icalepcs 2011

Model Oriented Application Generation For Industrial Control Systems

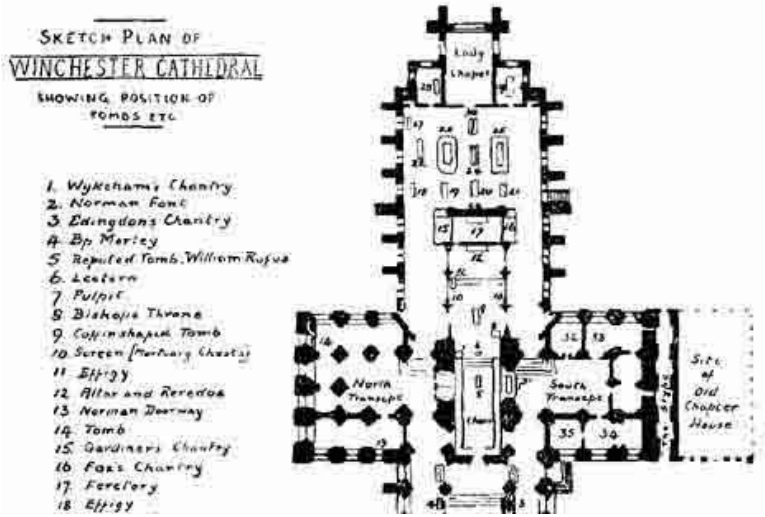
Brice Copy
on behalf of the UNICOS Project
CERN

EN Engineering Department

Outline

- 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”

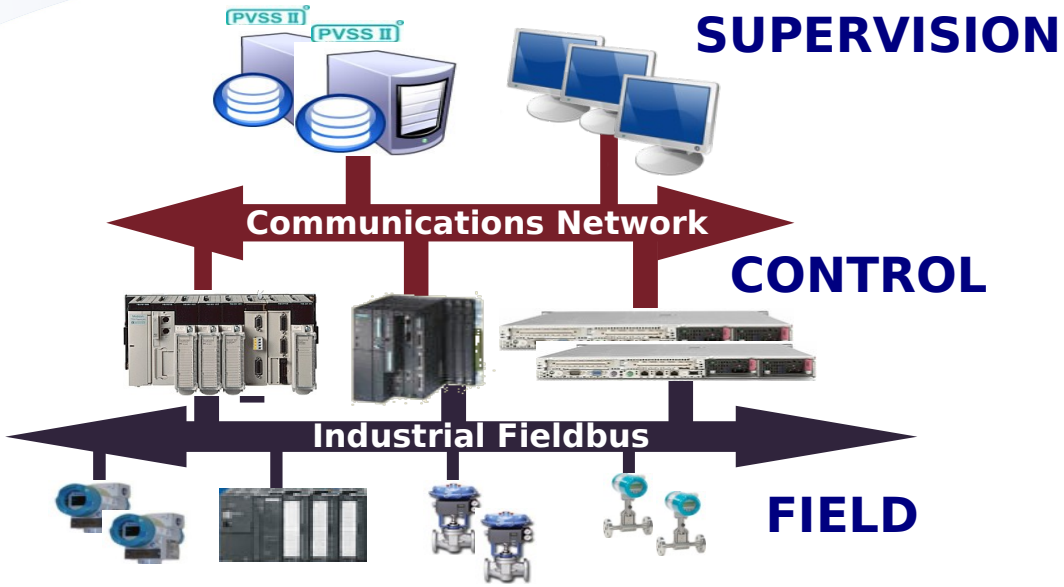
Liverpool Cathedral
World longest **modern** cathedral – 188 m
Completed : 1978

Meta-models

- 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



18 kW @ 4.5 Refrigerators

P4 Cooling towers

Projects built with UNICOS :

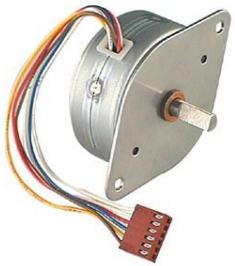
- LHC CRYO
  - 3.3 Kms / 2 PLCs / 3500 source files
- Cooling and ventilation
- LHC Gas Control System

