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

Data over Transport – Generic aspects – Transport network control aspects

Management information model for management-control components and functions

Recommendation ITU-T G.7719

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
General	G.7000–G.7099
Transport network control aspects	**G.7700–G.7799**
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T G.7719

Management information model for management-control components and functions

Summary

Recommendation ITU-T G.7719 establishes a protocol-neutral information model to manage components that provide management and control (MC) functions for transport network resources. Management requirements for such MC components are specified in Recommendation ITU-T G.7718 to support the MC functions specified in Recommendations ITU-T G.7701, ITU-T G.7702 and ITU-T G.7703. The information model established in Recommendation ITU-T G.7719 is specified using the Unified Modeling Language (UML).

This Recommendation includes an electronic attachment with the UML model developed for the Recommendation.

History

Edition	Recommendation	Approval	Study Group	Unique ID[*]
1.0	ITU-T G.7718.1/Y.1709.1	2006-12-14	15	11.1002/1000/9002
2.0	ITU-T G.7719	2021-06-29	15	11.1002/1000/14711

Keywords

ASON, component, control, control domain, controller, management, protocol-neutral information model, SDN, UML, virtual network.

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[*] 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/11.1002/1000/11 830-en.

FOREWORD

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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Table of Contents

Electronic attachment : The Papyrus UML developed for the Recommendation.

Recommendation ITU-T G.7719

Management information model for management-control components and functions

1 Scope

This Recommendation[1] establishes a protocol-neutral information model to manage the components that provide management and control (MC) functions for transport network resources. The concept whereby MC functions are considered to be a continuum is known as the management-control continuum (MCC); i.e., it expresses the view that MC functions are essentially the same and thus can be grouped into one set. The management requirements for such MC components are specified in [ITU-T G.7718] to support the MC functions specified in [ITU-T G.7701], [ITU-T G.7702], and [ITU-T G.7703].

The information model established in this Recommendation is interface protocol neutral and specified using the Unified Modeling Language (UML). The information model is derived through pruning and refactoring the ITU-T G.7711 core information model, extended with MC function specific characteristics. The information model can be used to derive the data model to be used in the interface to the administrative context or to client contexts. The translation of the information model into the data model of a specific protocol, such as NETCONF/YANG, is a decision of protocol-specific modelling design and lies outside the scope of this Recommendation.

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.798]	Recommendation ITU-T G.798 (2017), *Characteristics of optical transport network hierarchy equipment functional blocks*.
[ITU-T G.874]	Recommendation ITU-T G.874 (2017), *Management aspects of optical transport network elements*.
[ITU-T G.7701]	Recommendation ITU-T G.7701 (2016), *Common control aspects*.
[ITU-T G.7702]	Recommendation ITU-T G.7702 (2018), *Architecture for SDN control of transport networks*.
[ITU-T G.7703]	Recommendation ITU-T G.7703 (2021), *Architecture for the automatically switched optical network*.
[ITU-T G.7711]	Recommendation ITU-T G.7711/Y.1702 (2018), *Generic protocol-neutral management information model for transport resources*.
[ITU-T G.7718]	Recommendation ITU-T G.7718/Y.1709 (2020), *Framework for the management of management-control components and functions*.

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[1] This Recommendation includes an electronic attachment with the UML developed for the Recommendation.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 component: [ITU-T G.7701].

3.1.2 connection controller (CC): [ITU-T G.7701].

3.1.3 discovery agent (DA): [ITU-T G.7701].

3.1.4 link resource manager (LRM): [ITU-T G.7701].

3.1.5 network call controller (NCC): [ITU-T G.7701].

3.1.6 protocol controller (PC): [ITU-T G.7701].

3.1.7 routing controller (RC): [ITU-T G.7701].

3.1.8 subnetwork point (SNP): [ITU-T G.7701].

3.1.9 subnetwork point pool (SNPP): [ITU-T G.7701].

3.1.10 termination and adaptation performer (TAP): [ITU-T G.7701].

3.1.11 virtual network (VN): [ITU-T G.7701].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BRI	Boundary Resource Identifier
CC	Connection Controller
CPI	Control Plane Interface
DA	Discovery Agent
DCN	Data Communication Network
EMS	Element Management System
FP	Forwarding Point
ID	Identifier
LRM	Link Resource Manager
MC	Management and Control
MCC	Management-Control Continuum
MCS	Management and Control System
NCC	Network Call Controller
NE	Network Element
NMS	Network Management System
OTN	Optical Transport Network

PC	Protocol Controller
PNG	Portable Network Graphic
RC	Routing Controller
SCN	Signalling Communication Network
SDN	Software-Defined Networking
SNP	Subnetwork Point
SNPP	Subnetwork Point Pool
TAP	Termination and Adaptation Performer
UML	Unified Modeling Language
VN	Virtual Network

5 Conventions

5.1 Information modelling conventions

5.1.1 UML modelling conventions

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

5.1.2 Model artefact lifecycle stereotype conventions

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

5.1.3 Forwarding entity terminology conventions

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

5.1.4 Conditional package conventions

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

5.1.5 Pictorial diagram conventions

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

6 Management requirements for management-control components and functions

The management of MC components and functions is part of the transport network MC as shown in Figure 6-2 of [ITU-T G.7701]. MC components themselves need to be managed or controlled to fulfil their intended functionality. Their requirements for management include that of faults, configuration (including lifecycle), accounts, performance and security.

[ITU-T G.7718] specifies the management requirements of MC components or functions established in [ITU-T G.7701], [ITU-T G.7702] and [ITU-T G.7703]. The management requirements of components in an MC system are established in a similar way to the relationship between a transport technology functional block model (e.g., [ITU-T G.798] for optical transport network (OTN) functional blocks) and its management requirements (e.g., [ITU-T G.874] for OTN management requirements).

