

TECHNICAL REPORT



Field device tool (FDT) interface specification –
Part 502: Communication implementation for common object model – IEC 61784
CPF 2



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**Field device tool (FDT) interface specification –
Part 502: Communication implementation for common object model – IEC 61784
CPF 2**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references	6
3 Terms, definitions, symbols, abbreviated terms and conventions	7
3.1 Terms and definitions	7
3.2 Symbols and abbreviated terms.....	7
3.3 Conventions	7
3.3.1 Data type names and references to data types	7
3.3.2 Vocabulary for requirements.....	7
4 Bus category	8
5 Access to instance and device data	8
6 Protocol specific behavior.....	8
7 Protocol specific usage of general data types	8
8 Protocol specific common data types – DTMCIPDataTypeSchema	8
9 Network management data types.....	11
9.1 General.....	11
9.2 Node address	11
9.3 Scanner/Master – Bus Parameter Set (CIP) – FDTICIPDTMParameterSchema	11
10 Communication data types	16
11 Channel parameter data types.....	17
12 Device identification	19
12.1 Device type identification data types – FDTICIPIdentSchema	19
12.2 Topology scan data types.....	19
12.3 Scan identification data types – FDTICIPScanIdentSchema	19
12.4 Device type identification data types – FDTICIPDeviceTypeIdentSchema.....	20
Annex A (informative) Implementation hints	21
Bibliography.....	22
Figure 1 – Part 502 of the IEC 62453 series	5
Table 1 – Protocol specific usage of general attributes	8

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION –**Part 502: Communication implementation for common object model –
IEC 61784 CPF 2**

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IEC/TR 62453-502, which is a technical report, has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation:

This part, in conjunction with the other parts of the first edition of the IEC 62453 series cancels and replaces IEC/PAS 62453-1, IEC/PAS 62453-2, IEC/PAS 62453-3, IEC/PAS 62453-4 and IEC/PAS 62453-5 published in 2006, and constitutes a technical revision.

Each part of the IEC/TR 62453-5xy series is intended to be read in conjunction with its corresponding part in the IEC 62453-3xy series.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
65E/66/DTR	65E/115/RVC

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

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

The list of all parts of the IEC 62453 series, under the general title *Field Device Tool (FDT) interface specification*, can be found on the IEC website.

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.

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

INTRODUCTION

This part of IEC 62453 is an interface specification for developers of FDT (Field Device Tool) components for function control and data access within a client/server architecture. The specification is a result of an analysis and design process to develop standard interfaces to facilitate the development of servers and clients by multiple vendors that need to interoperate seamlessly.

With the integration of fieldbuses into control systems, there are a few other tasks which need to be performed. In addition to fieldbus- and device-specific tools, there is a need to integrate these tools into higher-level system-wide planning- or engineering tools. In particular, for use in extensive and heterogeneous control systems, typically in the area of the process industry, the unambiguous definition of engineering interfaces that are easy to use for all those involved is of great importance.

A device-specific software component, called DTM (Device Type Manager), is supplied by the field device manufacturer with its device. The DTM is integrated into engineering tools via the FDT interfaces defined in this specification. The approach to integration is in general open for all kind of fieldbuses and thus meets the requirements for integrating different kinds of devices into heterogeneous control systems.

Figure 1 shows how IEC/TR 62453-502 is aligned in the structure of IEC 62453 series.

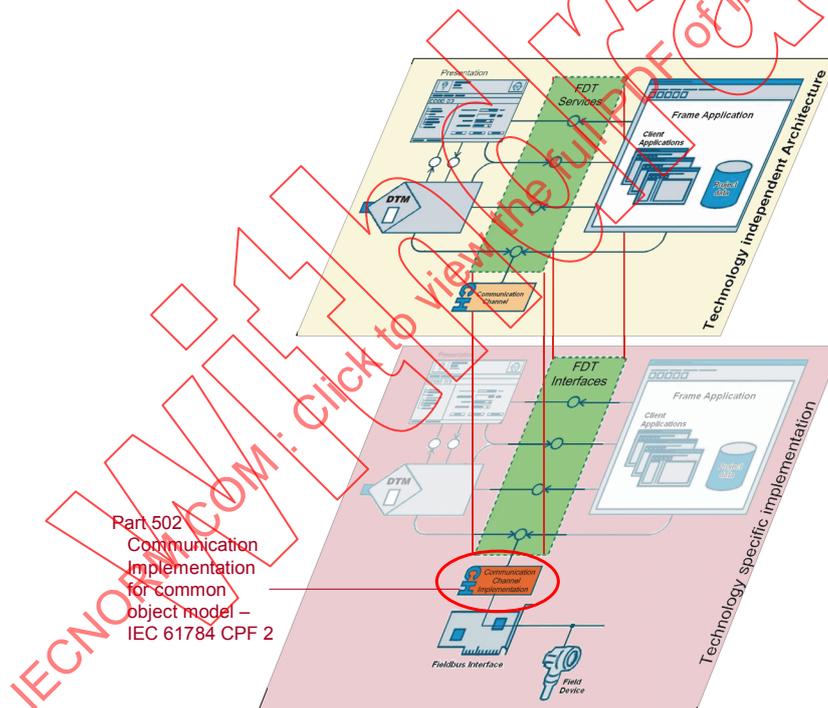


Figure 1 – Part 502 of the IEC 62453 series

FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION –

Part 502: Communication implementation for common object model – IEC 61784 CPF 2

1 Scope

IEC/TR 62453-502, which is a technical report, provides information for integrating the CIP™ technology into the COM based implementation of FDT interface specification (IEC/TR 62453-5).

