RT137 ITAP: SysML
Building Blocks for Cost Modeling

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Objectives

- Contribute key capability towards goals of ITAP, which is the *"-ilities" Tradespace and Affordability Program* (RT46/113/137)
- Provide model-based affordability analysis for tradespaces that include diverse complex "-ilities"

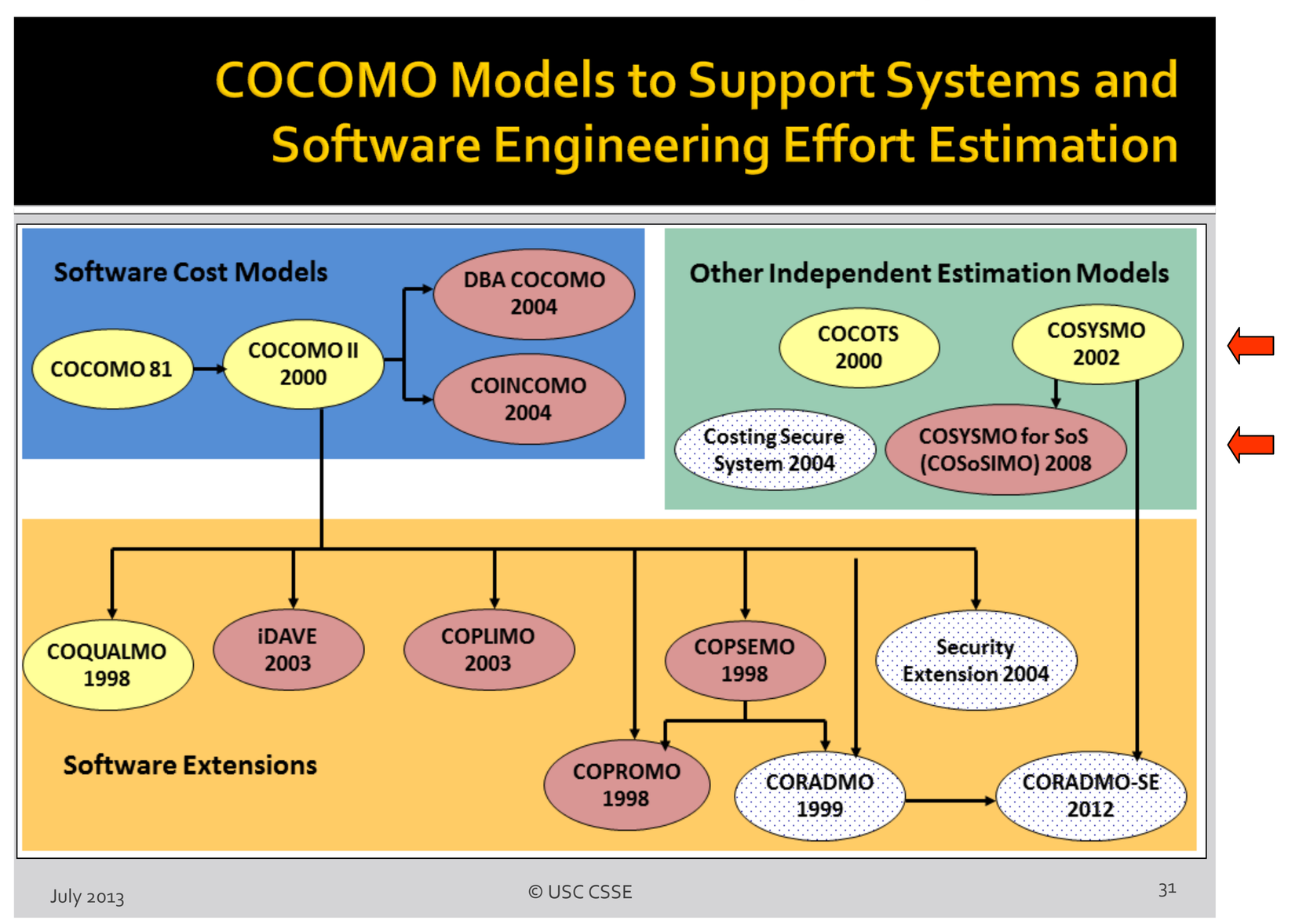
Overall Approach

- Leverage and extend several current bodies of work (BWi):
  - — BW1: Trade study capabilities (FACT/ERS/Cortex)
  - — BW2: Patterns for model interoperability (MIM)
  - — BW3: Cost modeling capabilities (COSYSMO ...)
  - — BW4: Implementation enablers (MBSE/SysML ...)
- Incorporate other "ilities" via BW3-like modeling in future phases

BW1: Trade Study Capabilities (FACT)

