



Model Oriented Application Generation For Industrial Control Systems

Brice Copy
on behalf of the UNICOS Project
CERN

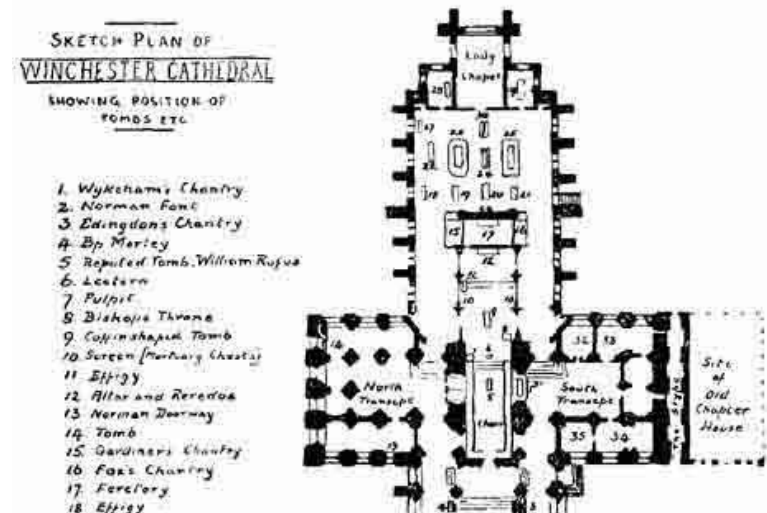
- Meta-models and models
- The UNICOS framework, meta-modeled
- Concrete Applications
- Closed meta-models
- Conclusions

Meta-models and models

“it helps to have a plan”



Winchester Cathedral
World longest cathedral – 170 m
Completed : 1400 A.D.



Meta-models and models

“it helps to have a plan”



Liverpool Cathedral
World longest **modern** cathedral – 188 m
Completed : 1978

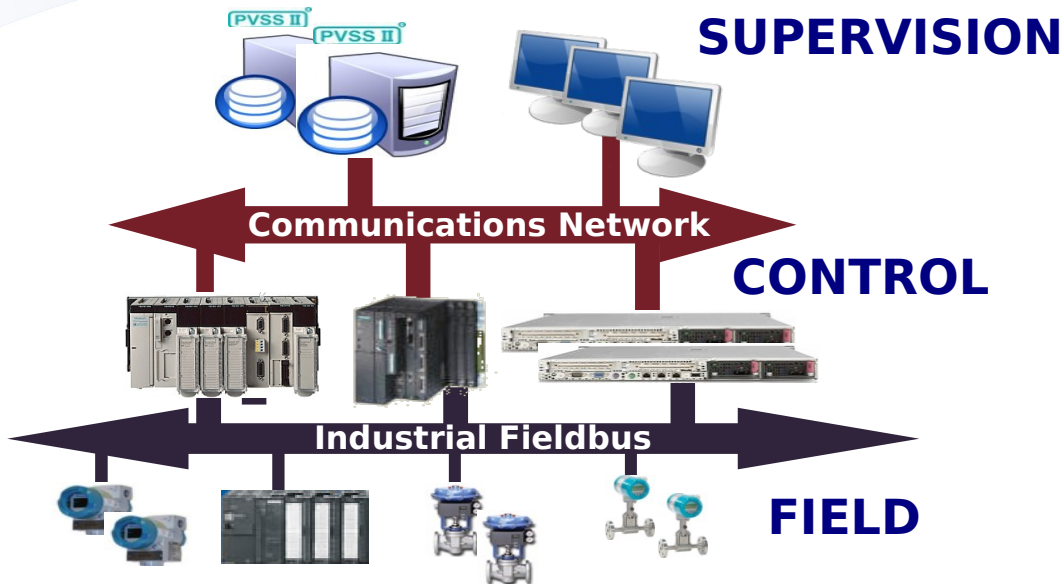


- C++ → BNF Grammars
- XML → XML Schema Definition (XSD)
- UML → MOF / XMI

- Meta-models let us conceptualize and apply problem resolution methods on models...
- ...Just like models do for data

UNICOS Framework

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18 kW @ 4.5 Refrigerators



P4 Cooling towers

Projects built with UNICOS :

