OPC DAY FINLAND 2018

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The journey towards an open digital twin & the DEXPLOPC UA companion specification for P&ID data exchange

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Industrie 4.0 – IIoT, data as the focus

Concepts such as the Industrial Internet of Things (IIoT) and Industrie 4.0 have gained positive momentum and are accepted as the future for industrial process lifecycle

• from requirement definition to design, testing, operation, maintenance and decommission

• a wealth of static (e.g. design) and dynamic (e.g. realtime operation) data sources are becoming available

Opening up industrial data

To enhance the adoption of IIoT we need open standards for data sources of our industrial process and an open standard communication framework to exchange this information

- Enable interoperability between tools, easier handover
 - Owner/Operators and subcontractors
 - Between design lifecycle phases
- Future-proof design data , consider systems with long lifecycles
- Mine the knowledge of past designs, generative design technologies
- Make the business proposition of developing IIoT services more attractive to SMEs

An open IIoT ecosystem



An IIoT ecosystem based on standards for interoperability



IIoT nodes concept (partial)



DEXPI specification

- The DEXPI specification further defines the ISO 15926 standard to enable adoption by CAE vendors for Piping and Instrumentation Diagram (P&ID) data exchange
- The DEXPI group includes owner-operators, software vendors, service providers and research institutions
- A stable version of the DEXPI specification is ready, the focus is now the CAE implementations

DEXPI group overview



> Aucotec

> Aveva

> PTC

> eVision

Siemens X-Visual

Research Organizations

- > AixCAPE e.V.
- VTT of Finland
- TU Berlin
- > RWTH Aachen University
- > Tecgraf/PUC Rio

CFIHOS NAMUR ≻

P&ID main components



International Standards

- DEXPI specification based on international standards
- Applicable for IEC, ISA and DIN based P&IDs

Plant Structure	Apparatus / Machines	Piping components	Instrumentation	Communication
ISO 10209	ISO 10628	ISO 10628	IEC 62424	ISO 15926
			IEC 61987	Proteus 4.0.1 (formerly XMPlant)
			(ANSI 5.1)	
			(DIN 19227)	

DEXPI interfaces of CAE systems



CAE Vendor		Product	DEXPI Interface
Autodesk	🙏 AUTODESK.	AutoCAD P&ID 2019	Import & Export
Aveva		Aveva PID	Import & Export
Intergraph	INTERGRAPH	SmartPlant PID	Export
Siemens	SIEMENS	Comos PID	Import & Export
VTT	VIT	Apros	Import
X-Visual	XVISUAL	PID	Import

P&ID data – DEXPI OPC UA



Data handover (example)



DEXPI OPC UA companion specification

Work started in Spring 2017 for developing an OPC UA companion specification for the DEXPI specification

- 11 WG meetings so far
- The engineering work for the specification is now done
 - Nodeset development, prototype implementation
- The specification document is mostly complete
 - We aim to have a good complete draft by the end of the year, ready to be sent to the TAC for the next steps

DEXPI OPC UA WG members

OPC Foundation:

Jouni Aro, Prosys OPC Betsy Hawkinson, Honeywell Karl Deiretsbacher, OPC Foundation John Gillerman, Grid Cloud Systems Stefan Hoppe, OPC Foundation Armin Fricke, Capital-Gain Cons. Rod Stein, Matrikon OPC Sandra Fabiano, Yokogawa

DEXPI group: Nikolaos Papakonstantinou, VTT (WG leader) Heiner Temmen, Evonik Michael Wiedau, Evonik Manfred Theissen, Aixcape David Vazquez-Landa, BASF Tommi Karhela, Semantum Juha Kortelainen, VTT Reiner Meyer-Roessl, Autodesk

DEXPI OPC UA example, P&ID model

🗾 Unified Automation UaExpert - The OPC Unified Architecture Client - Proteus					
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▷ 💑 PI4712.02_PIF_AS	-		ValueRank	-1	-
			References Attributes		

The UaExpert OPC UA client browses a Piping and Instrumentation Diagram (P&ID) over OPC UA

Lessons learned so far

- OPC UA's metamodel supports single inheritance, that is an issue for metamodels that include multiple inheritance
 - In this specification we used an additional hierarchy document for the DEXPI classes
- The specification document has redundant information engineering work for the specification is now done
 - Long lists of ObjectTypes, enumerations, in the main document, info overlapping with the nodeset xml file
- Mapping of engineering units is a pain...

