Mapping EtherNet/IP (CIP) object to OPC UA Information Model

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Keywords

CIP: Common Industrial Protocol
OPC UA: Open Platform for Connectivity - Unified Architecture
PA-DIM: Process Automation-Device Information Model
FDI: Field Device Integration
FDT/DTM: Field Device Tool/Device Type Manager
CDD: Common Data Dictionary
DCS: Distributed Control Systems
NOA: NAMUR Open Architecture
IRDI: International Registration Data Identifier
EDDL: Electronic Device Description Language
UIP: User Interface Plug-in
EDS: Electronic Data Sheet
CS: Companion Specification

Terms and Definition

For the purpose of this document and clarity, the following definitions apply

Parameterization:
Configuration of EtherNet/IP adapter device

FDI Host:
FDI Host application consists of FDI Server and FDI client module. FDI Server imports the FDI Device Package and exposes the FDI Information model. FDI Client renders the User Interface by interpreting the FDI Information Model

FDT Frame/Host:
FDT Host/Frame application hosts the Device/Communication DTM

FDT aware OPC UA Client:
OPC UA client capable of interpreting the FDT OPC UA Information Model

FDI aware OPC UA Client:
OPC UA client capable of interpreting the FDI Information Model

EtherNet/IP FDI Communication Server:
EtherNet/IP Device connects to the FDI Host using EtherNet/IP FDI Communication Server. EtherNet/IP FDI Communication server consists of OPC UA Server with EtherNet/IP driver exposing the FDI Communication device information model

Non-UI methods/command functions:
Any method, which does not require hosting the user interface. For instance, FactoryReset method

FDI EtherNet/IP PSD Specification:
FDI EtherNet/IP Protocol Specification Definition (PSD) file contains the information necessary to support EtherNet/IP communication protocol in FDI specification

1. Abstract

OPC is the most widely adopted interoperability standard for secure, reliable and platform-independent information exchange in the Industrial Automation space and other industries like Automotive, Building Automation etc. Mapping of EtherNet/IP (CIP) objects like Identity, Assembly to OPC UA Information Model shall enable standard OPC UA Services to access the objects of EtherNet/IP devices in a vendor neutral way.

This whitepaper mainly focuses on

- Various ways of supporting OPC UA standard for EtherNet/IP devices - Deployment Scenarios
- Some specific use cases relevant for Process Automation Industries
- Mapping and comparing the above use cases with various OPC UA Information model which are listed in this document

Supporting OPC UA standard for EtherNet/IP devices - Deployment Scenarios

The access of EtherNet/IP object via OPC UA Service is possible in three different scenarios
- Scenario 1: OPC supported Host/DCS system (FDT/FDI/PA-DIM)
- Scenario 2: EtherNet/IP OPC UA Server using EDS file embedded in Industrial Gateway or in any HMI/Industrial Software application
- Scenario 3: OPC UA Server directly embedded in EtherNet/IP device

Process Automation Industry specific use cases

Some of the process automation industry specific use cases relevant for EtherNet/IP device listed below.
- Use Case 1: Device Identification
- Use Case 2: Device Health Status (NAMUR NE107)
- Use Case 3: Monitoring Process Variable
- Use Case 4: Parameterization
- Use Case 5: Calibrating the field device

Scope of the whitepaper

- For Scenario 1: Map and compare the Process Automation Industry specific use cases listed above to
  - FDT OPC UA Information Model
  - FDI Information Model
  - PA-DIM
- For Scenario 2: Possible mapping of EDS Information to OPC UA Information model for above listed use cases
- For Scenario 3: High level understanding of supporting OPC UA in EtherNet/IP device

Note: This document is for audience with prior knowledge on OPC UA specification, FDT OPC UA Information, FDI Information Model and PA-DIM.

2. Mapping EtherNet/IP (CIP) object to OPC UA Information Model

This section covers the mapping of EtherNet/IP (CIP) object to OPC UA Information model for above three scenarios and process automation industry specific use cases.

2.1 Scenario 1: OPC supported Host/DCS system (FDT/FDI/PA-DIM)

OPC UA supported FDT/FDI Host or DCS system can expose the EtherNet/IP (CIP) object via any of the below three information model

- FDT OPC UA Information Model
- FDI Information Model
- Process Automation - Device Information Model (PA-DIM)

Below section provides high-level understanding and comparison of above three OPC UA information model, and mapping it to the process industry specific use cases.

2.1.1 EtherNet/IP objects mapped to FDT OPC UA Information Model

As part of IIoT/Industrie 4.0 strategy, FDT Group and OPC Foundation has jointly worked on FDT OPC UA Information model specification document.

EtherNet/IP devices connected to OPC enabled FDT Host/Frame allows access to the EtherNet/IP object via OPC UA Services. No additional implementation is necessary for exposing EtherNet/IP (CIP) via OPC UA services in FDT Host/Frame system.