- LHC CRYO
 - 3.3 Kms / 2 PLCs / 3500 source files
- Cooling and ventilation
- LHC Gas Control System

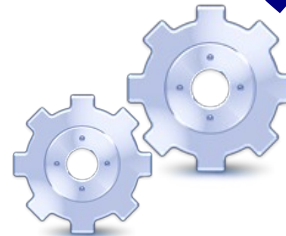
Slide credit : Dr E. Blanco

The UNICOS Framework : Generation

Process Logic



PLC



UAB

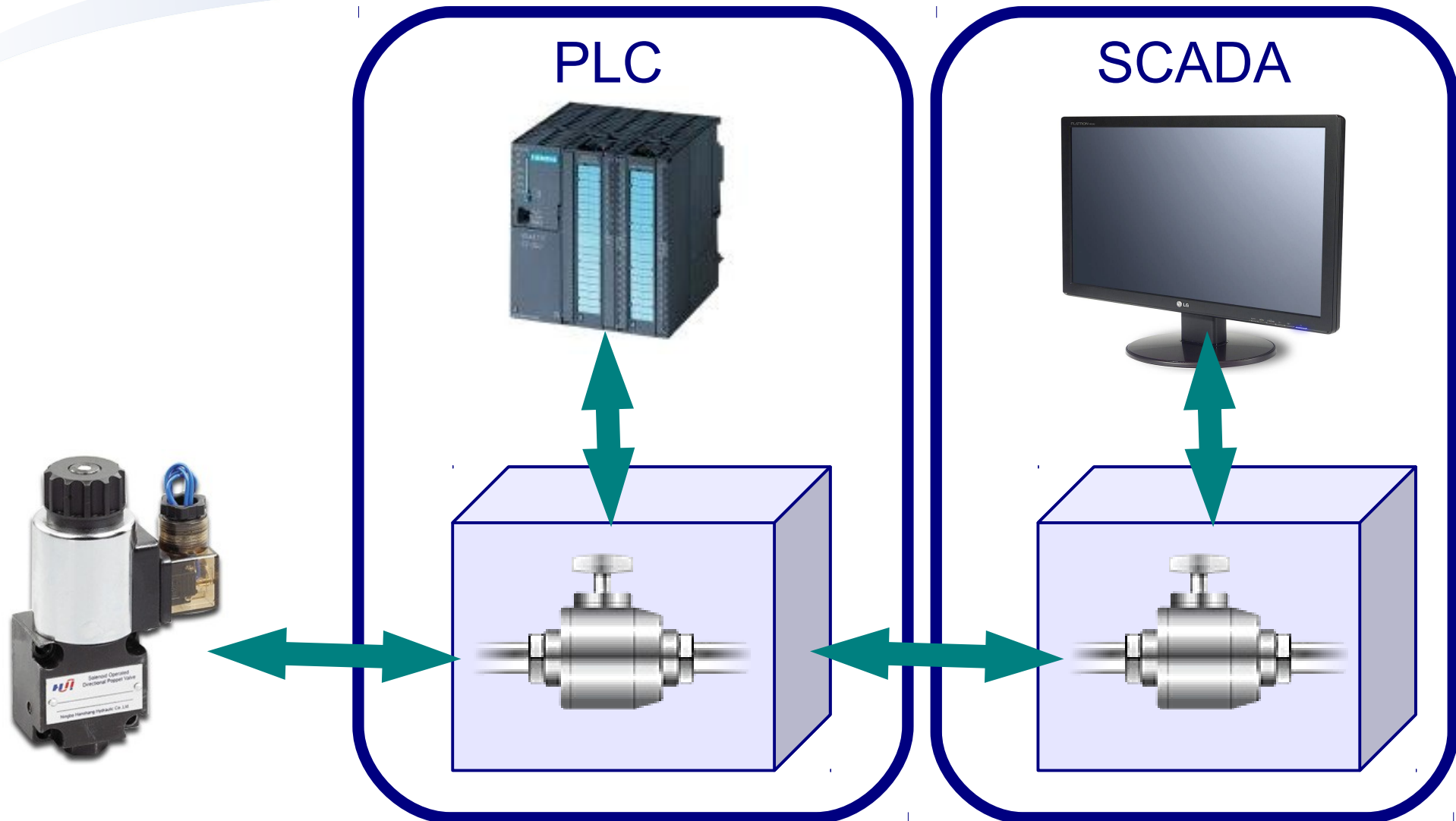
SCADA



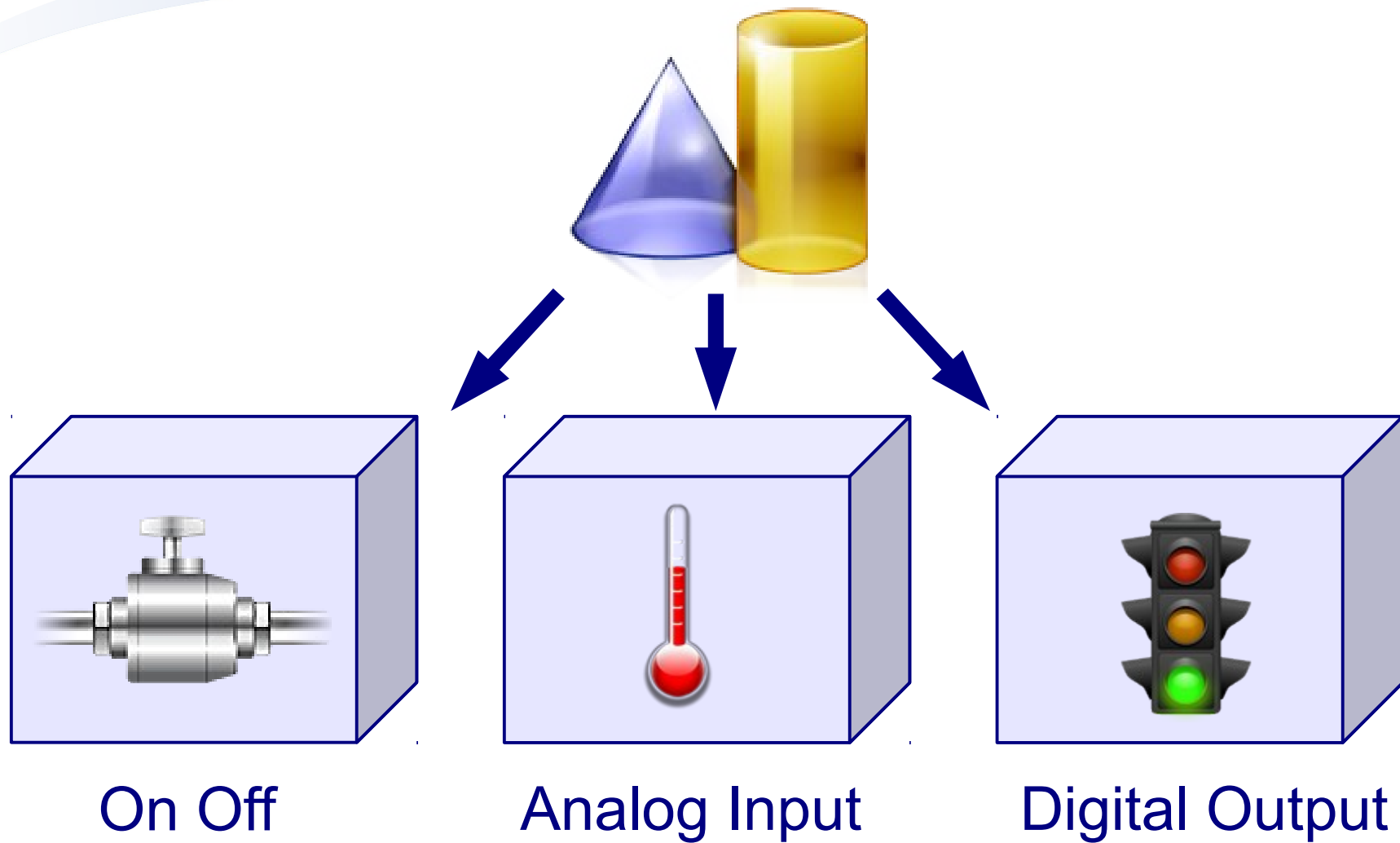
Device Inventory



The UNICOS framework : Device Instances



