

DIN EN 62769-5

ICS 35.240.50

Einsprüche bis 2013-03-07

Entwurf**Feldgeräteintegration (FDI) –
Teil 5: FDI-Informationsmodell
(IEC 65E/263/CD:2012), Text in Englisch**

Field Device Integration (FDI) –
Part 5: FDI Information Model
(IEC 65E/263/CD:2012), Text in English

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Gesamtumfang 81 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Nationales Vorwort

Die englische Originalfassung des internationalen Dokuments IEC 65E/263/CD:2012 „Field Device Integration (FDI) – Part 5: FDI Information Model“ (CD, en: Committee Draft) ist unverändert in diesen Norm-Entwurf übernommen worden.

Das internationale Dokument wurde vom SC 65E „Devices and integration in enterprise systems“ der Internationalen Elektrotechnischen Kommission (IEC) erarbeitet und den nationalen Komitees zur Stellungnahme vorgelegt.

Die IEC und das Europäische Komitee für Elektrotechnische Normung (CENELEC) haben vereinbart, dass ein auf IEC-Ebene erarbeiteter Entwurf für eine Internationale Norm zeitgleich (parallel) bei IEC und CENELEC zur Umfrage (CDV-Stadium) und Abstimmung als FDIS (en: Final Draft International Standard) bzw. Schluss-Entwurf für eine Europäische Norm gestellt wird, um eine Beschleunigung und Straffung der Normungsarbeit zu erreichen. Dokumente, die bei CENELEC als Europäische Norm angenommen und ratifiziert werden, sind unverändert als Deutsche Normen zu übernehmen.

Da der Abstimmungszeitraum für einen FDIS bzw. Schluss-Entwurf prEN nur 2 Monate beträgt, und dann keine sachlichen Stellungnahmen mehr abgegeben werden können, sondern nur noch eine „JA/NEIN“-Entscheidung möglich ist, wobei eine „NEIN“-Entscheidung fundiert begründet werden muss, wird bereits der CD als DIN-Norm-Entwurf veröffentlicht, um die Stellungnahmen aus der Öffentlichkeit frühzeitig berücksichtigen zu können.

Für dieses Dokument ist das nationale Arbeitsgremium K 956 „Feldbus“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

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Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

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Da sich die Benutzer des vorliegenden Normentwurfs der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der IEC 62769-5 veröffentlicht. Zu deren Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA des vorliegenden Normentwurfs hinzugefügt. Für viele der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Dieser Normentwurf steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Es ist vorgesehen, auch bei der entsprechenden zukünftigen Deutschen Norm auf die deutsche Sprachfassung zu verzichten und diese in der englischsprachigen Fassung zu veröffentlichen.

Nationaler Anhang NA (informativ)

3 Begriffe, Abkürzungen und Konventionen

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach IEC 62769-1.

– Leerseite –

CONTENTS

FOREWORD.....	5006
1 Scope.....	5008
2 Normative references	5008
3 Terms, definitions, abbreviated terms, acronyms and conventions.....	5009
3.1 Terms and definitions	5009
3.2 Abbreviated terms and acronyms	5009
3.3 Conventions for graphical notation	5010
4 General information to OPC Unified Architecture	5012
4.1 General.....	5012
4.2 General information to OPC UA Devices	5012
5 Concepts.....	5015
5.1 General.....	5015
5.2 Device Topology.....	5015
5.3 Online / Offline	5016
5.4 Catalogue (Type Definitions)	5017
5.5 Communication	5017
5.6 Type and Instance Extensions for FDI (AddIn capability)	5017
6 AddressSpace Organization	5019
7 Device Model Extensions for FDI	5021
7.1 General.....	5021
7.2 Online / Offline	5021
7.2.1 General	5021
7.2.2 IsOnline ReferenceType	5022
7.2.3 Offline-Online Data Transfer	5023
7.2.4 TransferResult DataType	5024
7.3 Device Health.....	5024
7.4 User Interface Elements	5025
7.4.1 General	5025
7.4.2 UIElement Type.....	5026
7.4.3 UI Description Type.....	5026
7.4.4 UI Plug-in Type.....	5027
7.5 Type-specific support information	5028
7.5.1 Device Type Image.....	5029
7.5.2 Documentation	5030
7.5.3 Protocol Support Files	5030
7.5.4 Images	5030
7.6 Actions.....	5030
7.6.1 Overview	5030
7.6.2 Action Type	5032
7.6.3 ActionService Type.....	5032
7.6.4 ActionService Object	5033
7.6.5 InvokeAction Method	5034
7.6.6 RespondAction Method.....	5035
7.6.7 AbortAction Method	5035
8 Network and Connectivity	5036
8.1 General.....	5036

8.2	Network.....	5037
8.3	ConnectionPoint.....	5038
8.4	ConnectsTo ReferenceType	5039
9	AddIn Capabilities	5041
9.1	Overview	5041
9.2	Locking	5041
9.2.1	Overview	5041
9.2.2	LockingServices Type.....	5041
9.2.3	LockingServices Object	5043
9.2.4	MaxInactiveLockTime Property	5043
9.2.5	InitLock Method	5044
9.2.6	ExitLock Method	5045
9.2.7	RenewLock Method	5045
9.2.8	BreakLock Method	5046
9.3	Edit Mode.....	5046
9.3.1	Overview	5046
9.3.2	EditMode Type	5047
9.3.3	EditMode Object	5048
9.3.4	EnterEditMode Method	5048
9.3.5	ExitEditMode Method.....	5049
9.3.6	AbortEditMode Method	5049
9.4	Direct Device Access	5050
9.4.1	General	5050
9.4.2	DirectDeviceAccess Type	5051
9.4.3	DirectDeviceAccess Object.....	5052
9.4.4	InitDirectAccess Method	5052
9.4.5	EndDirectAccess Method.....	5053
9.4.6	Transfer Method	5053
10	Parameter Types	5055
10.1	General	5055
10.2	Enumerated Parameters.....	5056
10.3	BitEnumerated Parameters.....	5056
11	Specialized Topology Elements	5057
11.1	General	5057
11.2	Modular Devices.....	5057
12	Auditing.....	5059
12.1	General	5059
12.2	FDI Client-provided context information.....	5059
12.3	LogAuditTrailMessage Method	5059
13	FDI Server Version.....	5061
14	Mapping FDI Package Information to the FDI Information Model.....	5062
14.1	General.....	5062
14.2	Localization.....	5062
14.2.1	Localized Text	5062
14.2.2	Engineering Units	5062
14.3	Device.....	5062
14.3.1	General	5062
14.3.2	Mapping to Attributes to a specific DeviceType Node.....	5062