Communication Profile Family 2 (commonly known as CIP™¹) defines communication profiles based on IEC 61158-2 Type 2, IEC 61158-3-2, IEC 61158-4-2, IEC 61158-5-2, and IEC 61158-6-2, IEC 62026-3. The basic profiles CP 2/1 (ControlNet™²), CP 2/2 (EtherNet/IP™³), and CP 2/3 (DeviceNet™¹) are defined in IEC 61784-1 and IEC 61784-2. An additional communication profile (CompoNet™), also based on CIP™, is defined in [13].

This part of IEC 62453 specifies communication and other services.

This specification neither contains the FDT specification nor modifies it.

2 Normative references

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

IEC 61158-2, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-3-2, *Industrial communication networks – Fieldbus specifications – Part 3-2: Data-link layer service definition – Type 2 elements*

IEC 61158-4-2, *Industrial communication networks – Fieldbus specifications – Part 4-2: Data-link layer protocol specification – Type 2 elements*

IEC 61158-5-2, *Industrial communication networks – Fieldbus specifications – Part 5-2: Application layer service definition – Type 2 elements*

¹ CIP™ (Common Industrial Protocol), DeviceNet™ and CompoNet™ are trade names of Open DeviceNet Vendor Association, Inc (ODVA). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this standard does not require use of the trade names CIP™, DeviceNet™ or CompoNet™. Use of the trade names CIP™, DeviceNet™ or CompoNet™ requires permission of Open DeviceNet Vendor Association, Inc.

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IEC 61158-6-2, *Industrial communication networks – Fieldbus specifications – Part 6-2: Application layer protocol specification – Type 2 elements*

IEC 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

IEC 61784-2, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

IEC 62026-3, *Low-voltage switchgear and controlgear – Controller-device interfaces (CDIs) – Part 3: DeviceNet*

IEC 62453-1:2009, *Field Device Tool (FDT) interface specification – Part 1: Overview and guidance*

IEC 62453-2:2009, *Field Device Tool (FDT) interface specification – Part 2: Concepts and detailed description*

IEC/TR 62453-41:2009, *Field Device Tool (FDT) interface specification – Part 41: Object model integration profile – Common object model*

IEC 62453-302:2009, *Field Device Tool (FDT) interface specification – Part 302: Communication profile integration – IEC 61784 CPF 2*

3 Terms, definitions, symbols, abbreviated terms and conventions

3.1 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC 62453-1 and IEC 62453-2 apply.

3.2 Symbols and abbreviated terms

For the purpose of this document, the symbols and abbreviations given in IEC 62453-1, IEC 62453-2 and the following apply.

CIP™	Common Industrial Protocol	
CP	Communication Profile	[IEC 61784-1]
CPF	Communication Profile Family	[IEC 61784-1]
EDS	Electronic Data Sheet	[ISO 15745]
UML	Unified Modelling Language	[ISO/IEC 19501]

3.3 Conventions

3.3.1 Data type names and references to data types

The conventions for naming and referencing of data types are explained in IEC 62453-2 Clause A.1

3.3.2 Vocabulary for requirements

The following expressions are used when specifying requirements.

Usage of “shall” or “Mandatory” No exceptions allowed.

Usage of “should” or “Recommended” Strong recommendation. It may make sense in special exceptional cases to differ from the described behavior.

Usage of “can’ or “Optional’ Function or behavior may be provided, depending on defined conditions.

4 Bus category

IEC 61784 CPF 2 protocol is identified in the attribute busCategory of the BusCategory element by the identifiers, as specified in IEC 62453-302.

5 Access to instance and device data

The elements and attributes specified in this clause are used at following methods:

- IDtmParameter::GetParameters()
- IDtmParameter::SetParameters()

All parameters defined in the Params section of the EDS shall be exposed in the ExportedVariables element.

6 Protocol specific behavior

IEC 61784 CPF 2 protocol specific requirements are specified in IEC 62453-302.

7 Protocol specific usage of general data types

Table 1 shows how general attributes are used with IEC 61784 CPF 2 devices.

