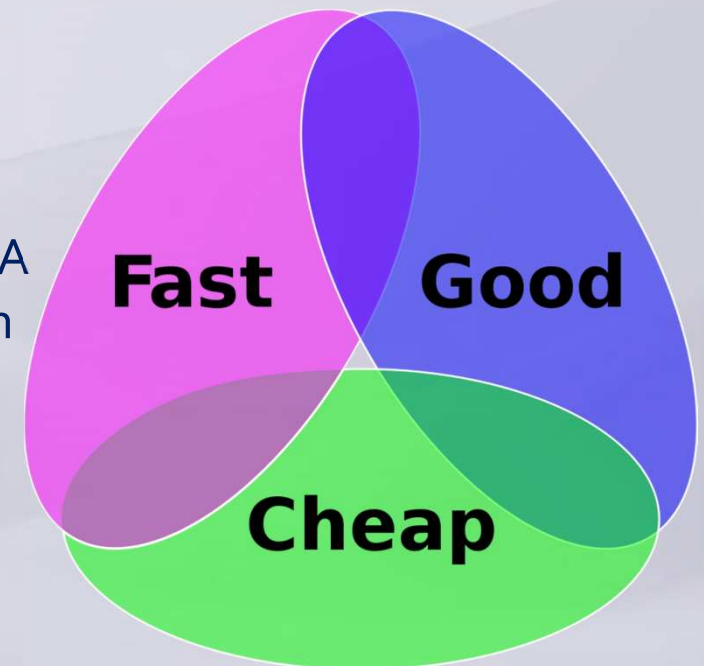


Faster, Better, Cheaper – The Fallacy of MBSE?

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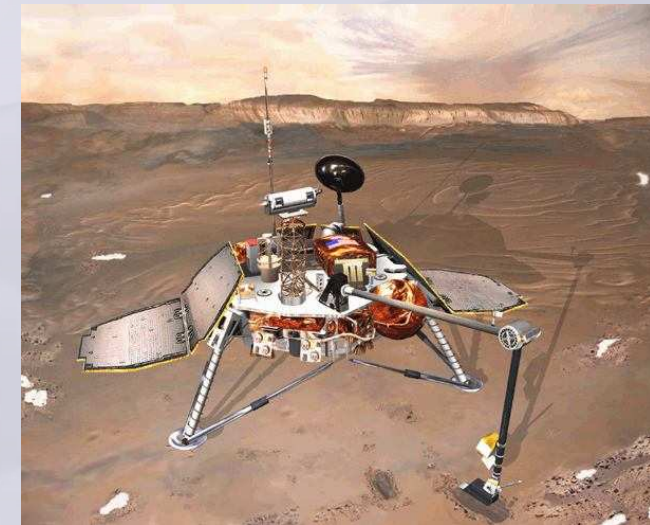
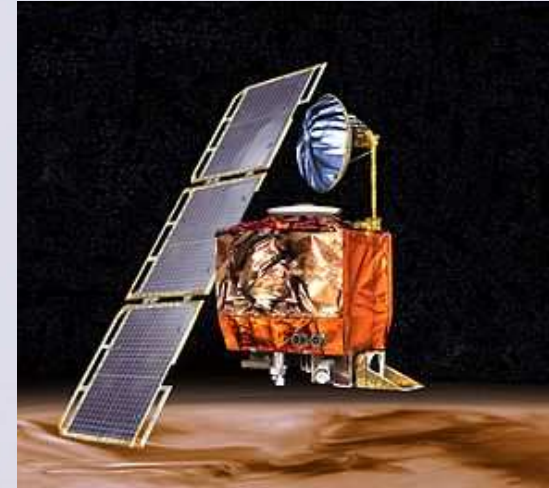
The Rise of Faster, Better, and Cheaper (FBC)

- Launched in 1992 by NASA Administrator Dan Goldin
- Sought to improve cost, schedule, and performance simultaneously in developing high tech systems
- Launched 16 missions during an 8 year period
 - 5 missions to mars
 - 1 mission to the moon
 - 3 space telescopes
 - 2 comet and asteroid rendezvous
 - 4 Earth-orbiting satellites
 - 1 ion propulsion test vehicle
- 9 of the first 10 missions succeeded



The Fall of FBC – The Twin Mars Mission Disasters of 1999

- Mars Climate Observer
 - Lost communication during orbital insertion
 - Cause of failure: units error (imperial vs metrics) resulted in incorrect atmospheric insertion and disintegration
- Mars Polar Lander
 - Failed to reestablish communication after descent
 - Likely cause of failure: premature engine cut off causing the lander to impact at a high velocity



The Fall of FBC, cont.

“FBC (resulted in) reduced workforce capability; increased safety risks; and minor oversights that resulted in lost spacecraft.”