14.3.3 Mapping to Properties	5063
14.3.4 Mapping to ParameterSet	5063
14.3.5 Mapping to Functional Groups	5063
14.3.6 Mapping to DeviceTypeImage.....	5063
14.3.7 Mapping to Documentation	5064
14.3.8 Mapping to ProtocolSupport	5064
14.3.9 Mapping to ImageSet.....	5064
14.3.10 Mapping to ActionSet	5064
14.3.11 Mapping to MethodSet.....	5064
14.4 Block	5064
14.4.1 General	5064
14.4.2 Mapping to Attributes.....	5064
14.4.3 Mapping to ParameterSet	5064
14.4.4 Mapping to Functional Groups	5065
14.4.5 Mapping to ActionSet	5065
14.4.6 Mapping to MethodSet.....	5065
14.4.7 Instantiation Rules	5065
14.5 Parameter	5065
14.5.1 General	5065
14.5.2 Private Parameters	5069
14.5.3 Arithmetic Parameters	5069
14.5.4 Enumerated Parameters	5069
14.5.5 Bit-enumerated Parameters	5070
14.5.6 Representation of records	5070
14.5.7 Representation of arrays, and lists of Parameters with simple data types	5071
14.5.8 Representation of values arrays, and lists of RECORD Parameters	5071
14.6 Functional Groups	5072
14.7 Actions	5072
14.8 UIPs	5073
14.9 Protocols, Networks and Connection Points	5073
Annex A (informative) Namespace and Mappings	5074
Bibliography.....	5076
Figure 1 – FDI architecture diagram	5008
Figure 2 – OPC UA Graphical Notation for NodeClasses	5010
Figure 3 – OPC UA Graphical Notation for References	5010
Figure 4 – OPC UA Graphical Notation Example	5011
Figure 5 – Optimised Type Reference	5011
Figure 6 – OPC UA Devices Example: Functional Groups	5013
Figure 7 – OPC UA Devices Example : Configurable components	5014
Figure 8 – Example of an Automation System	5015
Figure 9 – Example of a Device Topology	5016
Figure 10 – Example Device Types representing a Catalogue	5017
Figure 11 – Standard AddressSpace Structure.....	5019
Figure 12 – Online component for access to device data	5021
Figure 13 – Type Hierarchy for IsOnline Reference	5022

Figure 14 – UserInterface Types and their Association with FunctionalGroups	5025
Figure 15 – Integration of support information within a DeviceType	5029
Figure 16 – Integration of Actions within a TopologyElement	5031
Figure 17 – Action Service	5033
Figure 18 – Initial Example of a Device Topology	5036
Figure 19 – NetworkType	5037
Figure 20 – Example of ConnectionPointType Hierarchy	5038
Figure 21 – ConnectionPointType	5038
Figure 22 – ConnectionPoint Usage	5039
Figure 23 – Type Hierarchy for ConnectsTo Reference	5040
Figure 24 – Example with ConnectsTo Reference	5040
Figure 25 – LockingServicesType	5041
Figure 26 – Locking Services	5043
Figure 27 – Edit Mode	5048
Figure 28 – DirectDeviceAccessType	5051
Figure 29 – DirectDeviceAccess Instance	5052
Figure 30 – OPC UA VariableTypes including OPC UA DataAccess	5055
Figure 31 – Enumeration Type with example	5056
Figure 32 – Modular Device Structure	5057
Figure 33 – Example: Complex variable representing a RECORD	5070
Figure 34 – Complex variable representing a VALUE_ARRAY of RECORD's	5071
Table 1 – OnlineAccess Property Definition	5020
Table 2 – IsOnline ReferenceType	5022
Table 3 – TransferToDevice Method Arguments	5023
Table 4 – TransferToDevice Method AddressSpace Definition	5023
Table 5 – TransferFromDevice Method Arguments	5024
Table 6 – TransferFromDevice Method AddressSpace Definition	5024
Table 7 – TransferResult DataType Structure	5024
Table 8 – DeviceHealth Property Definition	5024
Table 9 – FunctionalGroupType with additions for UI elements	5026
Table 10 – UIElementType Definition	5026
Table 11 – UIDescriptionType Definition	5026
Table 12 – UIPlugInType Definition	5027
Table 13 – DeviceType with additions for support information	5029
Table 14 – TopologyElementType with additions for Actions	5031
Table 15 – FunctionalGroupType with additions for Actions	5031
Table 16 – ActionType Definition	5032
Table 17 – ActionServiceType Definition	5032
Table 18 – ActionService Instance Definition	5033
Table 19 – InvokeAction Method Arguments	5034
Table 20 – InvokeAction Method AddressSpace Definition	5034
Table 21 – RespondAction Method Arguments	5035

Table 22 – RespondAction Method AddressSpace Definition	5035
Table 23 - AbortAction Method Arguments	5036
Table 24 – AbortAction Method AddressSpace Definition	5036
Table 25 – NetworkType Definition	5037
Table 26 – ConnectionPointType Definition.....	5039
Table 27 – ConnectsTo ReferenceType	5040
Table 28 – LockingServicesType Definition.....	5042
Table 29 – LockingServices Instance Definition	5043
Table 30 – MaxInactiveLockTime Property Definition	5044
Table 31 – InitLock Method Arguments	5044
Table 32 – InitLock Method AddressSpace Definition.....	5044
Table 33 – ExitLock Method Arguments	5045
Table 34 – ExitLock Method AddressSpace Definition.....	5045
Table 35 – RenewLock Method Arguments	5045
Table 36 – RenewLock Method AddressSpace Definition	5045
Table 37 – BreakLock Method Arguments	5046
Table 38 – BreakLock Method AddressSpace Definition	5046
Table 39 – EditModeType Definition	5047
Table 40 – EditMode Instance Definition	5048
Table 41 – EnterEditMode Method Arguments	5049
Table 42 – EnterEditMode Method AddressSpace Definition	5049
Table 43 – ExitEditMode Method Arguments.....	5049
Table 44 – ExitEditMode Method AddressSpace Definition	5049
Table 45 – AbortEditMode Method Arguments	5050
Table 46 – AbortEditMode Method AddressSpace Definition	5050
Table 47 – DirectDeviceAccessType Definition	5051
Table 48 – DirectDeviceAccess Instance Definition.....	5052
Table 49 – InitDirectAccess Method Arguments	5053
Table 50 – InitDirectAccess Method AddressSpace Definition	5053
Table 51 – EndDirectAccess Method Arguments	5053
Table 52 – EndDirectAccess Method AddressSpace Definition	5053
Table 53 – Transfer Method Arguments	5054
Table 54 – Transfer Method AddressSpace Definition	5054
Table 55 – OptionSetType Definition.....	5057
Table 56 – LogAuditTrailMessage Method Arguments.....	5060
Table 57 – LogAuditTrailMessage Method AddressSpace Definition	5060
Table 58 – FDIServerVersion Property Definition	5061
Table 59 – DeviceType Property Mapping.....	5063
Table 60 – Setting OPC UA Variable Attributes from EDDL variable attributes	5066
Table 61 – Correspondence between EDDL and OPC UA standard data types	5067
Table 62 – Setting OPC UA AnalogItemType Properties from EDDL arithmetic type description	5069
Table A.1 – Numeric Identifiers for IEC 62769-5 defined nodes	5074

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIELD DEVICE INTEGRATION (FDI) –

Part 5: FDI Information Model

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62769-5 has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: industrial process measurement, control and automation.