Table 1 – Protocol specific usage of general attributes

Attribute	Description for use
fdt:address	All these attributes of the FDTDatatype schema are used as defined in IEC 62453-302.
fdt:protocolId	
fdt:deviceTypeId	
fdt:deviceTypeInfo	
fdt:deviceTypeInfoPath	
fdt:manufacturerId	
fdt:semanticId	
fdt:applicationDomain	
fdt:tag	

8 Protocol specific common data types – DTMCIPODataTypeschema

This schema specifies the protocol specific common XML elements and attributes, which are used in other schemas. The definition of the elements and attributes follows the data type definitions in IEC 62453-302.

<?xml version="1.0"?>

```

<Schema name="DTMCIPDataTypeSchema" xmlns="urn:schemas-microsoft-com:xml-data"
xmlns:dt="urn:schemas-microsoft-com:datatypes" xmlns:fdt="x-schema:FDTDataTypesSchema.xml"
xmlns:dtmInfo="x-schema:DTMInformationSchema.xml">
  <!-- Version of the Schema -->
  <AttributeType name="schemaVersion" dt:type="number" default="1.0"/>
  <!-- Definition of Attributes -->
  <AttributeType name="classId" dt:type="ui2"/>
  <AttributeType name="instanceId" dt:type="ui2"/>
  <AttributeType name="attributeId" dt:type="ui1"/>
  <AttributeType name="vendorID" dt:type="ui2"/>
  <AttributeType name="deviceType" dt:type="ui2"/>
  <AttributeType name="productCode" dt:type="ui2"/>
  <AttributeType name="majorRevision" dt:type="ui1"/>
  <AttributeType name="minorRevision" dt:type="ui1"/>
  <AttributeType name="serialNumber" dt:type="bin.hex"/>
  <AttributeType name="productName" dt:type="string"/>
  <AttributeType name="cipStatus" dt:type="ui2"/>
  <AttributeType name="portNumber" dt:type="ui2"/>
  <AttributeType name="extendedIdentifier" dt:type="string"/>
  <AttributeType name="shortIdentifier" dt:type="ui1"/>
  <AttributeType name="serviceCode" dt:type="ui1"/>
  <AttributeType name="serviceName" dt:type="string"/>
  <!-- refer to CIP Spec datatype definition Vol 1 C-2 through C-6 -->
  <AttributeType name="dataType" dt:type="enumeration" dt:values="byte float double int unsigned enumerator
bitEnumerator index ascii password bitString hexString date time dateAndTime duration binary structured
dtmSpecific"/>
  <AttributeType name="ePath" dt:type="bin.hex"/>
  <AttributeType name="bitOffset" dt:type="ui4"/>
  <AttributeType name="constValue" dt:type="ui4"/>
  <AttributeType name="symbolicAddress" dt:type="string"/>
  <!--Definition of Elements-->
  <ElementType name="Service" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="serviceCode" required="yes"/>
    <attribute type="serviceName" required="no"/>
  </ElementType>

  <ElementType name="CIPObjectId" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="classId" required="yes"/>
    <attribute type="instanceId" required="yes"/>
    <attribute type="attributeId" required="no"/>
  </ElementType>

  <ElementType name="CIPSymbolicAddress" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="symbolicAddress" required="yes"/>
  </ElementType>

  <!-- See CIP Specification Appendix C-1 -->
  <ElementType name="HexAddress" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="ePath" required="yes"/>
  </ElementType>

  <ElementType name="CIPObjectAddress" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <group order="one" minOccurs="1" maxOccurs="1">
      <element type="CIPObjectId"/>
      <element type="CIPSymbolicAddress"/>
      <element type="HexAddress"/>
    </group>
  </ElementType>

  <ElementType name="ParameterReference" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="fdt:idref" required="yes"/>
    <attribute type="bitOffset" required="no"/>
  </ElementType>

```

```

<ElementType name="Constant">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="constValue" required="yes"/>
</ElementType>

<ElementType name="ExtendedIdentifier" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="extendedIdentifier" required="yes"/>
</ElementType>

<ElementType name="ShortIdentifier" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="shortIdentifier" required="yes"/>
</ElementType>

<ElementType name="CIPNodeID" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <group order="one" minOccurs="1" maxOccurs="1">
    <element type="ExtendedIdentifier"/>
    <element type="ShortIdentifier"/>
  </group>
</ElementType>

<ElementType name="LinkAddress" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="CIPNodeID" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="Segment" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="portNumber" required="yes"/>
  <element type="LinkAddress" minOccurs="1" maxOccurs="1"/>
  <element type="Segment" minOccurs="0" maxOccurs="1"/>
</ElementType>

<ElementType name="RoutingPath" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="Segment" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="CIPPath" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="RoutingPath" minOccurs="0" maxOccurs="1"/>
  <element type="CIPNodeID" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="CIPDeviceIdentity" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="vendorID" required="yes"/> <!-- Identity Object Attribute 1 -->
  <attribute type="deviceType" required="yes"/> <!-- Identity Object Attribute 2 -->
  <attribute type="productCode" required="yes"/> <!-- Identity Object Attribute 3 -->
  <attribute type="majorRevision" required="yes"/> <!-- Identity Object Attribute 4.1 -->
  <attribute type="minorRevision" required="yes"/> <!-- Identity Object Attribute 4.2 -->
  <attribute type="serialNumber" required="yes"/> <!-- Identity Object Attribute 6 -->
  <attribute type="productName" required="yes"/> <!-- Identity Object Attribute 7 -->
</ElementType>

<ElementType name="CIPDevice" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="cipStatus" required="yes"/> <!-- Identity Object Attribute 5 -->
  <element type="CIPPath" minOccurs="1" maxOccurs="1"/>
  <element type="CIPDeviceIdentity" minOccurs="1" maxOccurs="1"/>
</ElementType>

<!-- used for reserved bits anywhere -->
<ElementType name="ReservedBits" content="eltOnly" model="open">
</ElementType>

</Schema>

