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Field device management based on FDT and OPC UA

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Abstract: This contribution describes a solution for management of field devices. The solution is based on existing standards FDT2.0 and OPC UA. The targets and the details of the solution are discussed.

Keywords: Field device management, FDT, FDT2.0, OPC UA, OPC UA for Devices.

1. INTRODUCTION

Providing OPC UA services for device management and device integration may be considered as a strategic development towards support of remote configuration of devices (e.g. via the Internet), support of access by mobile platforms and support of integration into cyber physical systems [1, 2].

This contribution discusses a general approach for providing OPC UA services for field devices, based on an already existing and widely supported device integration technology – FDT2.0.

1.1 FDT2.0

The specification for Field Device Technology (FDT) is based on two main concepts: Frame Application, which provides the runtime environment and an application context for the device integration, and Device Type Managers (DTMs), which provide the device specific data and functionality [3]. Examples for Frame Applications are service tools (like PACTware), engineering tools and asset management tools. DTMs may be provided for different types of devices such as field devices, communication infrastructure devices (e.g. gateways) and communication adapters.

FDT2.0 is the current version of the FDT specification, which has been developed based on .NET technology. FDT2.0 supports a wide range of fieldbus communication protocols, including PROFINET, PROFIBUS, HART, Foundation Fieldbus, CanOpen, CIP, and Modbus.

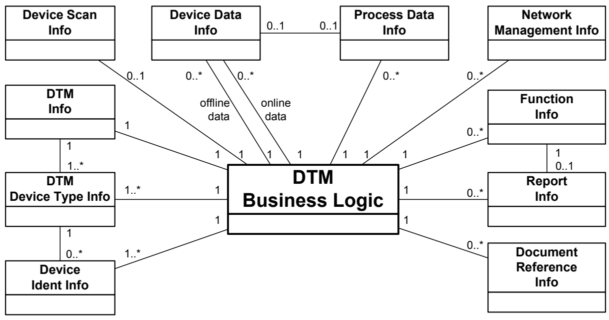

Fig.1 Information provided by a DTM [3].

As visible in Fig.1, DTMs may provide various information, which is necessary for commissioning, operation and diagnosis of the respective device, for example:

- information for identification of a device or device type,
- device parameters for configuration of a device, including semantic information for device parameters (e.g. value range, access),
- information about the I/O values of a device,
- information about available configuration, diagnosis and maintenance functions for a device,
- documentation of current data,
- references to device documentation (e.g. manuals, technical documentation, certificates).

Target of the project described here was to provide such information via OPC UA interface. The developed solution is based on the server architecture as defined by FDT2.0 specification.

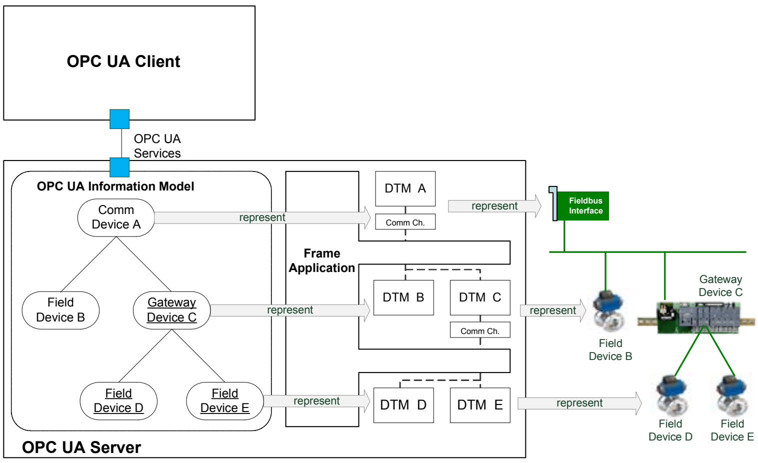

Fig.2 OPC UA architecture according FDT2.0 [3]

As visible in Fig.2 the OPC UA Server has a double role: the server acts as Frame Application according FDT2.0 and it acts as OPC UA Server. The Frame Application provides a runtime environment to the DTMs. The DTMs provide integration for the respective devices. Each device is represented by its corresponding DTM instance. The data and functions of the DTM serve as a base for the information model of the OPC UA Server. The OPC UA Server provides an information model according the companion standard "OPC UA for devices" [4]. If a client accesses the information model or the other OPC UA services, the requests are mapped to accessing the data and functions of the respective DTM.

1.2 OPC UA for Devices

OPC UA for Devices was developed as companion standard for OPC UA [4]. This development was provided by the OPC working groups for analyser devices and for field device integration. Each device is represented as Device Node. The child nodes of the Device Node provide access to information about the device, offline and online data, methods and network management information. Since this companion standard was chosen as a base for integration of FDT data, it defines a compatible interface supporting all devices. Experiences from the FDT project will be used to improve the OPC UA for devices specification.

2. OPC UA INFORMATION MODEL FOR FDT

FDT Group and OPC Foundation work jointly on a specification defining an information model for mapping of DTM information [5]. The development of the mapping of FDT2.0 to the OPC UA interface was based on an analysis of use cases for device integration.

