IEC TR 62453-51-20

Edition 1.0 2017-06

TECHNICAL REPORT

colour inside

Field device tool (FDT) interface specification – Part 51-20: Communication implementation for common object model – IEC 61784 CPF 2

IEC TR 62453-51-20:2017-06(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 25.040.40; 35.110.05; 35.110

ISBN 978-2-8322-4315-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION –

Part 51-20: Communication implementation for common object model – IEC 61784 CPF 2

FOREWORD

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IEC TR 62453-51-20, which is a technical report, has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process management, control and automation.

This document cancels and replaces IEC TR 62453-502 published in 2009. This edition constitutes a technical revision. The main change consists in improved support for Ethernet/IP.

Each part of the IEC 62453-51-xy series is intended to be read in conjunction with its corresponding part in the IEC 62453-3xy series. This document corresponds to IEC 62453-302.

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

Enquiry draft	Report on voting
65E/440/DTR	65E/514/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 document 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document 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- withdrawn,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 document using a colour printer.

INTRODUCTION

This part of IEC 62453 is an interface specification for developers of Field Device Tool (FDT) 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 Device Type Manager (DTM), 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 this part of the IEC 62453-51-xy series is aligned in the structure of the IEC 62453 series.

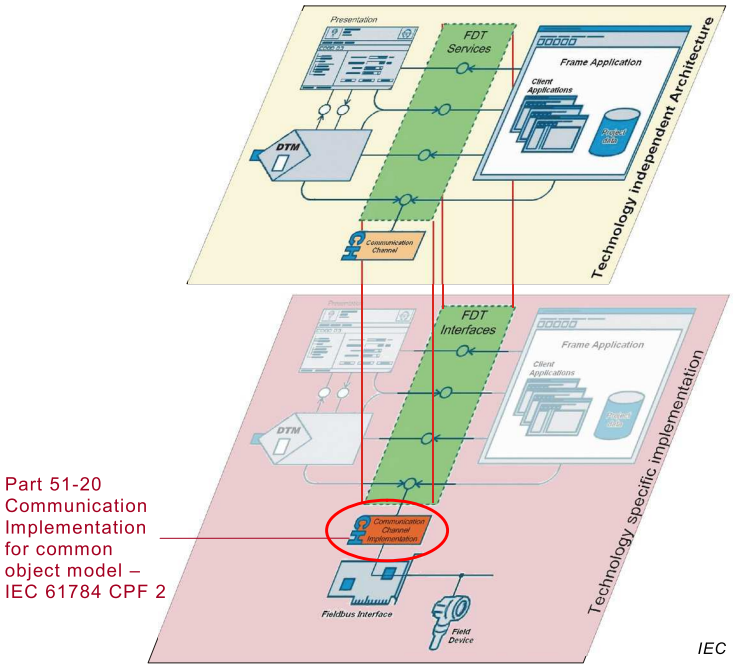

Figure 1 – Part 51-20 of the IEC 62453 series

FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION –

Part 51-20: Communication implementation for common object model – IEC 61784 CPF 2

1 Scope

This part of the IEC 62453-51-xy series, which is a Technical Report, provides information for integrating the CIP™ technology into the COM-based implementation of FDT interface specification (IEC TR 62453-41).

The 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 [15][4].

This document specifies implementation of communication and other services based on IEC 62453-302.

This document neither contains the FDT specification nor modifies it.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*

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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 document and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile 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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4 Figures in square brackets refer to the Bibliography.

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

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

IEC 61784-1:2014, *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 62453-1:2016, *Field device tool (FDT) interface specification – Part 1: Overview and guidance*

IEC 62453-2:2016, *Field device tool (FDT) interface specification – Part 2: Concepts and detailed description*

IEC TR 62453-41:2016, *Field device tool (FDT) interface specification – Part 41: Object model integration profile – Common object model*

IEC 62453-302:2016, *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 purposes of this document, the terms and definitions given in IEC 62453-1, IEC 62453-2, IEC TR 62453-41, and IEC 62453-301 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.2 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviations given in IEC 62453-1, IEC 62453-2, IEC 62453-302, and IEC TR 62453-41 apply.