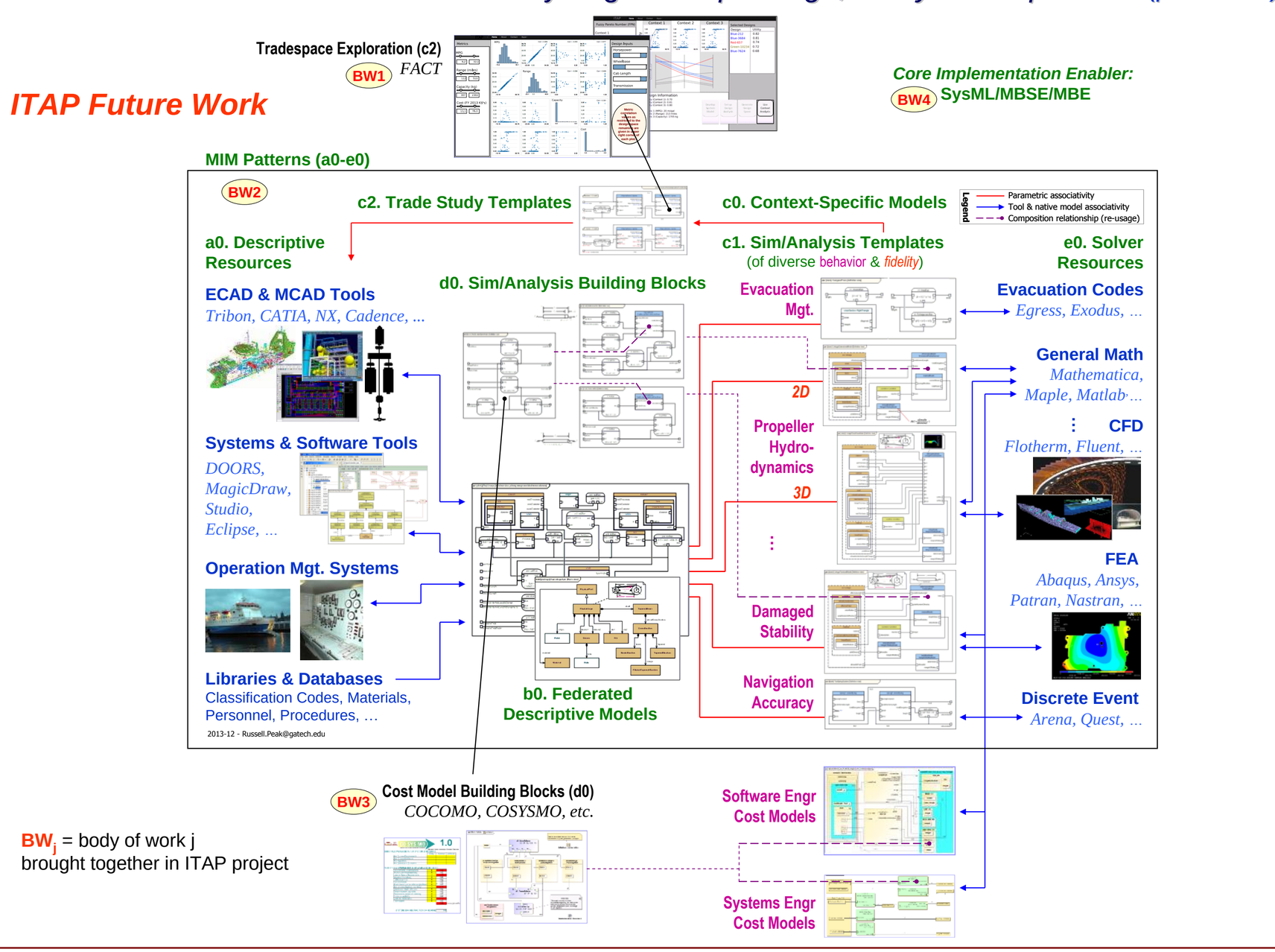
SysML-Based Environment for Advanced Trade Studies