```

9 Network management data types

9.1 General

The elements and attributes specified in this clause are used at following methods:

- IDtmParameter:GetParameters
- IDtmParameter:SetParameters

9.2 Node address

The CIPNodeID will be stored in the busAddress attribute of the fdt:MasterSlaveBus element. This is not used for CompoNet because the master has a fixed address – since this is a mandatory element, the recommendation is to use the value “0”.

9.3 Scanner/Master – Bus Parameter Set (CIP) – FDTICIPDTMParameterSchema

Information is sent to the CIP scanner/master within the UserDefinedBus element in the BusInformation element, using the CIPNode element defined in the schema below. This information shall be set to configure the scan list of scanner/master.

```
<?xml version="1.0"?>
<Schema name="FDTICIPDTMParameterSchema" xmlns="urn:schemas-microsoft-com:xml-data"
xmlns:dt="urn:schemas-microsoft-com:datatypes" xmlns:fdt="x-schema:FDTDataTypesSchema.xml" xmlns:cip="x-
schema:DTMCIPTDataTypesSchema.xml" xmlns:fdtpar="x-schema:DTMParameterSchema.xml">
  <!-- Version of the Schema -->
  <AttributeType name="schemaVersion" dt:type="number" default="1.1"/>
  <!--Definition of Attributes-->
  <AttributeType name="producedConnectionSize" dt:type="ui2"/>
  <AttributeType name="consumedConnectionSize" dt:type="ui2"/>
  <AttributeType name="expectedPacketRate" dt:type="ui2"/>
  <AttributeType name="inhibitTime" dt:type="ui2"/>
  <AttributeType name="rpi" dt:type="ui4"/>
  <AttributeType name="connectionNameString" dt:type="string"/>
  <AttributeType name="helpString" dt:type="string"/>
  <AttributeType name="compoNetIOLengthUnit" dt:type="ui1"/>
  <AttributeType name="compoNetIOLength" dt:type="ui2"/>
  <!--TriggerAndTransport attributes-->
  <AttributeType name="class0" dt:type="boolean" default="0"/>
  <AttributeType name="class1" dt:type="boolean" default="0"/>
  <AttributeType name="class2" dt:type="boolean" default="0"/>
  <AttributeType name="class3" dt:type="boolean" default="0"/>
  <AttributeType name="class4" dt:type="boolean" default="0"/>
  <AttributeType name="class5" dt:type="boolean" default="0"/>
  <AttributeType name="class6" dt:type="boolean" default="0"/>
  <AttributeType name="triggerCyclic" dt:type="boolean" default="0"/>
  <AttributeType name="triggerChangeOfState" dt:type="boolean" default="0"/>
  <AttributeType name="triggerApplication" dt:type="boolean" default="0"/>
  <AttributeType name="transportTypeListenOnly" dt:type="boolean"/>
  <AttributeType name="transportTypeInputOnly" dt:type="boolean"/>
  <AttributeType name="transportTypeExclusiveOwner" dt:type="boolean"/>
  <AttributeType name="transportTypeRedundantOwner" dt:type="boolean"/>
  <AttributeType name="server" dt:type="boolean" default="0"/>
  <!--ConnectionParameters attributes-->
  <AttributeType name="fixedSizeSupported" dt:type="boolean" default="0"/>
  <AttributeType name="variableSizeSupported" dt:type="boolean" default="0"/>
  <AttributeType name="realTimeTransferFormat" dt:type="ui1" default="0"/>
  <AttributeType name="connectionTypeNULL" dt:type="boolean" default="0"/>
  <AttributeType name="connectionTypeMulticast" dt:type="boolean" default="0"/>
  <AttributeType name="connectionTypePoint2Point" dt:type="boolean" default="0"/>
  <AttributeType name="priorityLow" dt:type="boolean" default="0"/>
  <AttributeType name="priorityHigh" dt:type="boolean" default="0"/>
  <AttributeType name="priorityScheduled" dt:type="boolean" default="0"/>
  <AttributeType name="async" dt:type="ui1"/>
  <AttributeType name="maxConsumerNumber" dt:type="ui1" default="15"/>