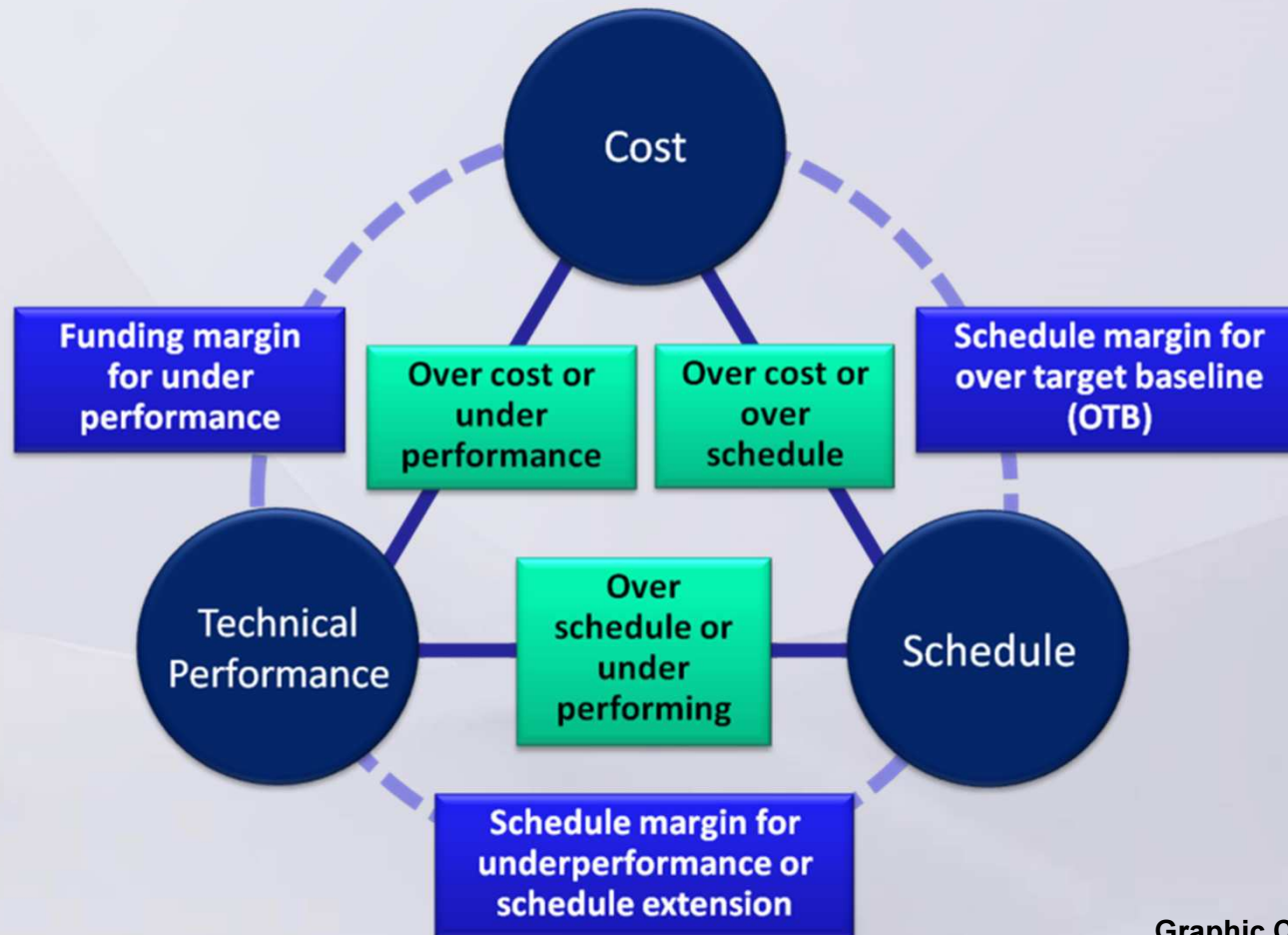
International Federation of Professional and Technical Engineers, 2003

“FBC should be thrown in the waste basket.”

US Senator Kay Bailey Hutchinson, 2003



The “Iron Triangle” of Project Management



Graphic Credit – Glen Alleman

Today's management mantra – “pick any two”



SO WHAT ABOUT MODEL-BASED SYSTEMS ENGINEERING?