The text of this standard is based on the following documents:

FDIS	Report on voting
65E/xxx/FDIS	65E/xxx/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

The National Committees are requested to note that for this publication the stability date is 2017.

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

IMPORTANT – The 'color inside' logo on the cover page of this publication indicates that it contains colors which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a color printer.

FIELD DEVICE INTEGRATION (FDI) –

Part 5: FDI Information Model

1 Scope

This International Standard defines the FDI Information Model. One of the main tasks of the Information Model is to reflect the topology of the automation system. Therefore it represents the devices of the automation system as well as the connecting communication networks including their properties, relationships, and the operations that can be performed on them. The types in the AddressSpace of the FDI Server constitute some kind of catalogue, which is built from FDI Packages.

The overall FDI architecture is illustrated in Figure 1. The architectural components that are within the scope of this document have been highlighted in this illustration.

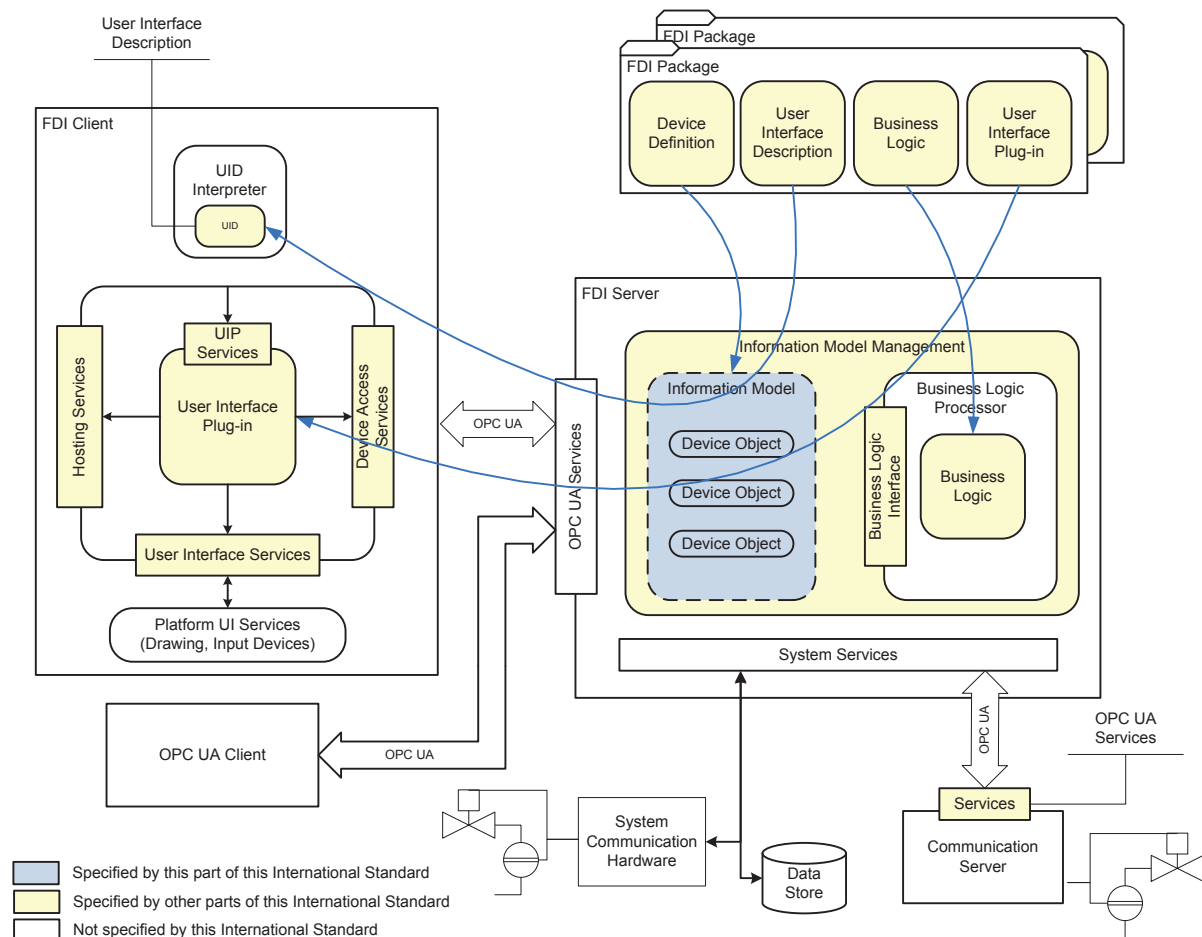


Figure 1 – FDI architecture diagram

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- 22 IEC 61784-1 *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*
- 23 IEC 61804-3 *Function block (FB) for process control and Electronic device description*
24 *language (EDDL) – Part 3: (EDDL) EDDL syntax and semantics*
- 25 IEC 62541-1: *OPC UA Specification – Part 1: Concepts*
- 26 IEC 62541-3: *OPC UA Specification – Part 3: Address Space Model*
- 27 IEC 62541-4: *OPC UA Specification – Part 4: Services*
- 28 IEC 62541-5: *OPC UA Specification – Part 5: Information Model*
- 29 IEC 62541-7: *OPC UA Specification – Part 7: Profiles*
- 30 IEC 62541-8: *OPC UA Specification – Part 8: Data Access*
- 31 IEC 62541-9: *OPC UA Specification – Part 9: Alarms & Conditions*
- 32 IEC 62769-1, *Field device integration (FDI) – Part 1: Overview*
- 33 NOTE IEC 62769-1 is technical identical to FDI-2021
- 34 IEC 62769-2, *Field device integration (FDI) – Part 2: FDI Client*
- 35 NOTE IEC 62769-2 is technical identical to FDI-2022
- 36 IEC 62769-3, *Field device integration (FDI) – Part 2: FDI Server*
- 37 NOTE IEC 62769-3 is technical identical to FDI-2023
- 38 IEC 62769-4, *Field device integration (FDI) – Part 2: FDI Packages*
- 39 NOTE IEC 62769-4 is technical identical to FDI-2024
- 40 IEC 62769-6, *Field device integration (FDI) – Part 6: FDI Technology Mapping*
- 41 NOTE IEC 62769-6 is technical identical to FDI-2026
- 42 IEC 62769-7, *Field device integration (FDI) – Part 7: FDI Communication Devices*
- 43 NOTE IEC 62769-7 is technical identical to FDI-2027
- 44 UA Part DI: *OPC Unified Architecture for Devices (DI) Companion Specification*

45 **3 Terms, definitions, abbreviated terms, acronyms and conventions**

46 **3.1 Terms and definitions**

47 For the purposes of this document, the terms and definitions given in IEC 62769-1 apply.

48 **3.2 Abbreviated terms and acronyms**

49 For the purposes of this document, the abbreviated terms and acronyms given in IEC 62769-1
50 and the following apply.

