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Towards a multidisciplinary platform based on OPC UA for accessing plant data: Open P&ID data access

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ABSTRACT

A complex system such a modern plant requires and produces a large amount of data during its lifecycle. This data relate to different engineering disciplines and different lifecycle phases of the system. Accessing this data in an open way can be challenging because of proprietary data formats and diversity in storage methods. The platform proposed in this research aims towards enabling access to a variety of data sources over a standard interface (OPC UA). A common access interface provides an abstraction layer which enables easier access to the data. This has the potential to enable innovative new applications. Some plant information sources already support the OPC UA interface, but in many cases a transformation process is needed. An example transformation process for accessing P&ID data stored in Proteus XML files is shown. This process is a proof of concept, but a formal OPC UA companion specification for the Proteus XML files can standardize the transformation mappings. The proposed data access framework is applied on a mining process cases study. In this example design, automation and simulation data were accessed with a custom plugin using the 3D model of the plant as a gateway.

1 INTRODUCTION

Accessing data related to a complex multidisciplinary system such as a plant is a challenging task due to the different tools and data formats of each engineering discipline. Although in some cases standard information exchange format have been suggested, the Computer Aided Engineering (CAE) tool vendors show a lack of interest in their adoption. This leads not only to vendor lock-in (very difficult migration path from one tool to another) but also to major difficulties in accessing this information for innovative new applications. An open platform is needed to provide access in a unified way to all plant data for allowing the easy transfer of information between engineering disciplines, between lifecycle phases and also to enable innovative applications. The platform presented in this paper is a first step towards this goal.

One of the domains which doesn't have a mature open data format for exchanging information is the Piping and Instrumentation Diagram (P&ID) which is commonly used as a key design document in plant design. The XMpLant XML schema was an early approach for an open schema which would support the exchange of P&ID and 3D plant data. The Proteus project by Fiatech /1/ continued this work, the schema was renamed to "Proteus" and it is now used by the ISO 15926 standard.

DECHEMA, a German engineering research institution has been supporting the Data Exchange in the Process Industry (DEXPI) group for the further development of the Proteus schema /2/. The DEXPI group is composed by large Owner/Operators (like BASF, BAYER, EVONIK), CAE vendors (like Autodesk, AVEVA, Intergraph, Siemens) and support organizations like AixCAPE and VTT.

The platform presented in this paper uses standard data representation as information sources and the OPC Unified Architecture (UA) client - server data transfer framework to provide homogeneous access to plant data from different engineering disciplines gathered over the lifecycle of the plant /3/. The OPC UA was chosen because it is platform independent, standardized (IEC 62541), secure (certificates and encryption ensure trust in the M2M communication) and extensible (multiple layers, new technologies can be added without breaking backwards compatibility). The OPC UA, although its origins are in the control automation domain, is based on an object oriented information modelling framework, designed to be able to describe complex structures from various data models /4/.

2 HOMOGENOUS ACCESS TO DATA SOURCES

2.1 OPC UA technology for accessing plant data

An overview of the proposed platform for providing homogenous access to various data sources related to the plant is presented in Figure 1. Many data sources already provide data access interfaces using OPC UA such as many major control automation systems (e.g. Siemens, Beckhoff) and process simulators (e.g. Apros), some data sources are in formats that can be translated using formal specifications for the model to model transformation to OPC UA address space like PLCopen data for automation software and the ISA95 for enterprise to control system interfacing.

Other data open data formats, like the P&ID data stored in a Proteus XML file, need to be transformed to an OPC UA address space XML file before they can be used to instantiate an OPC UA server. When all data sources are available through OPC UA interfaces, then standard OPC UA clients can be used to utilise the provided information. The 3D model of the plant can be a gateway to the data sources and the underlying data access technology needs to be transparent to the user.

In this research data access is unidirectional (i.e. changes made to the plant's design in the 3D tool will not be transferred to the source design documents over OPC UA). Some OPC UA Software Development Kits (SDKs) allow for dynamic OPC UA address space management. In these cases and there is potential for information flow towards the data sources. Source information can be automatically updated or it can be flagged as “needs update”.

