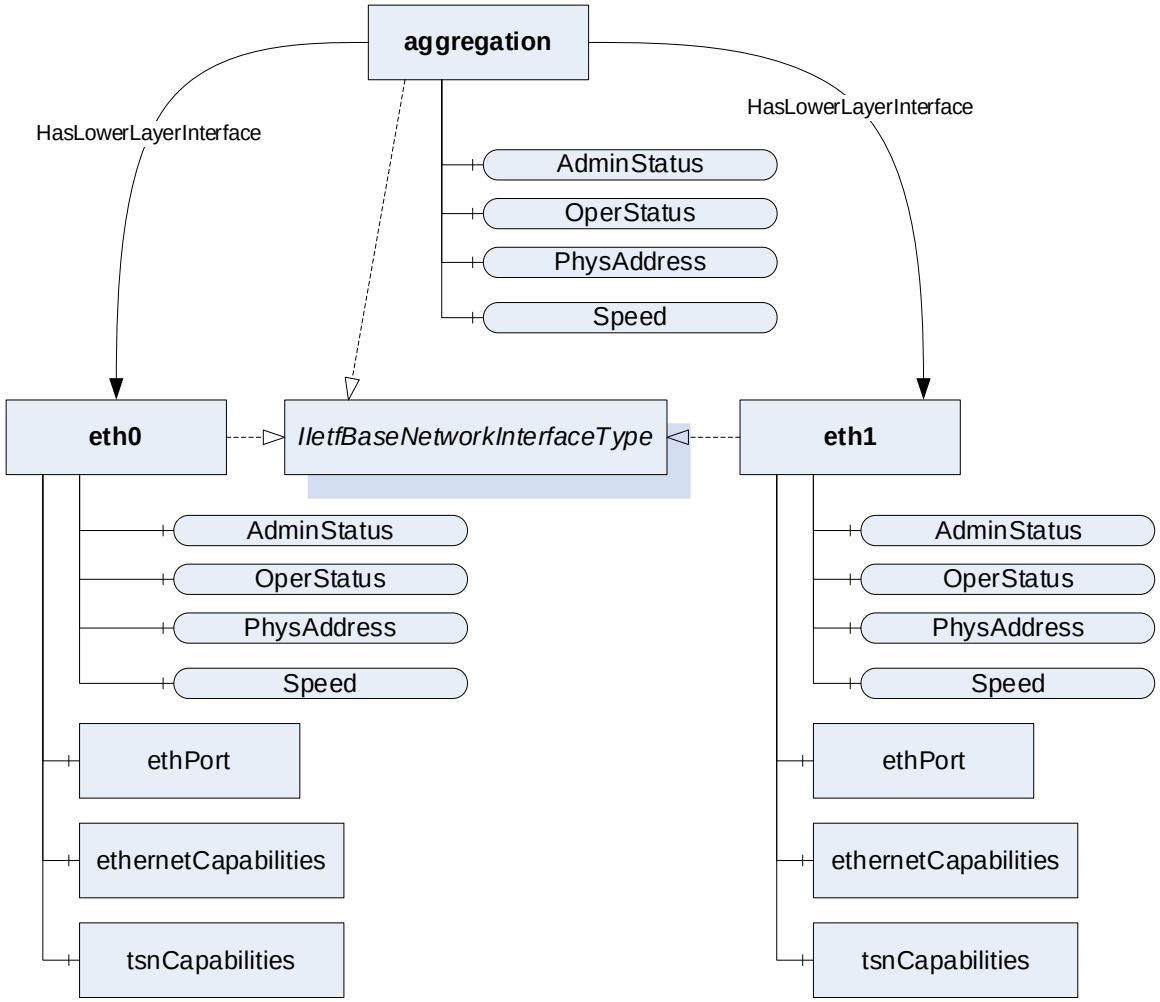


Figure A-2 – Modelling example for link aggregation

A.2 Modelling Examples for PriorityMappingEntries and IetfBaseNetworkInterface

All packets sent via this network interface will use the source address and – in case of VLAN interfaces – VLAN ID as specified by this interface to generate a packet. All packets received via this network interface will use – in case of unicast communication – the destination address and – in case of VLAN interfaces – VLAN ID as specified by the interface to filter incoming packets.

