Information-Based Complex Systems Synthesis

SPONSORS AND PARTNERS
Government: ARL, AFRL, ARO, FAA, NASA, NRL, NSA, NSF, State of Maryland
Develop systematic quantitative methods for Systems Engineering

CORE SYSTEMS ENGINEERING TOPICS

- Object Oriented modeling and beyond
- Automata, languages, design rules
- Trade-off analysis and multi-objective optimization
- Testing, validation, behaviors
- Logic programming and optimization
- Performance over time, hybrid systems
- Simulation and performance analysis
Core SE Process:
Current and Emerging Standards

Iterate to Find a Feasible Solution

- Define Effectiveness Measures
- Create Behavior Model
- Assess Available Information
- Create Structure Model
- Check design for defects
- Perform Trade-Off Analysis
- Improve defects at lower level
- Create Sequential build & Test Plan

Reduce defects via reallocation of resources
**Process Design of T/R Modules**

**PROBLEM**
- Integrate Electronic and Mechanical Design
  - information interchange among tools used by designers
- Identify alternative components
  - integration with part catalogs, corporate databases
- Help generate and evaluate alternative designs
  - estimate cost, manufacturing time, reliability, etc.
- Help generate process plans
  - process parameters, time estimates, etc.

**SOLUTION**
- Object-Relational Databases and Middleware to integrate heterogeneous distributed data sources:
  - multi-vendor DB, text, data, CAD drawings, flat, relational, object DBS
- Entity-Relation Diagrams to provide multiple expert views of the data and integrate product and process design phases into a single system environment
- Hierarchical Task Network planning to explore alternate options at each level of the product:
  - parts and material, processes, functions assemblies
- Multicriteria Optimization for trade-offs: cost, quality, manufacturability, ...
Intelligent Network Monitoring and Management

Objectives:

- Develop intelligent monitoring systems for satellite and hybrid network fault and performance management
- Develop schemes for efficient storage and aggregation of massive network monitoring data

Significance:

- Management of hybrid networks is a critical market differentiator and critical for network existence and operation
- Heterogeneity and increasing speed call for management automation and “non-conventional” ideas

Satellite Network Configuration Management

- Represent network in a OO data model (300,000 nodes)
- Advanced GUIs linked to OODB representation, browsing tools
- OODB linked to network simulations
- Performance objects in OODB linked to graphical widgets
- Allow multi-resolution (in time and dynamic range) performance data storage
- Embed management constraints OODB and multi-criteria optimization for decision assistance
Data Mining of System Data

- Efficient methods for computing, storing and manipulating the spatial and temporal aggregates of monitored network statistical data
- Flexible tools for defining and using hierarchies
- Aggregates across time, attributes, sessions, users, calls, beams, satellites

We used materialized views:

- two to three orders of magnitude improvement in both speed and size of data
- computes and stores temporal aggregates with different levels of granularity, providing finer granularity for recent data, and coarser granularity for older data, following an aging scheme
- provides SQL-based interface for querying the stored aggregates