2018 Annual INCOSE
Great Lakes Regional Conference
SYSTEMS AT THE CROSSROADS
17 - 20 October 2018 | Indianapolis, Indiana

Lean and Agile Systems Engineering of a Next Generation Energy Market System

www.incose.org/glrc2018

Scott Turner (sturner@misoenergy.org)
John Fitch (jfitch@misoenergy.org)

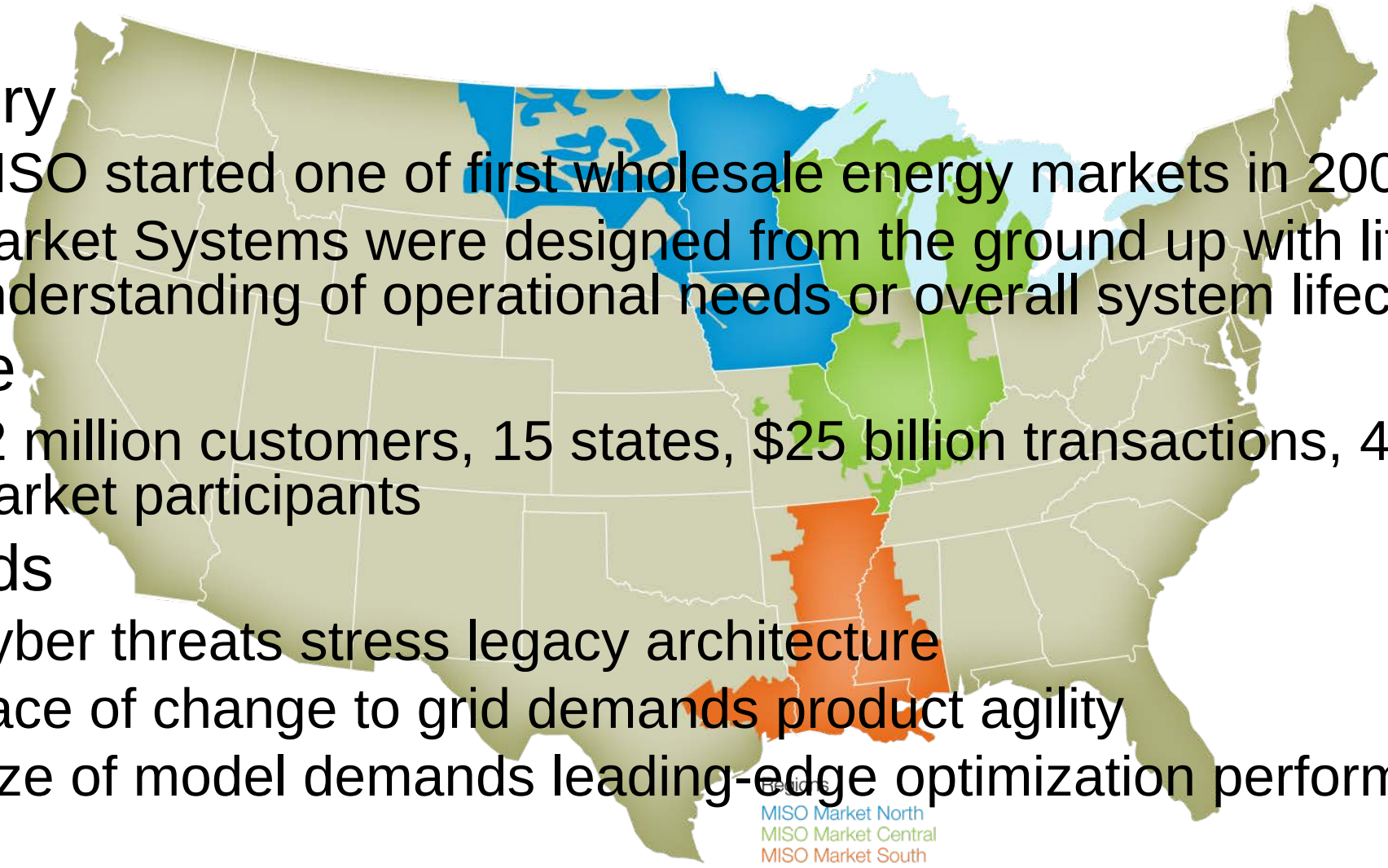
Midcontinent
Independent System Operator