HMI Human Machine Interface

SCADA Supervisory Control and Data Acquisition
TCP Transmission Control Protocol

3.3 Conventions for graphical notation

OPC UA defines a graphical notation for an OPC UA AddressSpace. It defines graphical symbols for all NodeClasses and how different types of References between Nodes can be visualized. Figure 2 shows the symbols for the NodeClasses used in this specification. NodeClasses representing types always have a shadow.

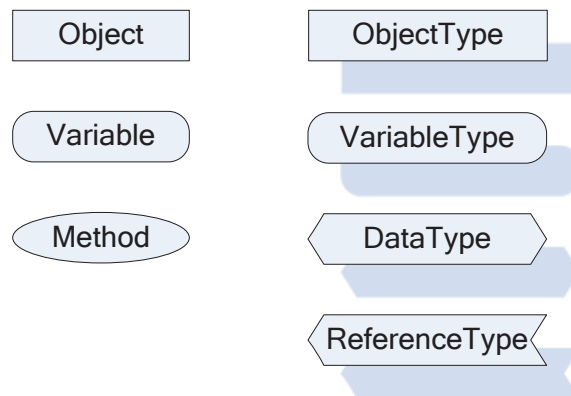


Figure 2 – OPC UA Graphical Notation for NodeClasses

Figure 3 shows the symbols for the ReferenceTypes used in this specification. The Reference symbol is normally pointing from the source Node to the target Node. The only exception is the HasSubType Reference. The most important References like HasComponent, HasProperty, HasTypeDefinition and HasSubType have special symbols avoiding the name of the Reference. For other ReferenceTypes or derived ReferenceTypes the name of the ReferenceType is used together with the symbol.

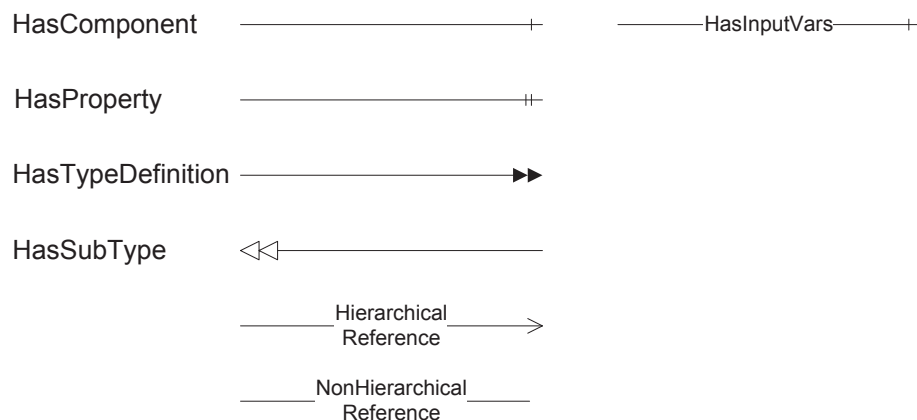
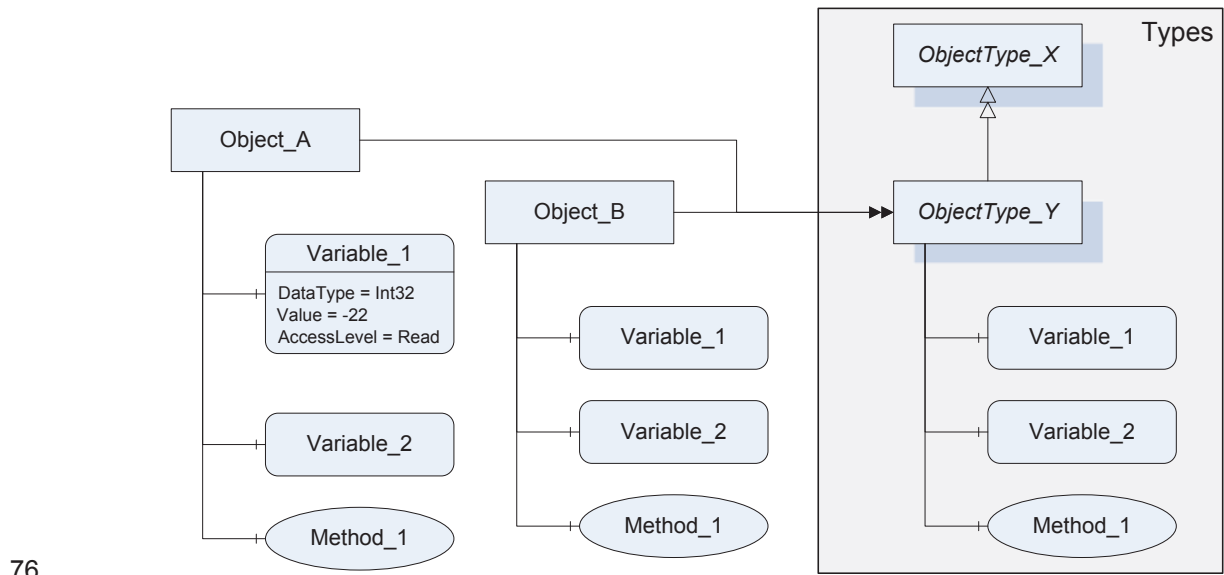


Figure 3 – OPC UA Graphical Notation for References

Figure 4 shows a typical example for the use of the graphical notation. Object_A and Object_B are instances of the ObjectType_Y indicated by the HasTypeDefinition References. The ObjectType_Y is derived from ObjectType_X indicated by the HasSubType Reference. The Object_A has the components Variable_1, Variable_2 and Method_1.

To describe the components of an Object on the ObjectType the same NodeClasses and References are used on the Object and on the ObjectType like for ObjectType_Y in the example. The instance Nodes used to describe an ObjectType are instance declaration Nodes.

74 To provide more detailed information for a Node, a subset or all Attributes and their values
75 can be added to a graphical symbol.



76

77

Figure 4 – OPC UA Graphical Notation Example

78 To improve readability, this document frequently includes the type name inside the instance
79 box rather than displaying both boxes and a reference between them. This optimisation is
80 shown in Figure 5.

81

82

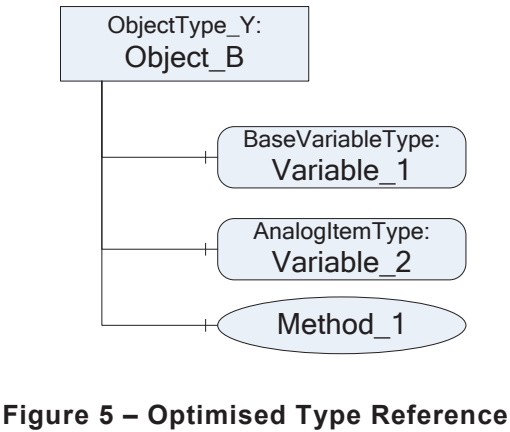


Figure 5 – Optimised Type Reference

4 General information to OPC Unified Architecture

4.1 General

The main use case for OPC standards is the online data exchange between devices and HMI or SCADA systems. In this use case the device data is provided by an OPC server and is consumed by an OPC client integrated into the HMI or SCADA system. OPC provides functionality to browse through a hierarchical namespaces containing data items and to read, write and to monitor these items for data changes.