BW3: Cost/Effort Modeling Capabilities



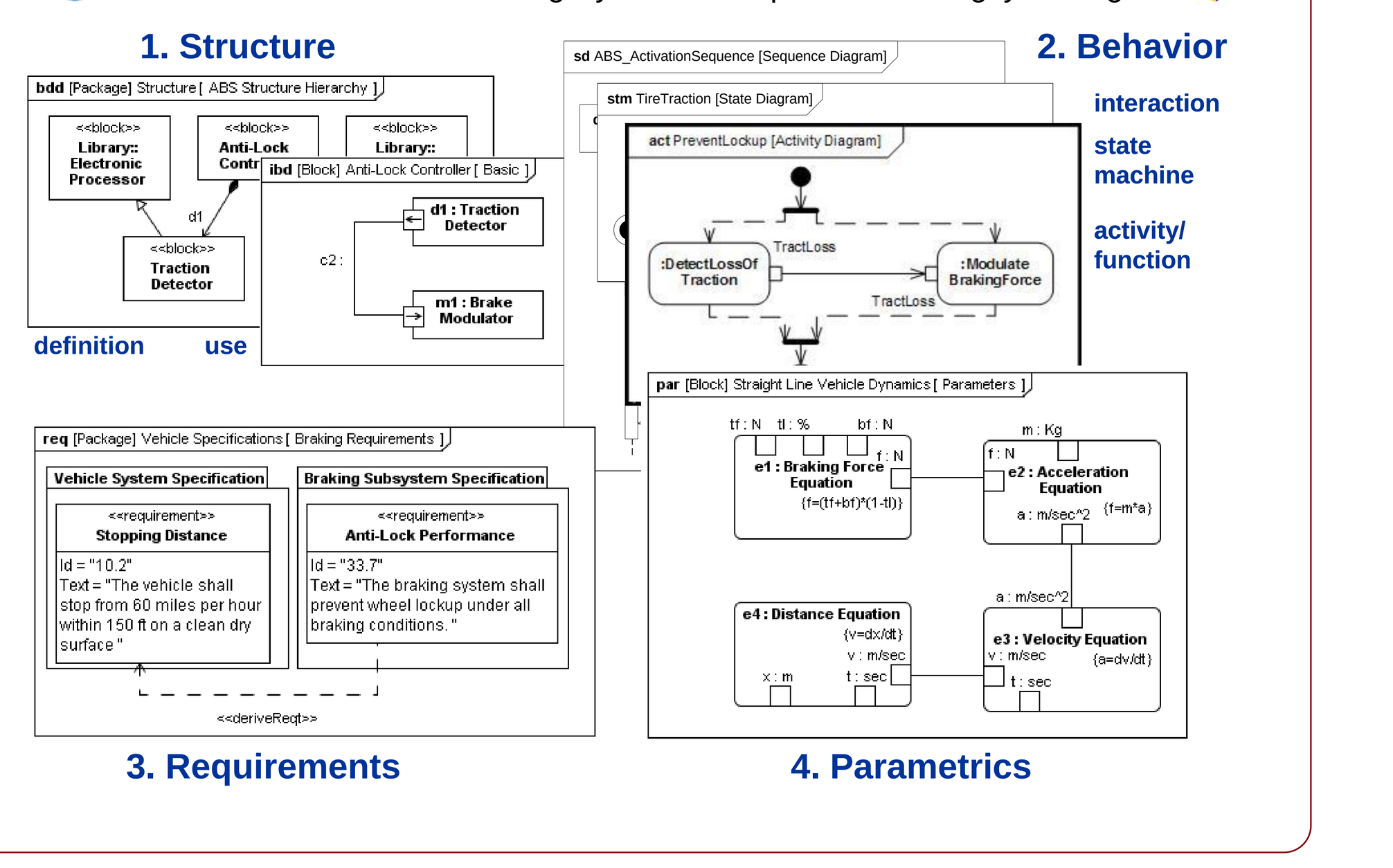
BW2: Patterns for Model Interoperability (MIM)

MIM Panorama with Envisioned ITAP Synergies: *Ship Design, Analysis & Operation (pro-forma)*