Our challenge

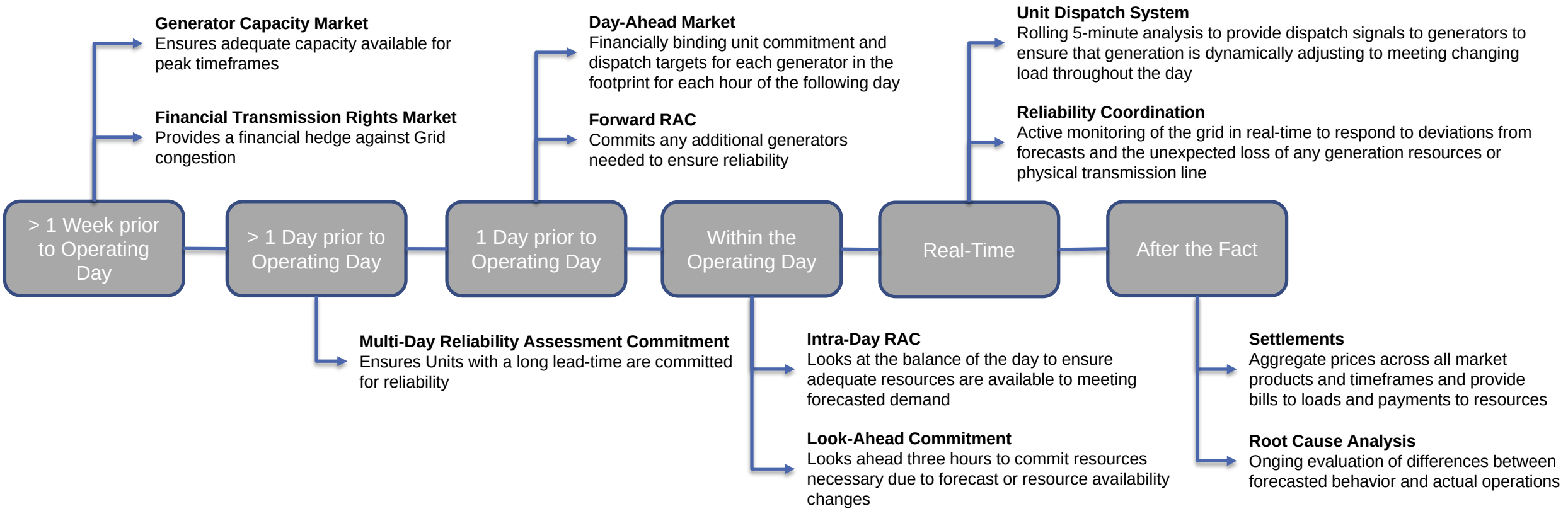
Energy Market Overview

The MISO Energy Market

- History
  - MISO started one of first wholesale energy markets in 2005
  - Market Systems were designed from the ground up with little understanding of operational needs or overall system lifecycle
- Scale
  - 42 million customers, 15 states, $25 billion transactions, 400+ market participants
- Trends
  - Cyber threats stress legacy architecture
  - Pace of change to grid demands product agility
  - Size of model demands leading-edge optimization performance



Current Market Structure



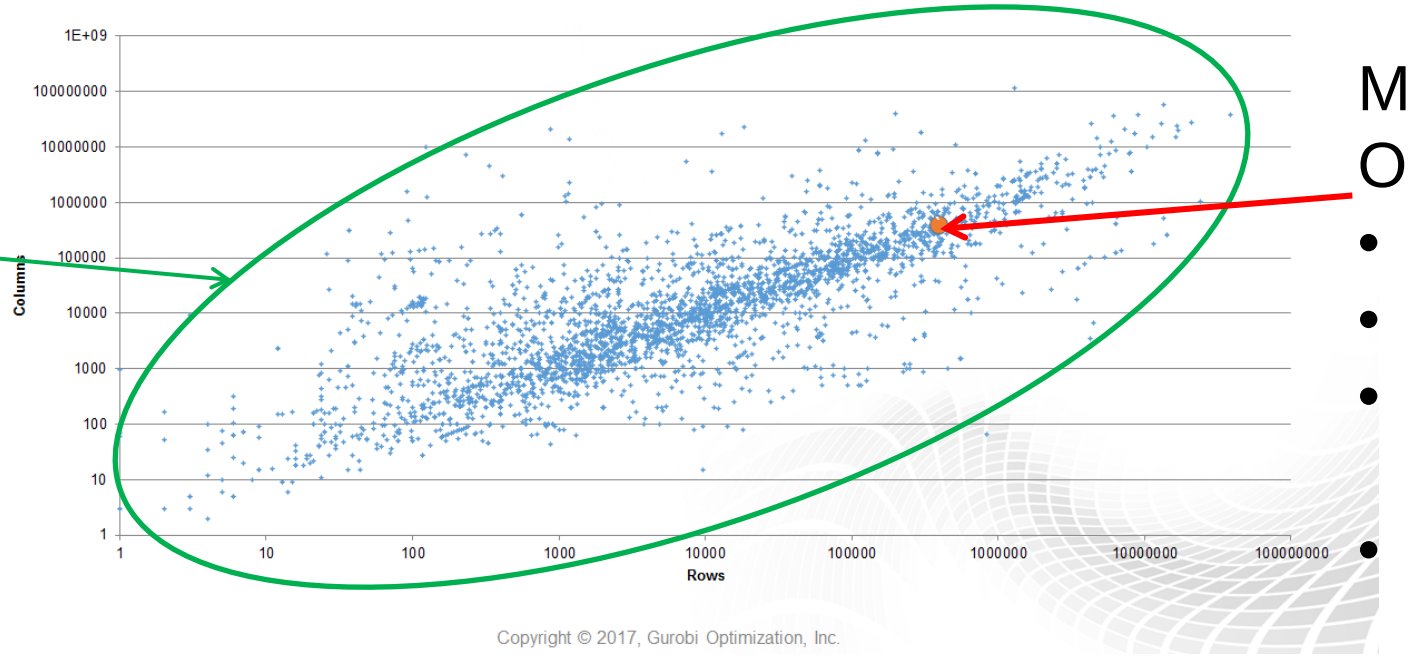
MISO is expected to run the energy market as efficiently as possible, while also ensuring that no load is interrupted even if we unexpectedly lose a 1200MW Generator or a 345kV Transmission line

