

Adaptation Policies for Managing Configurable Software

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Problem

- **Software applications must cope with resource constraints and user demands that vary dynamically (and often unpredictably)**
- **Software can adaptively respond to changes in operating conditions in two ways:**
 - **Dynamic reallocation of computing resources**
 - **Adaptations in software components that adjust to whatever resources are available**

This research focuses on solutions involving adaptations in configurable software components.

Background



Notional tactical scenario illustrating the problem with static bandwidth allocations

- In tactical applications, static resource allocations may not address dynamically changing mission needs.
- Bandwidth, for example, should be dynamically reallocated if mission needs change. (DARPA Control-Based Mobile Ad-Hoc Networking program is addressing this problem.)
- What about the traffic that has its bandwidth reduced after a reallocation? Those applications must adapt as well!

Objective

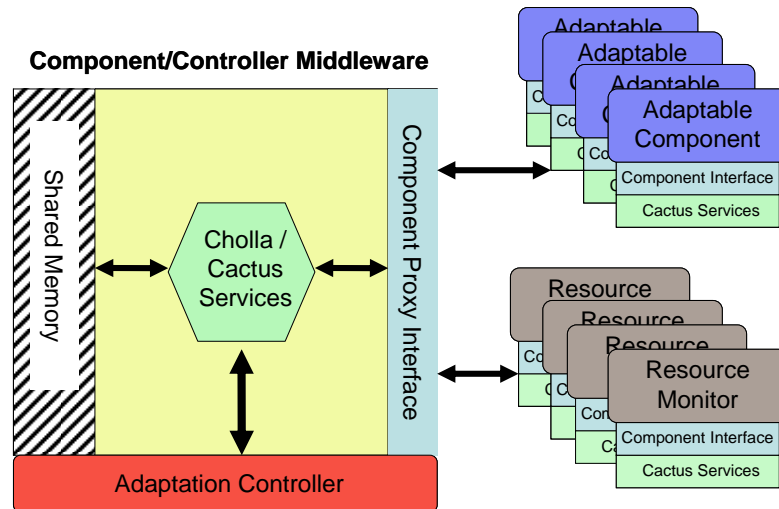
- **Develop prototypes of the infrastructure needed to control and coordinate adaptive changes in configurable software applications under dynamic operating conditions**
- **Use explicit adaptation policies, specified by a user/administrator, to manage a repertoire of pre-determined configuration options in legacy software components**
- **Explore the feasibility of this approach using simulations and a tactical C2 software application**

Hypothesis: Coordinated adaptation policies can preserve reasonable application performance and functionality in dynamic computing environments

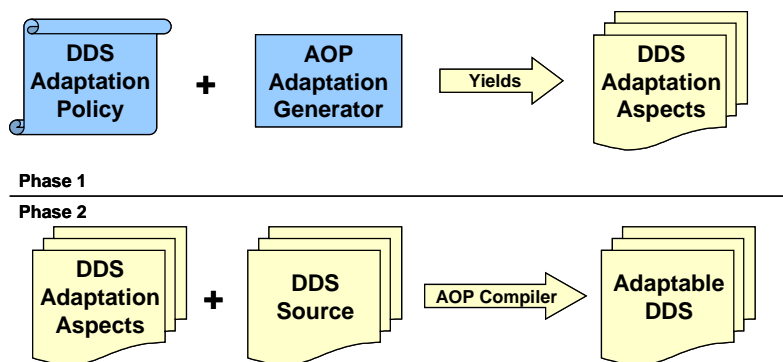
Activities

- **Implemented basic infrastructure for coordinating software adaptations, building on existing capabilities:**
 - Cholla, a software architecture that supports coordination of adaptive components (Univ. of New Mexico)
 - Cactus, a system that provides message/event handling capabilities (Univ. of Arizona)
- **Integrate adaptation mechanisms based on Aspect Oriented Programming (AOP) into the Blue Force Tracking (BFT) / Data Dissemination Service (DDS)**
 - DDS is a distributed, Web service-based information delivery system
 - Initial focus is on adaptation of memory cache usage in DDS
- **Build initial experimental prototype that integrates the infrastructure with a fuzzy rule system to represent policies and a cache management simulator to analyze policy effectiveness**