When using PubSub, each PubSubConnection as defined by the *PubSubConnectionDataType* in Part14 contains the address variable of type *NetworkAddressDataType*. If the networkInterface String of the *NetworkAddressDataType* matches the *BrowseName* of one Object in the NetworkInterfaces folder, it links the transmission or reception and the network interface. An example is shown in Figure A-3.

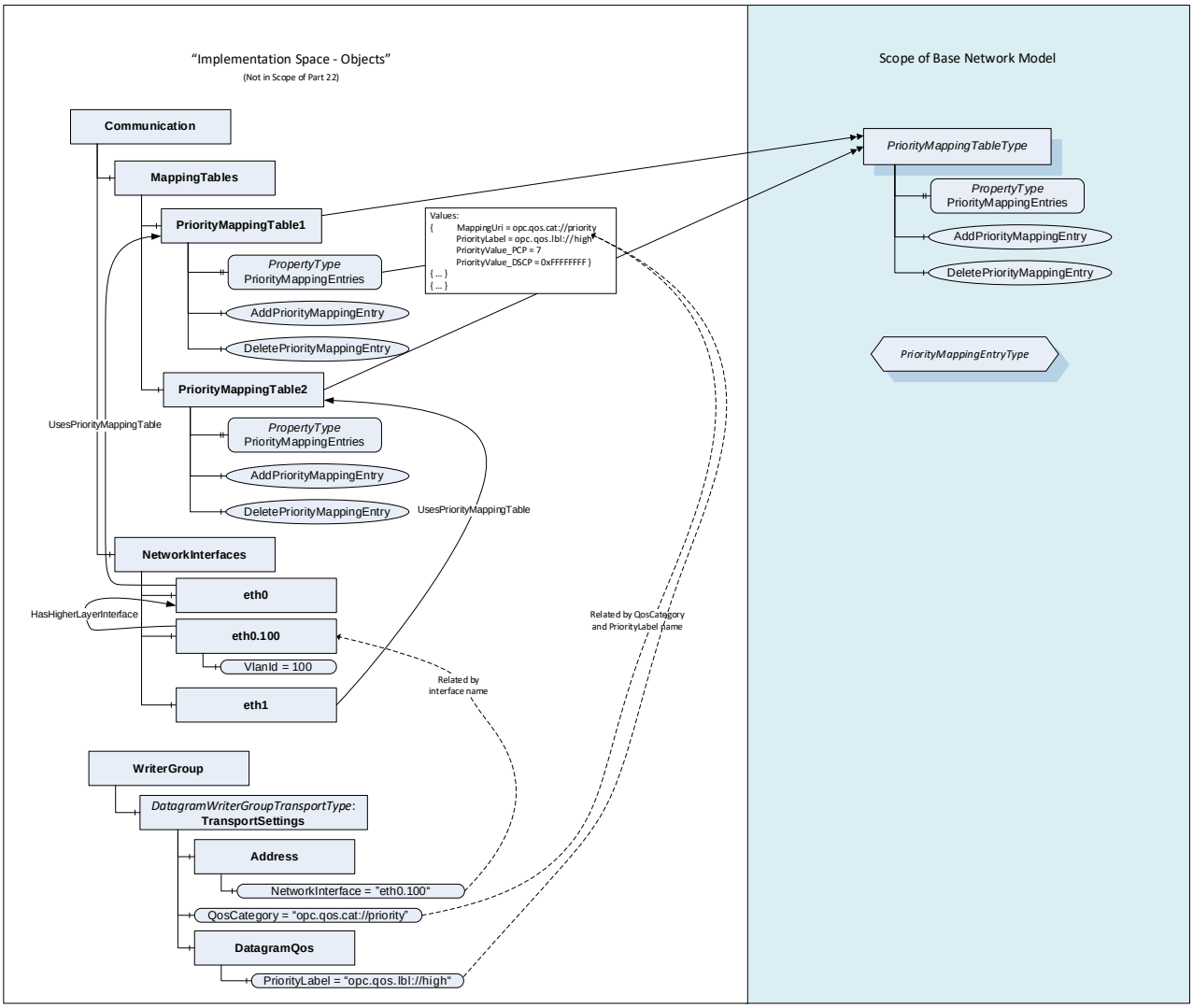


Figure A-3 – Modelling Example for PriorityMappingTableType and IetfBaseNetworkInterface

A.3 Connecting LldpPortInformationType and IetfBaseNetworkInterfaceType

The *LldpPortInformationType* is connected to the associated *Object* of type *IetfBaseNetworkInterfaceType* via the name of the variable *IetfBaseNetworkInterfaceName*. Figure A-4 shows an example of this reference for the *IetfBaseNetworkInterface* with the *BrowseName* eth0.