Model-Based Systems Engineering

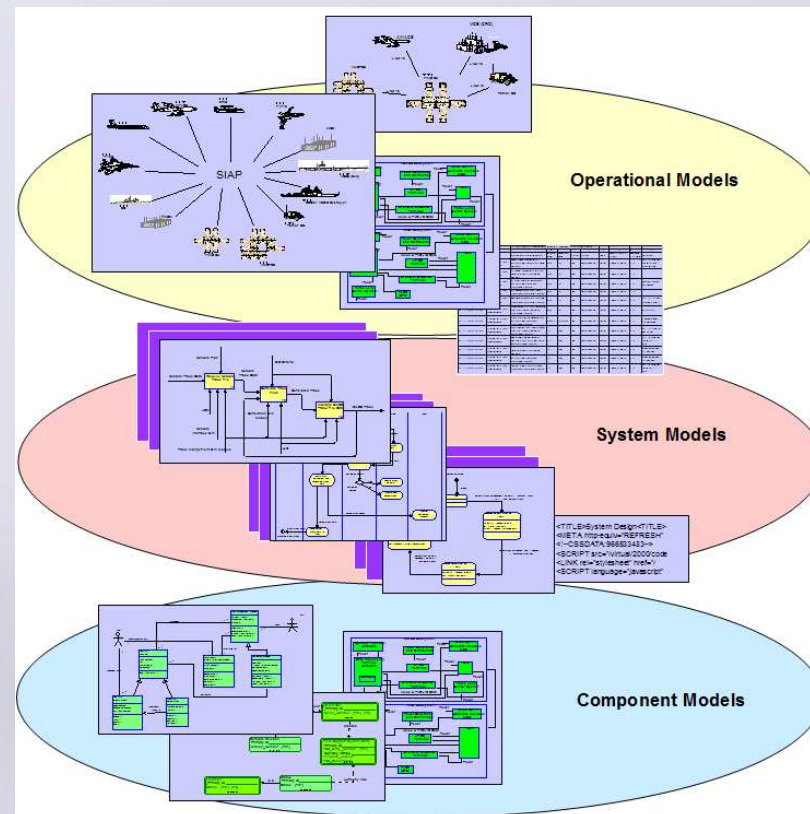
- Formalizes SE practice through the use of models
- Broad in scope
 - Integrates with multiple modeling domains across life cycle from SoS to component

- Results in quality/productivity improvements & lower risk
 - Rigor and precision
 - Communications among system/project stakeholders
 - Management of complexity

Life Cycle Support

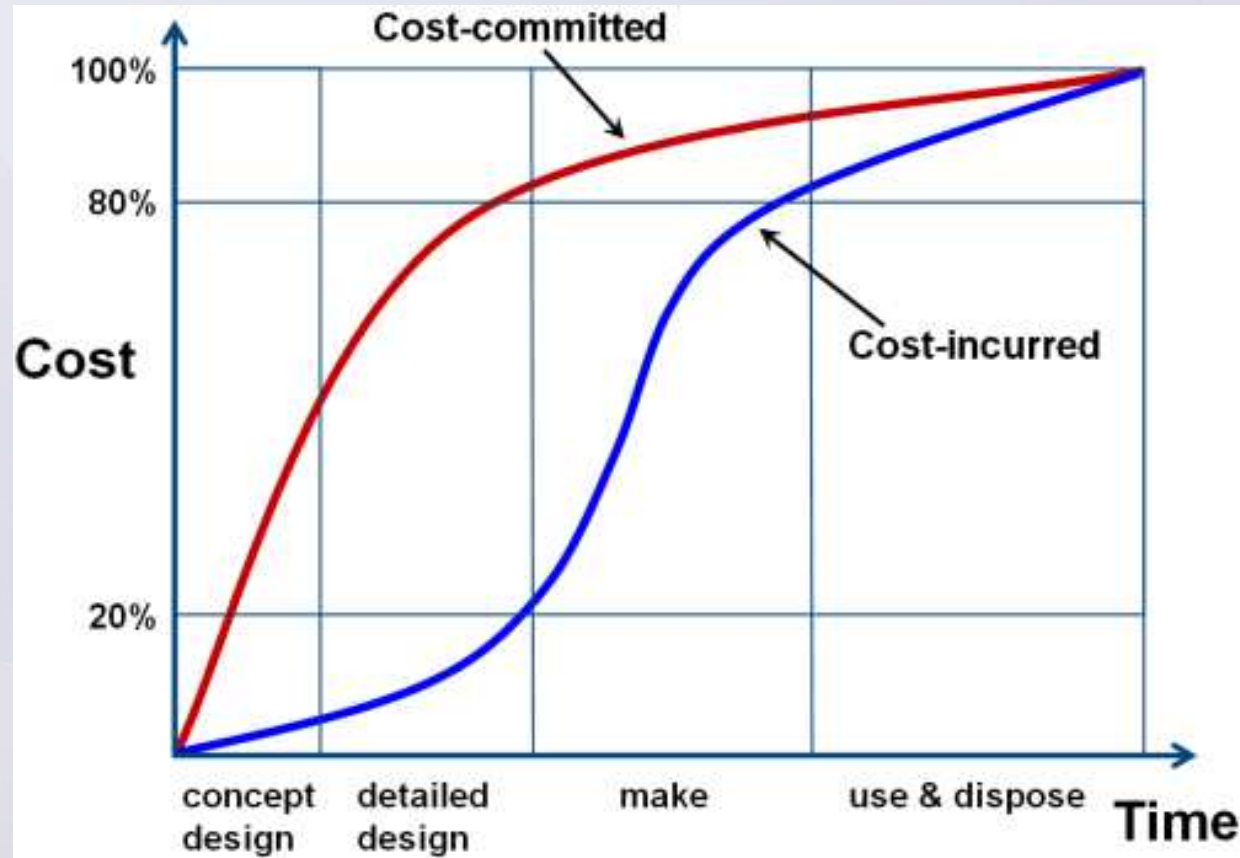
Concept- Design- Production- Utilization- Support- Retirement

Vertical Integration



Can MBSE Deliver More?

