I. Research Overview and Outcome

a) Problem Statement

Autonomic behavior (self-*) are important properties for enhancing reliability, consistency and manageability in collaborative communication such as CVM. In the case of self-configuration, this includes replacing, re-initializing, removing and introducing service components at runtime.

This presents the challenge of managing the combinatorial explosion of possible configurations especially at runtime where the potential for unknown variability exists. Selection techniques solely based on comparisons can quickly become intractable therefore, approaches for selection that scale well are needed.

b) Background

The Communication Virtual Machine (CVM) is a model-driven paradigm for realizing collaborative communication. The layered architecture of the CVM is shown on the right.

Network Communication Broker (NCB) is the layer of CVM responsible for providing a network independent API.

The diagram to the left shows the conceptual flow for the autonomic NCB.

The Alloy Model Analyzer is a lightweight modeling tool which is amenable to automatic analysis. The analysis involves the determination of the satisfiability of a constraint within a bounded search space. This search space is referred to as the scope.

c) Approach

The approach is based on model analysis and constraint solving to produce and validate consistent configurations. It allows for the accommodation of a continuum of target configurations. The model can capture not only architectural features and constraints, but also user- and system-defined policies and context-related metadata.

The approach accommodates both proactive (user-initiated) and reactive (or autonomic) adaptation. In the case of reactive adaptations, model-based simulation at runtime is used to dynamically generate suitable candidate configurations that guide the autonomic mechanisms in the task of evolving the platform to meet new unanticipated requirements and/or environmental conditions.

While model-based constraint solving is used to validate the resulting configurations for proactive adaptations.

The NCB metamodel, shown to the left, can be viewed as the interaction of three core aspects, namely base systems, policies and requests. The flow for the transformation of the models are shown on the right.

d) Preliminary Results

The preliminary results of a case study points to the feasibility of the approach. The figure to the left shows the results of a comparison of the new approach against a set reduction approach. Our approach scales significantly better as the number of frameworks grow.

The table to the right shows some of the metrics when using the Alloy Solver during model simulation.

Metrics from Alloy Runs

<table>
<thead>
<tr>
<th>Metric</th>
<th>Time</th>
<th>Speedup</th>
<th>Quality Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1000</td>
<td>5x</td>
<td>1.5x</td>
</tr>
<tr>
<td>5000</td>
<td>5x</td>
<td>10x</td>
<td>2x</td>
</tr>
<tr>
<td>10000</td>
<td>10x</td>
<td>15x</td>
<td>3x</td>
</tr>
</tbody>
</table>

II. International Experience

The PIRE program provided me with the opportunity for new experiences in collaborative research and Brazilian culture.

PIRE provided the opportunity for professional development by:
- working with experienced researchers in middleware and modeling.
- valuable feedback from the UFG team members to augment my current research.
- exposure to new research directions.

PIRE also provided opportunity for personal development through:
- exposure to new cultures and customs.
- appreciation of cultural differences.
- visits to historical sites.

III. Acknowledgement

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