Criticality of SQ Tradeoffs

- **SQs have systemwide impact**
  - System elements generally just have local impact
- **SQs often exhibit asymptotic behavior**
  - Watch out for the knee of the curve
- **Best architecture is a discontinuous function of SQ level**
  - "Build it quickly, tune or fix it later" highly risky
  - Large system response time example: 1-character change in 2000-page spec:
    - 4 seconds: cost $30 million; 1 second: cost $100 million

Software Ownership Cost vs. Reliability

- **Relative Cost to Develop, Maintain, Own and Operate**
- **COCOMO II RELY Rating**

SysML Building Blocks for Cost Modeling

- Implemented reusable SysML building blocks [Peak]
  - Based on SoS/COSYSMO SE cost (effort) modeling work by Lane, Valerdi, Boehm, et al.
- Successfully applied building blocks to healthcare SoS case study from [Lane 2009]
- Provides key step towards affordability trade studies combining architecture and cost driver tradeoffs

Piloting MMPTs with TARDEC, NAVSEA

- **Extended Set-Based Design**
  - Infrastructure reserves capacity keeps options open & costs down for future upgrades & defers limiting decisions
  - Potential future configurations and capabilities are enabled or excluded by design decisions
  - Focus on the achievable region of capability space given design decisions rather than regions of "configuration space"
- **Adversarial Risk Analysis**
  - Adversaries adapt by choosing battlefields, tactics and equipment that avoid our systems' strengths and exploit their limitations
  - Adversaries can be more nimble than the MDAP process
  - Adversaries learn from each other, potential adversaries learn from past adversaries
  - Technology Maturation Risks and Opportunities
    - Robust solutions can exploit opportunities, but are effective without them
    - Near-optimal over a range of maturity, cost & capability scenarios

MIT SQs Ontology: 14-D Semantic Basis

At ESD Level...
- **Major Combat Operations**
- **and System Level**
  - **Perform BDA**

Supporting Better Buying Power Objectives

- **Affordability**: Strengthen and expand "should cost"
  - Developing next-generation life-cycle cost models
- **Use of incentive-type contracts**: "formulic incentives"
  - Strengthening formulas; linking them to SysML models
- **Increase the use of performance-based logistics (PBL)**
  - Extending RT-18 Total Ownership Cost models
  - Strengthening software performance-based logistics
- **Use Modular Open Systems Architecture for Innovation**
  - Working with TARDEC and NAVSEA on set-based design
- **Provide clear "best value of performance" definitions for industry**
  - Working with industry on cost-performance trades via INCOSE, NDIA
- **Improve our leaders’ ability to understand and mitigate risk**
  - Fully integrated via RT-107 Quantitative Risk PI Gary Witus

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