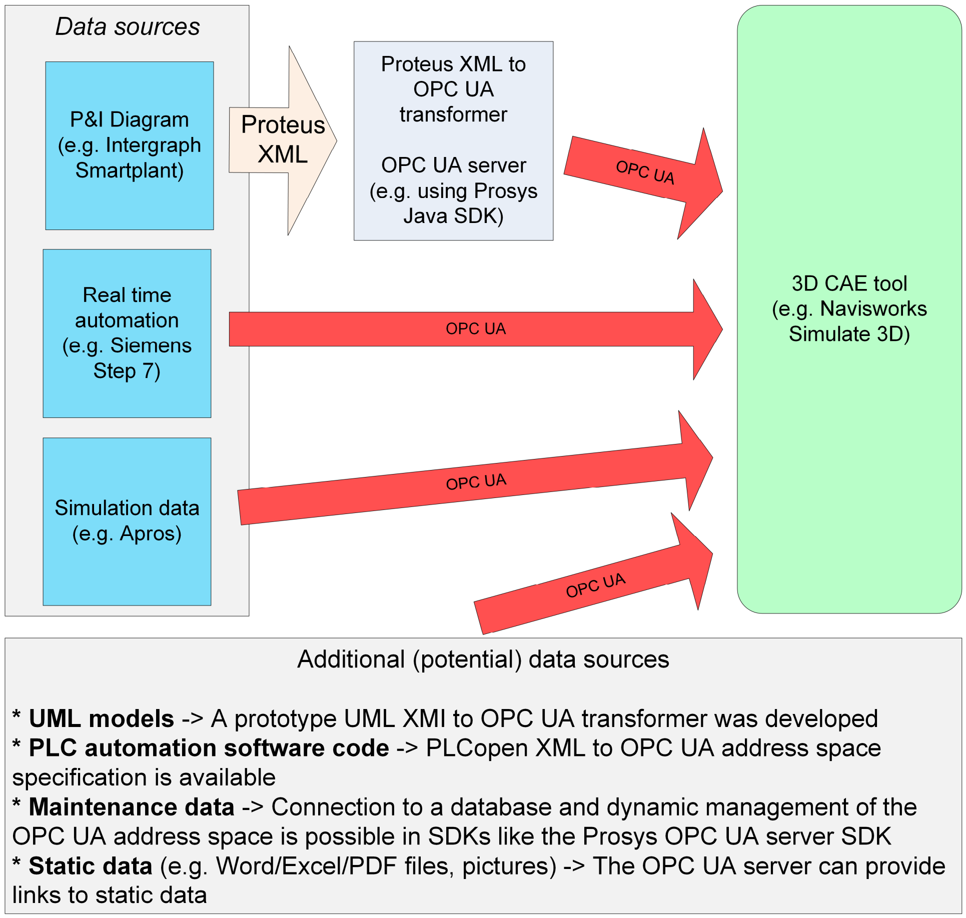

Figure 1. A platform for homogenous access to multidisciplinary plant information sources. Some data sources already provide OPC UA access but in other cases a static or a dynamic transformation is needed.

2.2 Accessing Proteus XML (P&ID) data over OPC UA

This section describes the steps needed to access over OPC UA P&ID data stored in a Proteus XML format /5/. A prototype mapping was developed to translate Proteus XML elements to OPC UA address space (see Figure 2). This mapping was straight forward to develop since the OPC UA address space metamodel follows a generic object oriented paradigm of objects which inherit attributes of object types. A software tool can use this mapping to automatically generate OPC UA address space XML files. The strategy for generating the OPC UA address space XML files is to first generate all the domain specific object types (UAObjectType) and then generate the objects (UAObject) according to the mapping and the contents of the Proteus XML source file. The output OPC UA address space XML file can be served to OPC UA clients by an OPC UA server. In this research the Prosys Java OPC UA SDK was used to create the OPC UA servers /6/.