Use Cases Supported by FDT OPC UA Information Model

Below are the set of use cases supported by FDT OPC UA Information Model

- List Topology
- Device Identification
- Browse Parameters and its attributes
- Get Device Status
- Get Device Diagnostics
- Read Offline Parameters
- Read Online Data
- Write Device Parameters
- Audit Trail

System Diagram

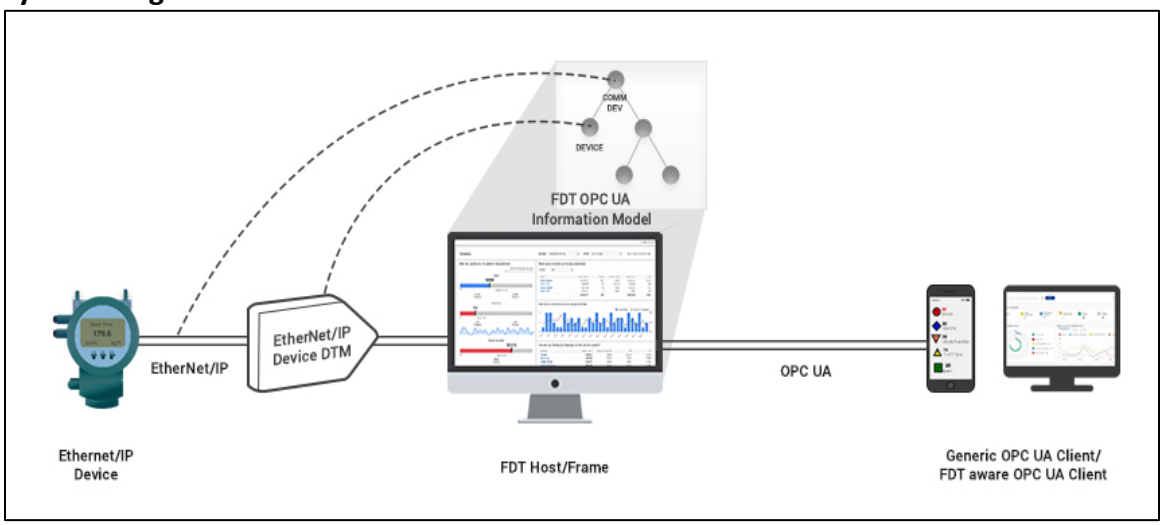

Figure #1: EtherNet/IP field device connected to FDT Host

As shown in Figure #1, EtherNet/IP field device represents EtherNet/IP Device DTM in the FDT Host/Frame application. FDT Host application exposes the FDT OPC UA Information model and enables the access to the EtherNet/IP device object via OPC UA Services. Any generic or FDT aware OPC UA Client can access the EtherNet/IP device by connecting to FDT OPC UA Server.

Components required for supporting EtherNet/IP field device in FDT OPC UA Information Model listed below

- FDT Host supporting OPC UA Server
- EtherNet/IP Communication DTM
- FDT EtherNet/IP (CIP) Annex Specification Document
- FDT EtherNet/IP Device DTM

2.1.2 EtherNet/IP objects mapped to FDI (Field Device Integration) Information Model

FDI specification can support EtherNet/IP devices using FDI generic protocol extension specification. EtherNet/IP devices connected to FDI Host supporting FDI Information model allows access to the EtherNet/IP device object via OPC UA Services.

No additional implementation is necessary for supporting EtherNet/IP device in FDI Information Model.

This topic is covered in our previous white paper presented at ODVA 2018 Annual Conference -"EtherNet/IP + FDI = Value in Process Automation"
https://www.odva.org/Portals/0/Library/Conference/Paper%201_2018-ODVA-Conference_Smitha%20Chatrapathi_EtherNetIP-FDI_FINAL.pdf

Use Cases Supported by FDI Information Model

- Asset Management
- Supporting all the methods defined in the EtherNet/IP FDI Device Package (For example: Calibration, Device Setup, and Echo Curve for Level Transmitter etc.)
- Supporting all functionalities defined in the EtherNet/IP Device Package like Configuration, Alarms, Diagnostics, Trends etc.
- UIP Hosting for supporting complex device functionalities
- Upload/Download for Offline Configuration
- Audit Trail

As shown in below Figure #2, EtherNet/IP FDI Device Package represents the EtherNet/IP device in FDI host system. FDI Server communicates with EtherNet/IP device using EtherNet/IP FDI Communication Server. It exposes the EtherNet/IP device object in the FDI Information Model. Any generic OPC UA Client or FDI Client application can access the EtherNet/IP device by connecting to the FDI Server (OPC UA Server).