MC components are modelled by pruning and refactoring model artefacts such as ControlConstruct, ConstraintDomain, ExposureContext and ControlPort that are specified in Annex H of

[ITU-T G.7711]. These objects need to be managed, including creation or deletion, for lifecycle management whenever a new client controller is connected to or disconnected from a server controller via the ControlPort.

Detailed management requirements of the MC components and functions are specified in clause 8 of [ITU-T G.7718]. Information models representing each control component and transport service are established in this Recommendation.

7 Management information model for management and control

Clause 6.8 and Annex H of [ITU-T G.7711] establish the general model suitable for representation of the capabilities that control the network and for representation of the relationship to the model of the network from the control perspective. This general control model can be used to model functional groupings, e.g., a software-defined networking (SDN) controller, giving a consistent view of the different elements in the control domain. The capability of the model is generalized so that it can handle all aspects of the management and control system (MCS).

7.1 Representation of a management and control system

In Figure 7-1, the control port, control construct and constraint domain represent the interface, functions and boundary respectively of an MCS managed by the administration role. The MCS could be an SDN controller, an element management system/network management system (EMS/NMS) or the equipment management function block of a network element (NE). Through the control constructs and control ports, the administration role can configure the MCS on initialization. If more than one server context is present in the associated constraint domain, the control constructs will also manage the links between the subnetworks in different server contexts.
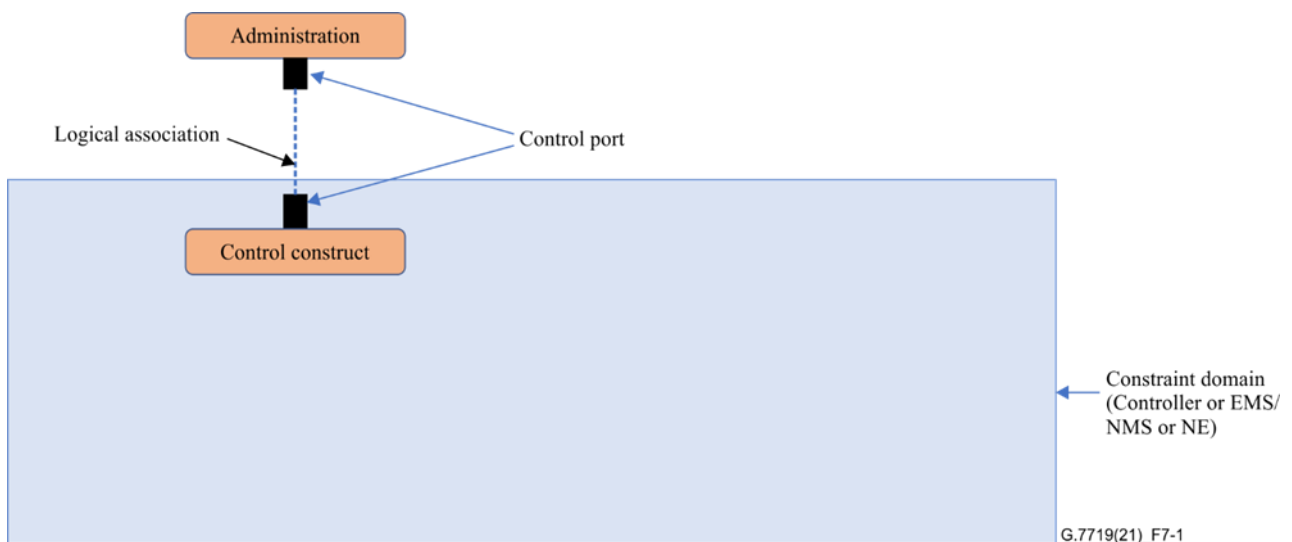
Figure 7-1 – Control construct for SDN controller or EMS/NMS or network element