Grid Optimization is a Very Complex Problem

Is SCUC MIP Model Particularly Large?

GUROBI OPTIMIZATION

Optimization Problem sizes from all industries using same Engine



MISO Day –Ahead Optimization problem:

- Large size
- Very limited time
- High requirement on solution accuracy
- Repeated daily

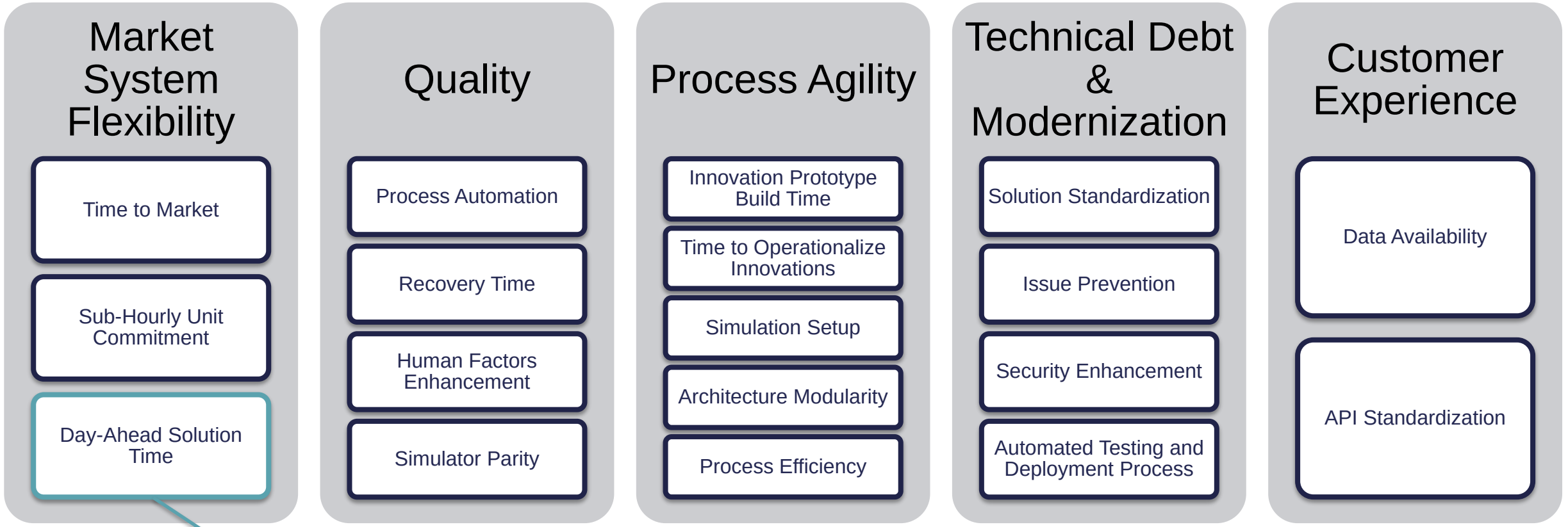
MISO's Security Constrained Unit Commitment (SCUC) needs to optimize thousands of resources delivering energy across tens of thousands of network elements, all of which are bound by a variety of physical constraints

Market System Enhancement (MSE) Program

- The Market Systems were designed in the early 2000's
  - No idea of pace and scale of renewable growth
  - Upgradeability, Configurability, and Observability were not a priority
  - Current Architecture no longer able to meet expected needs even using fastest hardware
- 7 Year program with a 9 figure budget
- Deliverables
  - Final selection of Strategic Partner/Supplier
  - Rationalization/consolidation of 200+ "gap tools"
  - New Market Management System (MMS) with modern, scalable architecture
  - Transformed business processes
  - New IT infrastructure capable of hosting the MMS
  - Flexibility to accelerate market innovation

Few "givens", many open decisions!

