Representing Product Line Architectures

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Product Line Architecture

- Common architecture for a set of related products or systems developed by an organization
- Vehicle for organizational-wide reuse
- Document architectural alternatives
- Capture architectural evolution
The Problem

- Many ADLs are available for describing software architectures...
  - Acme
  - Wright
  - Darwin
  - Rapide
- ...but none can accurately and fully describe a product line architecture
  - (Koala)
Modeling Approach: Extensible ADL

- Encapsulate ADL features in individual XML schemas
  - Modularity
  - Extensibility
- Extend and/or modify existing features by adding new XML schemas
  - Allows tailoring of the resulting language to organizational specifics
xADL 2.0

- xADL 2.0 = xArch + modular extensions from UCI
- Each extension is a schema (100-500 lines XML)
xArch: Architectural Instances Core

- **xArch** – the core of our new ADL
  - Written as an XML schema
  - Establishes the common set of architectural constructs
    - Components, connectors, interfaces, links
    - Sub-architectures (hierarchical composition)
    - General groups
  - Inherently distributed
  - Based on a collaboration with architecture researchers at CMU
Design-Time vs. Run-Time

Behavior information for static analysis

Design-oriented Properties

Comp1_Beh{
  if(recv(evt(q))){
    doProcess(q)
    emit(evt(b));
  }
}

Constraints

Invariant a{
  comp1.interface .type = top ->
  comp1.interface .link.type =
  bottom
}

Run-time State

State = BLOCKED
Waiting on event "A"

Information about distributed components

Event queue contents

Conn Inst 1

Machine = magister
Pid = 242
CPU = 1
Port = 8080
...

Conn Inst 2

Conn Inst 3

Comp Inst 1

Comp Inst 2

Comp Inst 3

Comp1

Comp2

Comp3

Conn1
Adding information about implementations to component, connector, and interface types is essential if the architecture is to be instantiated.
Current Set of XML Schemas
Tool support

- **DOM-based Java Libraries**
  - Programmatic, syntax-directed editing of xArch/xADL 2.0 documents, hiding nearly all of XML

- **Apigen**
  - Generates DOM-based Java Libraries using only the XML schemas

- **ArchEdit**
  - Syntax-directed graphical tree-based editor for xArch/xADL 2.0 documents

- **“Visio for xADL”**
  - Microsoft Visio extensions provide full graphical editing capabilities for xADL 2.0 architectures

- **Ménage**
  - Design environment with specific support for product line architectures
Experience & Evaluation

- Lockheed Martin Systems Integration
  - AWACS aircraft software systems modeled in 10,000 lines of xADL 2.0
  - Used as the basis for an architecture-derived simulation of the inter-component communication on AWACS

- Jet Propulsion Laboratories (JPL)
  - Extended xADL 2.0 to add domain-specific interface descriptions
  - Experimenting with modeling software architectures in xADL 2.0 for use in future Mars missions
Visit the Web Site

http://www.ics.uci.edu/projects/xarchuci/