System Diagram

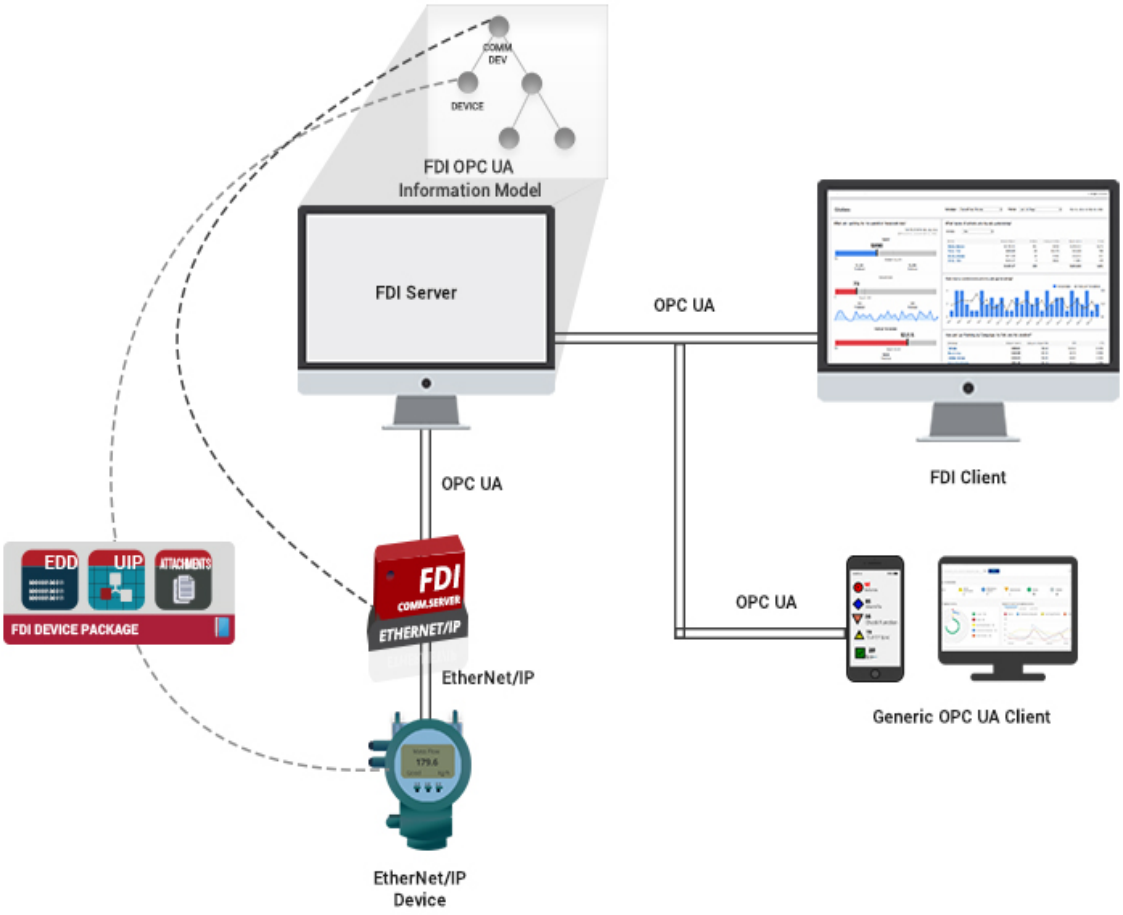

Figure #2: EtherNet/IP device connected to FDI Host supporting generic protocol extension.

Components required for supporting EtherNet/IP field device in FDI Information Model listed below

- FDI Server supporting generic protocol extension
- EtherNet/IP FDI Communication Server
- EtherNet/IP FDI PSD Annex specification document
- EtherNet/IP FDI Device Package

2.1.3 EtherNet/IP objects mapped to PA-DIM

Devices mainly used in the process industries like Chemical, Oil & Gas, Pharmaceutical, Food & Beverage, Power Generations, Water and Waste Water etc. are known as Process Automation Devices. They include measurement devices like Flow, Density, Level, Temperature etc. and controlling devices like valves, actuators and positioners.

It is necessary to access the common set of parameters and functions from these devices for effective commissioning, operation and maintenance of these devices. This may be necessary to have this information even during procurement stage of these devices. IEC standards like Common Data Dictionary (CDD) – IEC 61987 and eCl@ass have a unique way to identify the device parameters using the standard unique identifier. However, it is necessary to have the Information Model to manage the entire life cycle of device independent of the communication protocol.

OPC Foundation and FieldComm Group is jointly working on PA-DIM specification document

Use Cases Supported by PA-DIM

The first release of PA-DIM focus mainly on the NAMUR Device Core Parameter NE131 and NAMUR OPEN Architecture (NOA) use cases for Pressure, Temperature, Flow, Level, Density, Control Actuator/Positioner devices.