Highlight

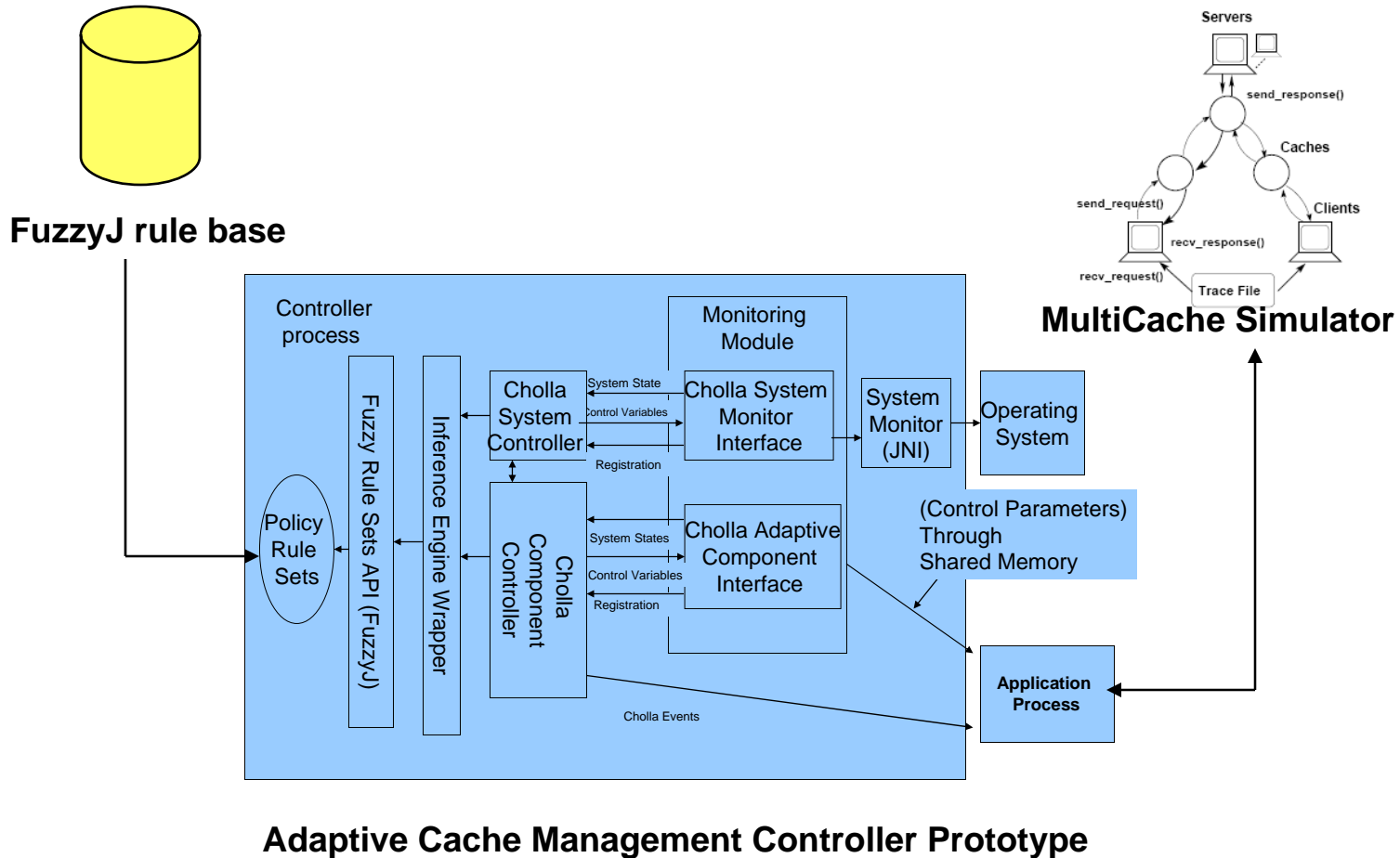


- Event-driven architecture uses event and message handling capabilities of Cactus-J
- Basic Cholla services have been implemented
- Initial resource monitor (CPU, memory) has been implemented



- Developed a simple Fuzzy Adaptation Markup Language for intra-application policies
- Implemented an AOP Adaptation Generator that binds policy with state information to produce AOP aspects in DDS

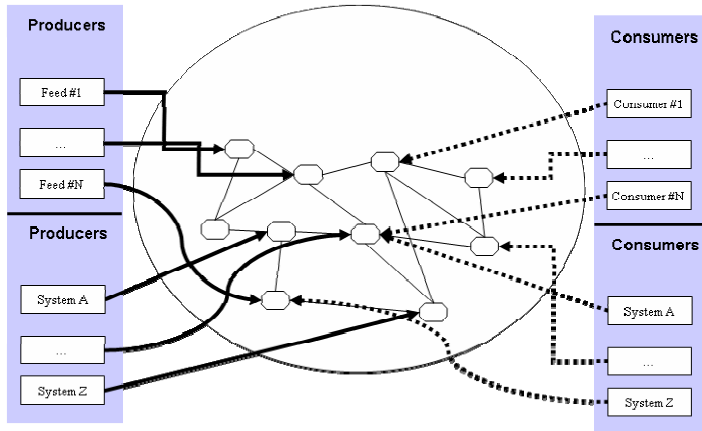
Demonstration



Impacts

- **Prototype may set the stage for a transition opportunity with DDS**
- **Applied research will help build collaborative relationships with academia (e.g., Univ. of New Mexico; Univ. of California, Santa Cruz)**
 - Testing some of these ideas on challenging applications should help advance the state of the art
- **Results will be demonstrated and documented**
 - MITRE publications and conference papers
- **Adaptation will increase the ability of sponsor applications to maintain critical functions given unanticipated changes in operating conditions**
 - Explicit policy guidance keeps users in control

Future Plans



FY07

- Demonstrate adaptation of cache management strategies for DDS
- Extend infrastructure to support user-level policies, policy management, and controller configuration
- Build more adaptation mechanisms for DDS (e.g., application layer routing, data compression)

FY08

- Extend framework to coordinate multiple controllers and applications (e.g., resolving conflicts, timing of controller execution, etc.)
- Develop policy language specification (state, control actions, multiple goals, user preferences, etc.): rule-based, model-based, or something else.
- Define metrics to assess the effectiveness of adaptation and the performance of the infrastructure