OPC UA incorporates features like Data Access, Alarms and Historical Data via platform independent communication mechanisms and generic, extensible and object-oriented modelling capabilities for the information a system wants to expose.

The current version of OPC UA defines an optimized binary TCP protocol for high performance intranet communication as well as a mapping to Web Services. The abstract service model does not depend on a specific protocol mapping and allows adding new protocols in the future. Features like security, access control and reliability are directly built into the transport mechanisms. Based on the platform independence of the protocols, OPC UA servers and clients can be directly integrated into devices and controllers.

The OPC UA information model provides a standard way for Servers to expose Objects to Clients. Objects in OPC UA terms are composed of other Objects, Variables and Methods. OPC UA also allows relationships to other Objects to be expressed.

The set of Objects and related information that an OPC UA Server makes available to Clients is referred to as its AddressSpace. The elements of the OPC UA Object Model are represented in the AddressSpace as a set of Nodes described by Attributes and interconnected by References. OPC UA defines various classes of Nodes to represent AddressSpace components most importantly Objects, Variables, Methods, ObjectTypes, DataTypes and ReferenceTypes. Each NodeClass has a defined set of Attributes.

Objects are used to represent components like folders, Devices or Networks. An Object is associated to a corresponding ObjectType that provides definitions for that Object.

Variables are used to represent values. Two categories of Variables are defined, Properties and DataVariables.

Properties are Server-defined characteristics of Objects, DataVariables and other Nodes. Properties are not allowed to have Properties defined for them. An example for Properties of Objects is the Manufacturer Property of a Device.

DataVariables represent the contents of an Object. DataVariables may have component DataVariables. This is typically used by Servers to expose individual elements of arrays and structures. This specification uses DataVariables mainly to represent the Parameters of Devices.

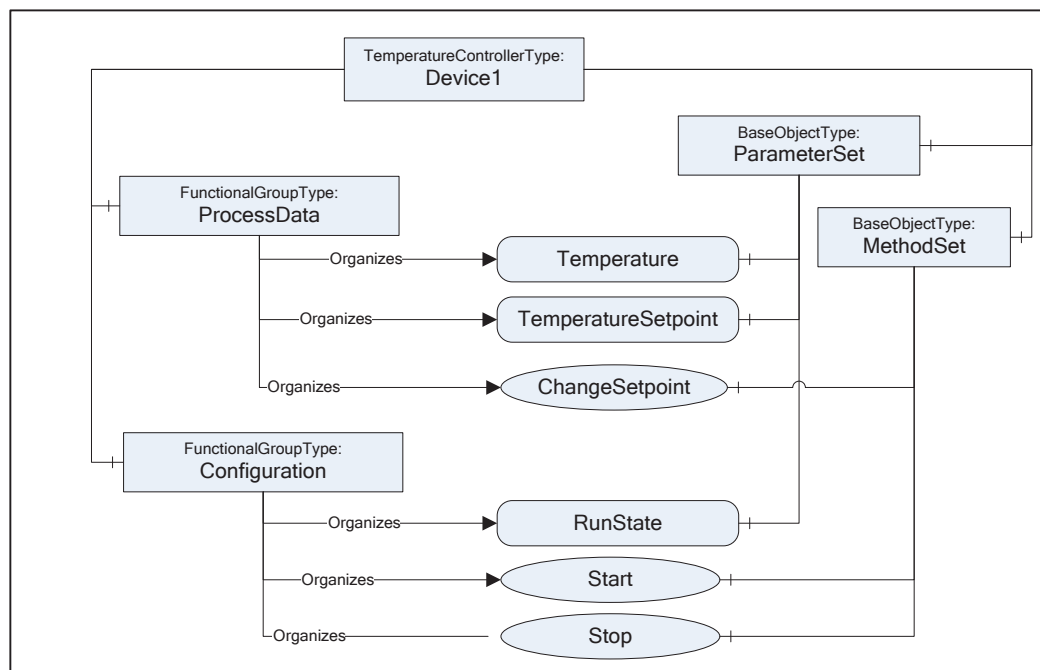
4.2 General information to OPC UA Devices

The OPC Unified Architecture for Devices (DI) Companion Specification (UA Part DI) specification is an extension of the overall OPC Unified Architecture specification series and defines the information model associated with Devices. The model is intended to provide a unified view of Devices irrespective of the underlying Device protocols.

The Devices information model specifies different ObjectTypes and other AddressSpace elements used to represent Devices and related components like the communication infrastructure in an OPC UA Address Space. The main use cases are Device configuration

127 and diagnostic but it allows a general and standardized way for any kind of application to
 128 access Device related information.

129 Figure 6 shows an example for a temperature controller represented as Device Object. The
 130 component ParameterSet contains all Variables describing the Device. The component
 131 MethodSet contains all Methods provided by the Device. Both components are inherited from
 132 the TopologyElementType, which is the root Object type of the Device Object type hierarchy.
 133 Objects of the FunctionalGroupType are used to group the Parameters and Methods of the
 134 Device into logical groups. The FunctionalGroupType and the grouping concept are defined in
 135 UA Part DI but the groups are DeviceType specific, i.e., the groups ProcessData and
 136 Configuration are defined by the TemperatureControllerType in this example.



138 **Figure 6 – OPC UA Devices Example: Functional Groups**

139 Another UA Part DI concept is illustrated in Figure 7. The ConfigurableObjectType is used to
 140 provide a way to group sub components of a Device and to indicate which types of sub
 141 components can be instantiated. The allowed types are referenced from the SupportedTypes
 142 folder. This information can be used by configuration clients to allow a user to select the type
 143 to instantiate as sub component of the Device.