- Identification
- Diagnostics
- Process Values
- Configuration

System Diagram

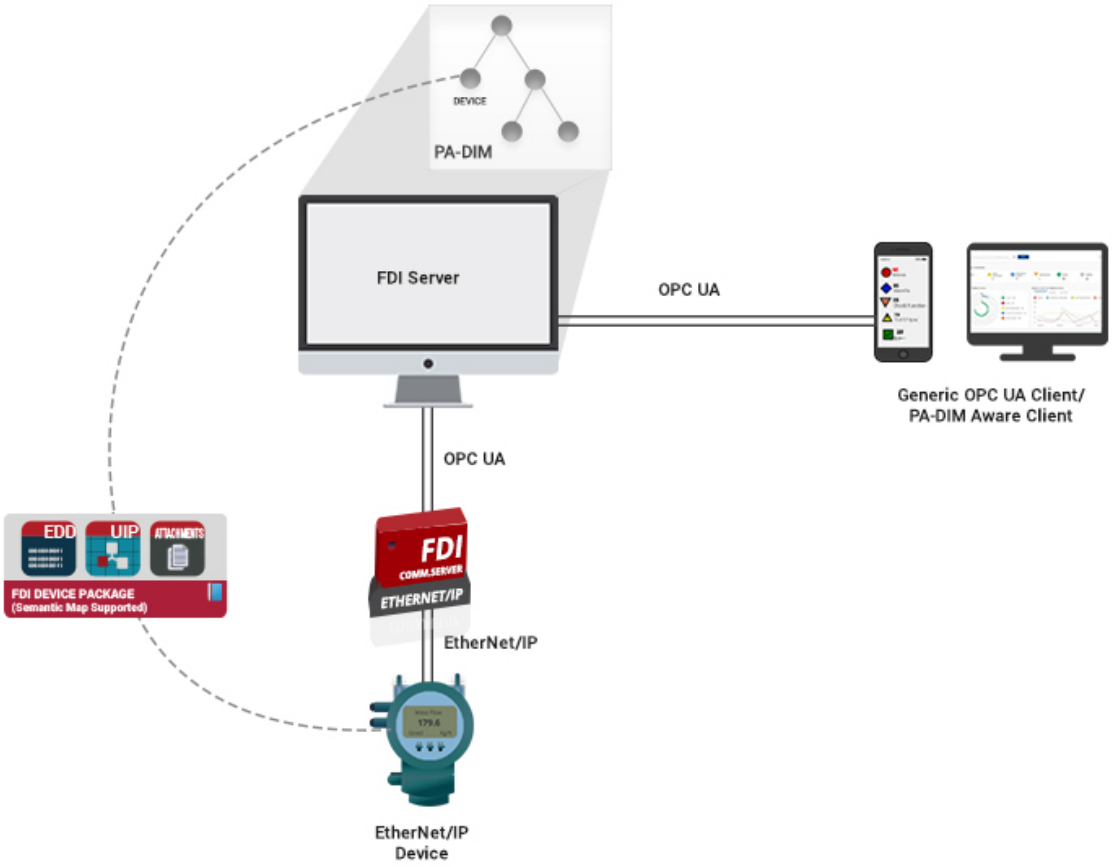

Figure #3: EtherNet/IP Device connected to PA-DIM Server

As shown in Figure #3, EtherNet/IP device connects to FDI Server using EtherNet/IP FDI Communication Server. FDI Server exposes the PA-DIM Server. EtherNet/IP FDI Device Package representing the EtherNet/IP field device supports the SEMANTIC_MAP information. PA-DIM Server exposes the EtherNet/IP device information. Any generic OPC UA client can access it by connecting to PA-DIM Server.

Components required for supporting EtherNet/IP field device in PA-DIM server listed below

- FDI Server supporting generic protocol extension
- EtherNet/IP FDI Communication Server
- EtherNet/IP FDI PSD Annex specification document
- EtherNet/IP Device Package supporting the SEMANTIC_MAP

2.1.4 Comparison of FDT OPC UA Information Model, FDI Information Model and PA-DIM

	FDT OPC UA Information Model	FDI Information Model	PA-DIM
Base Specification	OPC UA for Devices Companion Specification Document	OPC UA for Devices Companion Specification Document	OPC UA Core Specification Document with support for IrdiDictionaryEntryType etc. and OPC UA for Devices Companion Specification Document
Core Objective	Generic or FDT aware OPC UA client to fetch field device information from FDT OPC UA Server in vendor and protocol neutral way.	FDI Information model enables distributed deployment of FDI server and FDI client application.	Current version of PA-DIM mainly focuses on NAMUR specific use cases for Process Automation Devices.
Scope of Information Model	Limited: FDT OPC UA Information model is limited to list of supported use cases mentioned above. No support for rendering the DTM User Interface from the OPC UA Client application.	Elaborate: FDI Information Model is very elaborate and exposes the complete UI Element, Variable Definitions, methods, UIPs and communication network topology from FDI Device Package. FDI Client is thick client application.	Limited, highly focused on specific use cases: PA-DIM focuses on NAMUR specific use cases applicable for process automation devices. PA-DIM Information Model does not include the UI Element and Communication topology element.
Data Source for OPC UA Information Model	EtherNet/IP FDT2 and above DTM.	EtherNet/IP FDI Device Package	EtherNet/IP FDI Device Package with parameters/methods mapped to Semantic IDs as per Common Data Dictionary (IEC 61987)

Support for Method Execution	Supports only Non-UI methods (Command Functions) For ex: DeviceHealth Status, FactoryReset method.	All methods defined in the EtherNet/IP FDI Device Package are exposed via FDI Information Model.	Supports only Non-UI methods. Current version has support for methods like FactoryReset, ZeroPointAdjustment, AutoAdjustPositioner.
Specification Support and Roadmap	FDT OPC UA Information Model is available for FDT2.0 and above versions. Current EtherNet/IP Annex specification for FDT is available for FDT 1.2.1. FDT 2.0 CIP Annex specification will be released soon to support EtherNet/IP Device via FDT OPC UA Information Model	FDI Specification can support third party protocol like MODBUS, EtherNet/IP using generic protocol extension specification document. However, EtherNet/IP FDI PSD specification document to support EtherNet/IP devices will be released soon.	PA-DIM specification with support for specific use NOA use cases will be released soon.
Support for Machine Readability via Semantic ID	Not Supported	Not Supported	Supported
Device Profile Support	Independent of various device profile types (For ex: Level, Flow, Positioner etc.)	Similar to FDT OPC UA Information Model	Depends on specific device profile type and needs to be extended for each new device profile.

Table #1: Comparison table for FDT OPC UA Information Model, FDI Information Model, PA-DIM

2.1.5 Use Case Mapping for FDT OPC UA, FDI Information Model and PA-DIM

Below section maps and compares process industry specific use cases with all the above three OPC UA Information model

Use Case 1: Device Identification
Goal: Uniquely identify an EtherNet/IP field device in the network.