In Figure 7-2, multiple constraint domains, control constructs and control ports are used to represent the contexts of a client, server and administration inside an SDN controller, which interacts with the other SDN controllers at adjacent levels.
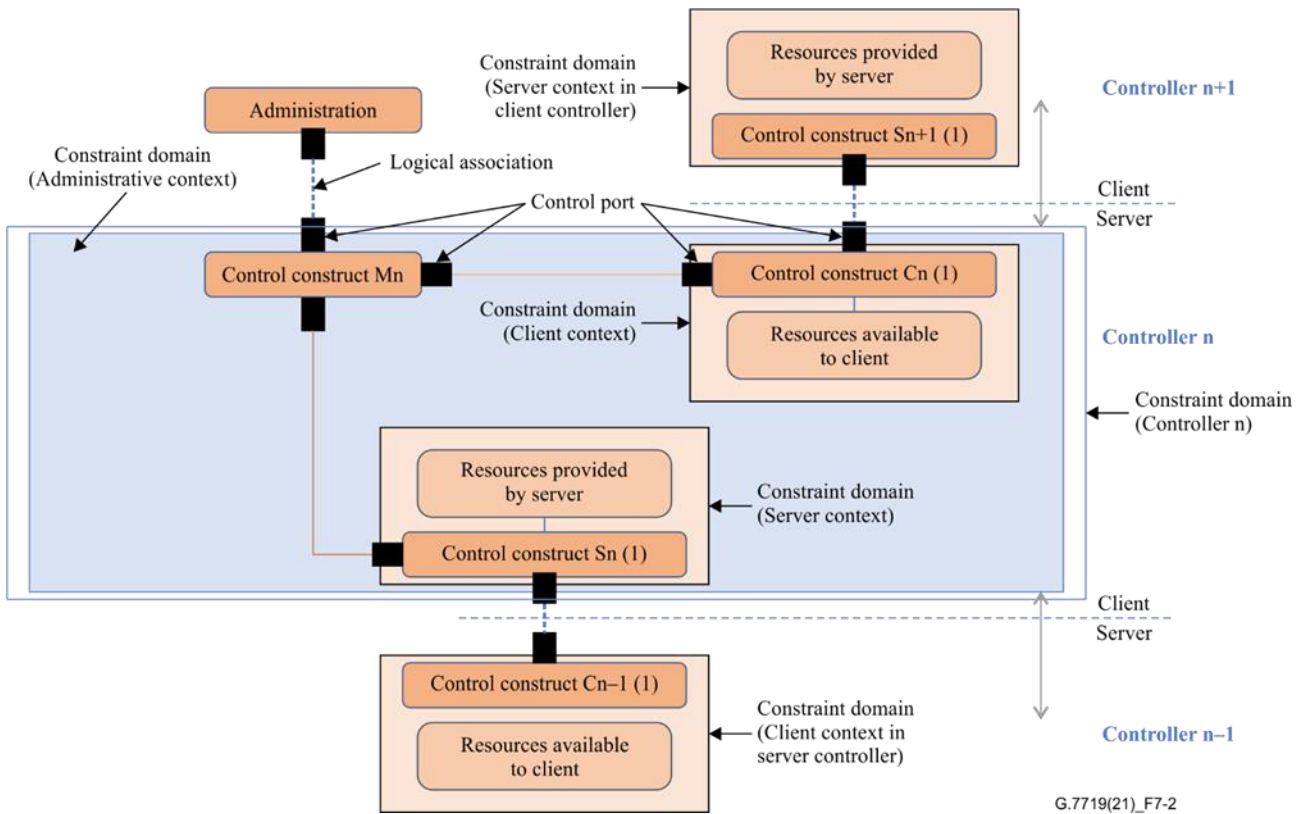
Figure 7-2 – ControlConstruct for SDN controller (Figure 3-14 of [b-ONF TR-512])

7.2 Representation of management-control components

7.2.1 Generic control model

Annex H of [ITU-T G.7711] provides the general control model. Figure 7-3 summarizes the control model.

The ConstraintDomain (CD) object class represents the boundary of a view that can represent the network resource or network control functions within its scope. An SDN controller can be represented by a ConstraintDomain object instance. Network resources and control functions inside a ConstraintDomain instance can be exposed to the client via a control port and then viewed by the client through the control plane interface (CPI).

The ExposureContext (EC) object class sets the rules and requirements for how the ConstraintDomain is to be exposed and can be accessed. The same resource can be exposed to different customers with different rules. The ExposureContext object class has an attribute pointing to a ConstraintDomain that determines the view of (i.e., groups of) the control functions or network resources to be exposed for management purposes. The ExposureContext has its lifecycle and different rules when it is exposed to different customers.

The ProcessingConstruct (PC) object class represents generalized processing functionality; it can be used to represent control processes.

The ControlConstruct (CtrlC) object class is a specialized PC. It represents the control capability and functionality. A ControlConstruct processes information to control other functions.

The ControlPort object class represents the port used for connections between controllers. Network resources and functions are exposed to client controllers via the ControlPort.
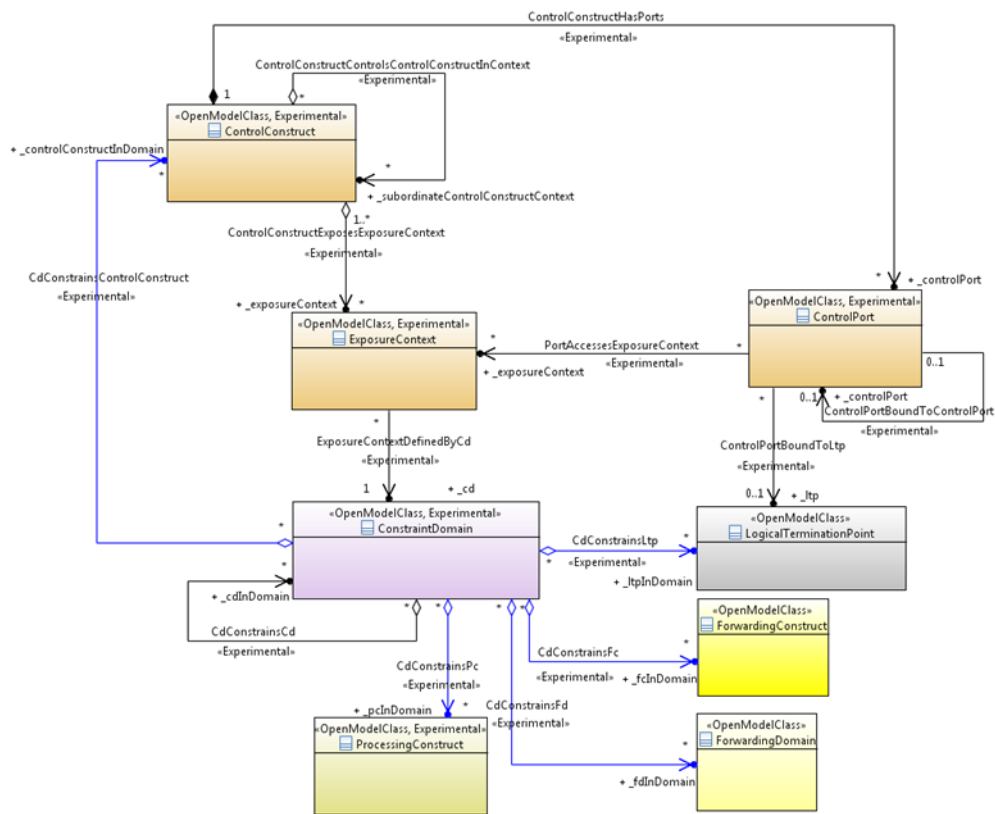
Figure 7-3 – Core control model summary (Figure H.1-3 of [ITU-T G.7711])