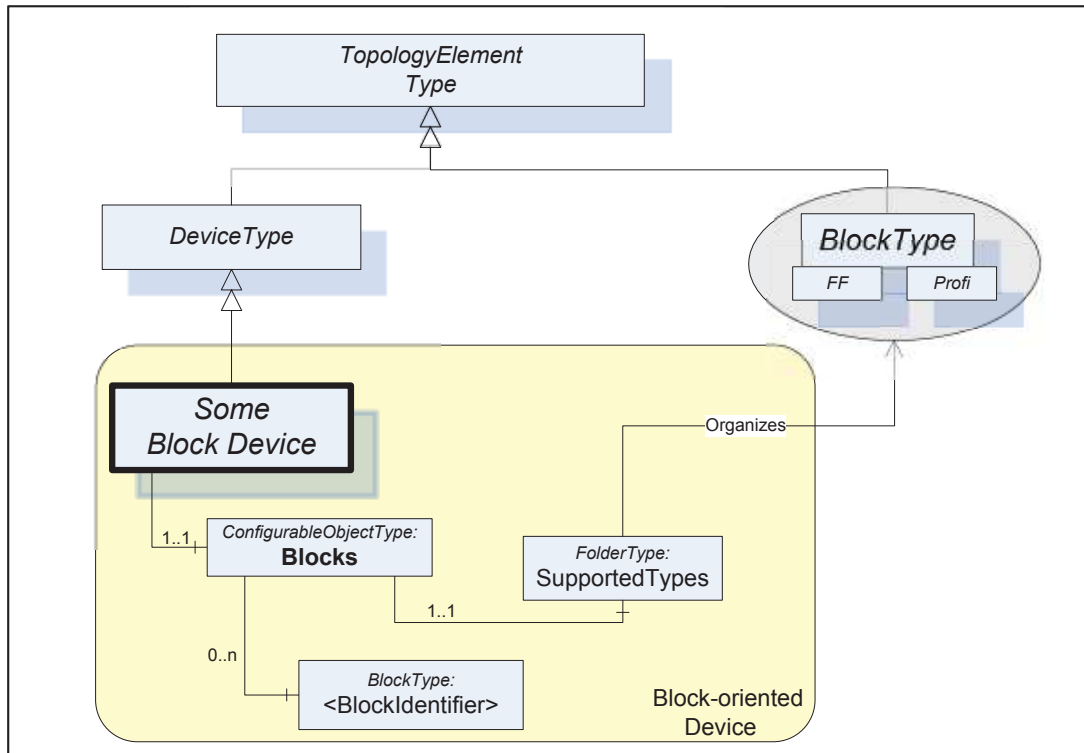


Figure 7 – OPC UA Devices Example : Configurable components

The SupportedTypes Folder can contain different subsets of ObjectTypes for different instances of the Block-oriented Device depending on their current configuration since the list contains only types that can be instantiated for the current configuration.

5 Concepts

5.1 General

The FDI Server provides FDI Clients access to information about Device instances and Device types regardless of where the information is stored, for example, in the Device itself or in a data store. This information is provided via OPC UA Services and is called the FDI Information Model.

The FDI Information Model specifies the entities that may be accessed in the FDI Server, including their properties, relationships, and the operations that can be performed on them. Which types of Devices or other topological elements are available in a given FDI Server is driven largely by the information in the FDI Packages.

5.2 Device Topology

One of the main tasks of the Information Model is to reflect the topology of the automation system. Therefore the Information Model represents the devices of the automation system as well as the connecting communication networks. The entry point Device Topology is the starting point within the Information Model for the topology of the automation system. The entry point Communication Devices contains the communication devices that are used by the FDI Server to access the elements of the topology. Figure 8 and Figure 9 illustrate an example configuration and the configured topology as it will appear in the FDI Server AddressSpace (details left out).

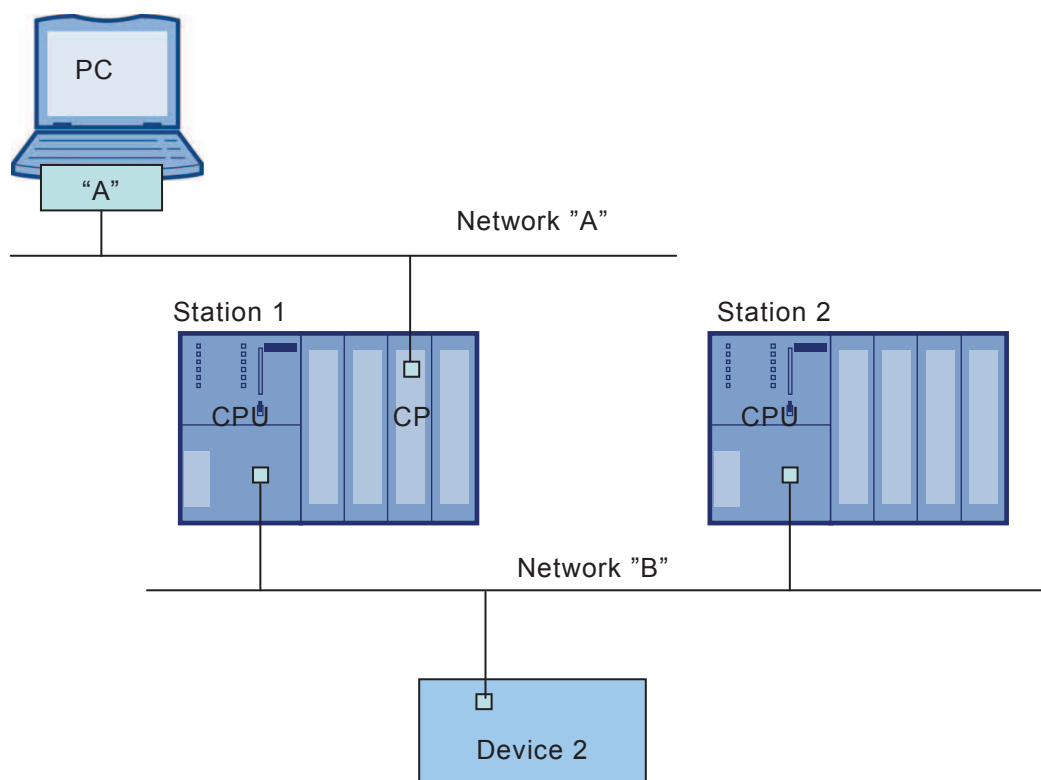


Figure 8 – Example of an Automation System

The PC in Figure 8 represents the FDI Server box. The FDI Server communicates with devices connected to Network "A" via Native Communication, and it communicates with devices connected to Network "B" via Nested Communication.