MSE Primary Business Requirements



Name	Description	Baseline	Target	Stretch Goal
DA Solution Time	Reduce Day-Ahead Market case solution time for MSE baseline "most likely future" use case	96 Mins	60 Mins	40 Mins

Guiding Principles & Constraints

- Use MSE to grow a right-sized Systems Engineering Capability
  - Operationally-focused culture
  - No requirements repository for current state
  - No documented SE processes or trained Systems Engineers
  - Greenfield opportunity
    - Yeah! – skip the document-centric heavyweight SE phase; no bloated process to kill off
    - Yikes! – grow the SE capability Just-in-Time on the flagship project that's getting lots of scrutiny
- Align with other active initiatives
  - Software/Enterprise Architecture
  - Agile software development
  - DevOps/Continuous Integration/Continuous Delivery (CI/CD) lifecycle
  - Business Capability Modeling
- Inform critical business process and program decisions
- Work with consortium to reduce MMS cost

Right-sizing the process

Lean and Agile Systems Engineering

Lean and Agile System Engineering

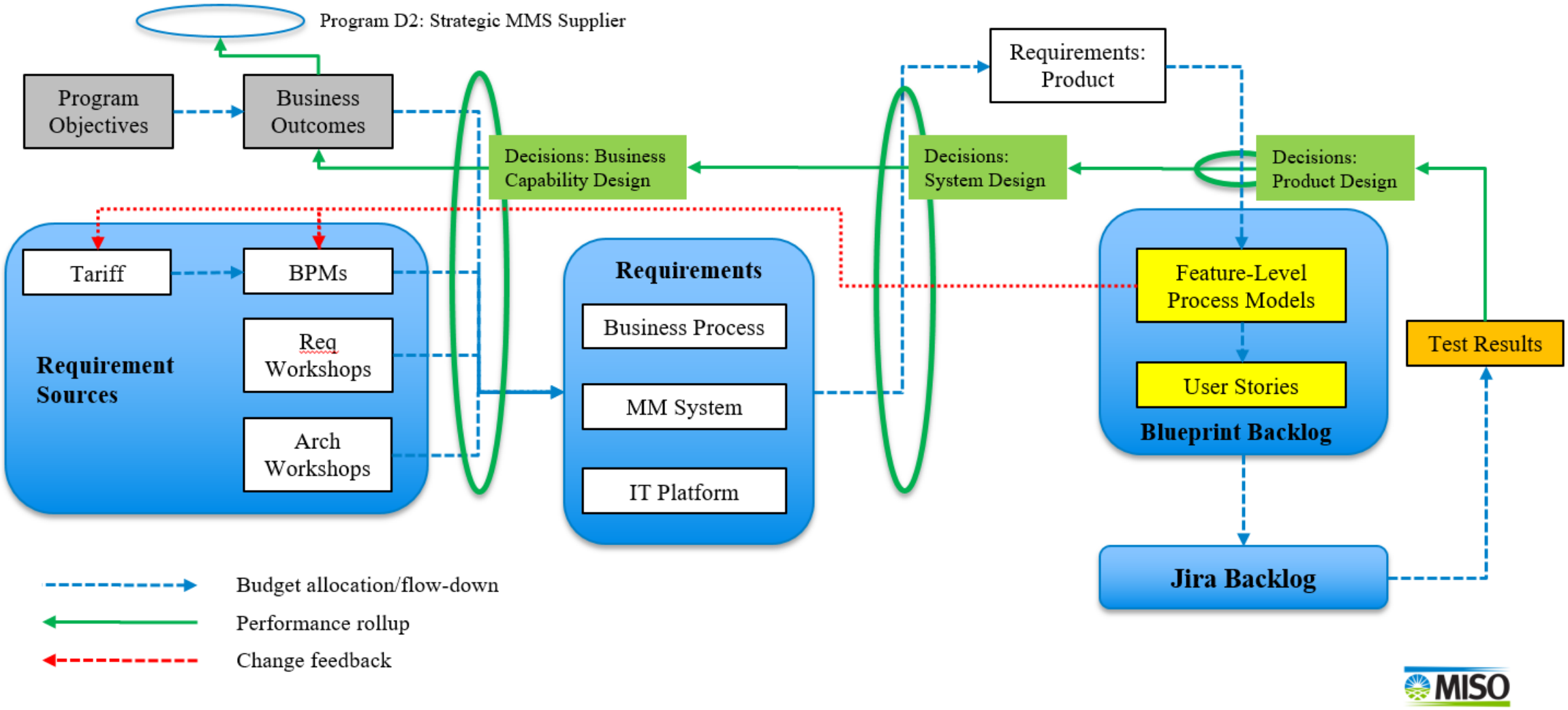
- Proactive Decision Management
  - Decisions are the value-creating engine & integrative mechanism for design
  - Leverage decision pattern “blitz” to frame the problem space
  - Manage large decision backlog using Agile principles

