## 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"

#### **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

interaction with components.

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

To reason about performance and reliability **Deployment View:** a mapping between

software and non-software elements in the former's environment.

Analyzing actual runtime performance,

### Environmental elements: hardware,

#### reliability, and security SW elements: CnC elements

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)**

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

**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

#### Architecture concepts are translated into runtime entities in Trinity

#### **Trinity Architecture Components**

Implementation Concepts

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

# Example

component Client

component Server

port getInfo: requires CSIface

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

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

they have explicit access.

components

Client client Server server

connectors

JSONCtr jsonCtr

attachments

connect client.getInfo and server.sendInfo with jsonCtr

entryPoints

Client: start

Compatible ports are connected