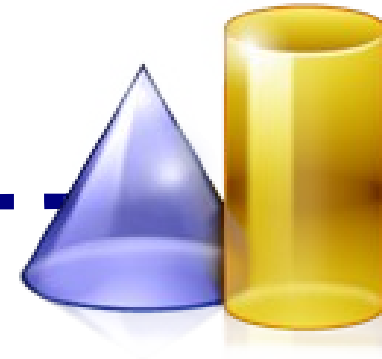
UNICOS Framework: Meta-modeled



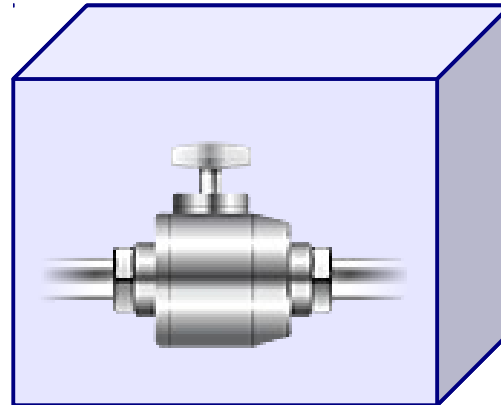
Meta-Modeling

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M 2



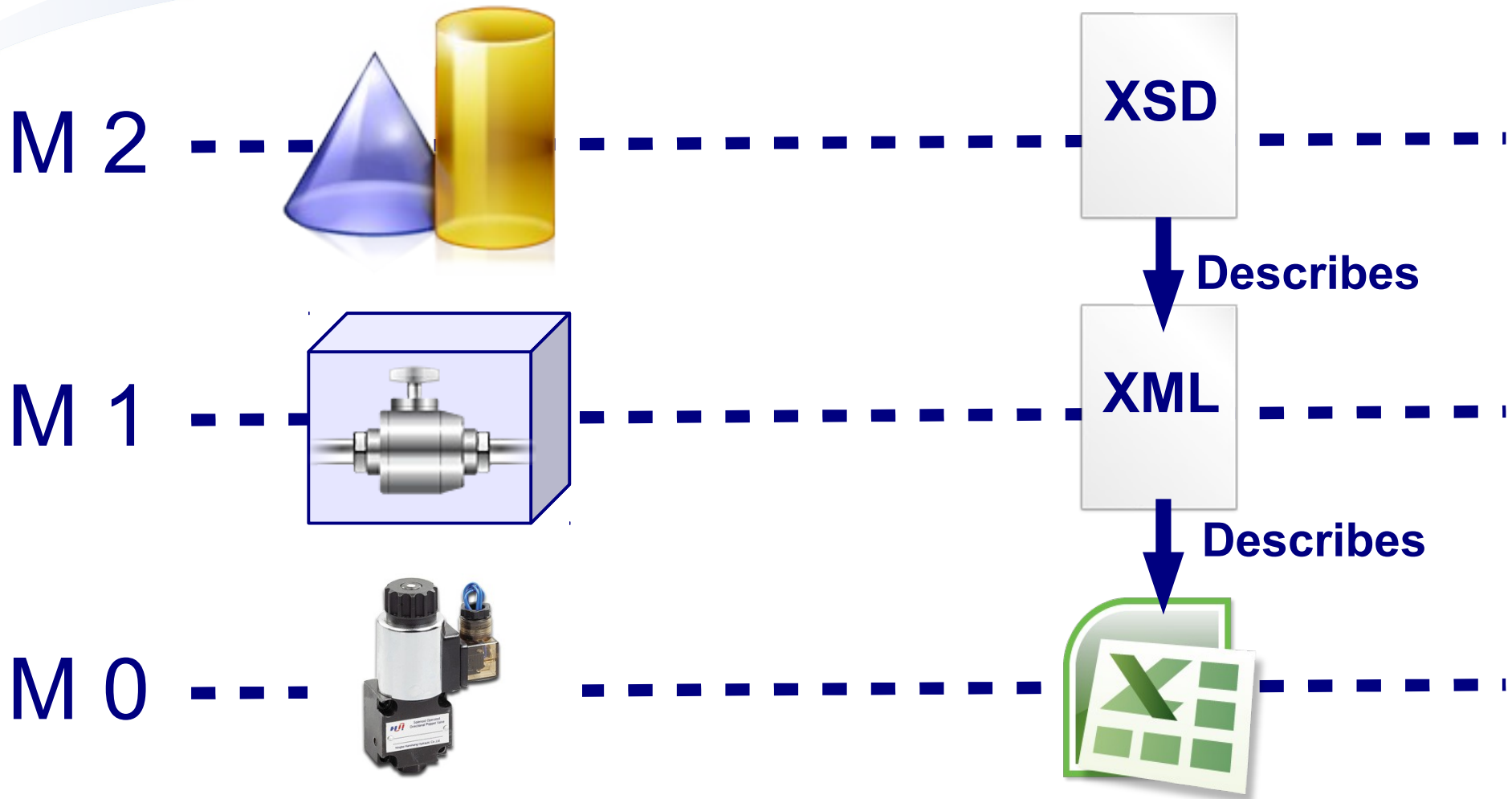
M 1



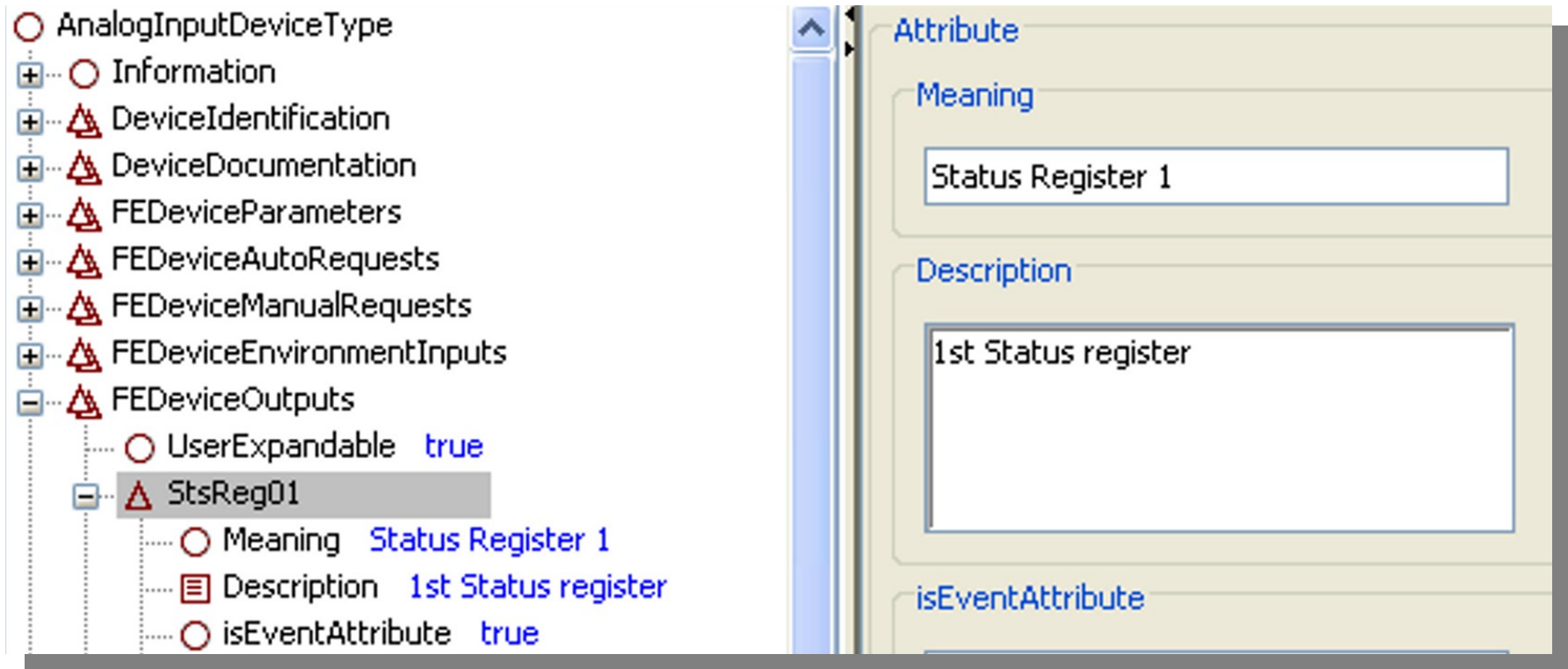
M 0



Meta-Modeling Implementation



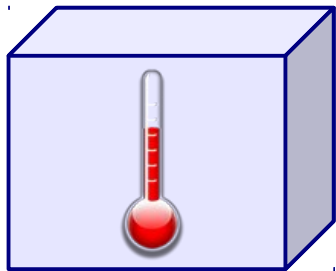