- Scalable Rigor
  - Pareto everything

- Continuous Object-Level Traceability
  - Lean decision-centric information architecture
  - 3-V traceability model (Decision->Req, Req->Test, Decision->Test)
  - Link as you think

- Rapid, efficient pivots when assumptions don’t pan out
  - Multi-decision tradeoffs, requirement what-ifs

Information Architecture



Design Teams

- MISO is leveraging a Design Team construct as our primary organization method
- Capability-focused, but operate at System and Product level
- Cross-functional:
  - Business Capability Owner (BCO)
  - Technical Capability Owner (TCO)
  - Systems Engineer / Business Analyst
  - Part-time Advocates / SMEs (e.g. Cybersecurity, Compliance)
- Own both decisions and requirements/features/user stories for their capability areas
- Intended to outlive the program to support CI/CD vision

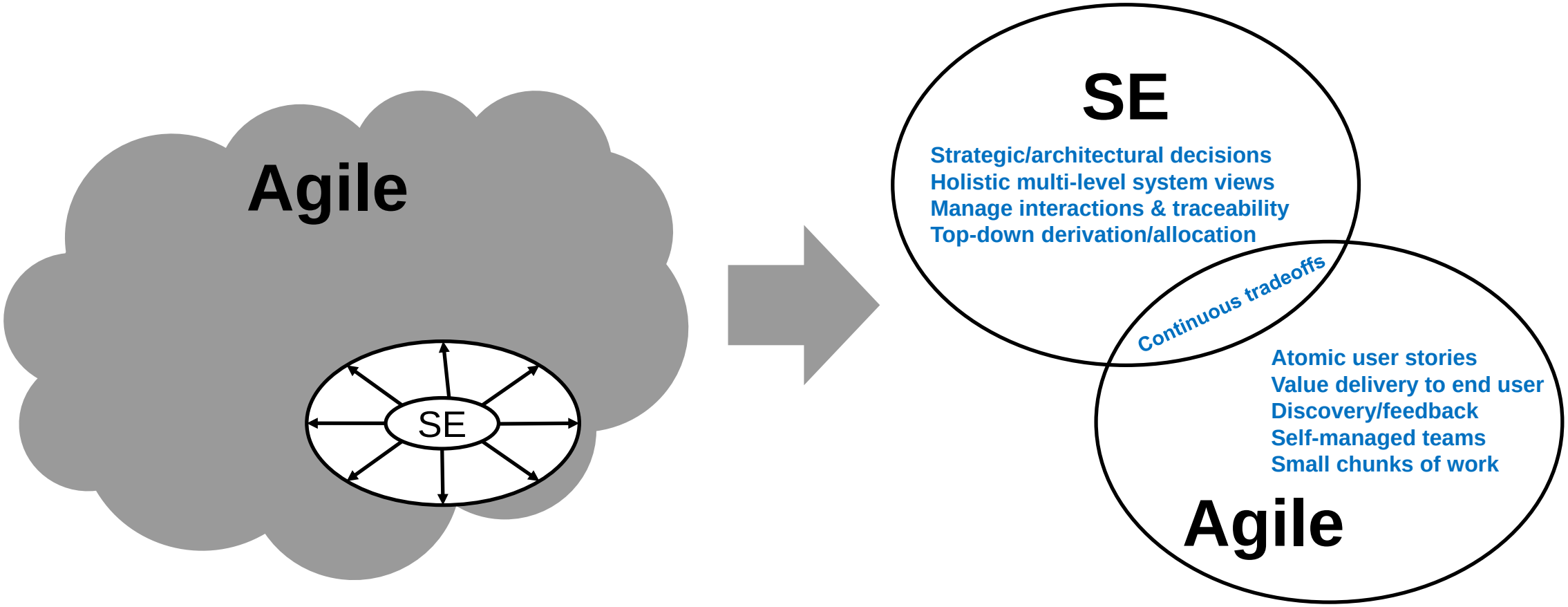
On the Softer Side

- SE attempts to bridge the world views of project managers, business owners (R&D -> ops), software architects, Agile IT teams, vendors and consortium members

- Even among the well-intentioned, differences matter:
  - Perceived conflicts in methods, terminology, cherished tools, work products and working styles
  - Overlapping definitions of the System of Interest

Perceived conflict in world views/methods

"When they first introduced the system engineer role, I kept asking how that would **fit in agile** because terms and processes are almost contradictory to agile."