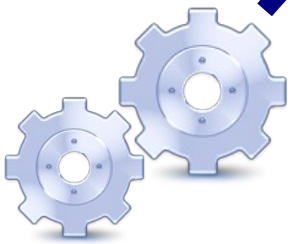
Slide credit : Dr E. Blanco

The UNICOS Framework : Generation

Process Logic

PLC



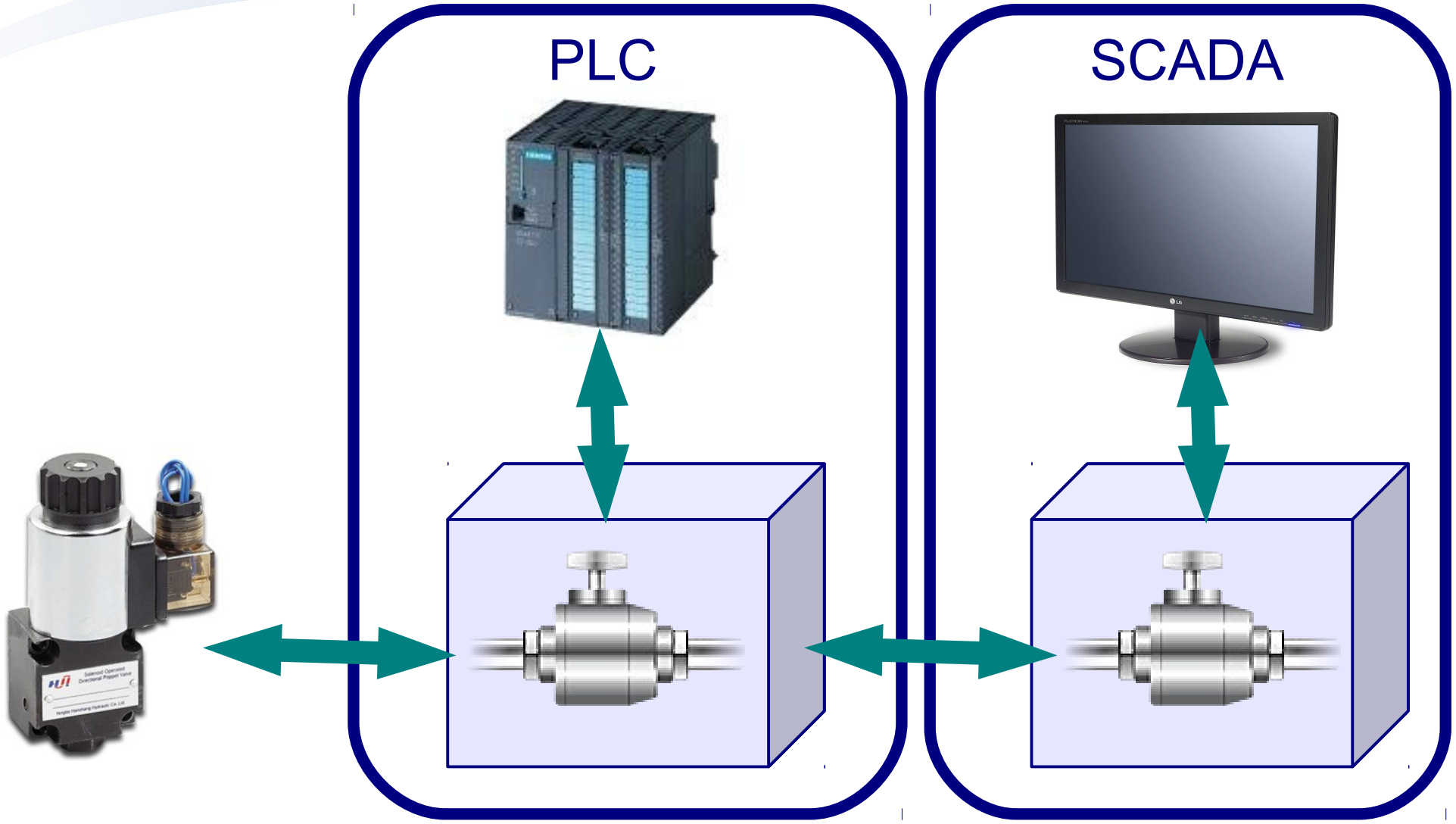


UAB

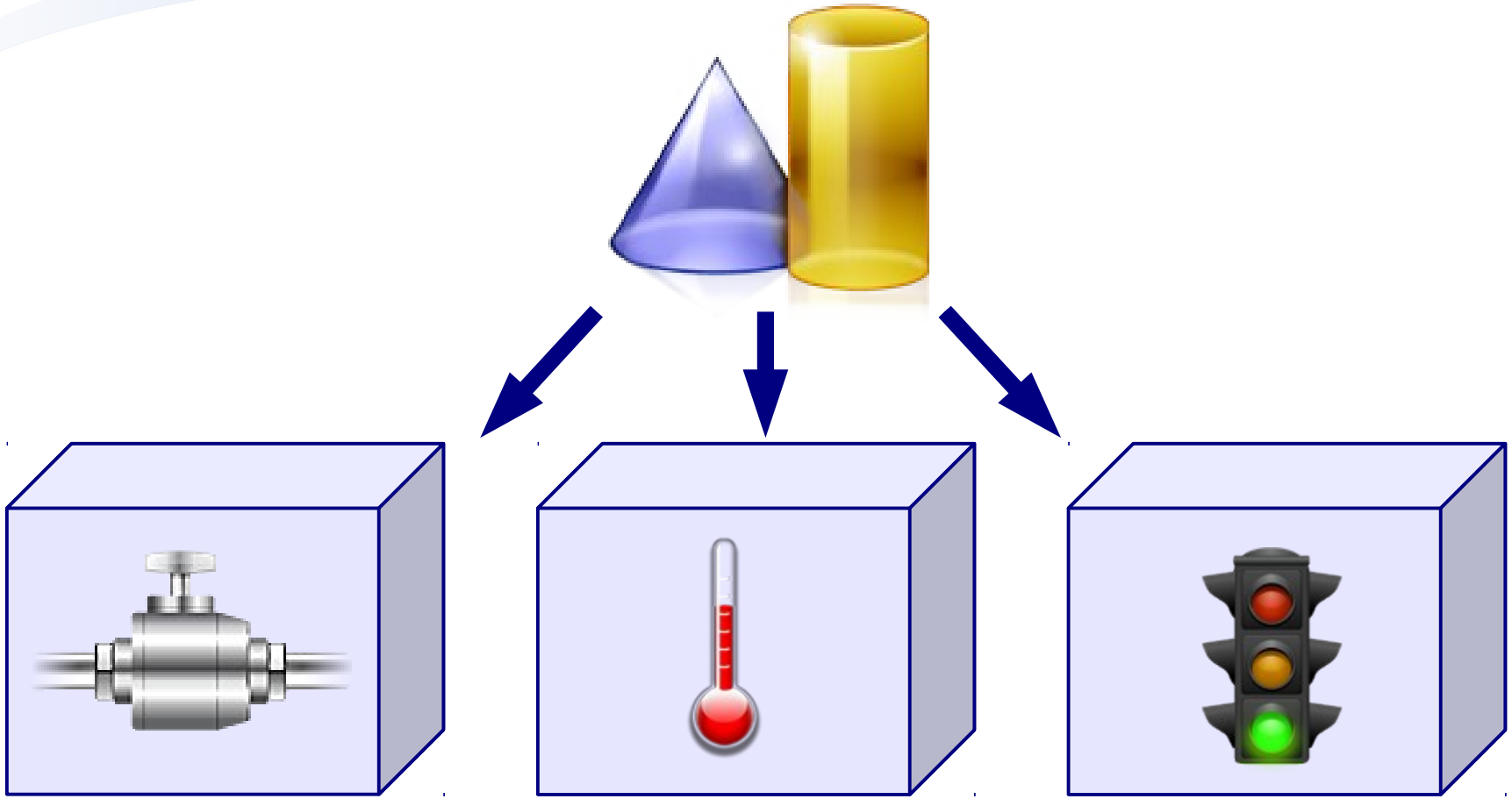
SCADA

Device Inventory