Below Table #2 shows the mapping of Device Identification i.e. EtherNet/IP Identity Object response from EtherNet/IP Device to FDT OPC UA Information Model, FDI Information Model and PA-DIM

	FDT OPC UA Information Model/ Modelling Rule*1	**FDI Information Model/ Modelling Rule*1**	**PA-DIM/ Modelling Rule*1**
EtherNet/IP Identity Object Response	**Identification FunctionalGroup in OPC UA for Devices Companion Spec**	**Identification FunctionalGroup in OPC UA for Devices Companion Spec**	**PADIMType in OPC UA CS for Process Automation Devices**
VendorID	ManufacturerId/(O)	Manufacturer(M)	Manufacturer (M)
DeviceType	DeviceTypeId/(O)	DeviceModel(M)	Model(M)
Product Code	-	-	Product Code(M)
Revision *2 (STRUCT of Major Revision, Minor Revision)	HardwareRevision(M), SoftwareRevision(M)	DeviceRevision(M)	Hardware Revision(M), Software Revision(M)
Serial Number	SerialNumber (M)	SerialNumber(M)	SerialNumber(M)
Product Name	-	-	-

Table #2: Mapping of Device Identification to FDT, FDI Information Model and PA-DIM

*1 - OPC UA Modelling Rule
(M) - Mandatory as per OPC UA Modelling Rule
(O) - Optional as per OPC UA Modelling Rule

*2 - Revision in EtherNet/IP specification is STRUCT of Major Revision and Minor Revision. This can be mapped to Hardware Revision and Software Revision.

Use Case 2: Device Health Status (NAMUR NE107)

Goal: DeviceHealth indicates the status of a device as defined by NAMUR Recommendation NE107.

Below Table #3 shows the mapping of Device Health i.e. Status Signal response from EtherNet/IP Process Device Diagnostics Object to FDT OPC UA Information Model, FDI Information Model and PA-DIM

	FDT OPC UA Information Model/ Modelling Rule*1	**FDI OPC UA Information Model/ Modelling Rule*1**	**PA-DIM/ Modelling Rule*1**
EtherNet/IP Process Device Diagnostics Object	**DeviceType Definition in OPC UA for Devices Companion Spec**	**DeviceType Definition in OPC UA for Devices Companion Spec**	**IDeviceHealthDiagnosticType Definition in OPC UA CS for Process Automation Devices**
Status Signal	DeviceHealth/(O)	DeviceHealth/(M)	DeviceHealth/(M)

Table #3: Mapping of Device Health to FDT, FDI Information Model and PA-DIM

*1 - OPC UA Modelling Rule
(M) - Mandatory as per OPC UA Modelling Rule
(O) - Optional as per OPC UA Modelling Rule

Notes:

- As per CIP Specification document, EtherNet/IP Process Device Diagnostics Object provides more information like Sequence Number, Timestamp Event occurred, Diagnostic Message, vendor specific diagnostic code etc.
- FDI Information Model - DeviceType definition has an additional component called DeviceHealthDiagnostics which is array of LocalizedText. It can contain additional information like the possible cause of an abnormal DeviceHealth status and suggested actions to return to normal. Similarly PA-DIM specification has defined DeviceHealthDiagnostic which is array of string
- Additional Information from EtherNet/IP Process Device Diagnostic Object like Diagnostic Message can be mapped to DeviceHealthDiagnostic information in FDI Information Model and PA-DIM
- As per CIP Specification document, EtherNet/IP Process Device Diagnostics Object is not mandatory object
- As per FDT Specification, DeviceStatus method is not mandatory
- In case, if EtherNet/IP FDT2.0 enabled DTM or EtherNet/IP field device does not support DeviceHealth, then this information cannot be mapped to OPC UA Information model

Use Case 3: Monitoring Process Variable

Goal: Remotely monitor the process variables read from the EtherNet/IP device using any OPC UA client application.

Below Table #4 maps and compares the Monitoring Process Variable use case support for FDT OPC UA Information Model, FDI Information Model and PA-DIM

	FDT OPC UA Information Model	**FDI Information Model**	**PA-DIM**
Accessing the Process Variable in OPC UA Information Model	DeviceType object contains ParameterSet and MethodSet. ParameterSet gathers the references to all Parameters that are exposed to the OPC UA Client.	Similar to FDT OPC UA Information Model	PA-DIM specification has defined the Type definition SignalSetType to expose the process values read from field device. It also defines the device profile type (Ex: LevelMeasurementVariableType.ControlVariableType) to represent the process values read from various device profile types.
Access Level	In EtherNet/IP Device DTM, only AccessibleData and StructDataGroup shall be represented in the ParameterSet	In EtherNet/IP FDI Device Package, variables defined with 'private' attribute shall not be exposed in the ParameterSet of FDI Information Model	Only the Variables which has mapping for Semantic ID will be exposed via PA-DIM
Mapping Process Values to FDT/FDI/PA-DIM interfaces/objects	DeviceDataParameters from FDT interface IDeviceData is mapped to Online instance of ParameterSet.	All the variables defined in the EtherNet/IP FDI Device Packages are mapped to Online instances of the ParameterSet.	EtherNet/IP FDI Device Package shall support Semantic Map for the variables. This will be exposed via PA-DIM based on device profile. For instance: In EtherNet/IP FDI Device Package, ActualVolumeFlowRateVariable shall be mapped to Semantic ID 3:0112/2///61987#ABB291#001 and can be exposed via PA-DIM

Table #4: Comparing the support of Monitoring Process Variable use case for FDT OPC UA Information Model, FDI Information Model and PA-DIM

Use Case 4: Parameterization
Goal: Remotely configure the EtherNet/IP adapter device via OPC UA client application