A Tale of Two Scopes (Control vs Influence)



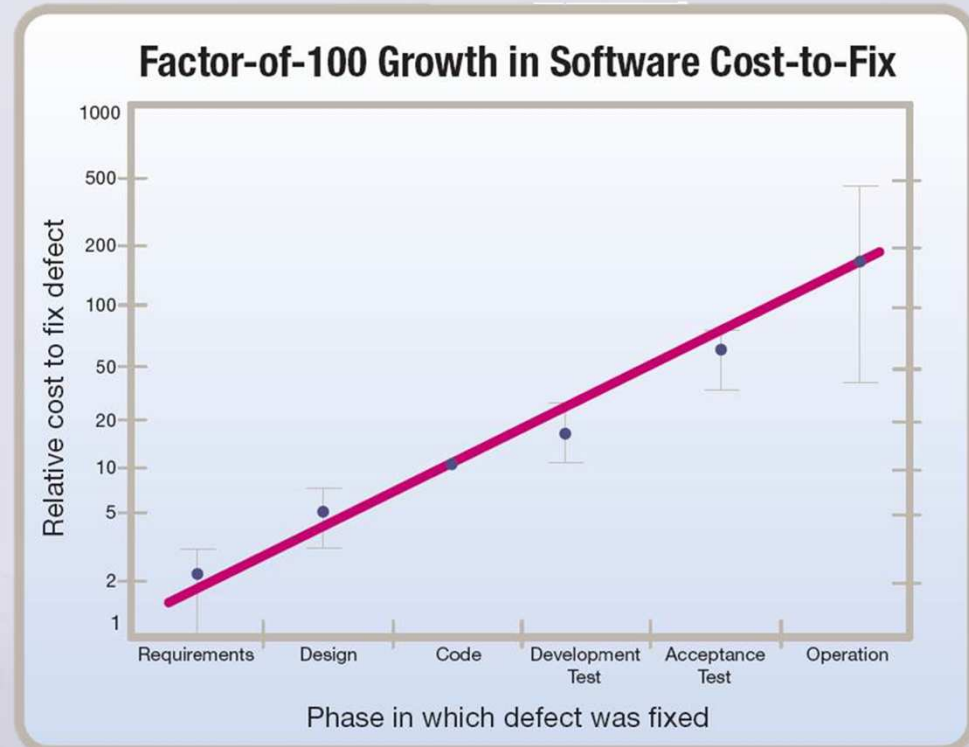
Faster, better, cheaper is possible...
if we focus on the full product lifecycle



Faster, Better, Cheaper with MBSE: The Law of Conservation of SE

“The amount of systems engineering required for a given project is fixed. You don’t get to choose how much SE you do. You simply get to choose when you do it (up front or during I&T), how much positive impact it has, and how much it costs.”

- Jim Long



CeBase Software Defect Reduction Top-10 List, Basili and Boehm, January 2001



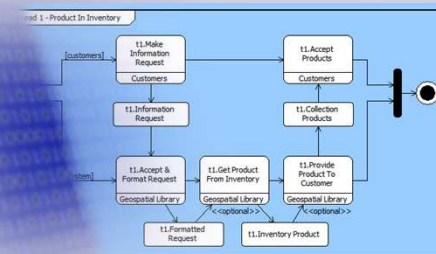
MBSE for Increased Lifecycle Quality



- Early identification of requirements issues
 - Missing requirements, conflicting requirements, and general defects
- Enhanced stakeholder communication to enable better validation
 - “We fail more often because we solve the wrong problem than because we get the wrong solution to the right problem.” (Ackoff)
- Disciplined (and defensible) basis for decision making
 - Moving beyond “a miracle occurs here” analysis
- Enhanced visibility into information gaps and system design integrity
 - Model-driven consistency vs document-driven hope
- Improved specification of allocated requirements to HW/SW
- Reduction in errors reaching integration and test
- Rigorous traceability from need through solution

