**Motivation**

- Large-scale systems of systems (SoS) are too complex to comprehend, develop, and operate.
- SoS failures are “...traceable to excessive complexity, poor architecture choices, ill-defined processes...” [INCOSE Vision 2020]
- Recent “Cloud Computing SoS” implementation issues demonstrate that unverified architectures may not meet stakeholder performance goals.

**Research Area**

- Goal Oriented System Engineering
- Early Stage System Architecture Evaluation with Simulation
- Non-Functional Requirements (NFR) Framework
- Cloud Computing Special Case Simulation
- Genetic Algorithms

**Current Funding**

- Keane Inc.
- NTT Data

**Key Contributions**

- A system and method to model and simulate Information Technology (IT) system architecture
- Goal oriented simulation of “Cloud Computing” based system architectures as a special case

**Companies that may have an Interest**

- Service Companies interested in designing, building, deploying and operating complex large scale Systems of Systems
- The approach is targeted at both traditional enterprise IT and the more recent Cloud Computing environment

**Goal Oriented Systems Engineering**

- Stakeholder NFRs are represented as softgoals
- The quality of the system is refined as a hierarchy of sub-goals
- Concrete goals are shown as quantitative values
- Goal analysis is used to confirm alternative designs and record decisions

The clouds on the SIG represent the system’s softgoals (e.g., Performance). Performance is refined to be Response Time and Throughput. Response Time is refined to be “4 seconds”.

**Architecture Evaluation with Simulation**

- Simulation confirms and reconfirms architecture decisions for the systems engineering lifecycle
- Maintenance & operations artifacts integrated into a repository to answer complexity questions

The ASM graphic shows the architecture topology components (servers, network, databases, etc), business workflow activities (in red) and one stakeholder goal (1 second response time).

**Non Functional Requirements Framework**

- Helps the developer represent and analyze Non Functional Requirements (NFRs)
- Identifies conflicts and synergies, as a basis for tradeoff analysis
- NFRs expressed explicitly, driving the software development process rationally
- Supports a variety of NFRs:
  - Performance, accuracy, cost, scalability...

**Cloud Computing Simulation**

- A method for architecting cloud-based systems that meet stakeholder goals.
- Cloud-Based Design is hard because it is:
  - Multi-Stakeholder, Multi-objective, Multi-dimensional and Large-Scale
- Our approach tries to handle this rationally

**Genetic Algorithms**

- Solve Multi-objective optimization problem for tradeoffs between conflicting goals
- Extend cloud-based SIG softgoal with quantitative issues
- Simulate quantitative SIG softgoal models
- Encode the optimization problem for design choices for cloud simulation configuration
- Incorporate above into Genetic Algorithm

Currently we consider the situation we have; with design options. In future, automated search on design space.