Below Table #5 compares the support of Parameterization use case for FDT OPC UA Information Model, FDI Information Model and PA-DIM

	FDT OPC UA Information Model	**FDI Information Model**	**PA-DIM**
Online Parameterization	DeviceType object contains ParameterSet and MethodSet. Using OPC UA Client write operation, EtherNet/IP device variables exposed in 'ParameterSet' can be configured	Similar to FDT OPC UA Information Model	Current version of PA-DIM specification has defined specific methods like SetPVtoZero, FactoryReset method to configure the field device. Performing write operation on device variable is not yet specified in PA-DIM specification document.
Offline Parameterization	Offline and Online Parameters are represented by two identical node instances of ParameterSet. A Reference connects the online and offline representation and allows navigating between them	Similar to FDT OPC UA Information Model	Supporting Offline values are not in current scope of PA-DIM
Mapping Online/Offline parameterization to FDT/FDI/PA-DIM interfaces/ objects	DeviceDataParameters from FDT interface IDeviceData is mapped to Online instance of ParameterSet. Similarly, DeviceDataParameters from FDT interface IInstanceData is mapped to Offline	All the Online/Offline variables defined in the EtherNet/IP FDI Device Packages are mapped to Online and offline instances of the ParameterSet.	EtherNet/IP FDI Device Package shall support Semantic Map for the variables. This will be exposed via PA-DIM based on device profile. For instance, EtherNet/IP Device Package for Flow measure device will have Semantic Map for variable 'LowFlowCutOff' to ID

	instance of ParameterSet.		'3:0112/2///61987#ABJ724#001". This will be mapped to FlowMeasurementVariableType. LowFlowCutOff in PA-DIM. No offline parameterization is in current scope of PA-DIM.

Table #5: Comparing the support of Parameterization use case for FDT OPC UA Information Model, FDI Information Model and PA-DIM

Use Case 5: Calibrating the field Instruments

Goal: Calibrating the field instrument remotely via OPC UA Client

Below Table #6 compares the support of Calibration use case for FDT OPC UA Information Model, FDI Information Model and PA-DIM

FDT OPC UA Information Model	FDI OPC UA Information Model	PA-DIM
Support any non-UI methods (Command function) defined in the EtherNet/IP Device DTM. For example: Performing Temperature Calibration for Temperature/Multi variable transmitter	Any simple or complex calibration methods defined in the EtherNet/IP FDI Device Package can be supported	Current version of PA-DIM specification supports only ZeroPointAdjustment (to determine the zero point of process variable) and AutoAdjustPositioner (to initiate the automatic commissioning of an actuator)
Any methods in EtherNet/IP Device DTM which requires user feedback during its course of execution is not supported	Any methods defined in Ethernet/IP FDI Device Package which requires user feedback during method execution phase can be supported	User feedback during method execution is not supported

Table #6: Comparing the support of Calibration use case for FDT OPC UA Information Model, FDI Information Model and PA-DIM

2.2 Scenario 2: EtherNet/IP OPC UA Server using EDS file embedded in Industrial Gateway or in any HMI/Industrial Software application

EDS File is plain text file created and distributed by EtherNet/IP device vendors. The EDS file provides detailed information related to the device identification, configuration parameters, process variables, composition of assemblies etc. EtherNet/IP Configuration tool uses the EDS file to configure the device.

System Diagram

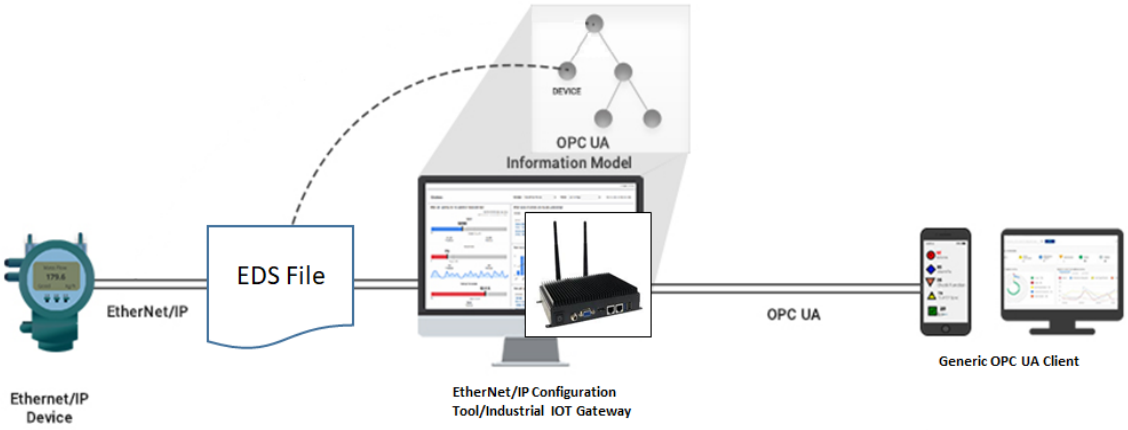

Figure #4: EDS supported EtherNet/IP OPA UA Server

Above Figure #4 shows the EtherNet/IP OPC UA Server deriving the information model from EDS file. EtherNet/IP OPC UA Server can be implemented in existing EtherNet/IP configuration tool or any Industrial IoT gateway supporting EtherNet/IP communication protocol.

'OPC UA for Devices - Part 100' specification is considered as base for mapping the EDS information to OPC UA.