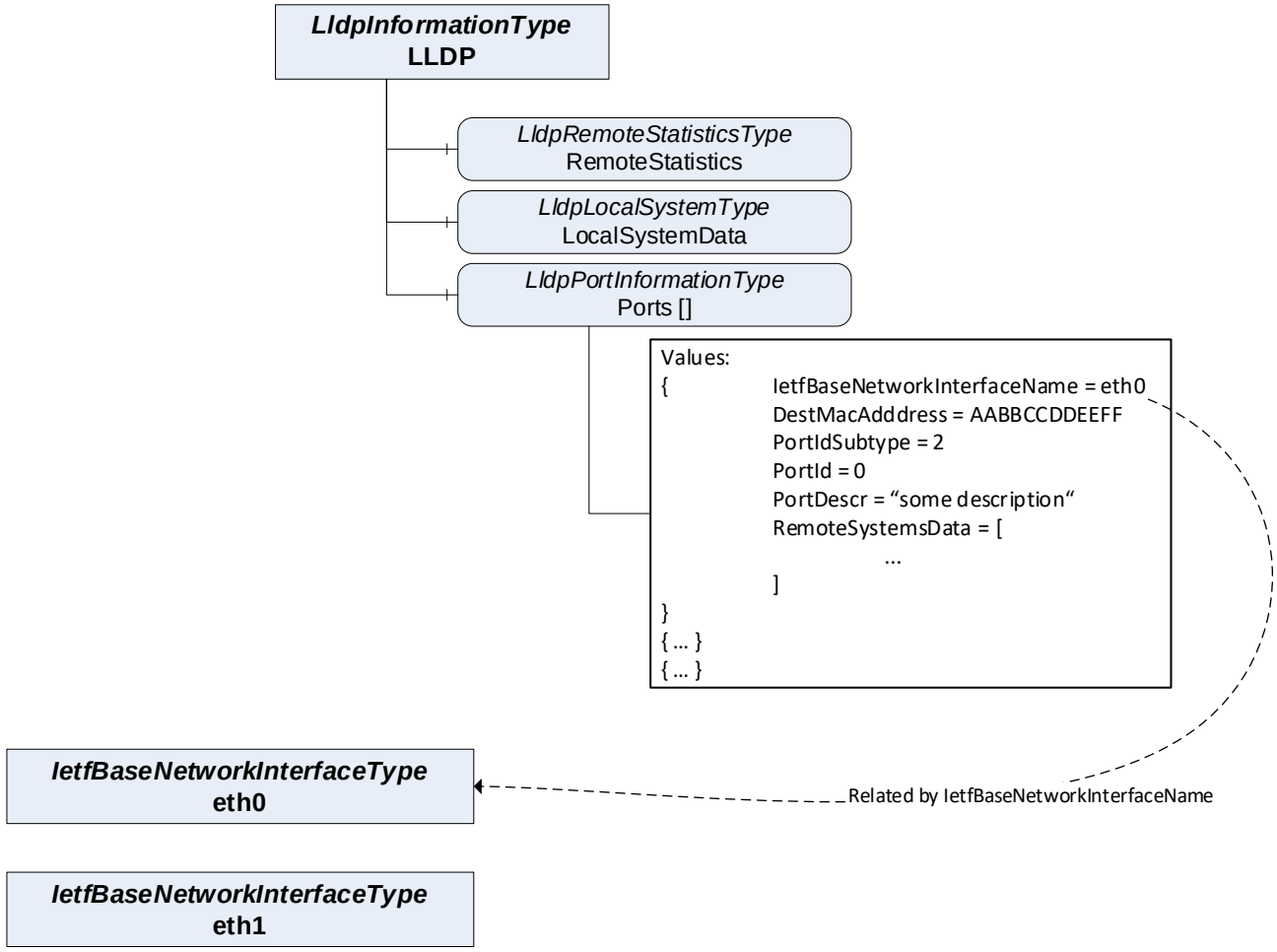


Figure A-4 – Connection between LLDP and IetfInterfaces

A.4 Topology Discovery with LldpRemoteSystems

LLDP exchanges information of the local system and its direct peers in the network through link-local communication. The local systems information of the peers is represented in the remote systems data structure. Figure A-5 shows an example for this connection between two different OPC UA *Servers* and their representation of the LLDP information. The *RemoteSystemsData* contains the information of the corresponding *LocalSystemsData* and *PortInformation*. For simplicity, this figure does not present all possible variables.