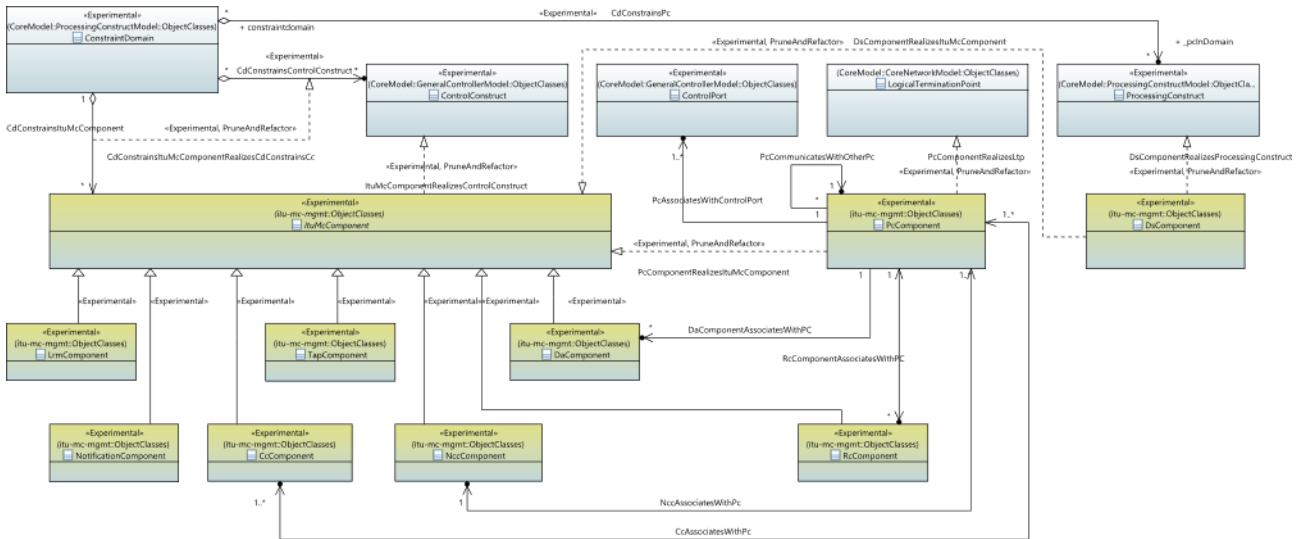### 7.2.2 Pruning and refactoring for management-control components

The information model established in this Recommendation is derived through pruning and refactoring the [ITU-T G.7711] model, extended with MC function specific characteristics. To represent the different MC components specified in [ITU-T G.7701], [ITU-T G.7702] and [ITU-T G.7703], augmentation to the pruned and refactored ControlConstruct, ProcessingConstruct and LogicTerminationPoint (LTP) object classes is needed.

A new abstract object class ItuMcComponent is a pruned and refactored class from ITU-T G.7711 ControlConstruct. It represents the common properties applicable to all MC components. To represent each specific control component, including NCC, CC, routing controller (RC), LRM, TAP and DA, specialized object classes are established by subclassing from ItuMcComponent with additional attributes that are specific for each MC control component.

The PC component is represented by the PcComponent object class, which is derived by pruning and refactoring the LTP object class. It represents both the protocol termination and control functions.

The directory service component is represented by the DsComponent, which is derived by pruning and refactoring the ProcessingConstruct object class.

The pruning and refactoring relationship of ITU-T G.7711 core object classes and the new object classes of this Recommendation are shown in Figure 7-4. Detailed attributes and relationships are shown in Figure 7-5.

Figure 7-4 – Pruning and refactoring for control components
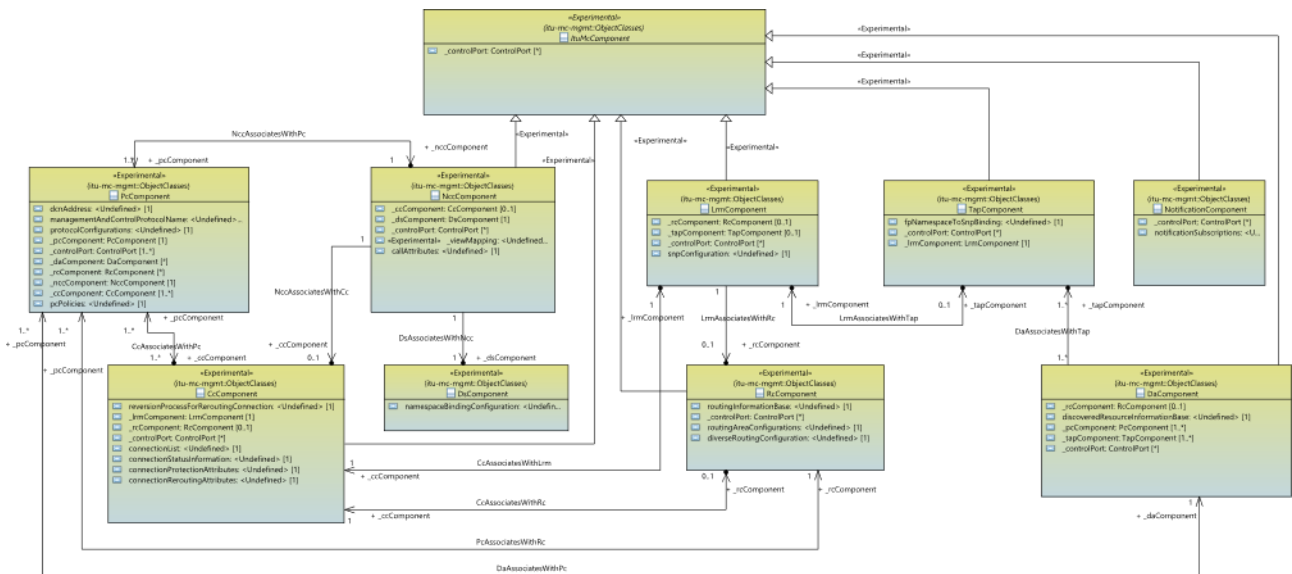
Figure 7-5 – Detail view of control components