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 62453-2:2016, 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 behaviour.
Usage of “can” or “optional”	Function or behaviour 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 the following methods:

- IDtmParameter methods
- IDtmSingleDeviceDataAccess methods
- IDtmSingleInstanceDataAccess methods

All parameters defined in the Params section of the EDS shall be exposed. For IdtmParameter, the parameters are exposed in the ExportedVariables element of the DtmParameter schema.

6 Protocol specific behaviour

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:deviceTypeInformation	
fdt:deviceTypeInformationPath	
fdt:manufacturerId	
fdt:semanticId	
fdt:applicationDomain	
fdt:tag	

8 Protocol specific common data types

8.1 Common data types – DTMCIPDataTypeSchema

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>
```

8.2 Data types for Ethernet/IP – DTMEIPDataTypeSchema

This schema specifies the protocol specific common XML elements and attributes for Ethernet/IP, 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="DTMEIPDataTypeSchema" 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="1.2"/>
        <!-- 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 = "IdvendorID" content = "eltOnly"  model = "closed">
        <attribute type="vendorID" required="yes"/> <!-- Identity Object Attribute 1 -->
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name = "IddeviceType" content = "eltOnly"  model = "closed">
        <attribute type="deviceType" required="yes"/> <!-- Identity Object Attribute 2 -->
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name = "IdproductCode" content = "eltOnly"  model = "closed">
        <attribute type="productCode" required="yes"/> <!-- Identity Object Attribute 3 -->
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name = "IdmajorRevision" content = "eltOnly"  model = "closed">
        <attribute type="majorRevision" required="yes"/> <!-- Identity Object Attribute 4.1 -->
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name = "IdminorRevision" content = "eltOnly"  model = "closed">
        <attribute type="minorRevision" required="yes"/> <!-- Identity Object Attribute 4.2 -->
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name = "IdserialNumber" content = "eltOnly"  model = "closed">
        <attribute type="serialNumber" required="yes"/> <!-- Identity Object Attribute 6 -->
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name = "IdproductName" content = "eltOnly"  model = "closed">
        <attribute type="productName" required="yes"/> <!-- Identity Object Attribute 7 -->
```

```
            <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
        </ElementType>

        <ElementType name="CIPDeviceIdentity" content="empty" model="closed">
            <attribute type="fdt:nodeId" required="no"/>
            <element type = "IdvendorID" minOccurs="1" maxOccurs="1"/>
            <element type = "IddeviceType" minOccurs="1" maxOccurs="1"/>
            <element type = "IdproductCode" minOccurs="1" maxOccurs="1"/>
            <element type = "IdmajorRevision" minOccurs="1" maxOccurs="1"/>
            <element type = "IdminorRevision" minOccurs="1" maxOccurs="1"/>
            <element type = "IdserialNumber" minOccurs="1" maxOccurs="1"/>
            <element type = "IdproductName" minOccurs="1" maxOccurs="1"/>
            <attribute type="vendorID" required="no"/> <!-- Obsolete after CIP v1.1 Identity Object Attribute 1 -->
            <attribute type="deviceType" required="no"/> <!-- Obsolete after CIP v1.1 Identity Object Attribute 2 -->
            <attribute type="productCode" required="no"/> <!-- Obsolete after CIP Identity Object Attribute 3 -->
            <attribute type="majorRevision" required="no"/> <!-- Obsolete after CIP Identity Object Attribute 4.1 -->
            <attribute type="minorRevision" required="no"/> <!-- Obsolete after CIP Identity Object Attribute 4.2 -->
            <attribute type="serialNumber" required="no"/> <!-- Obsolete after CIP Identity Object Attribute 6 -->
            <attribute type="productName" required="no"/> <!-- Obsolete after CIP 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 the 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) – FDTCIPDTMParameterSchema

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="FDTCIPDTMParameterSchema" 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" 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="scId" dt:type="bin.hex"/>
<AttributeType name="unId" 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"/>
            <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 accessable 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="scId" 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>
```

The fdt.nodeId for a CipConnection element represents the simple datatype connectionId as defined in IEC 62453-302. That is why it is mandatory to provide this attribute for CipConnection. For technical reasons, the attribute is marked as optional.