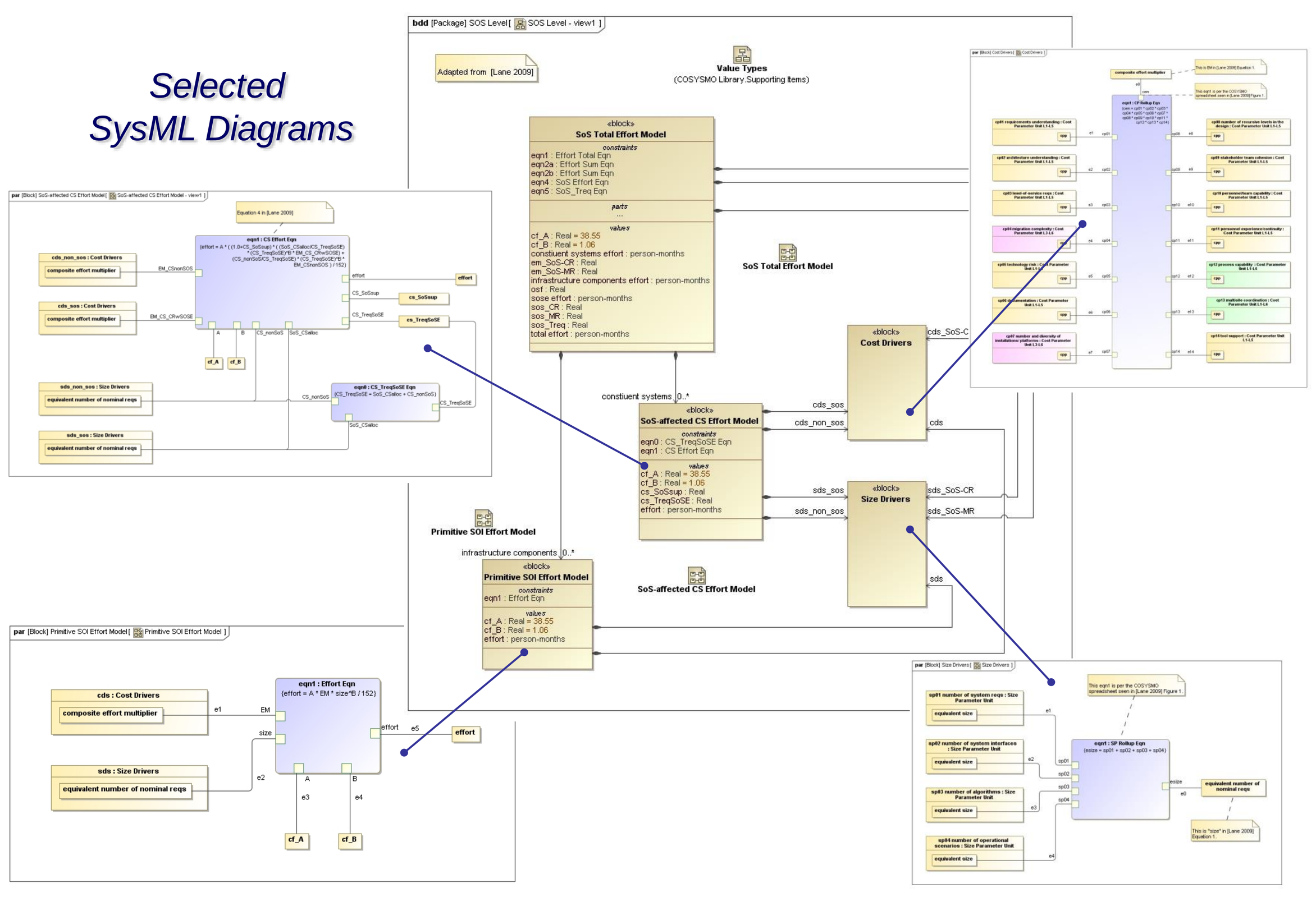


BW4: MBSE/SysML as Implementation Enablers

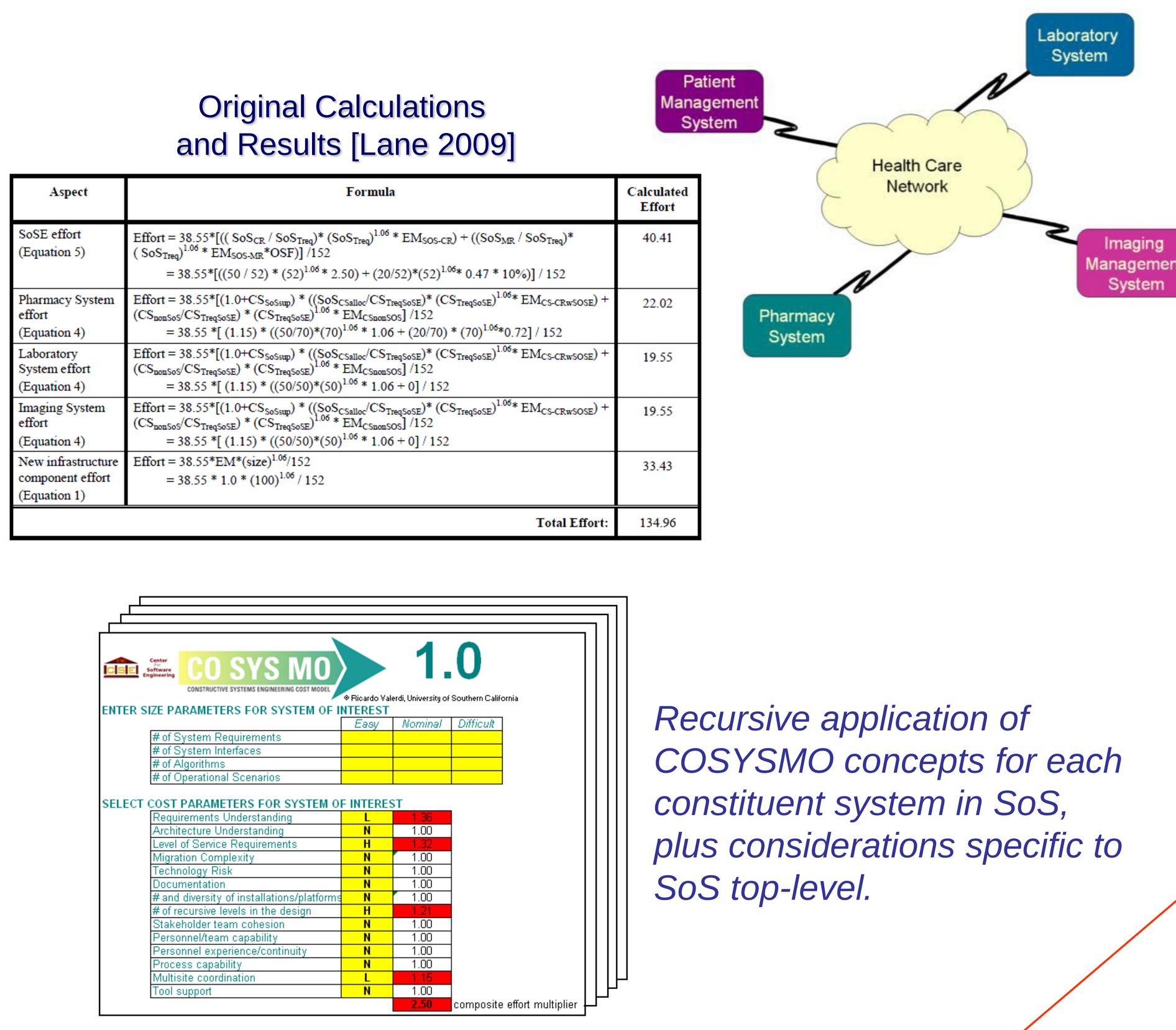
Automotive Anti-Lock Braking System Example – www.omgsysml.org