7.3 Representation of contexts

The ClientContext, ServerContext and AdministrativeContext object classes are derived in this Recommendation by pruning and refactoring the ITU-T G.7711 ConstraintDomain object class. Additional classes that contain context-specific attributes are also derived for decorating or augmenting these context object classes.

The ITU-T G.7711 ExposureContext object class represents that which can be accessed through a ControlPort and the rules regarding who can access the resources exposed by the ExposureContext. The ExposureContext object class exposes the highest-level (outermost) ConstraintDomain object class, which can contain multiple lower level (inner) ConstraintDomains. A new object class IteExposureContext is derived by pruning and refactoring ExposureContext, extended with additional attributes for management purposes.

Multiple ExposureContext instances can be created within a ClientContext, ServerContext and AdministrativeContext to represent different exposure policies and scopes.

The ViewMappingFunction translates the resources, reserved for a specific client, inside the ClientContext instance to a view to be exposed to the upper level controller. Namespace translation may be needed if a different namespace is used by the exposed view from the namespace used in the local resource database.

The ViewMappingFunction in the server context translates the resources in a view exposed by the lower level controller to the local resource database; a namespace may be translated if different namespaces are used.

The pruning and refactoring of the ITU-T G.7711 ClientContext, ServerContext, AdministrativeContext and ExposureContext object classes are shown in Figure 7-6. Detailed attributes of these object classes are shown in Figure 7-7.
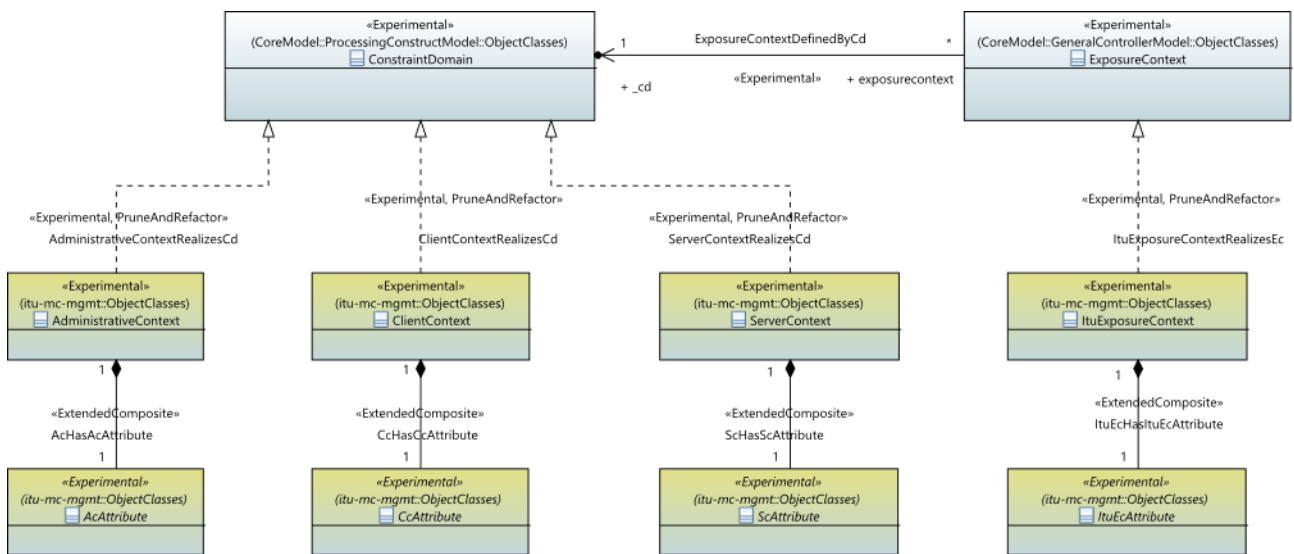
Figure 7-6 – Pruning and refactoring for context
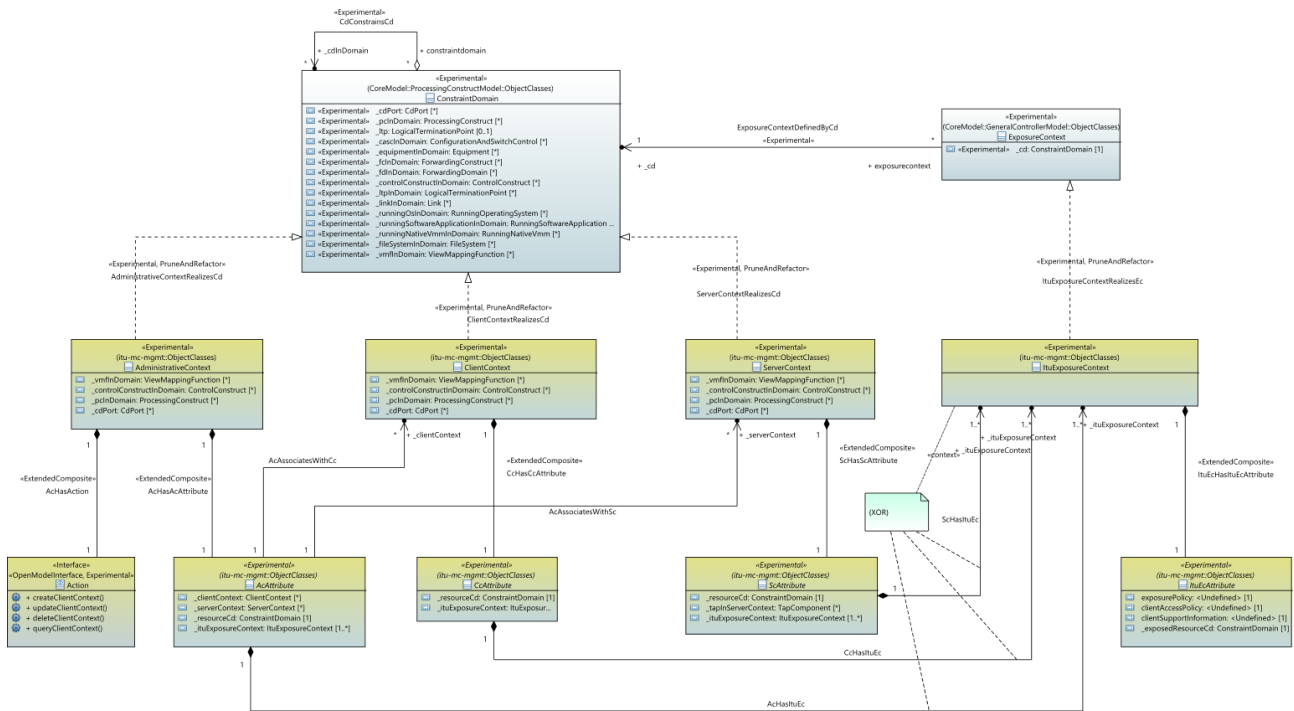
Figure 7-7 – Detailed view of context