The UNICOS framework : Device Instances

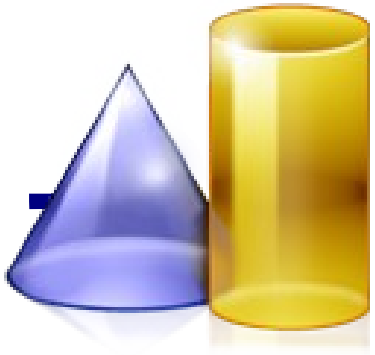


UNICOS Framework: Meta-modeled

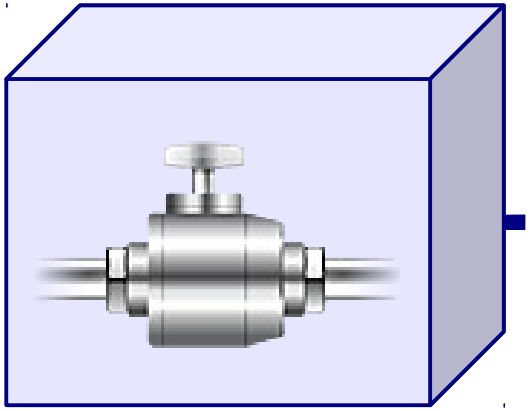


Meta-Modeling

M 2

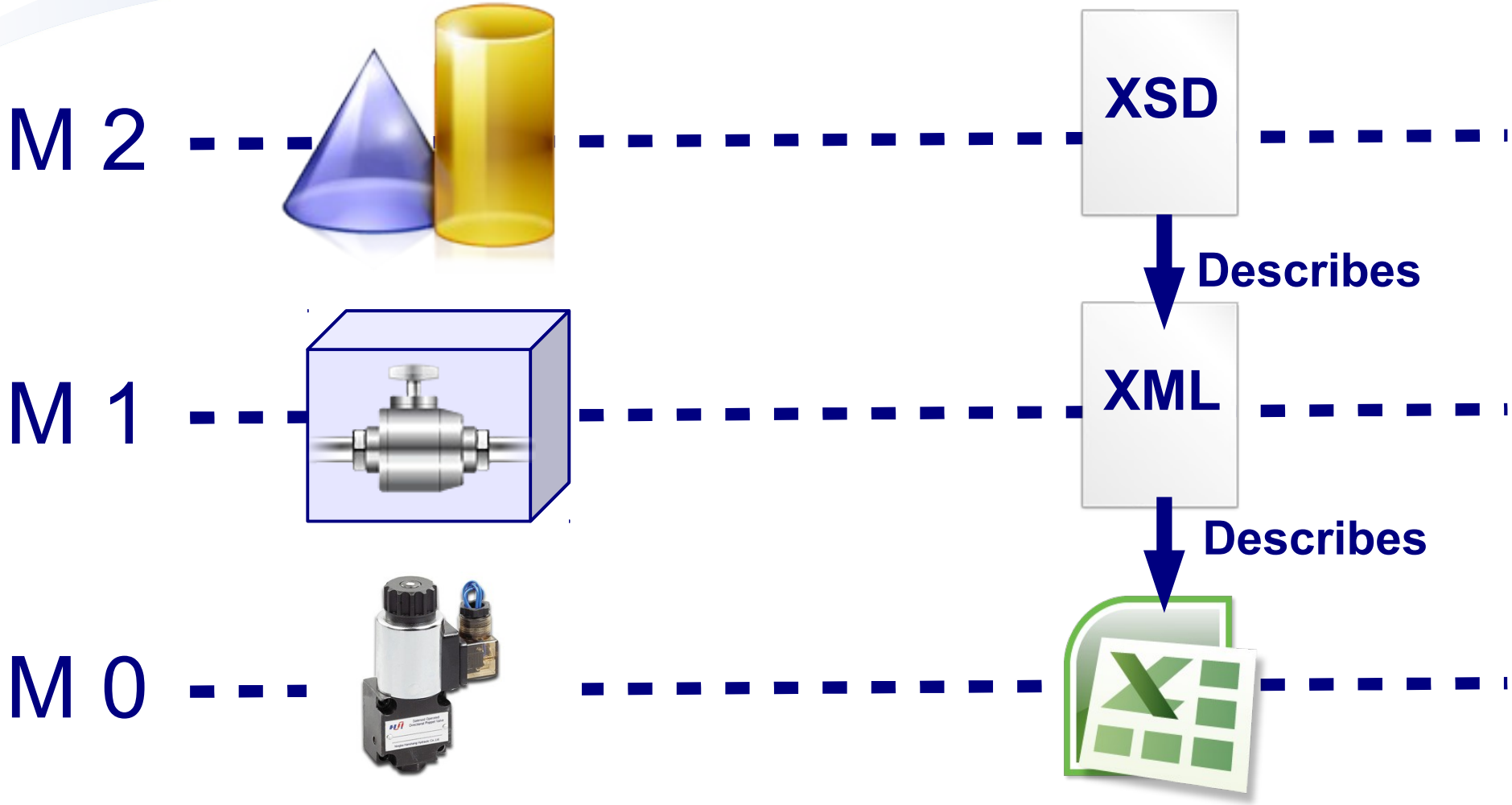


M 1

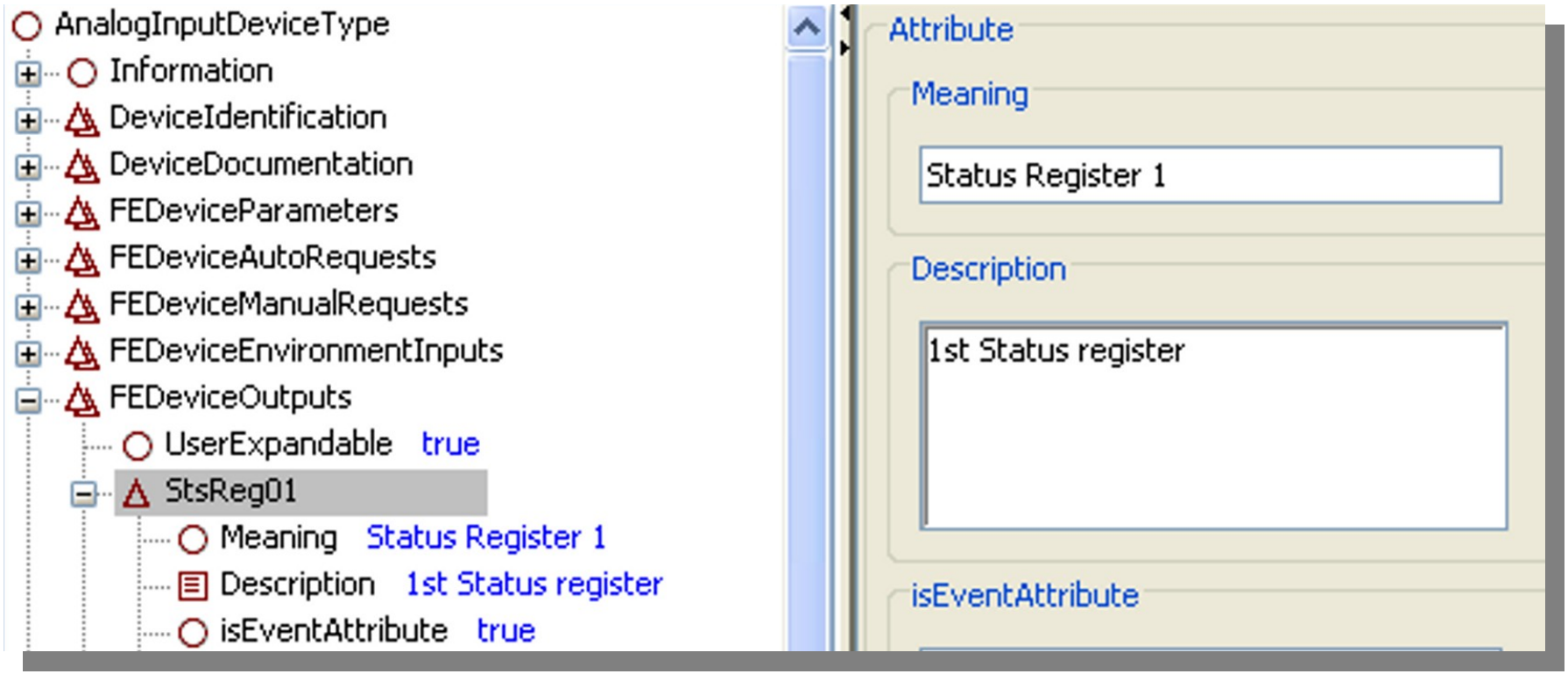


M 0