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="FDTCIPCommunicationSchema" 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"/>
    <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="FDTCIPChannelParameterSchema" 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" xmlns:fdtsystag="DTMSystemTagListSchema.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"/>
        <element type="fdt:VersionInformation" minOccurs="1" maxOccurs="1"/>
    </ElementType>

    <ElementType name="FDT" content="eltOnly" model="closed">
        <attribute type="fdt:nodeId" required="no"/>
        <element type="FDTChannelType" minOccurs="1" maxOccurs="1"/>
        <element type="FDTChannel" minOccurs="1" maxOccurs="1"/>
    </ElementType>
</Schema>
```

12 Device identification

12.1 Device type identification data types – FDTCIPIdentSchema

This schema provides general elements and attributes with a protocol specific semantic for identification of CIP nodes (data types are defined in IEC 62453-302).

```
<?xml version="1.0"?>
<Schema name="FDTCIPIdentSchema" xmlns="urn:schemas-microsoft-com:xml-data" xmlns:dt="urn:schemas-
microsoft-com:datatypes">
    <!-- Version of the Schema -->
    <AttributeType name="schemaVersion" dt:type="number" default="1.1"/>
    <!--Definition of Attributes-->
    <AttributeType name="busProtocol" dt:type="enumeration" dt:values="protocol_CIP_DeviceNet
protocol_CIP_EthernetIP protocol_CIP_ControlNet protocol_CIP_CompoNet"/>
    <AttributeType name="match" dt:type="string"/>
    <AttributeType name="nomatch" dt:type="string"/>
```

```
    <AttributeType name="idDTMSupportLevel" dt:type="enumeration" dt:values="genericSupport profileSupport
blockspecificProfileSupport specificSupport identSupport"/>
    <!--Definition of Elements-->
    <ElementType name="RegExpr" content="empty" model="closed">
        <attribute type="match" required="no"/>
        <attribute type="nomatch" required="no"/>
    </ElementType>
</Schema>
```

12.2 Topology scan data types

This schema specifies the elements and attributes which are used with the methods of IDtmEvents::OnScanResponse().

The schema describes one entry, CIPDevice (see 8.1, in the list of scanned CIP Devices).

12.3 Scan identification data types – FDTCIPScanIdentSchema

This schema defines the elements and attributes provided by a scan response of a CIP network.

```
<Schema name="FDTCIPScanIdentSchema" xmlns="urn:schemas-microsoft-com:xml-data"
xmlns:dt="urn:schemas-microsoft-com:datatypes" xmlns:cipident="x-schema:FDTCIPIdentSchema.xml"
xmlns:fdt="x-schema:FDTDataTypesSchema.xml" xmlns:cip="x-schema:DTMCIPDataTypeSchema.xml">
    <!--Definition of Attributes-->
    <AttributeType name="schemaVersion" dt:type="number" default="1.0"/>
    <AttributeType name="resultState" dt:type="enumeration" dt:values="provisional final error"/>
    <AttributeType name="configuredState" dt:type="enumeration" dt:values="configuredAndPhysicallyAvailable
configuredAndNotPhysicallyAvailable availableButNotConfigured notApplicable"/>
    <!--Definition of elements-->
    <ElementType name="IdBusProtocol" content="eltOnly" model="closed">
        <attribute type="cipident:busProtocol" required="no"/>
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>

    <ElementType name="ScanIdentification" content="eltOnly" model="closed">
        <attribute type="configuredState" required="no"/>
        <element type="fdt:CommunicationError" minOccurs="0" maxOccurs="1"/>
        <element type="IdBusProtocol" minOccurs="1" maxOccurs="1"/>
        <element type="cip:CIPDevice" minOccurs="1" maxOccurs="1"/>
    </ElementType>

    <ElementType name="ScanIdentifications" content="eltOnly" model="closed">
        <attribute type="fdt:busCategory" required="yes"/>
        <attribute type="resultState" required="yes"/>
        <element type="ScanIdentification" minOccurs="0" maxOccurs="*"/>
    </ElementType>
    <ElementType name="FDT" content="eltOnly" model="closed">
        <element type="ScanIdentifications" minOccurs="1" maxOccurs="1"/>
    </ElementType>
</Schema>
```

12.4 Device type identification data types – FDTCIPDeviceTypeIdentSchema

This schema defines elements and attributes which are used to provide protocol specific information for device types.