```

```

<AttributeType name="maxSafetyConnections" dt:type="ui1"/>
<AttributeType name="maxSafetyInputCnxns" dt:type="ui1"/>
<AttributeType name="maxSafetyOutputCnxns" dt:type="ui1"/>
<AttributeType name="defaultSafetyConnections" dt:type="ui1"/>
<AttributeType name="scld" dt:type="bin.hex"/>
<AttributeType name="unld" dt:type="bin.hex"/>
<AttributeType name="defaultValue" dt:type="string"/>
<AttributeType name="defaultConnection" dt:type="boolean" default="0"/>
<AttributeType name="maxCIPConnections" dt:type="ui2"/>
<AttributeType name="maxIOConnections" dt:type="ui2"/>
<AttributeType name="maxEMConnections" dt:type="ui2"/>

<AttributeType name="offset" dt:type="i2"/>
<AttributeType name="base" dt:type="ui2"/>
<AttributeType name="multiplier" dt:type="ui2"/>
<AttributeType name="div" dt:type="ui2"/>
<AttributeType name="precision" dt:type="ui2"/>
<AttributeType name="compoNetDeviceCategory" dt:type="ui1"/>

<!-- Definition of Elements -->
<ElementType name="Scaling" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="offset" required="yes"/>
  <attribute type="base" required="yes"/>
  <attribute type="multiplier" required="yes"/>
  <attribute type="div" required="yes"/>
  <attribute type="precision" required="no"/>
</ElementType>

<ElementType name="ProducedAssemblyReference" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="cip:CIPObjectAddress" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="ConsumedAssemblyReference" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="cip:CIPObjectAddress" minOccurs="1" maxOccurs="1"/>
</ElementType>

<!-- DeviceNet type of connections -->
<ElementType name="MasterSlaveConnection" content="mixed" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="producedConnectionSize" required="yes"/>
  <attribute type="consumedConnectionSize" required="yes"/>
  <attribute type="expectedPacketRate" required="no"/>
  <attribute type="inhibitTime" required="no"/>
  <element type="ConsumedAssemblyReference" minOccurs="0" maxOccurs="1"/>
  <element type="ProducedAssemblyReference" minOccurs="0" maxOccurs="1"/>
</ElementType>

<!-- forward_open type of connections -->
<ElementType name="TransportTypeListenOnly" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="transportTypeListenOnly" required="yes"/>
</ElementType>

<ElementType name="TransportTypeInputOnly" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="transportTypeInputOnly" required="yes"/>
</ElementType>

<ElementType name="TransportTypeExclusiveOwner" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="transportTypeExclusiveOwner" required="yes"/>
</ElementType>

<ElementType name="TransportTypeRedundantOwner" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="transportTypeRedundantOwner" required="yes"/>
</ElementType>

```

```

<ElementType name="TriggerAndTransport" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="class0" required="no"/>
  <attribute type="class1" required="no"/>
  <attribute type="class2" required="no"/>
  <attribute type="class3" required="no"/>
  <attribute type="class4" required="no"/>
  <attribute type="class5" required="no"/>
  <attribute type="class6" required="no"/>
  <attribute type="triggerCyclic" required="no"/>
  <attribute type="triggerChangeOfState" required="no"/>
  <attribute type="triggerApplication" required="no"/>
  <attribute type="server" required="no"/>
  <group order="one" minOccurs="1" maxOccurs="1">
    <element type="TransportTypeListenOnly"/>
    <element type="TransportTypeInputOnly"/>
    <element type="TransportTypeExclusiveOwner"/>
    <element type="TransportTypeRedundantOwner"/>
  </group>
  <element type="cip:ReservedBits" minOccurs="0" maxOccurs="1"/>
</ElementType>

<ElementType name="ConnectionParameters" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="fixedSizeSupported" required="no"/>
  <attribute type="variableSizeSupported" required="no"/>
  <attribute type="realTimeTransferFormat" required="no"/>
  <attribute type="connectionTypeNULL" required="no"/>
  <attribute type="connectionTypeMulticast" required="no"/>
  <attribute type="connectionTypePoint2Point" required="no"/>
  <attribute type="priorityLow" required="no"/>
  <attribute type="priorityHigh" required="no"/>
  <attribute type="priorityScheduled" required="no"/>
  <element type="cip:ReservedBits" minOccurs="0" maxOccurs="1"/>
</ElementType>

<ElementType name="Target2OriginatorParameters" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="rpi" required="no"/>
  <element type="ConnectionParameters" minOccurs="1" maxOccurs="1"/>
  <group order="one" minOccurs="1" maxOccurs="*">
    <element type="Size"/>
    <element type="Format"/>
  </group>
</ElementType>

<ElementType name="Originator2TargetParameters" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="rpi" required="no"/>
  <element type="ConnectionParameters" minOccurs="1" maxOccurs="1"/>
  <group order="one" minOccurs="1" maxOccurs="*">
    <element type="Size"/>
    <element type="Format"/>
  </group>
</ElementType>

<ElementType name="Size" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <group order="one" minOccurs="1" maxOccurs="1">
    <element type="cip:Constant" minOccurs="1" maxOccurs="1"/>
    <element type="cip:ParameterReference" minOccurs="1" maxOccurs="1"/>
  </group>
</ElementType>

<ElementType name="Format" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <group order="one" minOccurs="1" maxOccurs="1">
    <element type="cip:ParameterReference" minOccurs="1" maxOccurs="1"/>
  </group>
</ElementType>