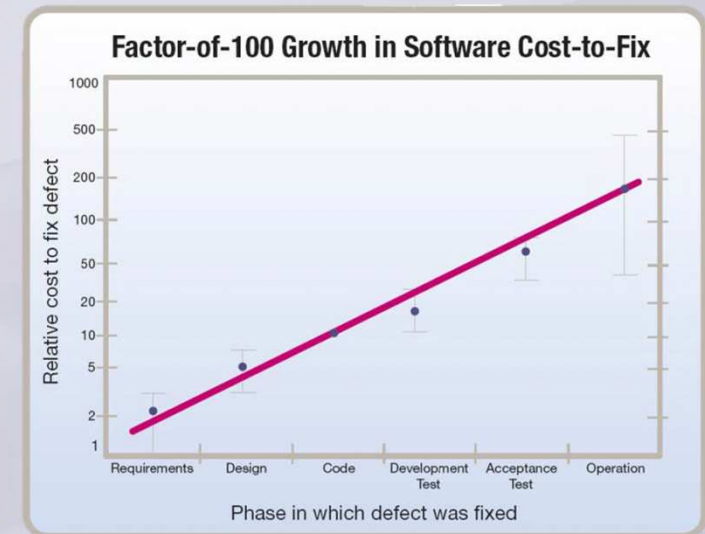


VS



MBSE for Reduced Lifecycle Cost

- Earlier error detection and reduced rework
- Early/on-going requirements validation and design verification
- Reuse across divergent products
- Identification and adoption of system patterns and heuristics
- Improved cost estimates
 - Insight is often as important as reduction
- Reduced cost overruns through higher lifecycle quality



MBSE for Accelerated Capability Delivery



- Enhanced individual command of the problem and solution
 - Opportunity to work at “thinkspeed” rather than document index speed
- Improved alignment of collective team understanding
 - One high-visibility version of truth
- Reduction of rework
- Reuse of models to support design/technology evolution
- Streamlined integration & test through fewer errors
- Simplified problem resolution (and expanded options) through early detection
- Improved impact analysis of requirements changes
- Knowing when you are done!
- Reduced schedule overruns through higher lifecycle quality

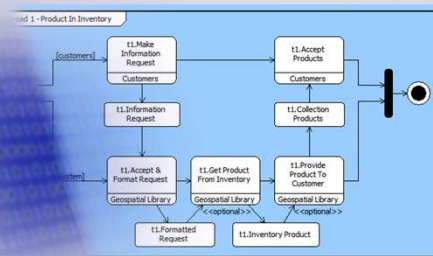


MBSE for Happier Customers

- Enhanced agility, adaptability, and responsiveness to change
- Improved communication & insight
- Increased confidence through argumentation and command of the problem and solution