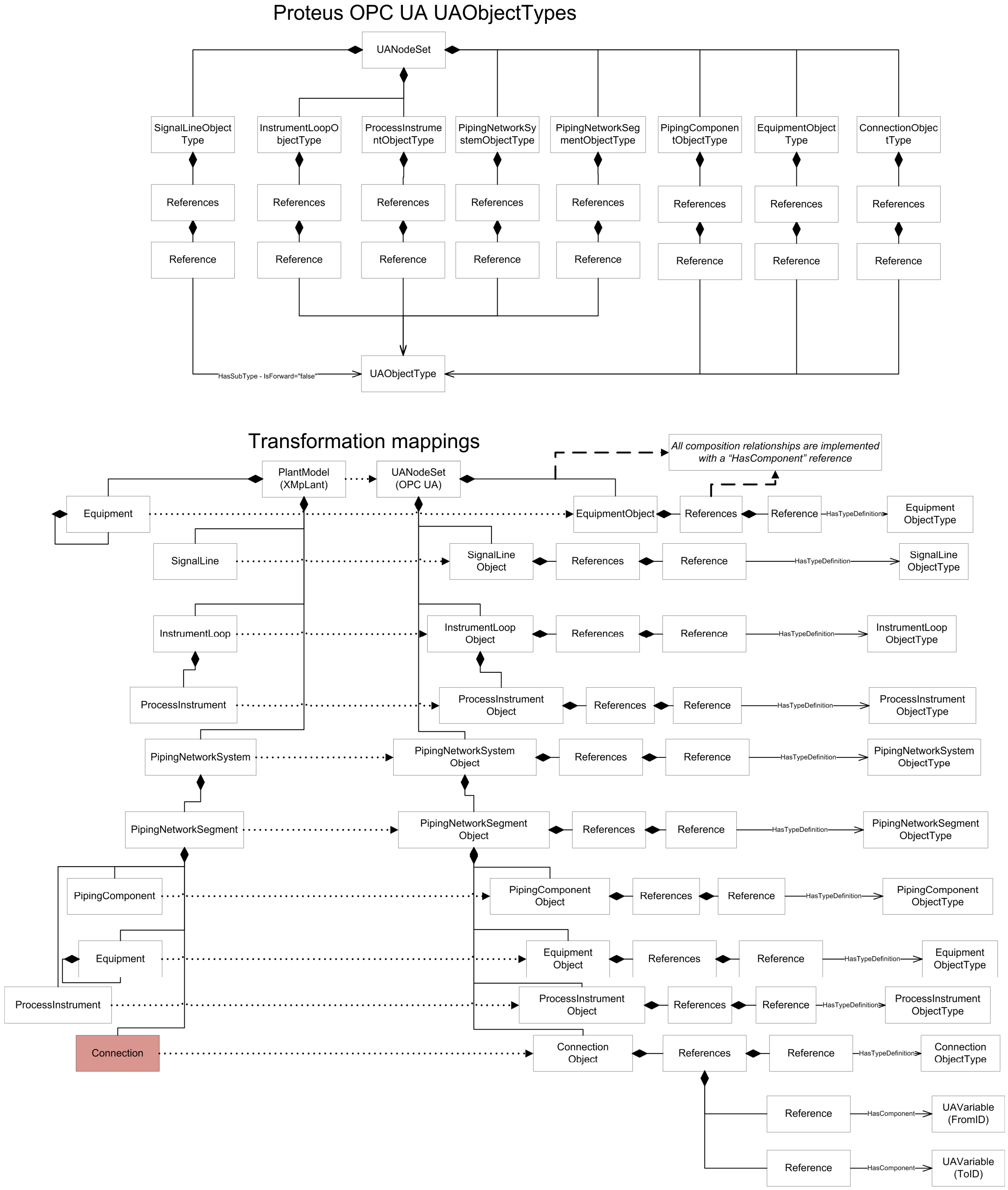

Figure 2. Prototype mappings that enable the transformation of P&ID drawings in Proteus XML format to OPC UA address space XML files which can then be used to instantiate OPC UA servers.

3 CASE STUDY – MINING PROCESS

A part of a mining process, the "autoclave", provided by Outotec Oyj, was used as a case study. In this case information from the P&ID (an Integraph Smartplant diagram exported s Proteus XML and then transformed to OPC UA address space XML), control automation data (using Siemens Step7's OPC UA server) and process simulation data (Apros' OPC UA server) were accessed using the 3D model of the plant as a gateway (Autodesk Navisworks 3D plugin for OPC UA access). A proxy software component was developed for facilitating access to the different OPC UA servers (see Figure 3). In Figure 4 the user has selected a component in the 3D model, asked for the available relevant data from the OPC UA servers and the responses are show in the output window of the plugin.