7.3.1 Client context model

The ClientContext object class has a subset of the attributes of ConstraintDomain as shown in Figure 7-7. Additional attributes for client context are modelled by a new abstract object class CcAttribute which decorates ClientContext, e.g., pointing to the grouping (via the ConstraintDomain instance) of resources reserved for the client and the ItuExposureContext instance(s) within the client context as shown in Figure 7-7.

7.3.2 Server context model

The ServerContext object class has a subset of attributes of ConstraintDomain as shown in Figure 7-7. Besides these attributes, server context has additional parameters, e.g., pointing to the TAP component, which performs the forwarding point (FP) namespace to SNPP namespace binding when the ServerContext has the visibility of the FP name space.

The ServerContext object class retains some attributes of ConstraintDomain, including pointing to ControlConstructs that represent the control functions. The control construct in the server context communicates with the corresponding control construct in the client context of the server controller to manage and control the resources. The new attributes for ServerContext are established in a new abstract object class ScAttribute. One new attribute is a pointer to ConstraintDomain and this ConstraintDomain contains the objects representing the set of network resources provided by the lower level controller.

The attributes for ServerContext and ScAttribute are shown in Figure 7-7. These attributes are determined based on the specification, function and management requirements of server context in clause 6.5.2.3 of [ITU-T G.7718], Figure 7-1 of [ITU-T G.7702] and [ITU-T G.7711].

7.3.3 Administrative context model

The administrative context is modelled as AdministrativeContext by pruning and refactoring the ITU-T G.7711 ConstraintDomain object class. It retains some of the attributes of ConstraintDomain

and is extended with additional attributes established in a new abstract class AcAttribute as shown in Figure 7-6 and Figure 7-7.

The AdministrativeContext object class represents a set of information used by the administration role, which has unrestricted visibility and authority to perform all necessary operations on the resources within its scope. New ClientContext, ServerContext and ExposureContext instances can be created via the AdministrativeContext.

The attributes, operations for AdministrativeContext and AcAttribute are shown in Figure 7-7. These attributes are determined based on the definition, function and management requirements of the administrative context in clause 9 of [ITU-T G.7718] and [ITU-T G.7711].