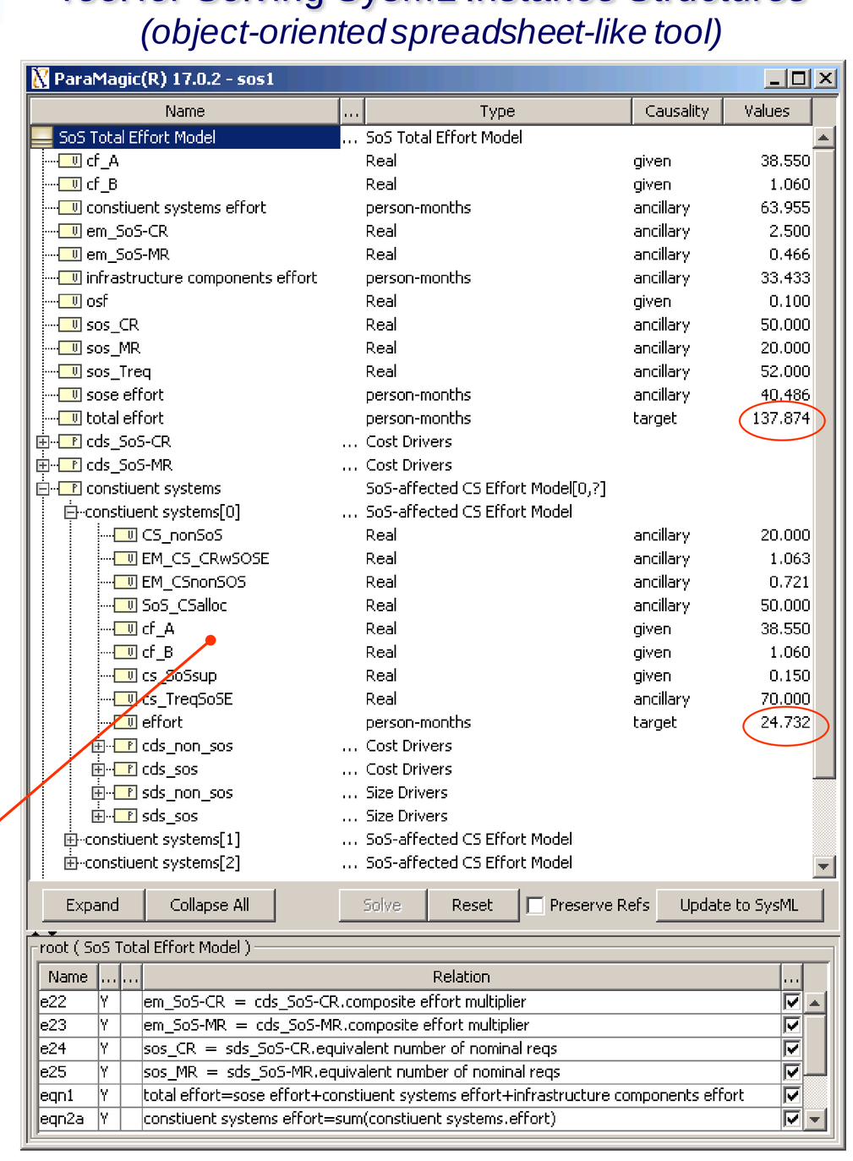
(A) Cost Modeling Concepts Implemented as SysML Building Blocks



