Model Driven System Development and UML

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Agenda

• OMG’s Model Driven Architecture - MDA
• Commercial tools
  – BridgePoint
  – Rhapsody
  – Rational Rose Real-Time
OMG’s Model Driven Architecture (MDA)

3 Core standards in MDA:
- **UML**: Unified Modeling Language
- **MOF**: Meta Object Facility
- **CWM**: Common Warehouse Metamodel

MDA’s PIM and PSM Models

- Models of different systems are structured explicitly into:
  - **Platform Independent Models (PIMs)**
    - A PIM is a formal specification of the structure and functions of a system that abstracts away technical details
  - **Platform Specific Models (PSMs)**
    - A PSM specifies the realization of the functionality in the PIM on a specific platform

- OMG standards are specified in terms of a PIM and, normally, one or more PSMs, all in UML
Example of PIM and PSM Models

Executable PIM Model

- The PIM can be complete and specific enough to enable *early execution and test* of the application
  - independent of design and implementation details
- Automation of an MDA approach provides the opportunity for:
  - a dramatic defect reduction
  - accelerated development
  - large scale reuse
  - easy platform migration of applications
Platform Specific Models in UML

- Example: to transform a PIM into a CORBA PSM – certain decisions need to be made
- Such decisions can be defined by a UML profile:
  - a set of extensions to UML using the built-in extension facilities of UML (stereotype types and tagged values)
  - UML Profile for CORBA – specifies how to use UML in a standard way to define CORBA IDL interfaces, structs, unions etc.
Example of a Semantically Enhanced CORBA Specification

```java
interface Account {
    attribute short number;
    attribute float balance;
}
```

Figure 7. IDL--By Nature Semantically Thin

MDA Meta Model Example
Four ways to transform a PIM into a PSM

1. Manually construction of PSM based on the PIM
2. Manually construction of PSM with utilization of known refinement patterns
3. Semi automatically – an algorithm can create a PSM skeleton based on the PIM to be manually enhanced
4. Automatically – an algorithm can create a complete PSM

Example: Platform Independent Model
A CORBA-Specific UML Model (PSM)

Two Development approaches

• The Elaborative approach (the normal case)
• The Translational approach (e.g. the BridgePoint approach)
Elaborative Development

BridgePoint Toolset

- **Company:** Project Technology provides the BridgePoint Toolset with the goal of:
  - “Accelerating Development of High-Performance Software with Model Driven Development Executable and Translatable UML (XT-UML)”

- **Stephen Mellor** (founder of Project Technology)
  - chairs the OMG Analysis and Design Task Force Working Group on MDA
  - a key group contributing to the detailed definitions of MDA elements
  - Stephen Mellor also chaired the consortium that defined OMG’s UML Action Semantic, which made the UML executable
Executable and Translatable UML

Translator

X_T UML Application Models

Target Optimized Source Code

Application-Independent
Target Optimized
Target Specific Translator

Application-Specific UML Models
Target and Implementation-Independent
Executable for Test and Debug

100% Generated Code for Modeled Components
Interfaces to COTS, Legacy and Hand-Written Code
Well-Commented, Understandable and Consistent
Low Defect = Elimination of Hand Coding Errors

The XT-UML Development Process

Software Architecture Design

Translation Design Elements

Project Initiation

X_T UML Application Models

Code Generation

Integration and Test

Target Source Code

Application Modeling

Project Structuring & Requirement Derivation
XT-UML Translator

XT-UML Iterative Application Development

New versions of application models fully translate to optimized target code
Target Migration

Target-Specific Translators
(Language, RTOS, S/W Architecture and H/W)

- X_ILUML Application
- Target 1 Source Code
- Target 2 Source Code

No changes to Application Models

Defect Reduction Points

- Well-structured projects are easier to manage
- Testing for separation of application and design
- Software Architecture Design
- Software Design can be tested early and without the application being complete
- Commercial Software Architecture Designs (Translations) are pre-tested
- Code Generation
- Integration and Test
- Complete code generation eliminates human errors
- Translator makes integration easier
- Defined analysis process results in completely specified systems
- Early specification testing through application model execution
- Automated checking at data entry
Rhapsody

- Company: Ilogix
  - David Harel (inventor of UML’s State Chart)
  - Bruce Powel Douglass (author of several books)
- Rhapsody features:
  - Model based code generation in C, C++ and Java
  - Model based simulation
    - object browser with attribute information
    - state change in state machines
    - automatic generation of sequence diagrams when running the program
  - Integrated Real-Time OS framework
    - ported to many commercial OS
- Proprietary extensions to UML

Rational-Rose Real Time

- Company: Rational Software Cooperation (now bought by IBM)
  - Booch, Rumbaugh, Ivar Jacobson
  - Bran Selic
- Rational-Rose Real Time is a specific product
  - a lot different from standard Rose
  - based on the ROOM Methodology – Bran Selic etc.
  - executable models based on a port-based abstraction
References

• Object Management Group (OMG)
  – “Model Driven Architecture (MDA)”, an OMG standard (ormsc/2001-07-01)
  – www.omg.org
• Project Technology – BridgePoint toolset
  – Paper: “Executable and translatable UML XTUML”
  – www.projtech.com/
• Rhapsody
  – www.ilogix.com
• Rational Rose Real-time
  – www.rational.com