Following use cases are supported:

- access to topology information
- access to device type information
- support of the different device types
- online identification of devices
- monitoring of device status
- access to device diagnosis
- access to offline and online data of devices
- access management for multi-user systems
- upload and download of device data
- monitoring of the network

These simple use cases have been selected such, that it is possible to combine them in order to provide support for more complex use cases. For instance a complex use case "condition monitoring" may be provided by combining the use cases "access to device diagnosis" and "access to online data" with a cloud service evaluating the data (see Fig.3).

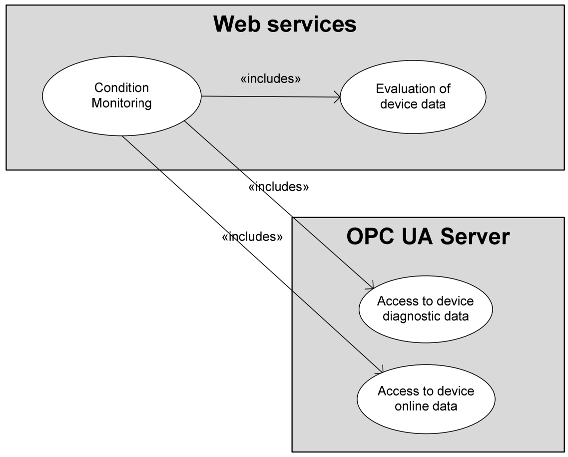

Fig.3 Use case "Condition monitoring"

The selected use cases have been the base for determining which information needs to be mapped from the DTM to the OPC UA interface. This mapping not only requires a transformation of data types, but also the different concepts for device handling have to be considered. These differences are the reason, why certain information in OPC UA for Devices is provided in a different context than it is provided in FDT. For instance in FDT2.0 the device identity (e.g. represented by a serial number) is provided as online data, while in OPC UA the serial number is provided as part of the type information (see Fig.4).

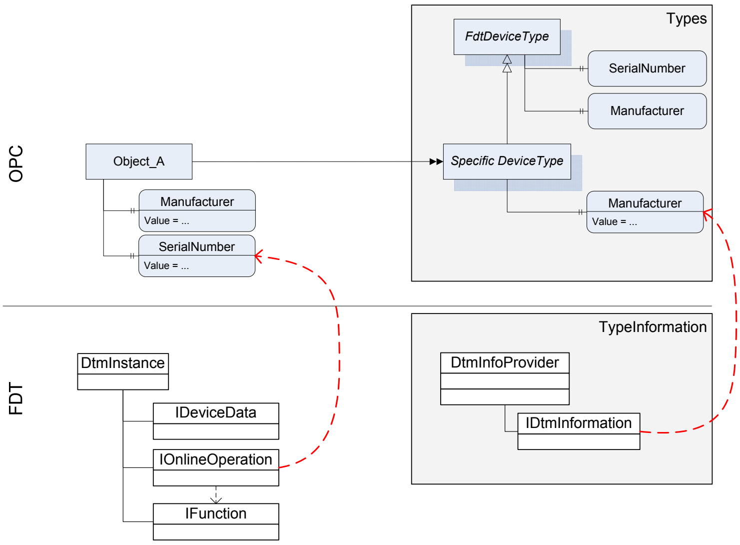

Fig.4 Mapping of device type information [5]

Further example for the necessary mapping of concepts is the representation of device parameters (see Fig.5). FDT2.0 allows for changing the structure of device data representation according to the current configuration of the device. For example a level device may be used for measuring the flow in a channel. Some intelligent field devices may be configured for such application and will provide a different data set, then in a standard application as a level sensor. The specification according to OPC UA for Devices expects a data set, which is determined for a specific device type.

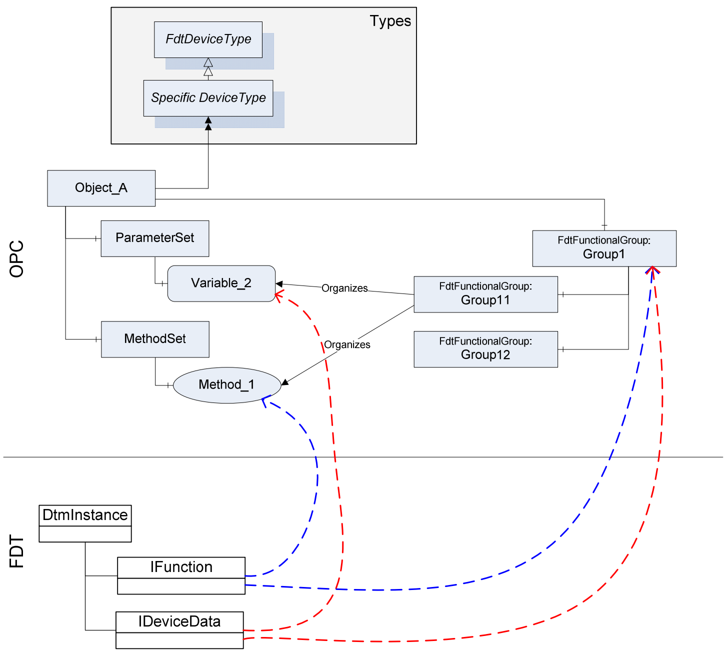

Fig.5 Mapping and integration of information [5].