```
<?xml version="1.0"?>
<Schema name="FDTCIPDeviceTypeIdentSchema" xmlns="urn:schemas-microsoft-com:xml-data"
xmlns:dt="urn:schemas-microsoft-com:datatypes" xmlns:cipident="x-schema:FDTCIPIdentSchema.xml"
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 Elements-->
    <ElementType name="IdBusProtocol" content="eltOnly" model="closed">
```

```
        <attribute type="cipident:busProtocol" required="no"/>
        <element type="cipident:RegExpr" minOccurs="0" maxOccurs="*"/>
    </ElementType>
    <ElementType name="DeviceIdentification" content="eltOnly" model="closed">
        <attribute type="cipident:idDTMSupportLevel" required="yes"/>
        <element type="IdBusProtocol" minOccurs="1" maxOccurs="1"/>
        <element type="cip:CIPDeviceIdentity" minOccurs="1" maxOccurs="1"/>
    </ElementType>
    <ElementType name="DeviceIdentifications" content="eltOnly" model="closed">
        <attribute type="fdt:busCategory" required="yes"/>
        <element type="DeviceIdentification" minOccurs="0" maxOccurs="*"/>
    </ElementType>
    <ElementType name="FDT" content="eltOnly" model="closed">
        <element type="DeviceIdentifications" minOccurs="1" maxOccurs="1"/>
    </ElementType>
</Schema>
```

Annex A
(informative)

Implementation hints

A.1 XML Characters

XML documents cannot contain the complete set of ASCII characters; they shall contain a certain set of available characters. Therefore, developers shall make sure that the provided data in the transaction request and response contain only available characters especially for string data type.

For instance, Communication DTM developers shall make sure that string attributes contain valid characters (e.g. vendor name, product name, tag). If the strings received from a connected device contain invalid characters, they shall be replaced with valid characters.

A.2 Support for FDT 1.2

Inline schemas shall be used in the XML documents for topology scan and DTM parameter access interfaces.

A.3 Addressing examples in CompoNet DTMs

The following XML document is an example of the use of the “ShortIdentifier” to specify the address within the “UserDefinedBus” element for CompoNet.

```
<BusInformation xmlns="x-schema:DTMParameterSchema.xml">
   <UserDefinedBus xmlns:cip="x-schema:DTMCIPDataTypeSchema.xml"
                        xmlns:cippar="x-schema:FDTCIPDTMParameterSchema.xml">
      <cippar:CIPNode>
         <cip:CIPNodeID>
        <cip:ShortIdentifier shortIdentifier="0"/>
         </cip:CIPNodeID>
         <cippar:PossibleConnections/>
         <cippar:CurrentConnections>
            <cippar:CompoNetIO compoNetDeviceCategory="2">
               <cippar:CompoNetOutputInfo>
                  <cippar:CompoNetIOInfo compoNetIOLengthUnit="2" compoNetIOLength="1"/>
               </cippar:CompoNetOutputInfo>
       </cippar:CompoNetIO>
    </cippar:CurrentConnections>
      </cippar:CIPNode>
   </UserDefinedBus>
</BusInformation>
```

The following XML document is an example of the ExtendedIdentifier contents for a Word OUT device at Node Address 5.

```
<FDT xmlns="x-schema:FDTCIPCommunicationSchema.xml" xmlns:fdt="x-schema:FDTDataTypesSchema.xml"
xmlns:cip="x-schema:DTMCIPDataTypeSchema.xml">
    <ConnectRequest>
        <cip:CIPPath>
            <cip:CIPNodeID>
                <cip:ExtendedIdentifier extendedIdentifier="0045"/>
            </cip:CIPNodeID>
        </cip:CIPPath>
    </ConnectRequest>
</FDT>
```

A.4 Unique identification of a connection

Device DTMs are allowed to export more than one connection. If a Device DTM exports more than one connection and sends an IDtmEvents::OnParameterChanged() notification, the Master DTM may not be able to determine if the event was fired because the previously existing connections are only modified or new connections are created.

EXAMPLE:

- Parent DTM retrieves a list of connections from a Device DTM containing two connections named “My Exclusive Owner”
- Device DTM sends an OnParameterChanged()event. The Parent DTM compares the updated connection list and detects that some parameters in the first “My Exclusive Owner” connection are different, but the Parent DTM cannot decide if these are modifications from the previous first “My Exclusive Owner” connection or for example, if the Device DTM has simply sent the list of connections in a different order (or if it is an entirely new connection)
- For consistency reasons, the Parent DTM should consider to internally re-create all information links to all the connections (delete all items linked to the connections and re-import all default items from the process channel)

Hence it shall be possible to uniquely identify a connection. The fdt:nodeId attribute shall be used to provide a unique identifier for the connection.

Usage of the <fdt:nodeId> attribute as unique identifier for a connection is given below:

```
<PossibleConnections>
  .
  .
  <cippar:CIPConnection
     connectionNameString=" ExOwner Present Data"
     helpString=" Direct Exclusive Owner Connection contains the Present data and Status word "
     cip:ePath="200424c7200424c6200425005d02"

     fdt:nodeId="GRP_MODULE_2_1/DISPLAY_CONN_0"

    defaultConnection="1"
  >
  .
  .
</PossibleConnections>
```

A.5 Relation between connections and device internal modularity

The DTMParameterSchema allows the description of modular devices using the InternalTopology element. For Ethernet/IP it is useful to have a possibility to show the relationship between the CIP connections and the single modules of a modular device. Since the Module element of the InternalTopology element defined in DTMParameterSchema has no reference to the CIPConnection element in the BusInformation element defined in FDTEIPDTMParameterSchema, it is not possible to reference directly a connection in a module description.

To describe the modularity of the device, the InternalTopology element is used. Each module shall be described with a Module element. The Module element shall contain an ExportedVariables element which shall be used to reference a connection described in the FDTEIPDTMParameterSchema.

Therefore it shall be possible to reference a connection within a device uniquely. How to identify the connection uniquely is described in Clause A.4. The name attribute of the fdt:DtmVariable element shall contain the unique identifier of the connection given in the fdt:nodeId attribute of the CIPConnection element.

Usage of exported variables in <InternalTopology> element is given below:

```
<InternalTopology>
  <InternalChannel>
    <Module moduleId="1">
      <fdt:VersionInformation name="Module No 1" vendor="Schneider Electric" version="1.0" date="2009-06-27"/>
      <ExportedVariables>
        <fdt:DtmVariables name="Connections"
              descriptor="references to connections which are linked to this module">
          <fdt:DtmVariable name="GRP_MODULE_2_1/DISPLAY_CONN_0" descriptor="reference to the connection">
            <fdt:Value>
              <fdt:Display string="ExOwner Present Data"/>
            </fdt:Value>
          </fdt:DtmVariable>
        </fdt:DtmVariables>
      </ExportedVariables>
    </Module>
  </InternalChannel>
</InternalTopology>
```

A.6 Handling of process channels

For performance reasons, a DTM should expose a single process channel per assembly only. The process channels (one per assembly) contain assembly member references. The assembly member reference points to an assembly member defined in the BusInformation element of the parameter document.

The fdt:idref attribute in the process channel definition shall be used to reference the assembly member in the BusInformation element. The BusInformation element contains an AssemblyMemberDefinition element with the referenced ID in its fdt:id attribute. An example of Process Channel is given below.

EXAMPLE

```
<?xml version="1.0"?>
<FDT xmlns="x-schema:FDTCIPChannelParameterSchema.xml"
     xmlns:fdt="x-schema:FDTDataTypesSchema.xml"
     xmlns:cip="x-schema:DTMCIPDataTypeSchema.xml"
     xmlns:cippar="x-schema:FDTEIPDTMParameterSchema.xml">
  <FDTChannelType>
    <fdt:VersionInformation
      name="Input Assembly 1"
      vendor="Schneider Electric"
      version="1.0"
      date="2009-06-27"/>
  </FDTChannelType>
  <FDTChannel
    fdt:tag="Input Assembly 1"
    fdt:id="assemblyId"
    protectedByChannelAssignment="0"
    fdt:dataType="structured"
    assemblySize="8"
    fdt:signalType="input"
    frameApplicationTag="Tag assigned from Frame"
    helpMessage="some help might help"
    >
    <ServiceSet>
      ....
    </ServiceSet>
    <cip:CIPObjectAddress>
      ....
    </cip:CIPObjectAddress>
    <AssemblyMembers>
      <AssemblyMember
        memberPosition="0"
        memberSize="32"
        >

      <AssemblyMemberReference fdt:idref="2331D177-5649-4898-AB7A-A4FFC411CE1A"/>
```

```
    </AssemblyMember>
    <AssemblyMember
     memberPosition="32"
     memberSize="8"
     >

