Two-Level Assurance of QoS Requirements for Distributed Real-time and Embedded Systems

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Key Challenges

Project Objective

Petri Nets: A formalism beneficial in modeling concurrent and asynchronous systems

• Transition: determine what, when and how QoS parameters are to be processed with associated predicates and functions for time, priorities and event triggers

Flow: control the flowing direction of QoS parameters

• Petri Net: a graph with associated terms

• Place represents a component in a DRE system

• Transition: describes how a component interacts with others

• Event: a trigger for the transition

• Time: transition is triggered at specific time

• Rate: transition is triggered at specific rate

• Discarding: transition rate decide the alternatives to be discarded by statistics

Background

AspectJ: Programmable Parameter Control for Evolutionary Algorithms

• AspectJ: a weaving framework in Java

• A Domain-Specific Scripting Language for Evolutionary Algorithms

• Define the modeling paradigm for Petri-Net graph

• Model: define modeling case by the type and range

• Interpreter: automatically generate source code based on the model created by using the Scripting Language

Generic Modeling Environment (GME): A malleable configurable modeling tool that permits the customization of visual domain languages that are capable of code generation

• Malleable: the modeling paradigm can be defined by the user

• Model: model created by the domain-specific scripting language

• Interpreter: generates the source code

Key Contributions

Overview of QoS-UniFrame

• Petri Nets as a formalism including predicates, time and event constraints.

• Dynamic and parallel elimination of infeasible alternatives by backtracking or branch-and-bound algorithm.

• Statistical results of Dynamic QoS of Design Spaces

• Non-strict QoS: parameters allows margins of orthogonality with respect to specific resource

A Case Study

Description

(a) The total flow processing capacity is at least 50 million gallons per day.

(b) The battery life of each Treatment Unit (TU) has at least 15 hours left.

(c) Total CRP range is at most 75.

(d) Total water treatment volume of selected TUs is at least 35 million gallons per day.

Non-functional Requirements

• Static parameters are design-related.

• Dynamic parameters are influenced by the deployment environment.

• Static parameters must satisfy requirements.

• Non-orthogonal: two parameters have mutual influence regarding specific resource.

• Orthogonal: two parameters have no mutual effects regarding specific resource.

Constraint Analysis by AspectJ

• The constraint analysis code for ‘Maximum Flow Processing Capacity’ is written in AspectJ-

• The alternative constraint is stored in AspectJ

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Experimental Results of QoS-UniFrame

A QoS-Oriented Approach to deal with unscalable GME

• Petri Net: a formalism including predicates, time and event constraints.

• GME: as a configurable and customizable tool for Petri Nets

• AspectJ provides modular and changeable metrics for constraint analysis

• Dynamic and parallel approach for eliminating infeasible alternatives.

• Statistical method to delete less probable alternatives.

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http://www.cis.uab.edu/~lush/QosUniFrame.htm