```

```

        <element type="fdt:ChannelReference" minOccurs="1" maxOccurs="1"/>      <!-- reference to an
assembly-->
    </group>
</ElementType>

<ElementType name="Config" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="Size" minOccurs="0" maxOccurs="1"/>
    <element type="Format" minOccurs="0" maxOccurs="1"/>
</ElementType>

<ElementType name="Config1" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="Config" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="Config2" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="Config" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="CIPConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="connectionNameString" required="yes"/>
    <attribute type="helpString" required="yes"/>
    <attribute type="cip:ePath" required="yes"/>
    <attribute type="defaultConnection" required="no"/>
    <element type="Config1" minOccurs="0" maxOccurs="1"/>
    <element type="Config2" minOccurs="0" maxOccurs="1"/>
    <element type="TriggerAndTransport" minOccurs="1" maxOccurs="1"/>
    <element type="Originator2TargetParameters" minOccurs="1" maxOccurs="1"/>
    <element type="Target2OriginatorParameters" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="SafetyInputConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="async" required="yes"/>
    <attribute type="maxConsumerNumber" required="no"/>
    <element type="CIPConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="SafetyOutputConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="maxConsumerNumber" required="no"/>
    <element type="CIPConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="PolledIOConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="MasterSlaveConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="BitStrobeConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="MasterSlaveConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="COSConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="MasterSlaveConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="CyclicConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="MasterSlaveConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="MulticastPollingConnection" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="MasterSlaveConnection" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="MasterSlaveConnectionSet" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>

```

```

    <element type="PolledIOConnection" minOccurs="0" maxOccurs="1"/>
    <element type="BitStrobeConnection" minOccurs="0" maxOccurs="1"/>
    <group order="one" minOccurs="0" maxOccurs="1">
      <element type="COSConnection" minOccurs="1" maxOccurs="1"/>
      <element type="CyclicConnection" minOccurs="1" maxOccurs="1"/>
    </group>
    <element type="MulticastPollingConnection" minOccurs="0" maxOccurs="1"/>
  </ElementType>

  <ElementType name="CompoNetIOInfo" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="compoNetIOLengthUnit" required="yes"/>
    <attribute type="compoNetIOLength" required="yes"/>
  </ElementType>

  <ElementType name="CompoNetInputInfo" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="CompoNetIOInfo" minOccurs="1" maxOccurs="1"/>
  </ElementType>

  <ElementType name="CompoNetOutputInfo" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="CompoNetIOInfo" minOccurs="1" maxOccurs="1"/>
  </ElementType>

  <ElementType name="CompoNetIO" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="CompoNetInputInfo" minOccurs="0" maxOccurs="1"/>
    <element type="CompoNetOutputInfo" minOccurs="0" maxOccurs="1"/>
    <attribute type="compoNetDeviceCategory" required="yes"/>
  </ElementType>

  <ElementType name="Capacity" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="maxCIPConnections" required="no"/>
    <attribute type="maxIOConnections" required="no"/>
    <attribute type="maxEMConnections" required="no"/>
  </ElementType>

  <ElementType name="PossibleConnections" content="mixed" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="maxSafetyConnections" required="no"/>
    <attribute type="maxSafetyInputCnxns" required="no"/>
    <attribute type="maxSafetyOutputCnxns" required="no"/>
    <attribute type="defaultSafetyConnections" required="no"/>
    <element type="Capacity" minOccurs="0" maxOccurs="1"/>
    <element type="CIPConnection" minOccurs="0" maxOccurs="*/>
    <element type="PolledIOConnection" minOccurs="0" maxOccurs="1"/>
    <element type="BitStrobeConnection" minOccurs="0" maxOccurs="1"/>
    <element type="COSConnection" minOccurs="0" maxOccurs="1"/>
    <element type="CyclicConnection" minOccurs="0" maxOccurs="1"/>
    <element type="MulticastPollingConnection" minOccurs="0" maxOccurs="1"/>
    <element type="SafetyInputConnection" minOccurs="0" maxOccurs="*/>
    <element type="SafetyOutputConnection" minOccurs="0" maxOccurs="*/>
    <element type="CompoNetIO" minOccurs="0" maxOccurs="1"/>
  </ElementType>

  <ElementType name="CurrentConnections" content="mixed" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="CIPConnection" minOccurs="0" maxOccurs="*/>
    <element type="MasterSlaveConnectionSet" minOccurs="0" maxOccurs="1"/>
    <element type="CompoNetIO" minOccurs="0" maxOccurs="1"/>
  </ElementType>

  <ElementType name="AssemblyMemberDefinition" content="eltOnly" model="open">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="fdt:id" required="no"/><!-- used in the AssemblyDefinition to reference this member -->
    <attribute type="fdt:tag" required="yes"/>
    <attribute type="fdt:descriptor" required="no"/>
    <attribute type="cip:dataType" required="yes"/>