Concrete Applications : Generic Rich UI Editor



The screenshot displays the FESA General Editor interface. On the left is a tree view showing a hierarchy of components. The selected component is 'StsReg01', which is expanded to show its properties: 'Meaning' (Status Register 1), 'Description' (1st Status register), and 'isEventAttribute' (true). On the right is a detailed view of the selected component, showing the 'Attribute' section with 'Meaning' (Status Register 1) and 'Description' (1st Status register) fields, and the 'isEventAttribute' property set to true.

FESA General Editor

Concrete Applications : Type documentation

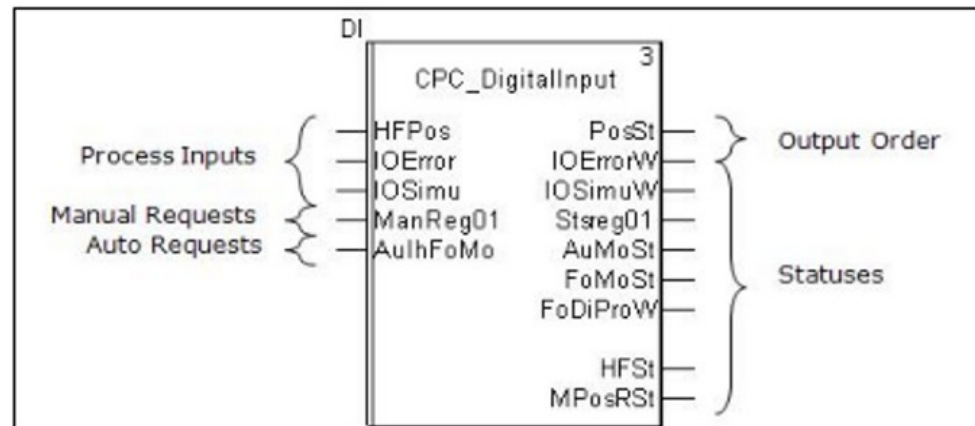


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XSLT



Signal description

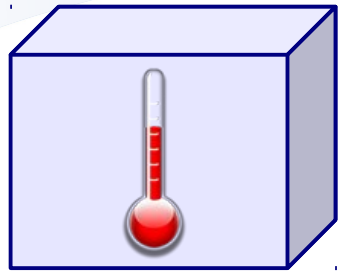


Device Inputs

Device Environment Inputs

Name	Type	Meaning	Description	BitPosition
HFPos	BOOLEAN	Hardware Feedback Position	Hardware feedback position	-
IOError	BOOLEAN	Input/Output Error	Error in the FE channel assigned to the device	-
IOSimu	BOOLEAN	Input/Output Simulation	The device is simulated by the operator	-