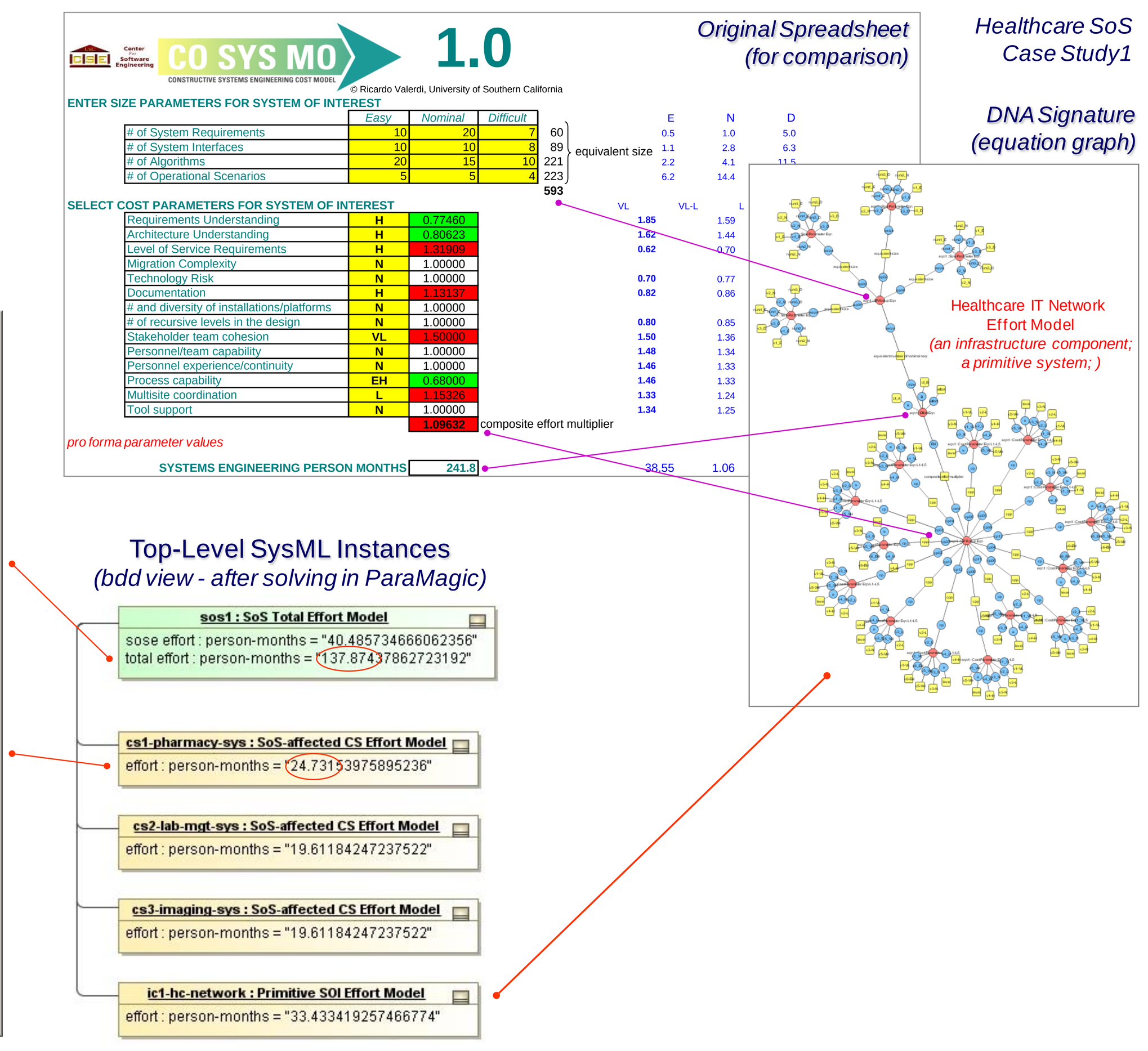
(B1) Healthcare SoS Case Study1 [Lane 2009]