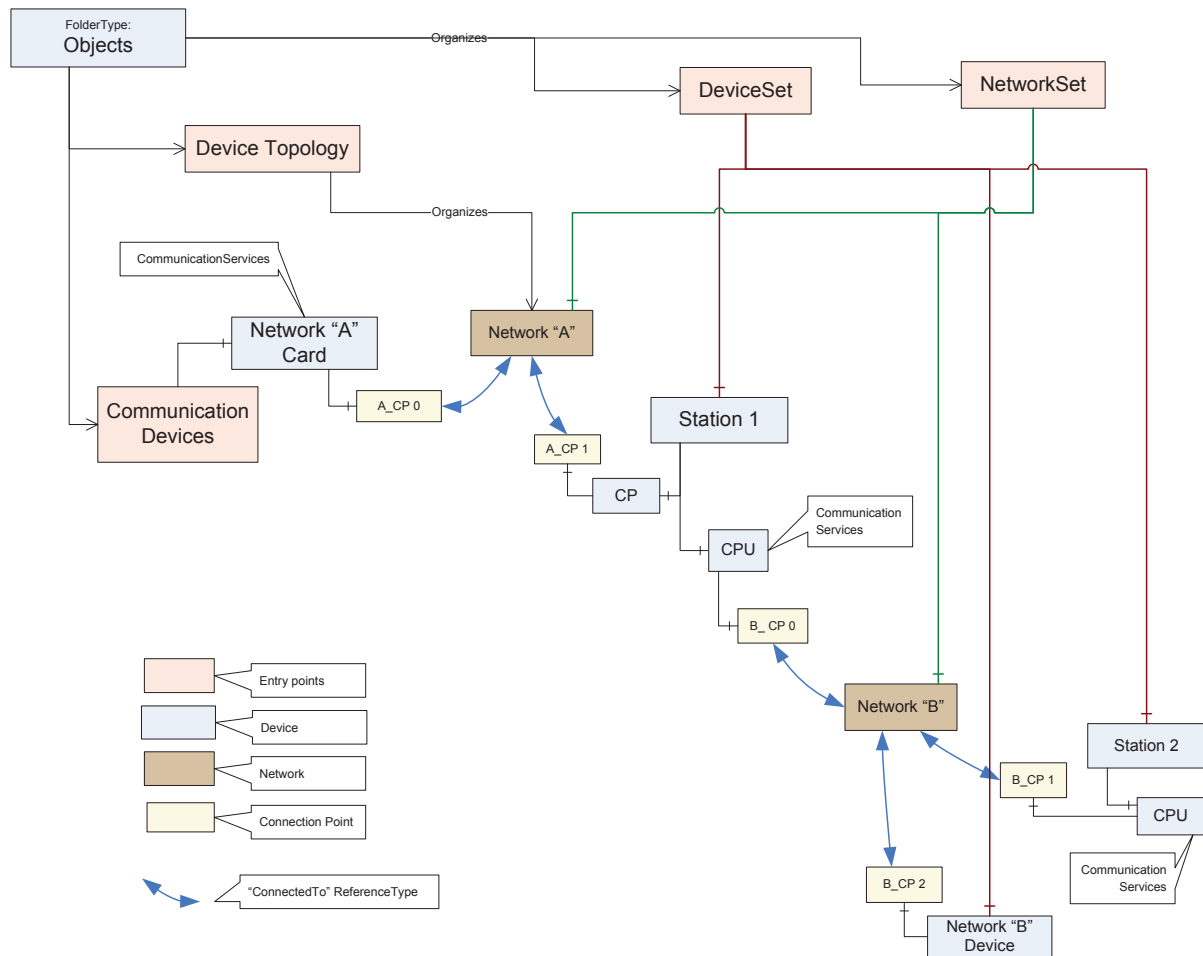


Figure 9 – Example of a Device Topology

Coloured boxes are used to easily recognize the various types of information.

Brown boxes represent the networks. Light blue boxes represent the Devices and light yellow is used for Connection Points.

Light red boxes represent the entry points that assure common behaviour across different implementations:

- DeviceTopology: Starting node for the topology configuration.
- CommunicationDevices: Starting node for the available communication devices (this includes devices in Communication Servers). Communication Devices and Communication Servers are specified in IEC 62769-7.
- DeviceSet: All instantiated Devices are components of this Object, i.e., they exist in the AddressSpace independent of the Device Topology.
- NetworkSet: All Networks are components of this Object.

5.3 Online / Offline

Management of the Device Topology is a configuration task, i.e., the elements in the topology (Devices, Networks, and Connection Points) are usually configured “offline” and – at a later time – will be validated against their physical representative in a real network.

To support explicit access to either the online or the offline information, each element is represented by two instances that are schematically identical, i.e., there exists

ParameterSet, FunctionalGroups, and so on. A Reference connects online and offline representation and allows to navigate between them.

5.4 Catalogue (Type Definitions)

The supported (sub-types of) TopologyElements are organised as Type definitions in the OPC UA AddressSpace forming some kind of a catalogue. These definitions typically are generated based on descriptive information from FDI Packages. The Type definitions contain the Parameters, and default values for Parameters, Methods, Actions and Functional Groups including user interface elements. FDI Server can include folders in the type model to organise the types according to manufacturer or other criteria.

Type definitions can then be used to create instances of Devices in the OPC UA AddressSpace. Instances can be created either offline or based on data determined by Scanning. Figure 10 illustrates an example of some Type definitions (details left out) as they may exist in the AddressSpace.

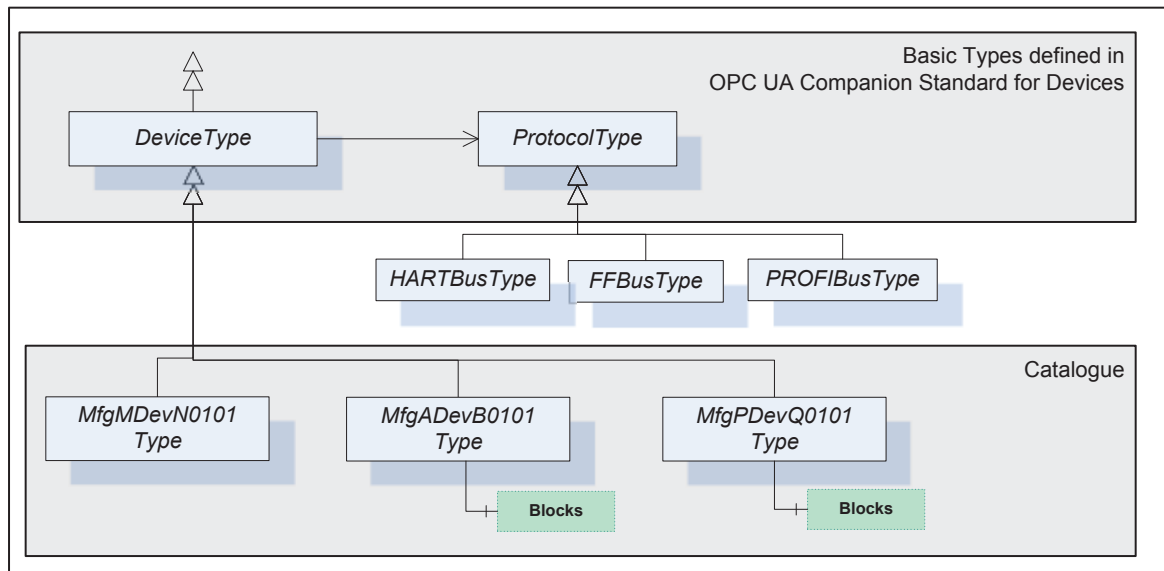


Figure 10 – Example Device Types representing a Catalogue

5.5 Communication

In order to integrate Devices, the FDI Server needs to be able to communicate to them. This can be done using Native Communication or Nested Communication.

The example in Figure 9 above for instance specifies that the FDI Server has direct access to the PROFINET Network using its PROFINET network card. In order to access “Station 2”, the FDI Server has to go through Station 1, which provides the communication services for the PROFIBUS DP Network (see IEC 61784-1, CPF 3). This can be achieved through Nested Communication, which is specified in IEC 62769-4. Communication Devices and Communication Servers are specified in IEC 62769-7.