7.4 Interworking of client, server and administrative contexts

Figure 7-8 illustrates interworking among the administrative, client and server contexts. It shows, as examples, the interactions among the ConstraintDomain (CD), ControlConstruct (CC), ExposureContext, and ViewMappingFunction (Vmf) object instances. Note that in Figure 7-8, the details of the VN views are intentionally not shown for simplicity. The transport resources and the topology of a VN can be represented by using object classes such as LTP, ForwardingDomain (FD), ForwardingConstruct (FC) and Link.
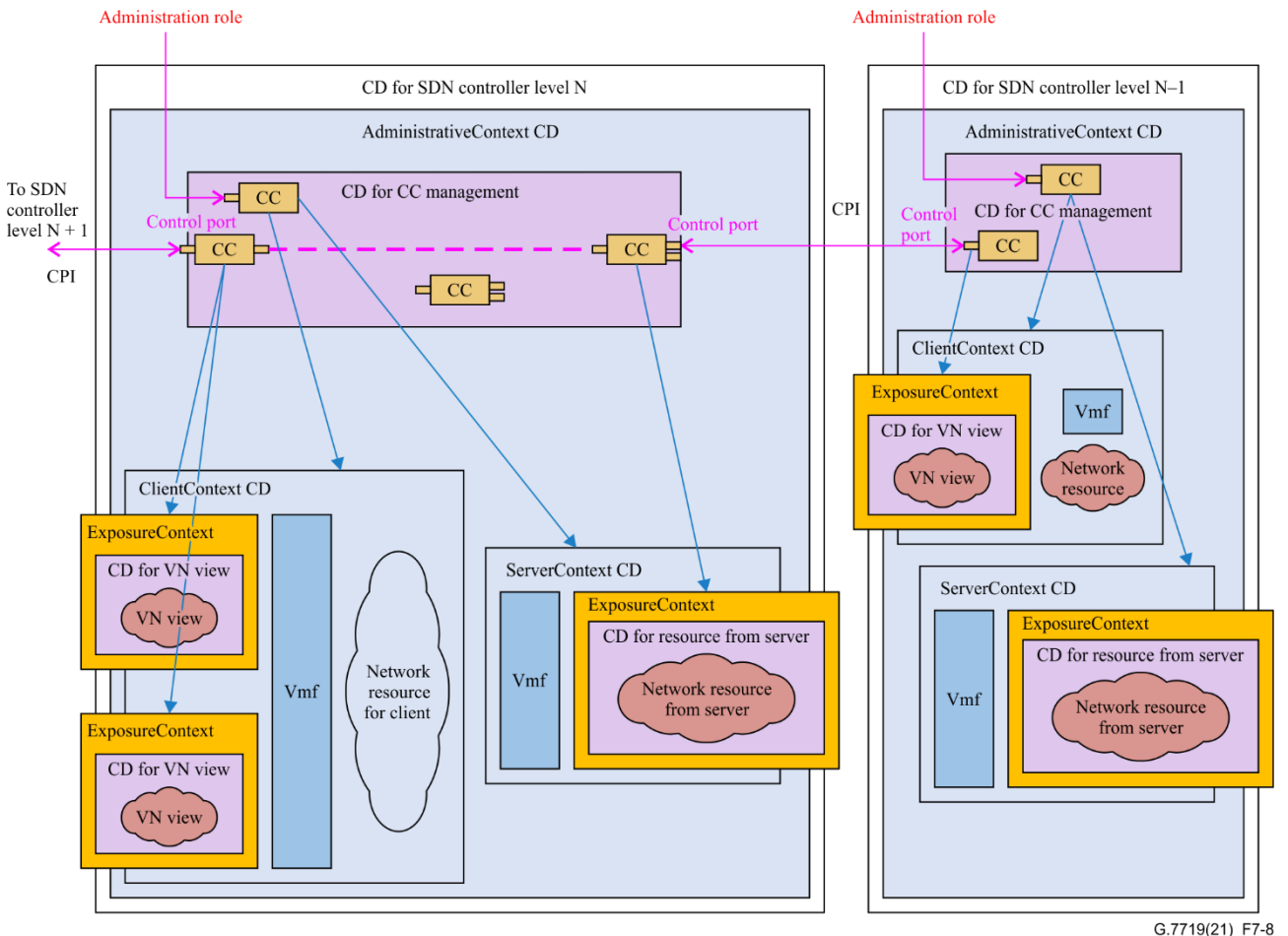

Figure 7-8 – Interworking between contexts

7.5 Management-control component attributes

7.5.1 PcComponent attributes

Attribute name	Description	Related Recommendations
pcIdentifier	PC component supports the configuration of unique identifier (ID) for their points of attachment to the data communication network (DCN), signalling communication network (SCN).	Clause 8.2.1 of [ITU-T G.7718]
dcnAddress	The DCN address of the PC component. The DCN address depends on the DCN technology used.	[ITU-T G.7712]
managementAndControlProtocolName	The management and control protocol name	
protocolConfigurations	Configurations for a specific protocol	
_controlPort	Protocol control component communicates with other PC via a list of control port	
pcPolicies	Protocol control policies	Clause 8.2.1 of [ITU-T G.7718]
_ccComponent	The association with CC	
_pcComponent	The association with PC	
_daComponent	The association with DA	
_rcComponent	The association with RC	
_nccComponent	The association with NCC	

7.5.2 NccComponent attributes

Attribute name	Description	Related Recommendations
callAttributes	The attributes of the calls	Clause 8.2.2 of ITU-T G.7718
_ccComponent	The association with CC	
_dsComponent	The association with DS	
_controlPort	Protocol control component communicates with other PC via a control port	
_viewMapping	The association with view mapping functions	

7.5.3 DsComponent attributes

Attribute name	Description	Related Recommendations
nameSpaceBindingConfiguration	Name space binding	Clause 8.2.3 of [ITU-T G.7718]

7.5.4 TapComponent attributes

Attribute name	Description	Related Recommendations
fpNamespaceToSNPBinding	The binding relationship between FP and SNP	Clause 8.2.4 of [ITU-T G.7718]
_controlPort	Protocol control component communicates with other PC via a control port	
_lrmComponent	The association with LRM	

7.5.5 LrmComponent attributes

Attribute name	Description	Related Recommendations
snpConfiguration	Configuration information for the SNPP	Clause 8.2.5 of [ITU-T G.7718]
_controlPort	Protocol control component communicates with other PC via a control port	
_rcComponent	The association with RC	
_tapComponent	The association with TAP	

7.5.6 RcComponent attributes

Attribute name	Description	Related Recommendations
routingInformationBase	The routing information within the RC	Clause 8.2.6 of [ITU-T G.7718]
_controlPort	Protocol control component communicates with other PC via a control port	
routingAreaConfigurations	Configuration information for routing area	Clause 8.2.6 of [ITU-T G.7718]
diverseRoutingConfiguration	Configuration information for diverse routing	Clause 8.2.6 of [ITU-T G.7718]

7.5.7 CcComponent attributes

Attribute name	Description	Related Recommendations
connectionList	List of connections managed by connection control component	Clause 8.2.7 of [ITU-T G.7718]
connectionStatusInformation	Status of connections	Clause 8.2.7 of [ITU-T G.7718]
connectionProtectionAttributes	Configurations about connection protection	Clause 8.2.7 of [ITU-T G.7718]
connectionReroutingAttributes	Configurations about connection re-routing	Clause 8.2.7 of [ITU-T G.7718]
_lrmComponent	The association with LRM	
_rcComponent	The association with RC	