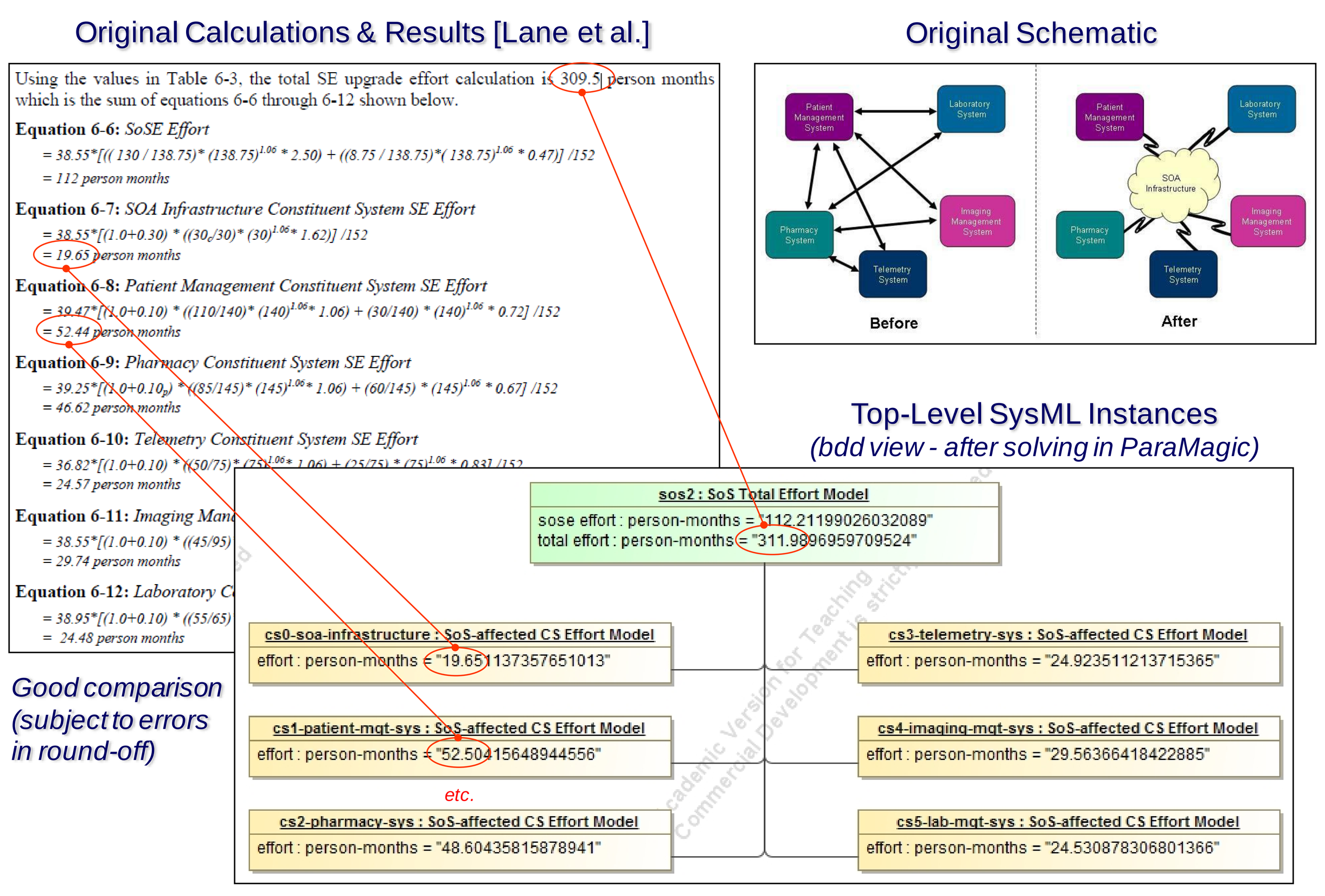
Case Study 1: Model Execution



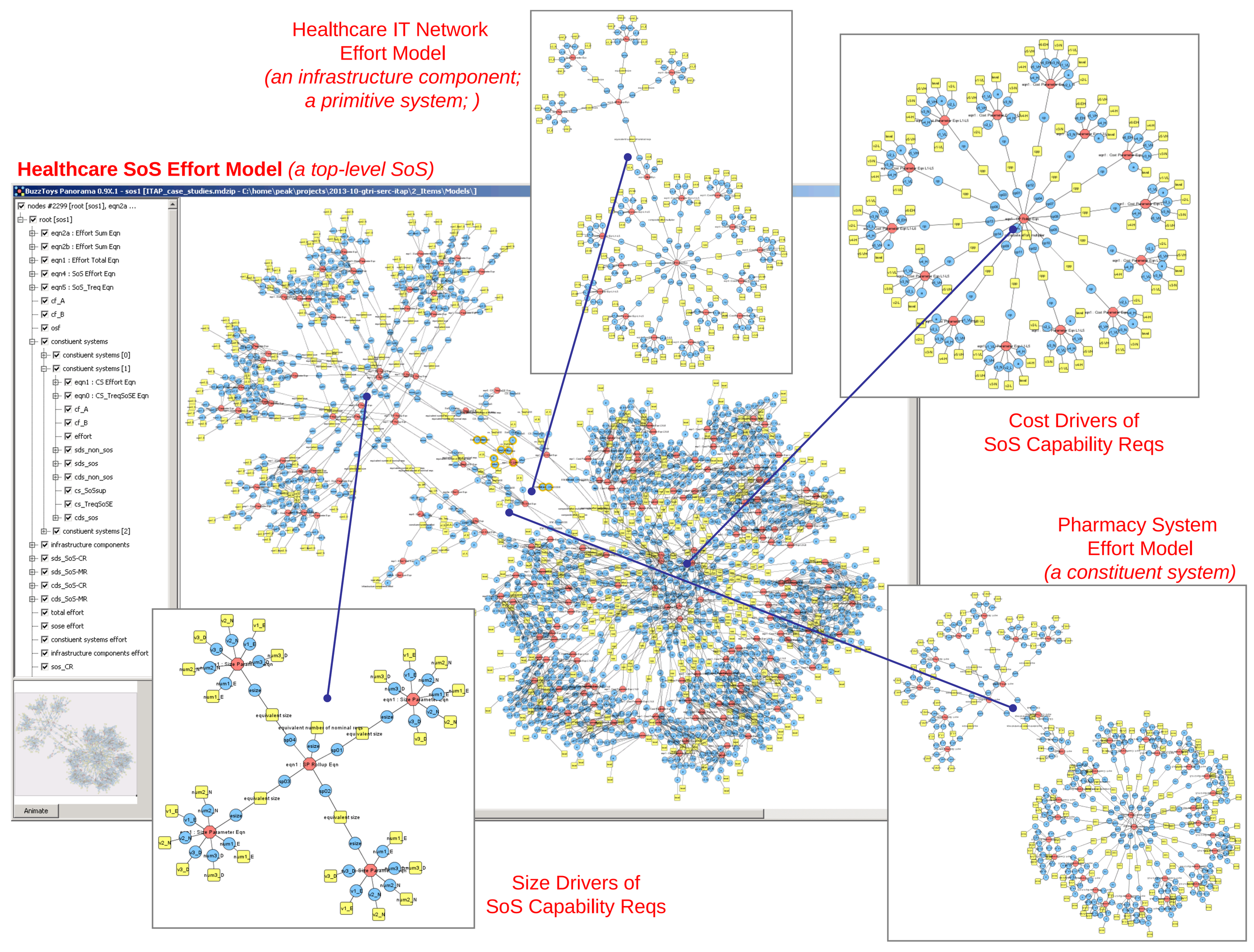
Subset of SysML Model - DNA Signature View



