Model Oriented Application Generation
For Industrial Control Systems

Brice Copy
on behalf of the UNICOS Project
CERN
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.
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

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

Device Inventory

UAB

PLC

SCADA
The UNICOS framework: Device Instances

PLC

SCADA
UNICOS Framework: Meta-modeled

- On Off
- Analog Input
- Digital Output
Meta-Modeling

M_0

M_1

M_2
Meta-Modeling Implementation

M 2

M 1

M 0

XSD

XML

Describes

Describes

icalepics 2011
Concrete Applications: Generic Rich UI Editor

FESA General Editor
Concrete Applications:
Type documentation

**Signal description**

**Device Inputs**

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Meaning</th>
<th>Description</th>
<th>BitPosition</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFPoS</td>
<td>BOOLEAN</td>
<td>Hardware Feedback Position</td>
<td>Hardware feedback position</td>
<td>-</td>
</tr>
<tr>
<td>IOError</td>
<td>BOOLEAN</td>
<td>Input/Output Error</td>
<td>Error in the FE channel assigned to the device</td>
<td>-</td>
</tr>
<tr>
<td>IOSimu</td>
<td>BOOLEAN</td>
<td>Input/Output Simulation</td>
<td>The device is simulated by the operator</td>
<td>-</td>
</tr>
</tbody>
</table>
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

Entity

Attribute
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

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**
- M. Dutour, "Software factory techniques ...", ICALEPCS 2007, TPPA03
- E. Blanco, “Cryogenics Instrumentation … for the LHC”, ICALEPCS 2007