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

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#### Software Architecture

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

The Problem

It is hard to determine

whether the logical

relationships between

entities in architecture

diagrams are present in

system implementations.

#### **Architecture Views**

Modules: principal units of implementation

Used to explain system functionality +

**Components:** elements that have some runtime

Ports: component interfaces that define possible

presence (processes, objects, clients, servers).

Connectors: components' pathways of

Guide development around structure

To reason about performance and reliability

Analyzing actual runtime performance,

network elements, and their capabilities

reliability, and security

SW elements: CnC elements

Environmental elements: hardware,

Show how the system works

& behavior of runtime elements

interaction (protocols, information flows).

A blueprint for code construction

and incremental development

Analysis of code dependency

structure of code base

# Module

Deployment

interaction with components.

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

# 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.

#### **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,

Demonstrated Principles

Trinity's design demonstrates the following principles:

Readability

CnC, and deployment)

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 Wyvern's capability-based module system ensures that elements only have direct control of capabilities to which they have explicit access.

## Example

component Client

port getInfo: requires CSIface

port sendInfo: provides CSIface

component Server

external component DB

port dbIface: target DBModule

connector JDBCCtr val connectionString: String

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

CnC elements like components and connectors are Wyvern/Trinity objects.

Client does not get direct access to network capabilities

Code for JSON connector is generated

#### Client-Server interface functions are provided by the programmer

// Code provided by the programmer // Common between client and server resource type CSIface def getVal(key:String): String

#### architecture

components

Client client Server server

connectors

JSONCtr jsonCtr

attachments

connect client.getInfo and server.sendInfo with jsonCtr

entryPoints

Client: start

Compatible ports are connected