Concrete Applications : Scripting based generation



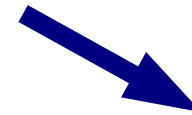
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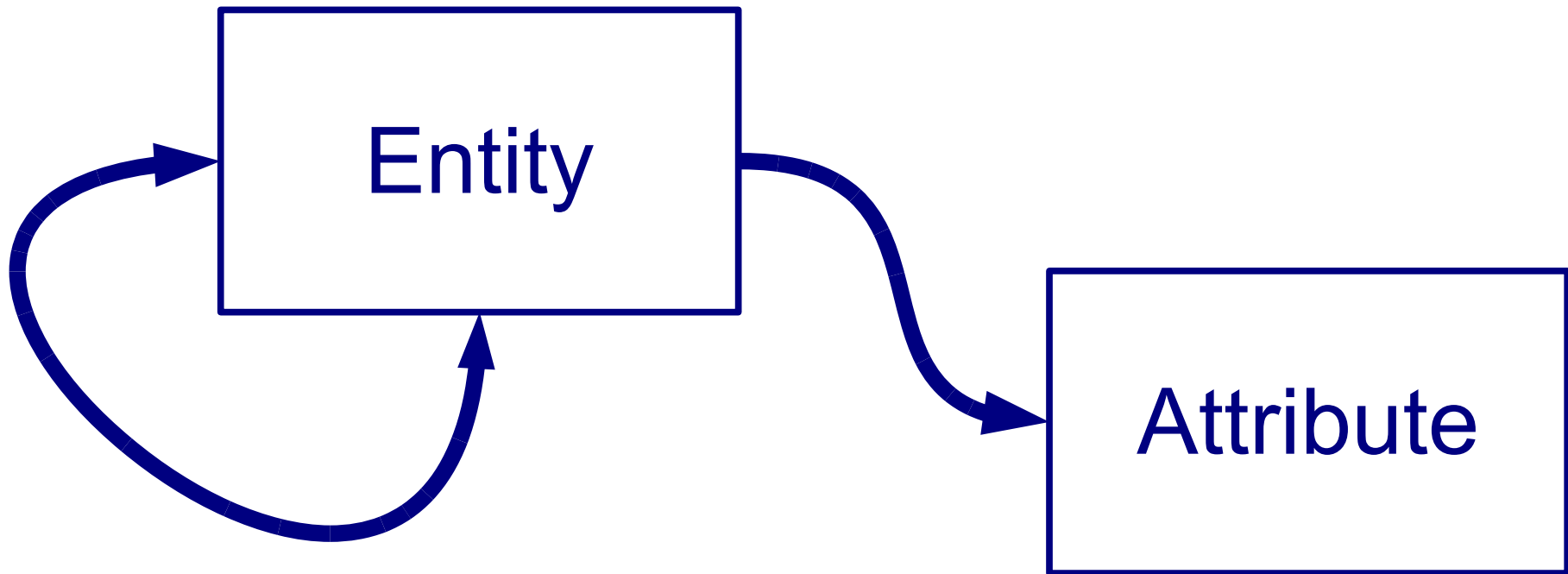
Jython



- Mature tooling, built-in validation
 - Transformations using XSLT
 - Mapping to Java and scripting with JAXB
- BUT :
- Lack of flexibility, expressiveness
 - XSD import limitations
 - XSD Tooling not on a par with DSL Tooling

The ultimate meta-model

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Closed meta-models

Future leads

- **OMG's MetaObject Facility is a closed meta-model**
 - It is used to describe UML
 - It can describe itself
 - It comes with tooling
- **Eclipse Modeling Framework (EMF)**
 - Subset implementation of MOF
 - Tooling generation (editors, code completion, generation, validation, OCL support) through Xtext

- Meta-model support provides a formal backbone
 - Validation, Object Mapping, Transformations etc...
 - New device types are easily defined
- Generation performance greatly increased
- Migration to new XSD friendly technologies will be eased thanks to having a meta-model
- If you model, think about your meta-model
- If you meta-model, think about your meta-meta..

Thank you !

- **Wednesday Poster Session**
 - **WEPKS006** - UNICOS Evolution : CPC v6
 - **WEPKS033** – UNICOS CPC v6 : Automated code generation
 - **WEPKN024** - UNICOS for Vacuum and Ventilation
 - **WEPKN025** - Supervision Application for POPS (PS' New Power Supply)

UNICOS References

- H. Milcent, "UNICOS : An open framework", ICALEPCS 2009
- M. Dutour, "Software factory techniques ...", ICALEPCS 2007, TPPA03
- E. Blanco, "Cryogenics Instrumentation ... for the LHC", ICALEPCS 2007
- P. Gayet, R. Barillère, "Unicos : A Framework ...", ICALEPCS 2005

Backup Slides

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- **Attributes and Elements just do not mix**
 - Cannot constraint attribute or element dependencies
 - Sequence, choice, all or nothing
- **Unordered Content, Mixed Content**
- **Validation messages need to be translated for end-users**