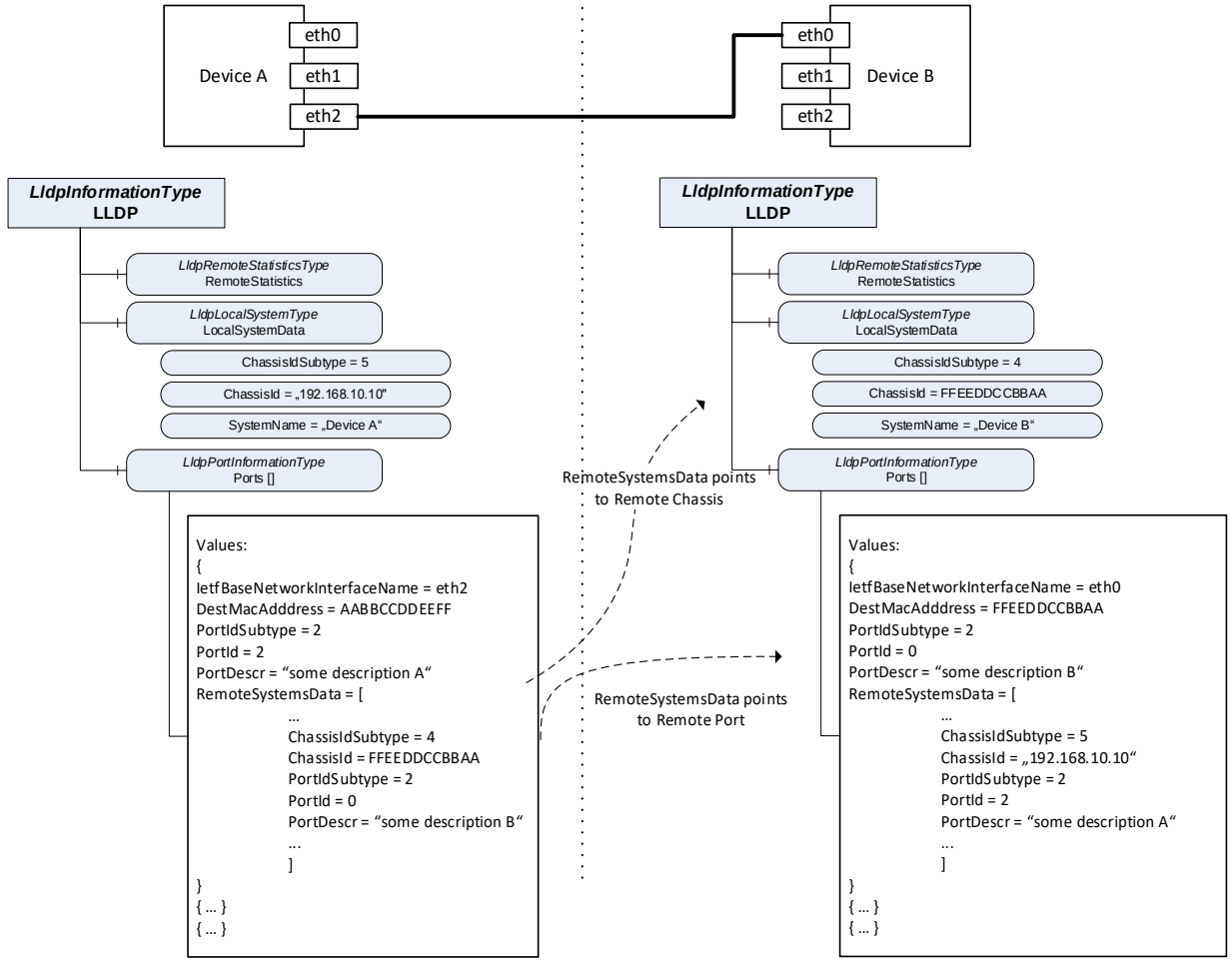


Figure A-5 – Topology Discovery via LLDP

A.5 Usage of BNM in other UA Specifications

A.5.1 Usage of BNM for PubSub over TSN

An example using the BNM for PubSub over TSN is shown in Figure A-6.