Below section maps information derived from EDS file to the process industry specific use cases listed.

Use Case 1: Device Identification
Goal: Uniquely identify an EtherNet/IP field device in the network.

Below Table #7 shows the possible mapping of EtherNet/IP Identity object response to the information derived from EDS file

EtherNet/IP Identity Object Response	Mapping to EDS File [Device] Section	Mapping to OPC UA Information Model - Part 100(IVendorNamePlateType)
VendorID	VendCode	Manufacturer
DeviceType	ProdType	Model
Product Code	ProdCode	ProductCode
Revision (STRUCT of Major Revision, Minor Revision)	MajRev, MinRev	DeviceRevision
Serial Number	-	SerialNumber
Product Name	ProdName	-

Table #7: Mapping Device Identification to OPC UA Information Model from EDS file

Note:

1. DeviceRevision is mapped to “Major Revision.Minor Revision” (Revision attribute of EtherNet/IP Identity object)
2. SerialNumber is not part of EDS file. OPC UA Information model can get the Serial Number by fetching the ‘SerialNumber’ attribute from Identity Object

Use Case 2: Device Health Status (NAMUR NE107)
Goal: Device Health indicates the status of a device as defined by NAMUR Recommendation NE107.

EDS file does not have any standardized way to identify the device health. EtherNet/IP device health can be derived by reading the status attribute of Identity Object. However, values of Status attribute are not as per NAMUR Recommendation NE107.

Future Possibility/Work Around:
Below are the options to map the Device Health Status to OPC UA DeviceHealth enumeration based on NAMUR Recommendation NE107

Option #1:

- Process Device Diagnostic Object (Class Code 0x108) defined in CIP specification document follows the NAMUR Recommendation NE107. The EtherNet/IP device shall implement this object.
  Note: It is not mandatory to implement the Process Device Diagnostic Object.
- EDS file shall specify the details in the Public Object Class Sections to indicate the presence of Process Device Diagnostic Object.

Option #2:

- Standardization of a new Diagnostic Assembly as part of Predefined Diagnostics Assembly Instances of the EtherNet/IP spec as per NAMUR Recommendation NE107

  Note:
  As per the EtherNet/IP specification, for most of the objects it is not mandatory to specify the details in the Public Object Class Sections of EDS file.

Use Case 3: Monitoring Process Variable

Goal: Remotely monitor the process variables read from the EtherNet/IP device using any OPC UA client application.

In OPC UA for Device Information Model, ParameterSet object of DeviceType instance can be mapped to device parameter information available from EDS file as listed below for monitoring the process values.

Option #1

Parameters of EtherNet/IP devices are listed in the [Params] section of EDS file. Each parameter may contain the possible enumeration details associated with it. This parameter can be mapped to OPC UA Information Model.

Link Path in the EDS file allows access to parameter. However, as per EDS specification Link Path is optional. Hence, OPC UA Information model mapping will not be possible for parameter without Link Path information.

Option #2

Another possibility to map the Parameter would be to use the [Assembly] section of the EDS file. Parameter Members of the each Assembly section can be mapped to OPC UA Information Model.

Note: Read/Subscription can be performed on ParameterSet in OPC UA Information Model for monitoring the process values.

Use Case 4: Parameterization

Goal: Remotely configuring EtherNet/IP adapter device parameters using OPC UA client.

Parameterization use case is similar to Option #1 and Option #2 of Use Case 3.

Note: Write operation can be performed on ParameterSet in OPC UA Information Model.

Use Case 5: Calibration

Goal: Calibrating the field instrument remotely via OPC UA Client

Device profiles implementing S-Sensor Calibration Object can be calibrated from OPC UA Client. However, this requires the EDS file to specify the object details in the Public Object Class Sections. The instance services can be mapped to method call nodes of the OPC UA Information Model.

2.3 For Scenario 3: OPC UA Server directly embedded in EtherNet/IP device

Apart from fetching the information from OPC supported host system, it is possible to have the OPC UA embedded in EtherNet/IP adapter devices, drives, PLCs and Controllers. This enables the vertical communication between the EtherNet/IP device and higher-level systems like MES, Visualization Tools for diagnostics, Asset monitoring, Configuration use cases.

Figure#5 shows the OPC UA server embedded in EtherNet/IP Controller, Adapter Device, PLC and I/O Device.