(B2) Healthcare SoS Case Study2: Results Verification



Case Study1: Full SysML Model - DNA Signature View

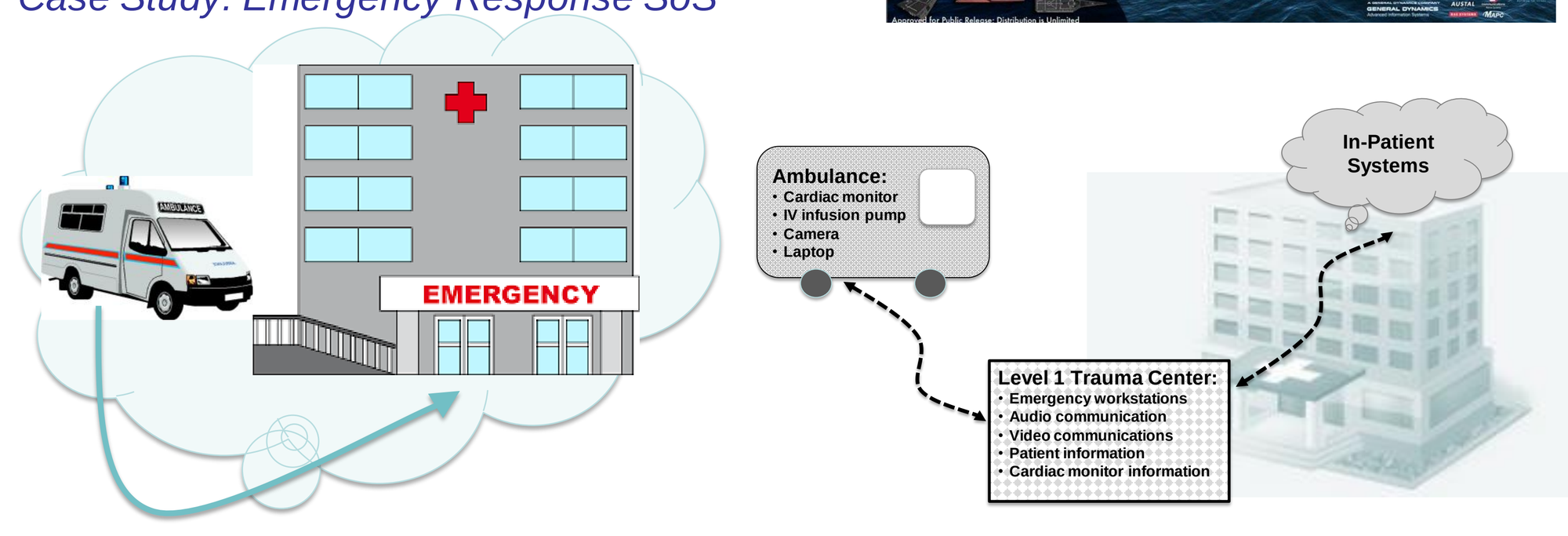


(C) Applications and Candidate Future Case Studies

- Analysis of alternatives (AoA)
  - – Subsystem/component upgrades
  - – Levels of capability option performance within SoS
  - – Interoperability assessments for alternatives
- System/component retirement (or replacement) assessments
- Capabilities vs. costs

Case Study: Military Operations SoS

Case Study: Emergency Response SoS



Approach (Oct 2013 - Dec 2015)

- Implement cost modeling concepts as SysML building blocks
  - — Based on SoS/COSYSMO systems engineering cost (effort) modeling work by Lane, Valerdi, Boehm, et al.
  - — Provides generic, reusable knowledge capture
- Apply SysML building blocks to system-of-systems (SoS) case studies
- Characterize broader applications for affordability trade studies

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Accomplishments & Observations

- Created cost modeling building blocks in SysML
- Successfully validated via two healthcare SoS case studies:
  - — Base complexity (Case 1) and increased complexity (Case 2)
- Characterized integration approach and application usages:
  - — *By other tools:* FACT/ERS/Cortex, ...
  - — *With other capabilities:* risk analysis, schedule analysis, …
  - — *In normal system models:* idealization algorithms for sizing/costing factors
  - — *Via user-friendly interfaces:* OpenMBEE for model-based wikis
- Benefits:
  - — Enables better knowledge capture (e.g., includes units):
    - — More modular, reusable, precise, maintainable, complete, ...
    - — Acausal; better verification & validation vs. spreadsheets; ...
  - — Enables swapping in/out alternative subsystem designs
  - — Provides patterns that are easy-to-apply with many systems/SoS
- *Provides key step for affordability trade studies with diverse "-ilities"*