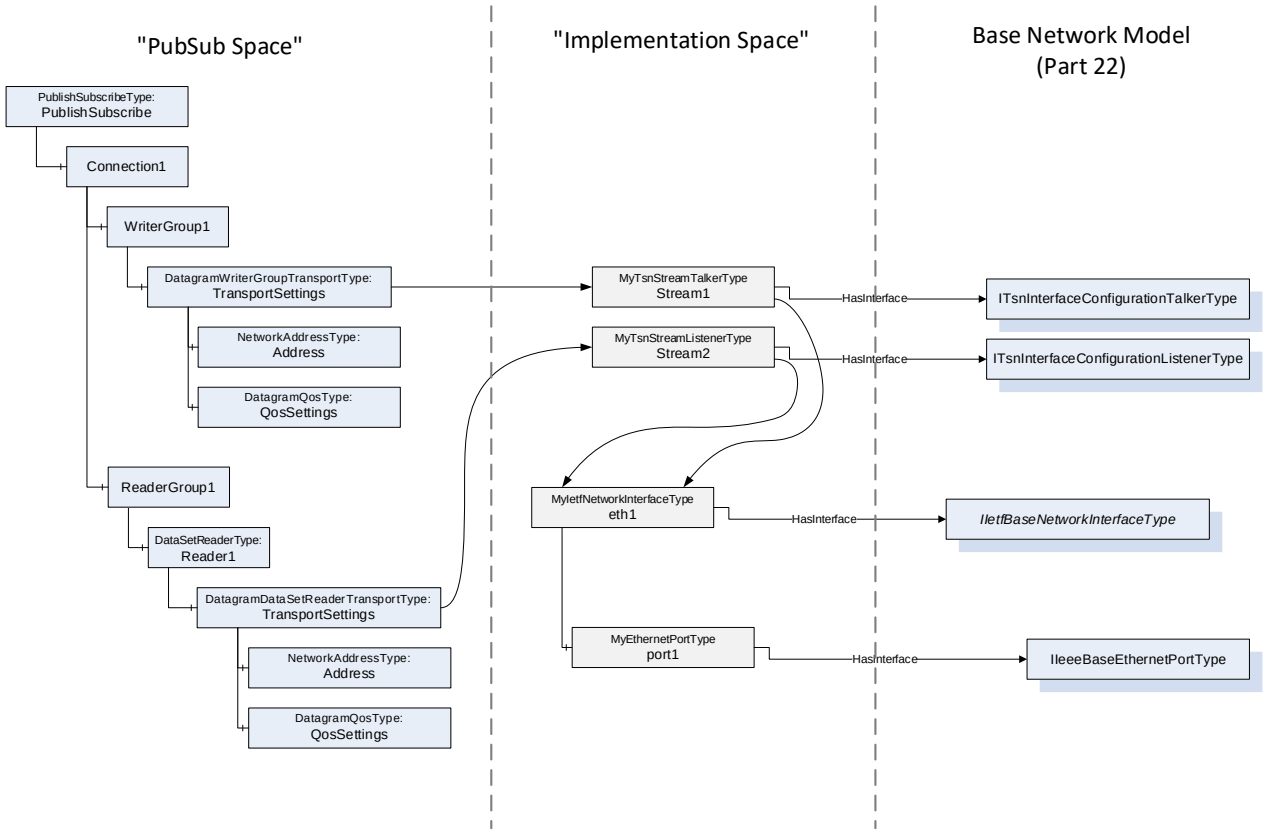


Figure A-6 – Possible Integration of BNM into PubSub

A.5.2 Usage of BNM in PROFINET Companion Spec

An example is shown in Figure A-7.