VS

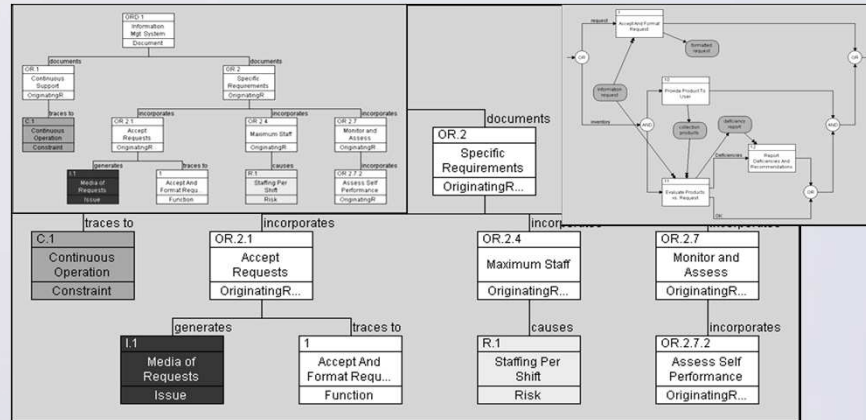


**BUT WHAT IF I MUST DO MBSE
FASTER, BETTER, OR CHEAPER**

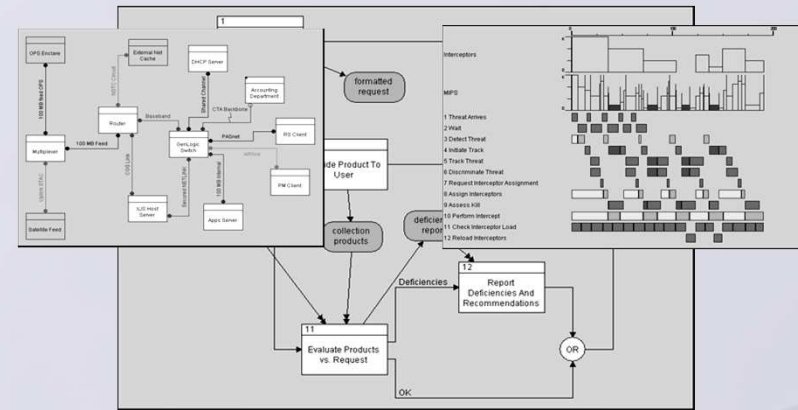


Moving Beyond Our Entrenched Waterfall Mindset

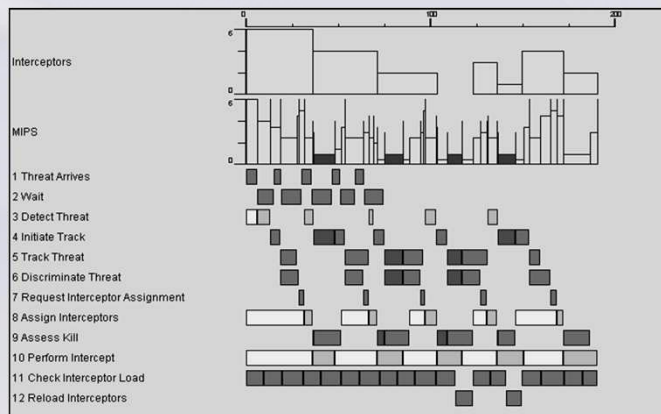
Source Requirements Domain



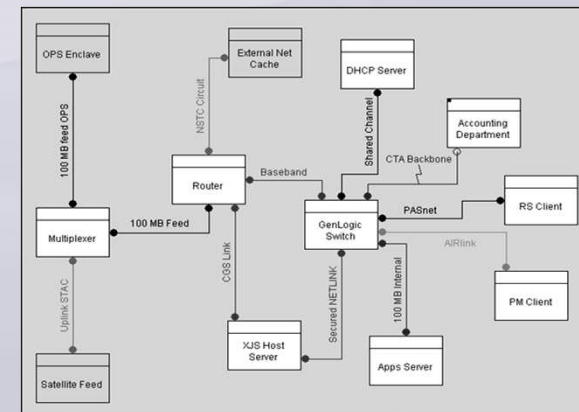
Behavior Domain



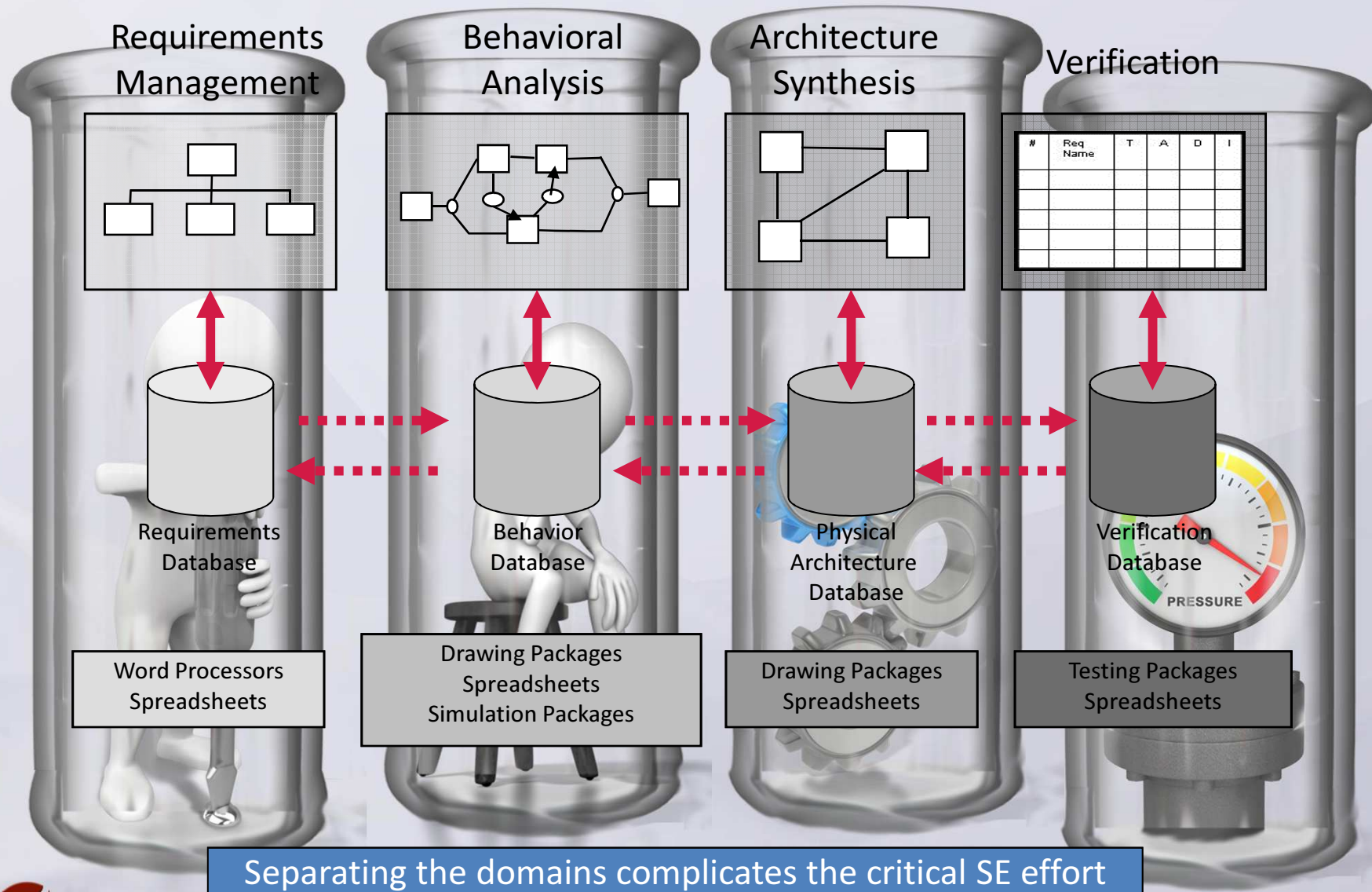
Test & Evaluation Domain

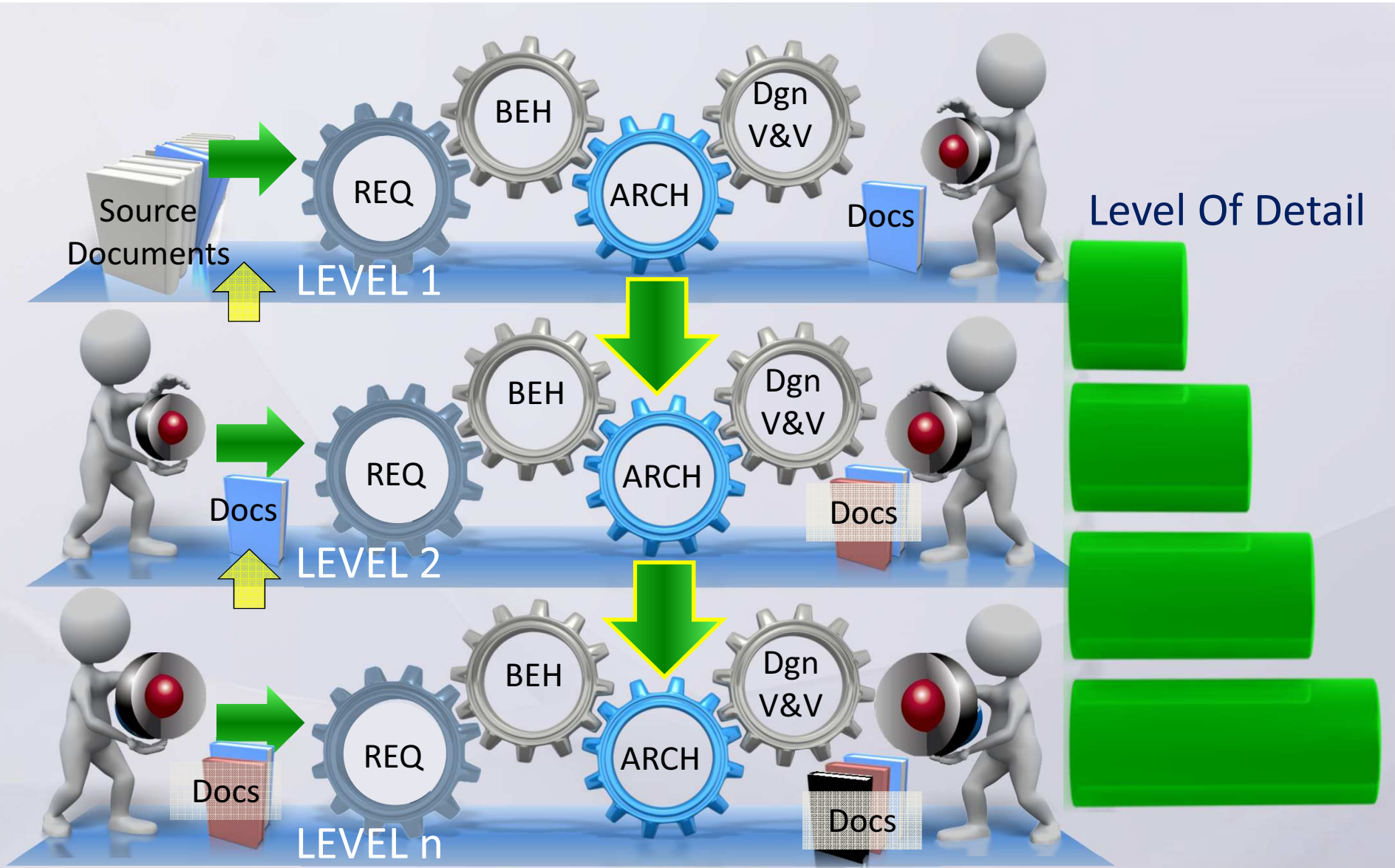


Architecture Domain



The Problem of Entrenched Stovepipes



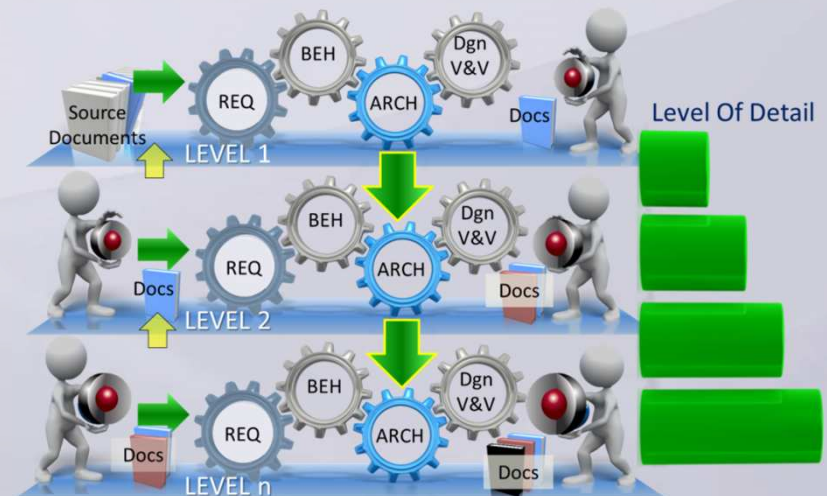


Integrated Systems Engineering Process



Optimizing MBSE for Quality

- Defend the existing SE schedule and budget
- Enjoy all of the SE and lifecycle benefits listed previously
- Maximize project degrees of freedom as you apply the MBSE approach
 - MBSE technology adoption
 - Exploration of alternatives
 - Analysis through executable models
 - Reduction of risk