Meta-Modeling Implementation

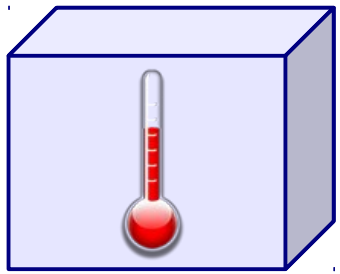


Concrete Applications : Generic Rich UI Editor



FESA General Editor

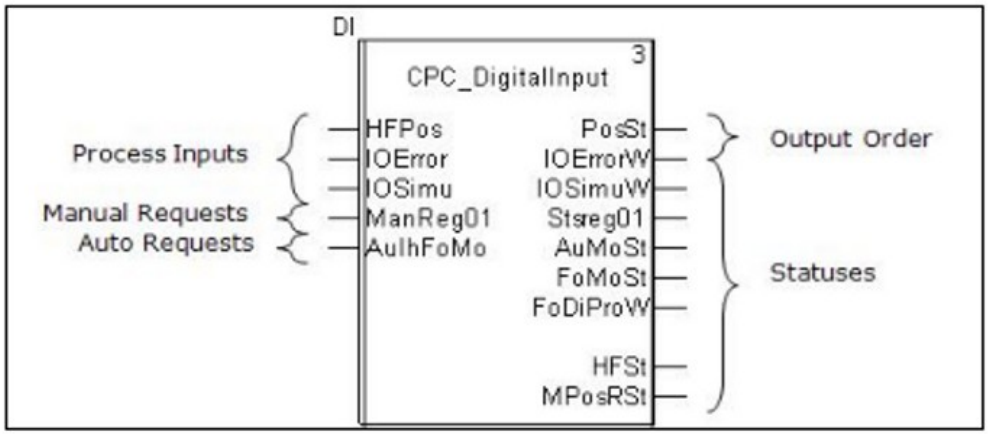
Concrete Applications : Type documentation



+

XSLT

Signal description