System Diagram

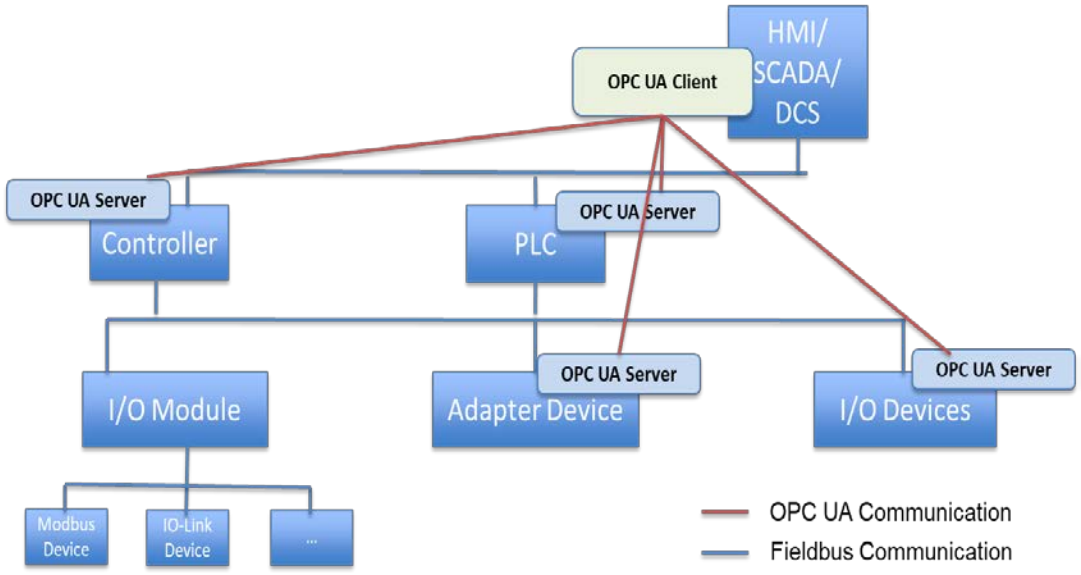

Figure #5: OPC UA Server embedded in EtherNet/IP Controller, PLC, I/O Device and Adapter devices

Scope of this document does not include mapping Use Cases for EtherNet/IP (CIP) companion specification.

3. Conclusion

Exposing EtherNet/IP object via OPC UA Information model will accelerate the adoption of EtherNet/IP devices in the process automation industry.

FDT OPC UA Information Model:
EtherNet/IP Device DTM can take an advantage of FDT OPC UA Information model without any additional implementation. However, FDT2 CIP Annex specification document is necessary. FDT OPC UA Information model supports the network topology and other use cases listed in this document. Even though EtherNet/IP DTM supports Complex methods/functionalities, it cannot executed from OPC UA client via FDT OPC UA Information model. For example: Calibration methods, which requires user feedback during method execution, are not supported. Best suited if the EtherNet/IP device has FDT2 EtherNet/IP Device DTM.

Good Support for below use cases
Use Case 1: Device Identification
Use Case 2: Device Health Status (NAMUR NE107)
Use Case 3: Monitoring Process Variable
Use Case 4: Parameterization
Limited Support for
Use Case 5: Calibrating the field device

FDI Information Model:
FDI Information Model is very elaborate and it allows the distributed deployment of FDI Client and Server module. It is possible to support any complex methods remotely using FDI Client. Some sections of FDI Information Model has been validated with the tools (reference FDI Host). FDI Client application is thick client application and requires complex UI Engine module. EtherNet/IP FDI PSD specification document is necessary to support FDI Information model for EtherNet/IP device. Best suited for EtherNet/IP device has support for other communication protocol like HART and EDD file

Good Support for below use cases
Use Case 1: Device Identification
Use Case 2: Device Health Status (NAMUR NE107)
Use Case 3: Monitoring Process Variable
Use Case 4: Parameterization
Use Case 5: Calibrating the field device

PA-DIM:
PA-DIM is limited, but highly focused on NAMUR use cases applicable for process automation industry. Using the Semantic ID, PA-DIM can fetch information from the field device without knowledge of the device or parameter specific details. PA-DIM supported Industrial IoT gateway can push the data to the cloud. Semantic Map of the parameter is

necessary to support PA-DIM Server. PA-DIM may require additional update to the Common Data Dictionary (IEC document) to support more use cases. Supporting complex method is not in scope of PA-DIM yet.
Note: Scope of this whitepaper does not include supporting PA-DIM without FDI Package for EtherNet/IP device.

Good Support for below use cases
Use Case 1: Device Identification
Use Case 2: Device Health Status (NAMUR NE107)
Use Case 3: Monitoring Process Variable
Limited Support for below use cases
Use Case 4: Parameterization
Use Case 5: Calibrating the field device

Deriving Information model using EDS file:
EDS file is mandatory for the EtherNet/IP device. Due to the flexible nature of EDS file, OPC UA Information model may have interoperability issues. Supporting the complex methods, UI etc. is not possible using EDS file.

Good Support for below use cases
Use Case 1: Device Identification
Limited Support for below use cases
Use Case 2: Device Health Status (NAMUR NE107)
Use Case 3: Monitoring Process Variable
Use Case 4: Parameterization
Use Case 5: Calibrating the field device

EtherNet/IP OPC UA Companion Specification Document:
Companion specification document provides all the flexibility to map any EtherNet/IP object to OPC UA Information Model. Apart from supporting the common use cases like Device Identification, Parameterization, Monitoring process Values; Companion Specification should focus on Industry focused use cases like Diagnostic Information etc.
Note: use case mapping for EtherNet/IP OPC UA companion specification is not as part of scope of this proposal.

Based on specific business use cases, appropriate OPC UA information model shall be considered.

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References

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https://www.namur,net

"EtherNet/IP + FDI = Value in Process Automation"
https://www.odva.org/Portals/0/Library/Conference/Paper%201_2018-ODVA-Conference_Smitha%20Chatrapathi_EtherNetIP-FDI_FINAL.pdf

"Asset Health Monitoring using FDT Server and OPC Pub/Sub mechanism"
https://www.fdtgroup.org/asset-health-monitoring-using-fdt-3-0-fits-opc-pubsub/

Specification Documents

OPC UA Specification Document
OPC UA for Devices Companion Specification Document
FDT Specification Document
FDT OPC UA Information Model Document
FDI Specification Document
EDDL Specification Document
CIP Specification Document
PA DIM Specification Document
EDDL to OPC UA Mapping Specification Document