 - ...

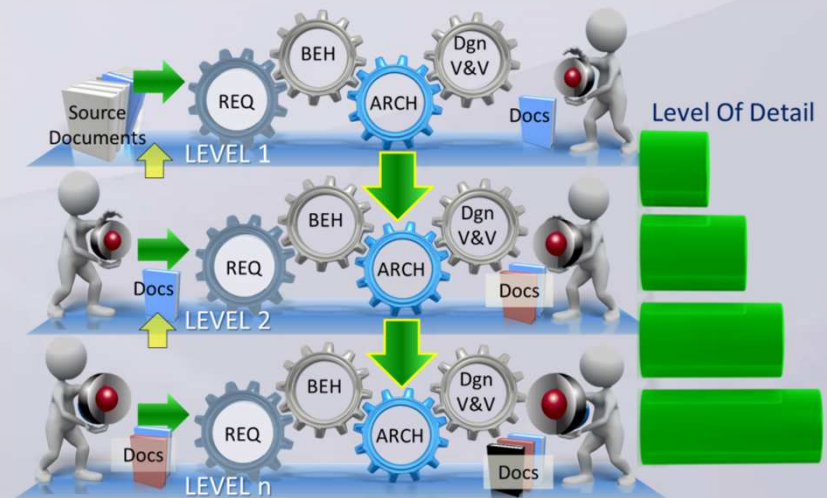


The scenario we hope for!



Optimizing MBSE for Schedule and/or Budget

- Realize inherent savings from MBSE transformation
 - Reduced (eliminated) specification production costs
 - Reduced cost of change request / impact analysis
 - Enhanced team productivity
 - Enhanced team comprehension by eliminating the “plague of vague”
 - Enhanced process efficiency and effectiveness
- Reduce team size
- Ask “who” questions rather than “what” / “how” questions
 - Who has done this before such that I can reuse models or patterns?
- Sacrifice level of detail, not quality, consistency, or completeness

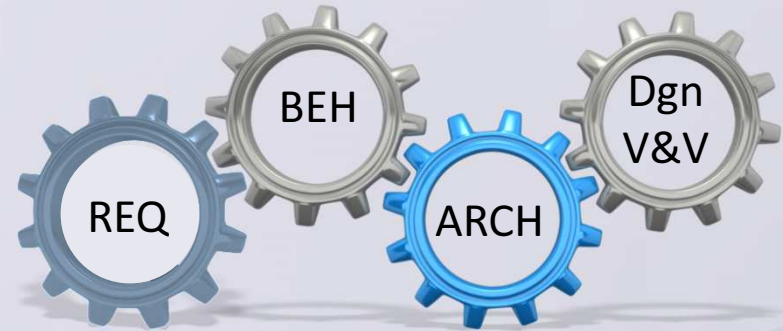


The scenario we will eventually face



Faster, Better, Cheaper is Possible: An Integrated, MBSE Approach

- Provides discipline and structure
- Enhances communication
- Increases quality
- Reduces risk
- Ensures convergence through layered approach
- Speeds delivery and enhances agility, especially in the face of change
- Accelerates (radically) the exploration of revisions, alternatives, and variants



Selling the Benefits of Model-Based Systems Engineering

- Realize that faster, better, cheaper is possible
 - But understand the “silver bullet syndrome”
- Focus first on lifecycle value
- Argue by analogy
 - Who would perform CAD or integrated circuit design by hand?
- Move the conversation from price and cost to value and ROI
- Sell technologies only to technologists
- Avoid telling all that you know
 - The curse of the engineer
- Don't underestimate the costs of transformation (tools, training, and experience)

Under-promise and over-deliver to maximize the likelihood of success for you, your project, and our practice



For Additional Information



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