    <AssemblyMemberReference fdt:idref="A1587D88-AC6D-421e-B0F1-7E111C01A7A8"/>

    </AssemblyMember>
   </AssemblyMembers>
  </FDTChannel>
</FDT>
```

Corresponding assembly member definition in <CIPNode> element:

```
<?xml version="1.0"?>
<FDT xmlns="x-schema:DTMParameterSchema.xml"
    xmlns:fdt="x-schema:FDTDataTypesSchema.xml"
    xmlns:cip="x-schema:DTMCIPDataTypeSchema.xml"
    xmlns:cippar="x-schema:FDTEIPDTMParameterSchema.xml"
  fdt:storageState="persistent"
  fdt:dataSetState="default"
>
  .
  .
  .
  <DtmDevice fdt:tag="myTag">
    <fdt:ChannelReferences>
     <fdt:ChannelReference idref="assemblyId" />
     </fdt:ChannelReferences>
     <BusInformation>
      <UserDefinedBus>
       <cippar:CIPNode>
         .
         .
         .
        <cippar:AssemblyMemberDefinitions>
         <cippar:AssemblyMemberDefinition

          fdt:id="2331D177-5649-4898-AB7A-A4FFC411CE1A"

          fdt:tag="label"
          fdt:descriptor="some description"
          cip:dataType="float"
          >
          <cip:CIPObjectAddress>
           <cip:CIPObjectId
             .
             .
             .
            />
          </cip:CIPObjectAddress>
         </cippar:AssemblyMemberDefinition>
        <cippar:AssemblyMemberDefinition

         fdt:id="A1587D88-AC6D-421e-B0F1-7E111C01A7A8"

         fdt:tag="label2"
         fdt:descriptor="some description"
         cip:dataType="byte"
         >
         <cip:CIPObjectAddress>
          <cip:CIPObjectId
             .
             .
             .
           />
         </cip:CIPObjectAddress>
        </cippar:AssemblyMemberDefinition>
```

```
        </cippar:AssemblyMemberDefinitions>
      </cippar:CIPNode>
    </UserDefinedBus>
  </BusInformation>
  .
  .
  .
 </DtmDevice>
</FDT>
```

A.7 Identification of Modules in Modular Devices

The CIPDeviceIdentity element is related to one CIP node, respectively one entire CIP device. The identification of an individual module within a modular device is not possible.

The InternalTopology element shall be used to describe the modularity of the device. Each module shall be described with a Module element. The Module element shall contain an ExportedVariables element which shall be used to define variables containing the required information Vendor Code, Product Type, Product Code, Major Revision and Minor Revision of the module.

Module identification in the InternalTopology element:

```
<InternalChannel>
 <Module moduleId="7" slot="7" fdt:nodeId="GRP_MODULE_8_7">
  <fdt:VersionInformation name="Module No 1" vendor="Schneider Electric" version="1.0" date="2009-06-27"/>
  <ExportedVariables>
   <fdt:DtmVariables name="Identification" descriptor="contains information about the module indentification">
    <fdt:DtmVariable name="VendorCode" descriptor="Vendor Code of the module">
     <fdt:Value>
      <fdt:Display string="1"/>
     </fdt:Value>
    </fdt:DtmVariable>
    <fdt:DtmVariable name="ProductType" descriptor="Product Type of the module">
     <fdt:Value>
      <fdt:Display string="12"/>
     </fdt:Value>
    </fdt:DtmVariable>
    <fdt:DtmVariable name="ProductCode" descriptor="Product Code of the module">
     <fdt:Value>
      <fdt:Display string="58"/>
     </fdt:Value>
    </fdt:DtmVariable>
    <fdt:DtmVariable name="Major Revision" descriptor="Major Revision of the module">
     <fdt:Value>
      <fdt:Display string="2"/>
     </fdt:Value>
    </fdt:DtmVariable>
    <fdt:DtmVariable name="Minor Revision" descriptor="Minor Revision of the module">
     <fdt:Value>
      <fdt:Display string="1"/>
     </fdt:Value>
    </fdt:DtmVariable>
   </fdt:DtmVariables>
  </ExportedVariables>
  ....
 </Module>
</InternalChannel>
```

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NOTE See also the IEC Multilingual Dictionary – Electricity, Electronics and Telecommunications (available on CD-ROM and at <http://www.electropedia.org>)

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