POSC Caesar Reference Data Library (DEXPI) to UNECE (OPC UA) mapping of units (Excel)

1	Unitgroup	Unitname	UNECE Common Code	UNECE Name	Additional conversion	Notes	Notes (Manfred)
22	PowerUnit	Picowatt	C75	picowatt			OK
23	PowerUnit	Terawatt	D31	terawatt			OK
24	PowerUnit	Watt	WIT	watt			OK
			M67	acre-foot (based on U.S. survey foot)			AcreFoot in DEXPI is
							http://data.posccaesar.org
							/rdl/RD\$1313909 ; it is not really clear
							whether this is international or US
							(survey) acre foot. As many other units
25	VolumeUnit	AcreFoot					contain the term "survey" for the US
26	VolumeUnit	Barrel	J57	barrel (UK petroleum)		Assuming UK barrel, the US is sepa	probably OK
							conversion OK (perhaps use larger unit from
27	VolumeUnit	BillionFootQubed	?	?	multiply value by 1000000000 and use "\	ubicfoot"	same "series")
28	VolumeUnit	Centilitre	ar	centiltre			OK
29	VolumeUnit	CentimetreCubed	CMQ	cubic centimetre			OK
30	VolumeUnit	Cubem	?	?		Unitnotfound	remove from DEXPI?
31	VolumeUnit	Decilitre	DLT	decilitre			OK
32	VolumeUnit	DecimetreCubed	DMQ	cubic decimetre			OK
33	VolumeUnit	FootCubed	FTQ	cubic foot			OK if both are international cubic foot
34	VolumeUnit	HectareMetre	?	?	multiply value by 10000 and use "'cubic	netre"	remove from DEXPI?
35	VolumeUnit	Hectolitre	HLT	hectoftre			OK
36	VolumeUnit	HundredFootCubed	?	?	multiply value by 100 and use "cubic fo	ot"	remove from DEXPI?
37	VolumeUnit	InchCubed	NQ	cubic inch			OK if both are international inch
38	VolumeUnit	KilometreCubed	H20	cubic kilometre			OK
39	VolumeUnit	Litre	LTR	litre			OK
40	VolumeUnit	MetreCubed	MTQ	cubic metre			OK
41	VolumeUnit	MicrometreSquaredMetre	?	?		Unitnotfound	remove from DEXPI?
42	VolumeUnit	MileCubed	M69	cubic mile (UK statute)			OK if both are international miles
43	VolumeUnit	Millilitre	MLT	millitre			OK
44	VolumeUnit	MillimetreCubed	MMQ	cubic millimetre			OK
45	VolumeUnit	MillionBarrel	?	7	multiply value by 1000000 and use "ban	el (UK petroleum)"	OK if both are UK barrels; conversion OK
46	VolumeUnit	MillionFootQubed	?	?	multiply value by 1000000 and use "cubic foot"		OK if both are international foot; conversion OK
47	VolumeUnit	MillionMetreCubed	?	7	multiply value by 1000000 and use "cub	c metre"	conversion OK
48	VolumeUnit	StandardFootCubed	9	standard cubic foot			
49	VolumeUnit	StandardMetreCubed	?	7		Unitnotfound	
50	VolumeUnit	ThousandBarrel	?	?	multiply value by 1000 and use "'barrel i	UK petroleum)"	
51	VolumeUnit	ThousandFootCubed	?	?	multiply value by 1000 and use "'cubic fo	iot"	
52	VolumeUnit	ThousandUkGallon	?	?	multiply value by 1000 and use "'gallon	(UK)"	
53	VolumeUnit	ThousandUsGallon	?	?	multiply value by 1000 and use "'gallon	(US)"	
54	VolumeUnit	UkBushel	BUI	bushel (UK)			
55	VolumeUnit	UkFluidOunce	OZI	fluid ounce (UK)			
56	VolumeUnit	UkGallon	GLI	gallon (UK)			
57	VolumeUnit	UkPint	PTI	pint (UK)			
58	VolumeUnit	UkQuart	ଦ୍ୟା	quart (UK)			
59	VolumeUnit	UsBarrel	BLL	barrel (US)			
60	VolumeUnit	UsBushel	BUI	bushel (UK)			
61	VolumeUnit	UsDryBarrel	BLD	dry barrel (US)			
62	VolumeUnit	UsDryPint	PTD	dry pint (US)			
63	VolumeUnit	UsFluidOunce	OZA	fluid ounce (US)			
64	VolumeUnit	UsGallon	IGLL	gallon (US)	I		
	•		m				
14	DEXPT Unit	The LINECE Linuts mann					

UNECE (OPC UA) to OPC UA mapping of units (Excel)

UNECECode	UnitId	DisplayName	Description
C81	4405297	rad	radian
C25	4403765	mrad	milliradian
B97	4340023	μrad	microradian
DD	17476	•	degree [unit of angle]
D61	4470321	I	minute [unit of angle]
D62	4470322	н	second [unit of angle]
A91	4274481	gon	gon
M43	5059635	mil	mil
M44	5059636	rev	revolution
D27	4469303	sr	steradian
H57	4732215	in/revolution	inch per two pi radiant
MTR	5067858	m	metre
E96	4536630	°/s	degree per second
H27	4731447	°/m	degree per metre
M55	5059893	m/rad	metre per radiant
DMT	4476244	dm	decimetre
CMT	4410708	cm	centimetre
4H	13384	μm	micrometre (micron)
ммт	5066068	mm	millimetre

Future work

- At VTT we consider this line of research as a key for plant digitalization and development of digital twins
 - As enablers of advanced data and model driven applications

- If you share this vision, please contact us. We have ongoing research project proposal efforts and we are looking for consortium partners – end users
 - E.g. H2020 ICT and SPIRE calls, Business Finland AI Business

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Thank you!



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