**A QoS-Based Semi-Automatic Design Space Exploration and Assurance Toolkit for Distributed Real-Time and Embedded Heterogeneous Components**

**Project Objective**
This project presents a semi-automatic toolkit to achieve the following objectives in the context of Distributed Real-time and Embedded (DRE) systems:

- Explore possible alternatives based on different design and deployment decisions.
- Eliminate infeasible and less probable alternatives based on the evaluation of quality of service (QoS) requirements by using Evolutionary Algorithms (EAs) and statistics.
- Assure feasible alternatives and obtain the optimal one based on the QoS utility functions defined in the evolutionary algorithms.

This project consists in reducing the overload of designing and developing DRE systems, and provides the advantages of flexibility and modularity for alternative analyses.

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**Background**

**Challenge 1: Design and Deployment**

- **AspectJ**: A formalism beneficial in modeling concurrent and asynchronous systems for DRE systems.
- **Generic Modeling Environment (GME)**: A metaconfigurable modeling tool that permits the customization of visual domain languages that are capable of code generation.
- **Petri Nets**: A formalism beneficial in modeling concurrent and asynchronous systems for DRE systems.
- **PPCEA**: Programmable Parameter Control for Evolutionary Algorithms

**Key Challenges**

- **Challenge 2: Non-functional Requirements**
  - **Static QoS**: non-strict & non-orthogonal
  - **Dynamic QoS**: strict & orthogonal

**Project UniFrame**

- **Components and Non-Functional Requirements**
  - **QoS Model**
  - **Component Repository**
  - **Knowledge Base of UniFrame**

**QoS Parameter Classification**

- **QoS Parameters**
  - Design-related: parameters are design-related.
  - Deployment environment: Dynamic parameters are influenced by the deployment environment.
  - Non-functional: parameters must satisfy requirements.
  - Behavioral: less parameters have no mutual influence regarding specific resource.
  - Orthogonal: two parameters have no mutual effects regarding specific resource.

**Non-functional Requirements**

- **QoS Requirements**
  - The total flow processing capacity is at least 50 million gallons per day.
  - The battery life of each Treatment Unit (TU) has at least 15 hours left.
  - Total CPU usage is at most 70%.
  - Total water treatment volume of selected TUs is at least 35 million gallons per day.

**Constraint Analysis by AspectJ**

- The constraint analysis code for “Maximum Flow Processing Capacity” is written in AspectJ.

**Experimental Results of QoS-uniFrame**

- The alternative that violated constraint (b) is eliminated.

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**References**