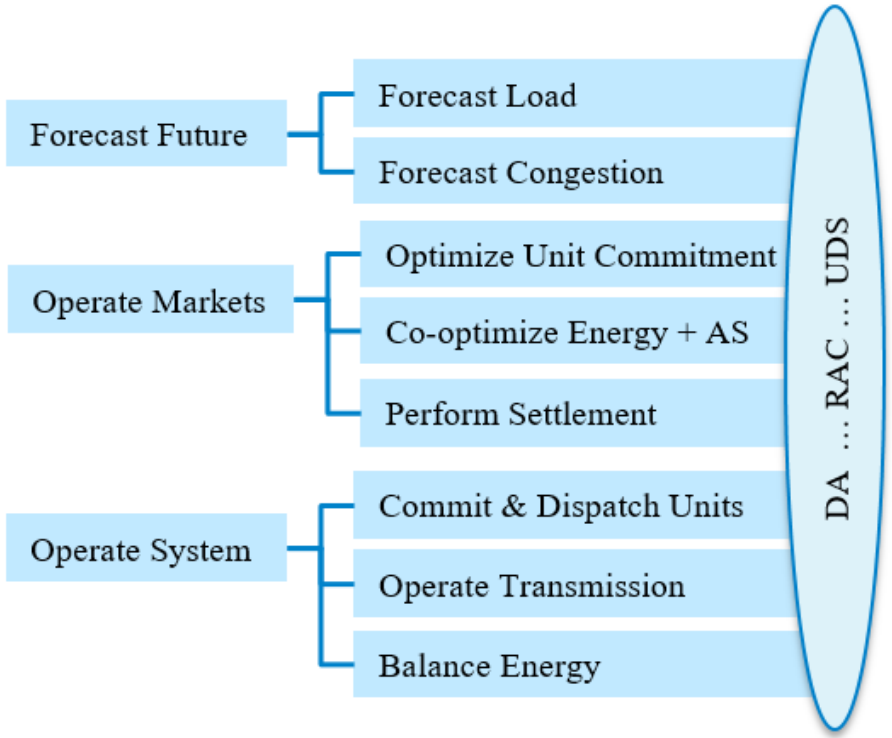


Incremental improvement or business transformation?

Agile's focus on incremental end-user value delivery leads to impatience with big picture thinking, but who frames and how you frame a problem affects the level of innovation possible

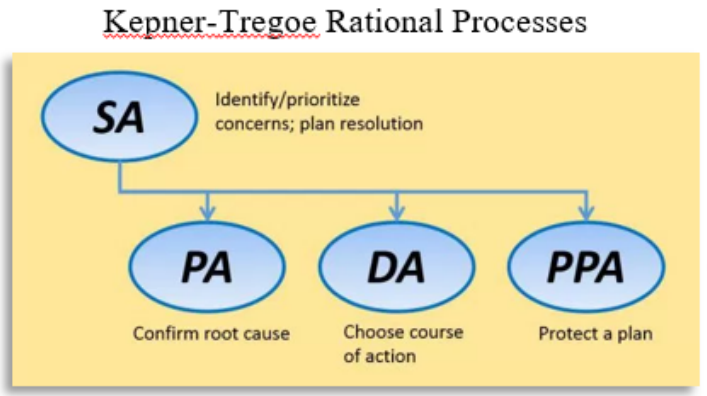
Organize by Traditional Business Capabilities

MMS is a common platform for operating many complex and diverse energy/AS markets with different time horizons