```

```

<attribute type="defaultValue" required="no"/>
<element type="Scaling" minOccurs="0" maxOccurs="1"/>
  <element type="cip:CIPObjectAddress" minOccurs="0" maxOccurs="1"/><!-- only for accessible parameters
-->
  <element type="fdt:BitEnumeratorEntries" minOccurs="0" maxOccurs="1"/>
  <element type="fdt:EnumeratorEntries" minOccurs="0" maxOccurs="1"/>
  <element type="fdt:Unit" minOccurs="0" maxOccurs="1"/>
  <element type="fdt:Ranges" minOccurs="0" maxOccurs="1"/>
  <element type="fdt:SubstituteValue" minOccurs="0" maxOccurs="1"/>
</ElementType>

<ElementType name="AssemblyMemberDefinitions" content="mixed" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="AssemblyMemberDefinition" minOccurs="0" maxOccurs="*" />
</ElementType>

<ElementType name="CIPNode" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="fdt:readAccess" required="no"/>
  <attribute type="fdt:writeAccess" required="no"/>
  <!-- needed for DeviceNet Safety, EthernetIP and ControlNet devices -->
  <attribute type="fdtpar:configurationData" required="no" />
  <attribute type="sclId" required="no" />
  <attribute type="unId" required="no" />
  <!-- needed for connection establishment in DeviceNet Safety -->
  <element type="cip:CIPDeviceIdentity" minOccurs="1" maxOccurs="1"/>
  <element type="cip:CIPNodeID" minOccurs="1" maxOccurs="1"/>
  <element type="PossibleConnections" minOccurs="1" maxOccurs="1"/>
  <element type="CurrentConnections" minOccurs="1" maxOccurs="1"/>
  <element type="AssemblyMemberDefinitions" minOccurs="0" maxOccurs="1"/>
</ElementType>
</Schema>

```

10 Communication data types

This schema specifies the elements and attributes which are used with the methods of IFdtCommunication.

```

<?xml version="1.0"?>
<Schema name="FDT_CIP_Communication_Schema" xmlns="urn:schemas-microsoft-com:xml-data"
  xmlns:dt="urn:schemas-microsoft-com:datatypes" xmlns:fdt="x-schema:FDTDataTypesSchema.xml" xmlns:cip="x-
  schema:DTMCIPDataTypeSchema.xml">
  <!-- Version of the Schema -->
  <AttributeType name="schemaVersion" dt:type="number" default="1.0"/>
  <!-- Definition of Attributes -->
  <AttributeType name="communicationReference" dt:type="uuid"/>
  <AttributeType name="statusCode" dt:type="ui1"/>
  <AttributeType name="extendedStatusCode" dt:type="bin.hex"/>
  <AttributeType name="sequenceTime" dt:type="ui4"/>
  <AttributeType name="delayTime" dt:type="ui4"/>
  <!-- Definition of Elements -->
  <ElementType name="ServiceResponse" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="cip:serviceCode" required="yes"/>
    <attribute type="statusCode" required="yes"/>
    <attribute type="extendedStatusCode" required="no"/>
  </ElementType>
  <ElementType name="ConnectRequest" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <element type="cip:CIPPath" minOccurs="1" maxOccurs="1"/>
  </ElementType>
  <ElementType name="ConnectResponse" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="communicationReference" required="yes"/>
    <element type="cip:CIPDevice" minOccurs="1" maxOccurs="1"/>
  </ElementType>
  <ElementType name="DisconnectRequest" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>