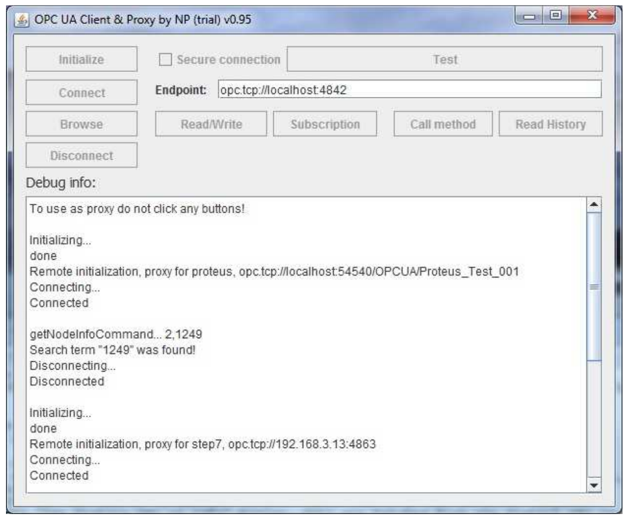

Figure 3. A proxy software which enables access of data stored in OPC UA servers from the Autodesk Navisworks 3D plugin (see Figure 4). The Prosys OPC UA Java client SDK was used as the basis for this tool.

4 CONCLUSION

Developing a homogenous method for accessing various data sources related to the plant can provide benefits during all lifecycle phases of the system (design, deployment, testing, operation, maintenance and decommission). Engineering data can be re-used when possible and innovative applications can utilise them for providing decision support services to different user categories, such as managers, operators, and maintenance crew. More research is needed to identify the combinations of data that can provide value to these users and motivate further development of the platform.

Solving the data access barrier is a required step, but more work is needed for developing a universal plant information platform. Data elements in different design domains usually do not have a unique, known, identifier (unless all data live in the same engineering database). This issue has to be addressed with a method for automatically linking the relevant data source elements.

In this research a proof of concept mapping from the Proteus P&ID data format to the OPC UA address space was implemented. VTT has brought in contact the DEXPI group and the OPC foundation in order to develop a formal OPC UA companion specification and it is expected for this work to begin very soon.

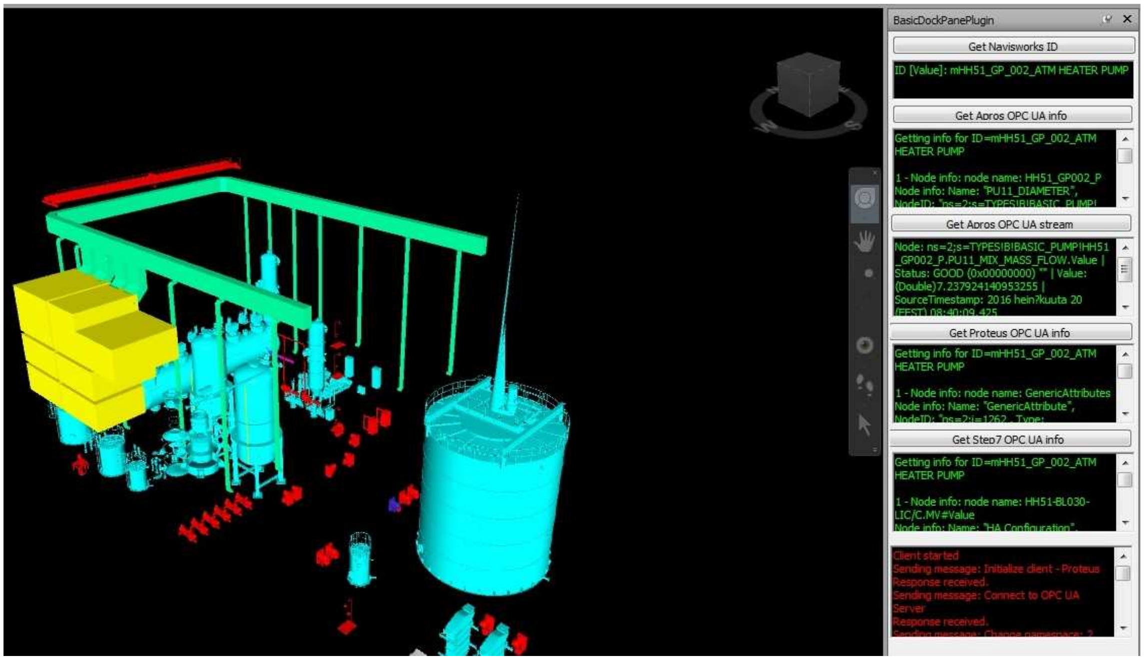

Figure 4. The 3D model of the plant (in Autodesk Navisworks 3D) acted as a gateway to access data from various sources (design, operation and simulation in this case). A plugin was developed to communicate with a proxy software tool (see Figure 3) to enable this process. The case study material was provided by Outotec Oyj.

ACKNOWLEDGEMENT

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