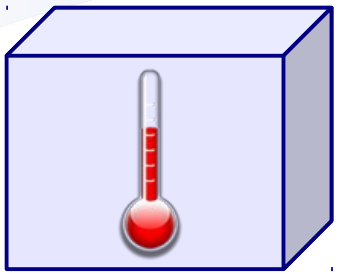


Device Inputs

Device Environement 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

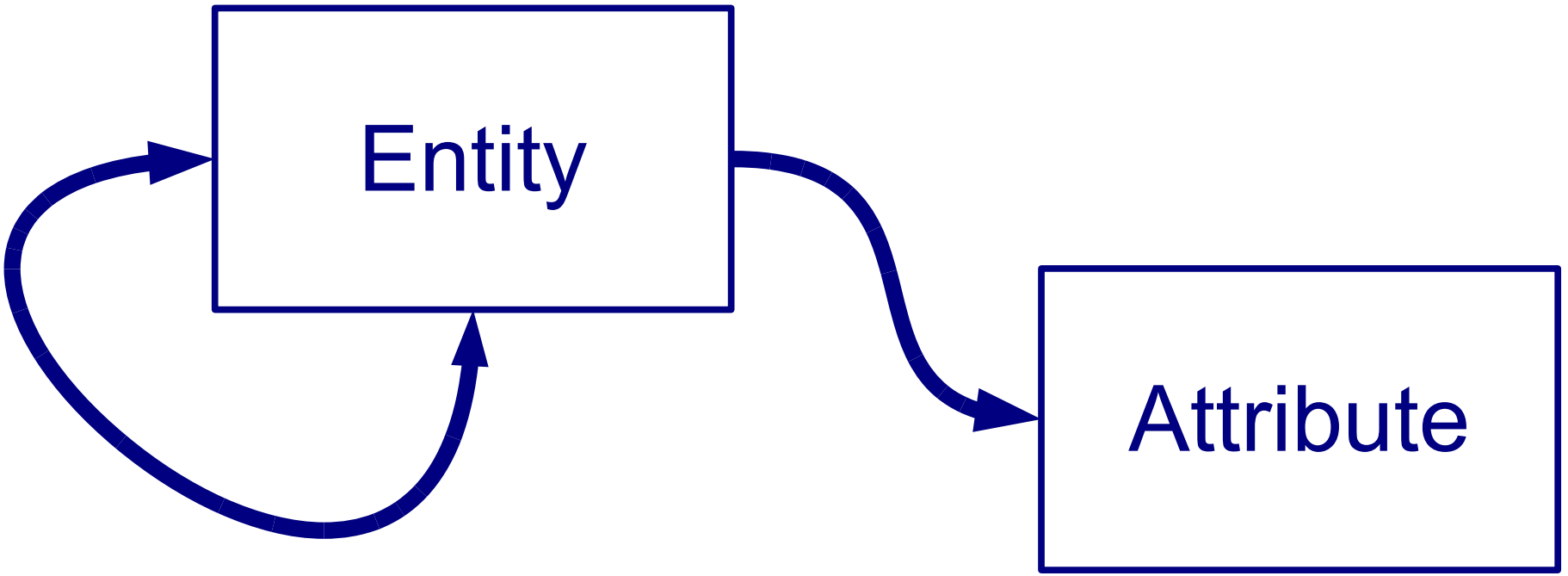


Meta-Modeling with XSD

- 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



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

Conclusions

- 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..

Posters and references

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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