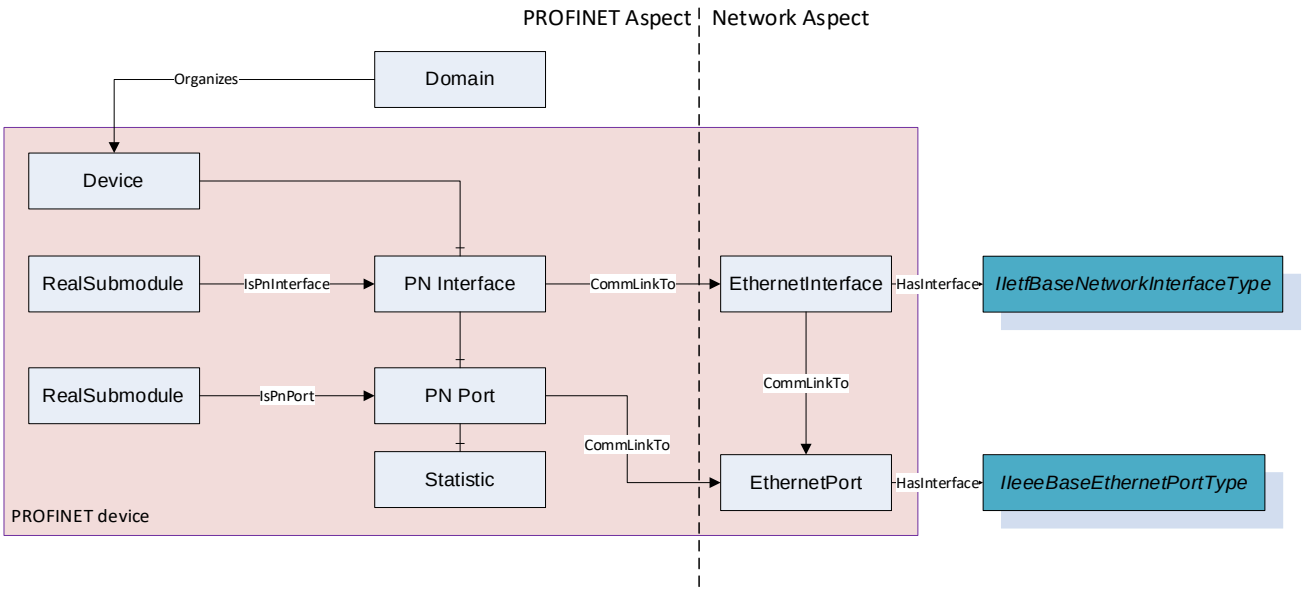


Figure A-7 – Recommended Integration of BNM into Companion Spec exemplified by PROFINET

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