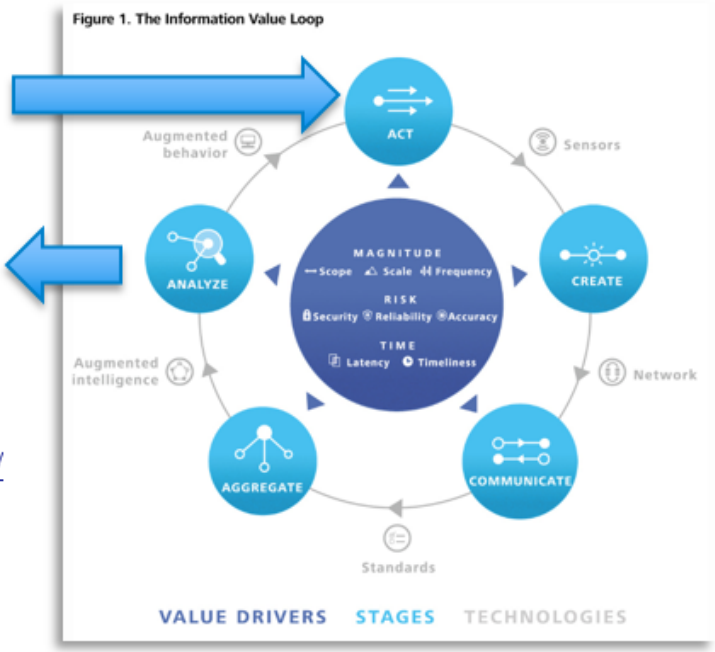


Organize by Thinking/Action Patterns Supported by Information Value Loops

MMS is an adaptive knowledge management/learning system to continuously inform pattern-based operational/strategic analyses/actions that manage/operate/improve the energy market/grid



https://decisiondriven.wordpress.com/2016/10/14/a-foundation-for-great-thinking/



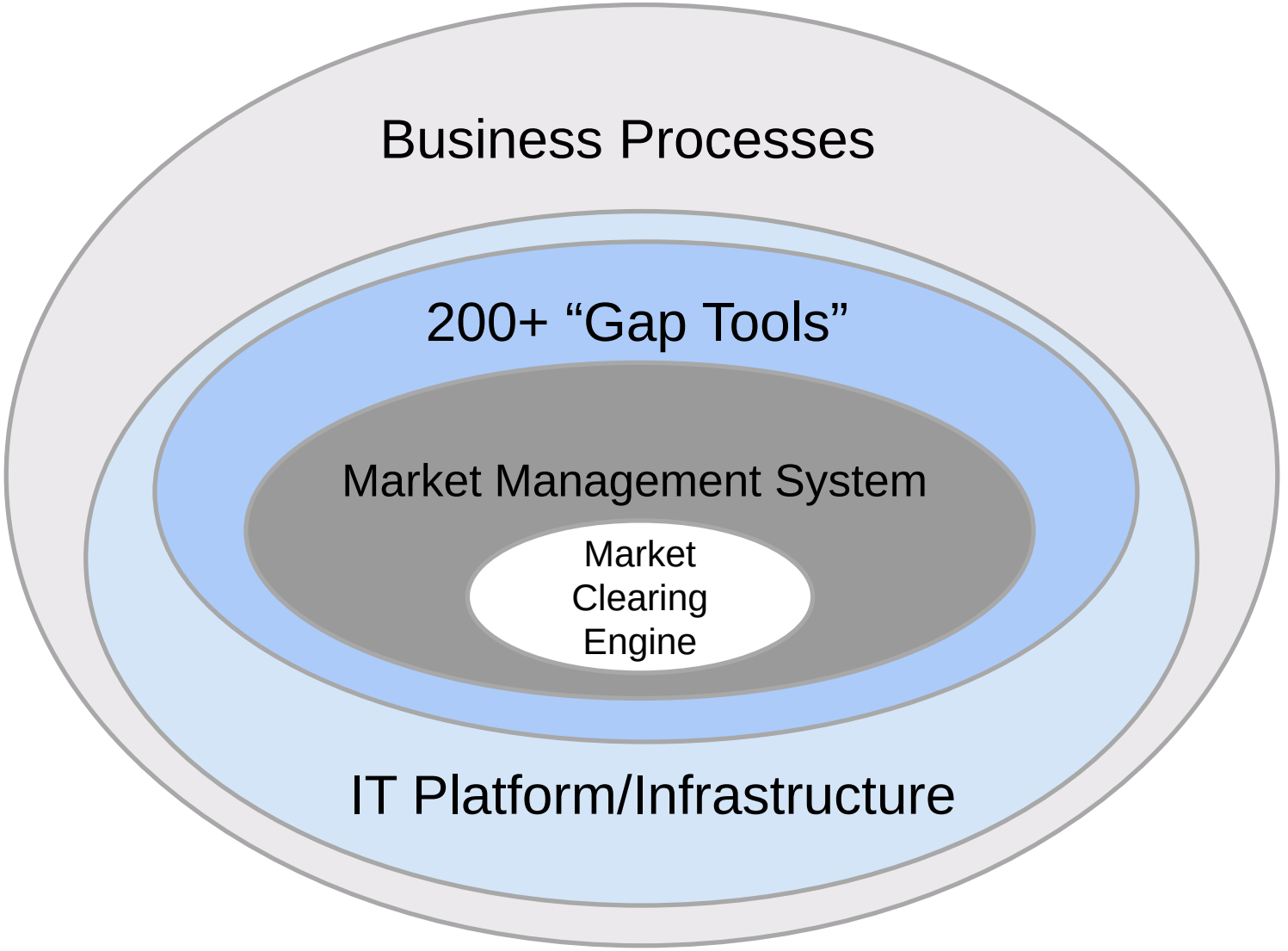
https://www2.deloitte.com/insights/us/en/deloitte-review/issue-17/value-creation-value-capture-internet-of-things.html