5.6 Type and Instance Extensions for FDI (AddIn capability)

The type model of OPC UA is targeted towards single inheritance, i.e., an ObjectType or a VariableType is assumed to be sub-type of only one super-type. Besides sub-typing, however, OPC UA in general allows extending Types or instances with additional components. OPC UA describes a ‘Best Practice’ how to extend Objects and Variables in OPC UA and avoid multiple inheritances – called **AddIn Capability**. AddIn capabilities are comparable to the interface technology found in some programming languages.

- 224 Each AddIn capability is modeled as an ObjectType, indistinguishable from other ObjectTypes
225 used to expose full functionality with one exception: instances of AddIn ObjectTypes will
226 always have pre-defined BrowseNames.
- 227 FDI uses the AddIn capability concept for various features, in particular:
- 228 • Actions
- 229 • Locking and Edit Mode
- 230 All AddIn usages of the Information Model Methods of the Type and each instance of this
231 Type are shared. The NodeId of these Methods will be fixed and defined in this specification.
232 FDI Clients do not have to browse for these Methods but rather can use the fixed NodeId as
233 the MethodId of the Call Service.

6 AddressSpace Organization

To promote interoperability of FDI Clients and FDI Servers, a set of Objects and relationships are defined in the following subclauses. FDI Servers can implement a subset of these standard Nodes, depending on their capabilities.

Based on OPC UA rules, an OPC UA Server separates the AddressSpace in two parts:

- The Types-part contains information about all components that have been generated based on descriptive information from FDI Packages (see 5.4).
- The Objects-part contains the Device Topology with all instantiated components. All instances of the AddressSpace are related to a type of the Types folder

Figure 11 illustrates the structure of the AddressSpace with the browse entry points for FDI.

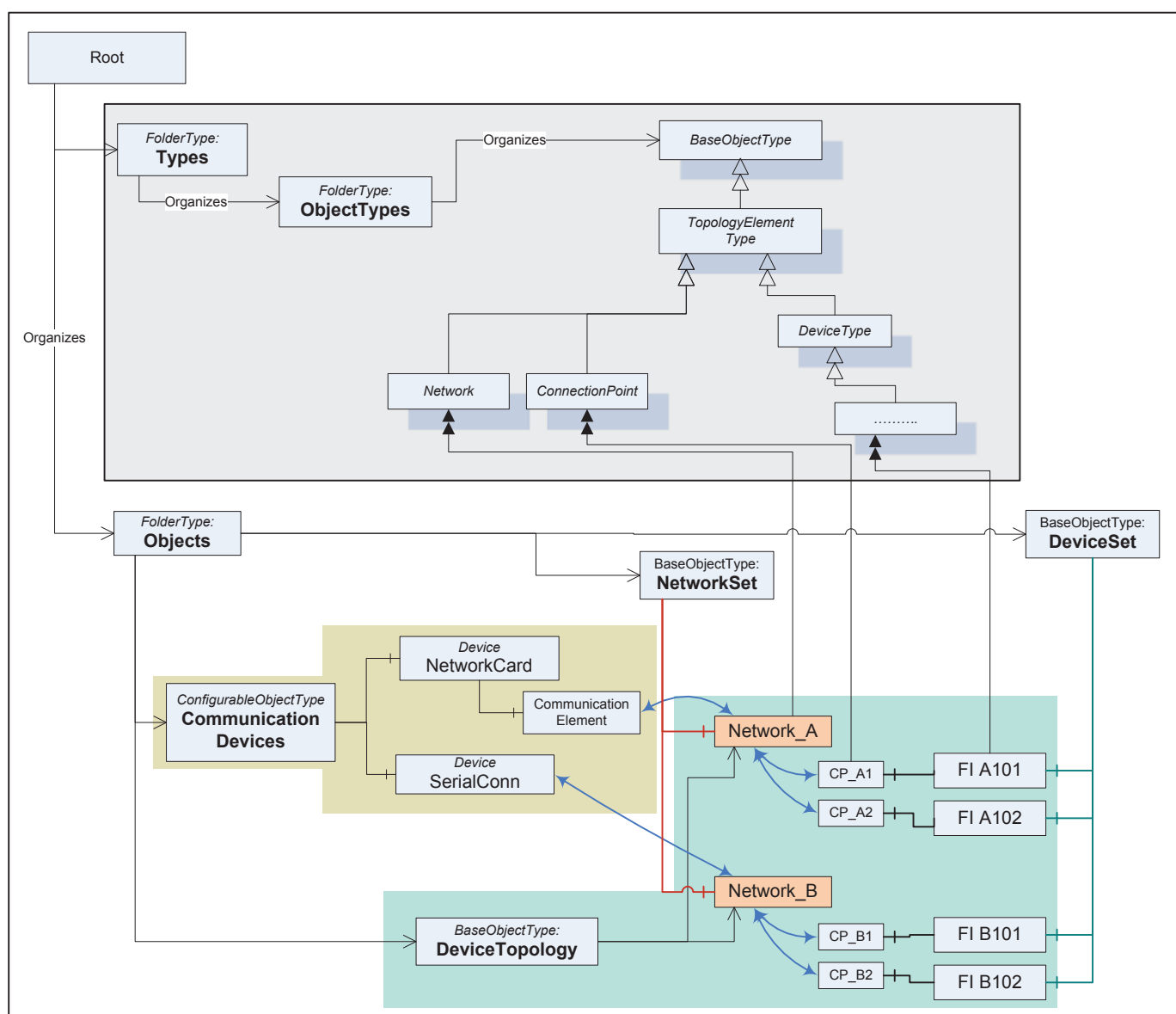


Figure 11 – Standard AddressSpace Structure

247 The figure highlights three separate areas:

- 248 • ObjectTypes (grey area) represents the AddressSpace part where all type information is
249 located. The entry point is called ObjectTypes. Underneath BaseObjectType are all
250 ObjectTypes specified in this document. ObjectTypes and BaseObjectType are specified
251 in IEC 62541-5.
- 252 • DeviceTopology is used to aggregate the top level Networks that provide access to all
253 instances that constitute the Device Topology ((sub-)networks, devices and
254 communication elements). Some example elements are shown here and highlighted using
255 the green colour. The parent of DeviceTopology is the Objects folder standardized by IEC
256 62541-5. The Property OnlineAccess is mandatory for the DeviceTopology Object. See
257 Table 1 for the formal definition of this Property:

258 **Table 1 – OnlineAccess Property Definition**

Name	DataType	Description
OnlineAccess	Boolean	This Property provides a hint of whether the FDI Server is currently able to communicate to Devices in the topology. False means that no communication is available.

- 259
- 260 • CommunicationDevices is used to aggregate the communication elements of the system
261 (brown area). The parent of CommunicationDevices is the Objects folder standardized by
262 IEC 62541-5.
- 263 • All instantiated Devices are components of the DeviceSet Object, i.e., they exist in the
264 AddressSpace independent of the Device Topology. All Networks are components of the
265 NetworkSet Object.

266 FDI Servers can either automatically create Device Objects or they may only show the
267 available types (SupportedTypes folder) and leave it to the user to create proper instances.
268 When using Native Communication the system will typically provide the Device Topology
269 without having to have it configured by the FDI Client.