Trinity: A Language for Multi-View Architecture Description and Control

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Software Architecture

the "fundamental organization of a system embodied in its components, their relations to each other, and the environment"

Architecture Views

Module or Code

Modules: principal units of implementation

- Used to explain system functionality + structure of code base
- A blueprint for code construction and incremental development
- Analysis of code dependency

Component and Connector (CnC)

Components: elements that have some runtime presence (processes, objects, clients, servers).
Connectors: components' pathways of interaction (protocols, information flows).
Ports: component interfaces that define possible interaction with components.

- Show how the system works
- Guide development around structure & behavior of runtime elements
- To reason about performance and reliability

Deployment

Deployment View: a mapping between software and non-software elements in the former's environment.

- Analyzing actual runtime performance, reliability, and security
- SW elements: CnC elements
- Environmental elements: hardware, network elements, and their capabilities

The Problem

It is hard to determine whether the logical relationships between entities in architecture diagrams are present in system implementations.

Previous Solutions

Architecture Description Languages (ADLs)

- (-) *Description:* Inferred by the name, ADLs only describe software architectures; they do not prescribe, or enforce conformance to them
- (+) *Analysis:* ADLs are focused on system analyses
- (+) *Formal Notation:* Currently, ADLs are the most formal mainstream architecture tools available

ArchJava Java extension unifying architecture and implementation

- (+) *Conformance:* Checks for architecture conformity
- (-) *Distributed Systems:* No conformance checks in distributed systems (ArchJava supports multiple systems via custom connectors, but does not enforce conformity)
- (-) *Multiple Views:* Lacks support for multiple architecture views; focuses only on Component-and-Connector view

Trinity's Approach

- Make software architecture a **"live" component** of Trinity systems
- Trinity enforced **architecture conformance** complements ADL analyses
- Support architecture conformance and **communication integrity** in **distributed systems**
- Directly translate the conceptual entities from multiple views into **code-enforced constructs**
- Support **all three software architecture views** (module or code, CnC, and deployment)

Design

Implementation Concepts

Architecture concepts are translated into runtime entities in Trinity

Trinity Architecture Components

component: a runtime entity that may interact with other components through ports.

connector: interaction pathways that join two compatible component ports.

port: component access points that can allow interaction with other components.

attachments: declarations that enable connections between compatible components to be made

entryPoints: a program starting point that permit execution.

Demonstrated Principles

Trinity's design demonstrates the following principles:

- **Readability**
  System architecture is contained in a single file and is prescriptive, uniting design and implementation.
- **Reuse and Adaptability**
  Compatibility checking and code generation make switching, adding, and removing architecture elements easier and more secure.
- **Communication Integrity in Distributed Systems**
  jfdlkasjfdklasfjs

Example

```
component Client
        port getInfo: requires CSIface

component Server
        port sendInfo: provides CSIface

external component DB
        port dbIface: target DBModule

connector JDBCCtr
        val connectionString: String

// Server and database are connected
// using the JDBC Connector
```

```
architecture

    components
        Client client
        Server server

    connectors
        JSONCtr jsonCtr

    attachments
        Connect client.getInfo and
        server.sendInfo with jsonCtr

    entryPoints
        Client: start
```