```

```

    <attribute type="communicationReference" required="yes"/>
  </ElementType>
  <ElementType name="DisconnectResponse" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="communicationReference" required="yes"/>
  </ElementType>
  <ElementType name="DataExchangeRequest" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="communicationReference" required="yes"/>
    <attribute type="cip:serviceCode" required="yes"/>
    <element type="cip:CIPObjectAddress"/>
    <element type="fdt:CommunicationData" minOccurs="0" maxOccurs="1"/>
  </ElementType>
  <ElementType name="DataExchangeResponse" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="communicationReference" required="yes"/>
    <element type="ServiceResponse" minOccurs="1" maxOccurs="1"/>
    <element type="fdt:CommunicationData" minOccurs="0" maxOccurs="1"/>
  </ElementType>
  <ElementType name="SequenceBegin" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="sequenceTime" required="no"/>
    <attribute type="delayTime" required="no"/>
    <attribute type="communicationReference" required="yes"/>
  </ElementType>
  <ElementType name="SequenceEnd" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="communicationReference" required="yes"/>
  </ElementType>
  <ElementType name="SequenceStart" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <attribute type="communicationReference" required="yes"/>
  </ElementType>
  <ElementType name="Abort" content="empty" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
  </ElementType>
  <attribute type="communicationReference" required="yes"/>
  </ElementType>
  <ElementType name="FDT" content="eltOnly" model="closed">
    <attribute type="fdt:nodeId" required="no"/>
    <group order="one" minOccurs="1" maxOccurs="1">
      <element type="ConnectRequest"/>
      <element type="ConnectResponse"/>
      <element type="DisconnectRequest"/>
      <element type="DisconnectResponse"/>
      <element type="DataExchangeRequest"/>
      <element type="DataExchangeResponse"/>
      <element type="SequenceBegin"/>
      <element type="SequenceEnd"/>
      <element type="SequenceStart"/>
      <element type="Abort"/>
      <element type="fdt:CommunicationError"/>
    </group>
  </ElementType>
</Schema>

```

11 Channel parameter data types

This schema specifies the elements and attributes which are used with the following methods:

- IFdtChannel::GetChannelParameters()
- IFdtChannel::SetChannelParameters()

```

<?xml version="1.0"?>
<Schema name="FDTICIPChannelParameterSchema" xmlns="urn:schemas-microsoft-com:xml-data"
xmlns:dt="urn:schemas-microsoft-com:datatypes" xmlns:fdt="x-schema:FDTDataTypesSchema.xml" xmlns:cip="x-
schema:DTMICIPDataTypesSchema.xml" xmlns:fldtsystag="DTMSysTagListSchema.xml">

```

```

<!-- Version of the Schema -->
<AttributeType name="schemaVersion" dt:type="number" default="1.1"/>

<!--Definition of Attributes-->
<AttributeType name="assemblySize" dt:type="ui1"/>
<AttributeType name="memberPosition" dt:type="ui4"/>
<AttributeType name="memberSize" dt:type="ui4"/>
<AttributeType name="frameApplicationTag" dt:type="string"/>
<AttributeType name="gatewayBusCategory" dt:type="uuid"/>
<AttributeType name="protectedByChannelAssignment" dt:type="boolean"/>
<AttributeType name="helpMessage" dt:type="string"/>

<!--Definition of Elements-->
<ElementType name="AssemblyMemberReference" content="empty" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="fdt:idref" required="yes"/>
  <attribute type="cip:bitOffset" required="no"/>
</ElementType>

<ElementType name="ChannelReference">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="cip:bitOffset" required="yes"/>
  <element type="fdt:ChannelReference" />
  <element type="cip:CIPObjectAddress" minOccurs="1" maxOccurs="1"/>
</ElementType>

<ElementType name="AssemblyMember" content="eltOnly" model="closed">
  <!-- could be: a non-displayed, displayed parameters or assemblies -->
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="memberPosition" required="yes"/>
  <attribute type="memberSize" required="yes"/>

  <group order="one" minOccurs="1" maxOccurs="1">
    <element type="AssemblyMemberReference" minOccurs="0" maxOccurs="1"/>
    <element type="ChannelReference" minOccurs="0" maxOccurs="1"/>
    <element type="cip:CIPObjectAddress" minOccurs="1" maxOccurs="1"/>
    <element type="cip:Constant" minOccurs="1" maxOccurs="1"/>
  </group>
</ElementType>

<ElementType name="AssemblyMembers" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="AssemblyMember" minOccurs="0" maxOccurs="*/>
</ElementType>

<ElementType name="ServiceSet" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <element type="cip:Service" minOccurs="1" maxOccurs="*/>
</ElementType>

<ElementType name="FDTChannel" content="eltOnly" model="closed" order="seq">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="fdt:tag" required="yes"/>
  <attribute type="fdt:id" required="yes"/>
  <attribute type="protectedByChannelAssignment" required="yes"/>
  <attribute type="fdt:dataType" required="yes"/>
  <attribute type="assemblySize" required="yes"/>
  <attribute type="fdt:signalType" required="yes"/>
  <attribute type="frameApplicationTag" required="no"/>
  <attribute type="helpMessage" required="no"/>
  <element type="fdt:SemanticInformation" minOccurs="0" maxOccurs="*/>
  <element type="ServiceSet" minOccurs="1" maxOccurs="1"/>
  <element type="cip:CIPObjectAddress" minOccurs="1" maxOccurs="1"/>
  <element type="AssemblyMembers" minOccurs="0" maxOccurs="1"/> <!--should be used if the data type is
structured -->
</ElementType>

<ElementType name="FDTChannelType" content="eltOnly" model="closed">
  <attribute type="fdt:nodeId" required="no"/>
  <attribute type="gatewayBusCategory" required="no"/>

```