Attribute name	Description	Related Recommendations
_controlPort	Protocol control component communicates with other PC via a control port	

7.5.8 DaComponent attributes

Attribute name	Description	Related Recommendations
discoveredResourceInformationBase	Information about the discovered peers	Clause 8.2.8 of [ITU-T G.7718]
discoveryDisclosureInformation	Information disclosed to peers	Clause 8.2.8 of [ITU-T G.7718]
_pcComponent	The association with PC	
_rcComponent	The association with RC	
_tapComponent	The association with TAP	
_controlPort	Protocol control component communicates with other PC via a control port	

7.5.9 NotificationComponent attributes

Attribute name	Description	Related Recommendations
_controlPort	Notification through a ControlPort	
notificationSubscriptions	Notification subscriptions	Clause 8.2.9 of [ITU-T G.7718]

7.6 Context attributes

7.6.1 AdministrativeContext attributes

Attribute name	Description	Related Recommendations
_vmfInDomain	View mapping function in the AdministrativeContext	
_controlConstructInDomain	Control constructs in the CD	
_pcInDomain	Processing constructs in the CD	
_cdPort	Constraint domain port	

7.6.2 AcAttribute attributes

Attribute name	Description	Related Recommendations
_resourceCd	The resource constraint domain	
_clientContext	The ClientContext in AdministrativeContext	[ITU-T G.7718]
_serverContext	The ServerContext in AdministrativeContext	[ITU-T G.7718]
_ituExposureContext	The ExposureContext in ServerContext	[ITU-T G.7718]

7.6.3 AcAction

Action name	Description	Related Recommendations
createClientContext	The action of creating a ClientContext	[ITU-T G.7718]
updateClientContext	The action of updating a ClientContext	[ITU-T G.7718]
deleteClientContext	The action of deleting a ClientContext	[ITU-T G.7718]
queryClientContext	The action of querying a ClientContext	[ITU-T G.7718]

7.6.4 ClientContext attributes

Attribute name	Description	Related Recommendations
_vmfInDomain	View mapping function in the ClientContext	
_controlConstructInDomain	Control constructs in the CD	
_pcInDomain	Processing constructs in the CD	
_cdPort	Constraint domain port	

7.6.5 CcAttribute attributes

Attribute name	Description	Related Recommendations
_resourceCd	The resource constraint domain	
_ituExposureContext	The ExposureContext in ClientContext	

7.6.6 ServerContext attributes

Attribute name	Description	Related Recommendations
_vmfInDomain	View mapping function in the ServerContext	
_controlConstructInDomain	Control constructs in the CD	
_pcInDomain	Processing constructs in the CD	
_cdPort	Constraint domain port	

7.6.7 ScAttribute attributes

Attribute name	Description	Related Recommendations
_resourceCd	The resource constraint domain	
_tapInServerContext	The TAP in the ServerContext	
_ituExposureContext	The ExposureContext in ServerContext	

7.6.8 ItuEcAttribute attributes

Attribute name	Description	Related Recommendations
exposurePolicy	The policy of exposure	
clientAccessPolicy	The TAP in the ServerContext	
clientSupportInformation	The ExposureContext in ServerContext	
_exposedResourceCd	ConstraintDomain be exposed	

8 UML model file

The UML model for this Recommendation developed using the Papyrus open-source modelling tool [b-Eclipse-Papyrus] can be found at https://www.itu.int/ITU-T/formal-language/itu-t/g/g7719/2021/g7719_v1.06_uml.zip.

This zip file contains the following folders:

- The G.7719_v1.06 folder, which contains the following files:
    - The Papyrus project file.
        - o .project.
    - The .di, .notation, and .uml files of the itut-mc-mgmt module.
        - o itut-mc-mgmt.di;
        - o itut-mc-mgmt.notation;
        - o itut-mc-mgmt.uml.
    - The UmlProfiles sub-folder, which contains the UML Profiles that establish the properties of the UML artefacts.
        - o The OpenModelProfile folder, which contains the .di, .notation, and uml of the *open model profile*;
        - o The OpenInterfaceModelProfile folder, which contains the .di, .notation, and uml of the *open model interface profile*;
        - o The ProfileLifecycleProfile folder, which contains the .di, .notation, and uml of the *profile lifecycle profile*;
        - o The ClassDiagramStyleSheet.css style sheet.
    - The OnfModel sub-folder, which contains the ITU-T G.7711 Core model (identical to the Open Network Foundation (ONF) Core model [b-ONF TR-512]) that is needed (i.e., imported) by the ITU-T G.7719 model.
    - The diagrams sub-folder, which contains the portable network graphic (PNG) images of all the class diagrams.

To load the ITU-T G.7719 UML model into an Eclipse Papyrus workspace, proceed as follows.

- In the Project Explorer / right click / Import / General / Projects from Folder or Archive / Next / Archive / Select the [ITU-T G.7719] zip file / Open / Select the folders of the models to be loaded (NOTE) / Finish.

NOTE – If a supporting (i.e., to be imported by [ITU-T G.7719]) model already exists in the workspace, do not select it for loading.

Bibliography

[b-ITU-T G.7710]   Recommendation ITU-T G.7710/Y.1701 (2020), *Common equipment management function requirements*.

[b-Eclipse-Papyrus] Eclipse Foundation (2020). *Eclipse Papyrus: Modeling environment,* v5.0.0. Available [viewed 2021-08-27] at: https://www.eclipse.org/papyrus/

[b-ONF TR-512]   ONF TR-512 (2018), *Core information model (CoreModel)*, v1.4. Available [viewed 2021-08-27] at: https://www.opennetworking.org/wp-content/uploads/2018/12/TR-512_v1.4_OnfCoreIm-info.zip

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