When mapping the data from a DTM to the OPC UA information model the data for a device instance are provided in the OPC UA information model based on the data from the respective DTM instance. Data and information are retrieved from the interfaces of the DTM, are represented as Variables or Methods in the respective Folders ("DataSet" or "MethodSet") of the device and then are provided together in FunctionalGroup elements (see Fig.5).

The mapping includes a mapping for data types as well as a mapping for instance data. In order understand the structure and semantic of the instance data, it is necessary to provide the information regarding the respective data types. In FDT2.0 data types are defined either in the FDT specification or by information provided in the DTM interface (e.g. for enumeration types). This data type information needs to be mapped to the types-section of the OPC UA server namespace. Fig.5 shows such a type mapping for a 'device type'. Basing on an 'FdtDeviceType' (defined by the FDT Group), the information provided by the DTM is mapped to a 'Specific DeviceType'. The 'Specific DeviceType' represents the specific device type (vendor-specific product-type) that is supported by the DTM.

3. DEVELOPMENT PROCESS

The development process for the OPC UA information model for FDT has been organized in following phases:

- selection and definition of use cases
- definition of mapping to the information model
- Prototyping

The selection and definition of use cases as well as the definition of the mapping already has been described in section 3.

The prototyping has been organized into 2 phases: in the first phase a prototyping of the data types has been provided, in the second phase a full prototyping has been executed.

For prototyping of the data types a complete information model for the OPC UA Server was generate. The FDT-specific data types have been implemented completely and were instantiated with simulated values. This means some device types (for communication adapter, gateway and field device) together with the respective device instance nodes were represented the OPC UA information model. A simple device topology was implemented. – With that simulation it was possible to test the selected use cases completely with the OPC UA interface.

In the second step a Frame Application component was integrated into the OPC UA Server. The data representing the device types, the device topology, the device instance nodes and the respective data was based on information from the DTMs and the FDT project. Devices were represented with offline as well as with online data. Method execution could be tested and retrieval of documents was implemented.

The prototype OPC UA Server can be accessed by any kind of OPC UA client. In generic OPC UA clients, the data is represented as provided by the OPC UA server. This means, that the network topology is hard to understand, that enumeration values are represented in a generic way and that device specific features (like monitoring of device status) are not available. In order to demonstrate that a high level of representation may be provided with such an OPC UA server, an FDT-specific OPC UA client prototype was developed to represent the device topology, monitoring the device status and able to read, write and to subscribe to device data. With OPC UA it is also possible to provide logos and icons, in order to represent the devices similar like an FDT Frame Application (see Fig.6).

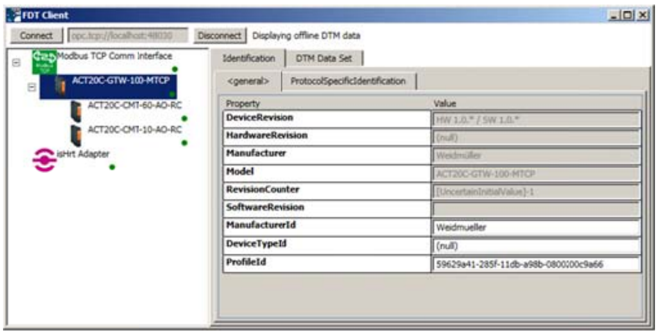

Fig.6 FDT-specific OPC UA client.

A full proof for the specified functionality was provided.

4. LESSONS LEARNED

In order to support device management with the OPC UA interface, a DTM needs to provide appropriate support for the device.

For instance a DTM should provide sufficient support to the IData interface. It is not sufficient just to provide the interfaces, but a DTM also needs to provide all data necessary for device configuration.

The data provided in the IData interfaces should be organized similar to the DTM user interfaces (in respect to quantity and organization of the data).

Online data and offline data need to be separated into IDeviceData(online) and IInstanceData(offline) interfaces.

Although the FDT2.0 specification recommends to reflect all DTM user interfaces into the IData interfaces, it is not recommendable to reflect the MainOperation UI. Since MainOperation UI is a collection of all other user interfaces, reflecting it in IData would result in an unnecessary redundancy (all data elements would be provided at least twice).

DTM functions without user interface should be provided as CommandFunctions. Online-CommandFunctions should be provided only if the DTM is in state “communication allowed”.

In order to improve the overall performance, the support of StaticFunctions (e.g. for retrieving the device status) should be considered.

5. CONCLUSION AND OUTLOOK

Based on the results of the project it is possible to show that remote configuration of field devices is possible if they are supported by DTMs. This allows to provide OPC UA support for a wide range of devices, which previously have not been supported. Prototyping proved that support for field devices with proprietary protocols can be provided too.

Using OPC UA as technology for remote access allows for such features as secure identification, authentication, and encryption of communication.

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