System of Interest

Systems Engineering's holistic, multi-dimensional views of the System of Interest provides much-needed **context** for Agile's atomic end **user stories**

There is much more to a system than its user-facing operations

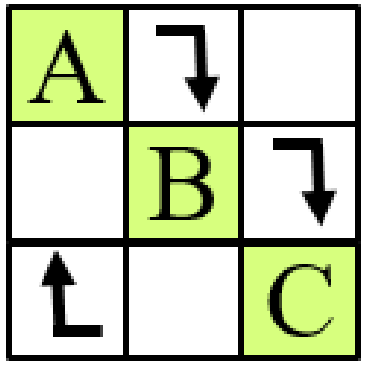
End-user value often can't be realized in small chunks

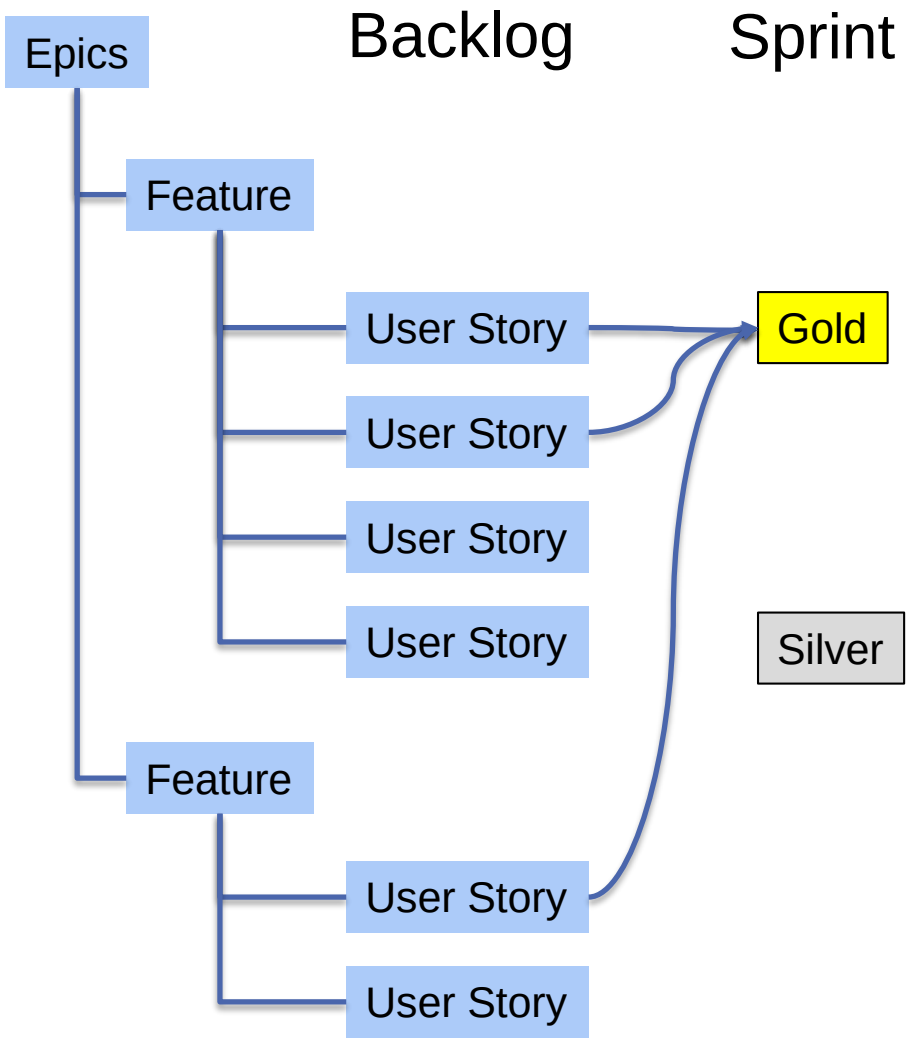


Managing Interactions

Systems Engineering's emphasis on explicit modeling of system, product and feature interactions supplements Agile's decomposition of work into small, independent sprints

Behavioral and interaction models make dependencies visible and guide sprint planning





Managing an Explicit Decision Backlog

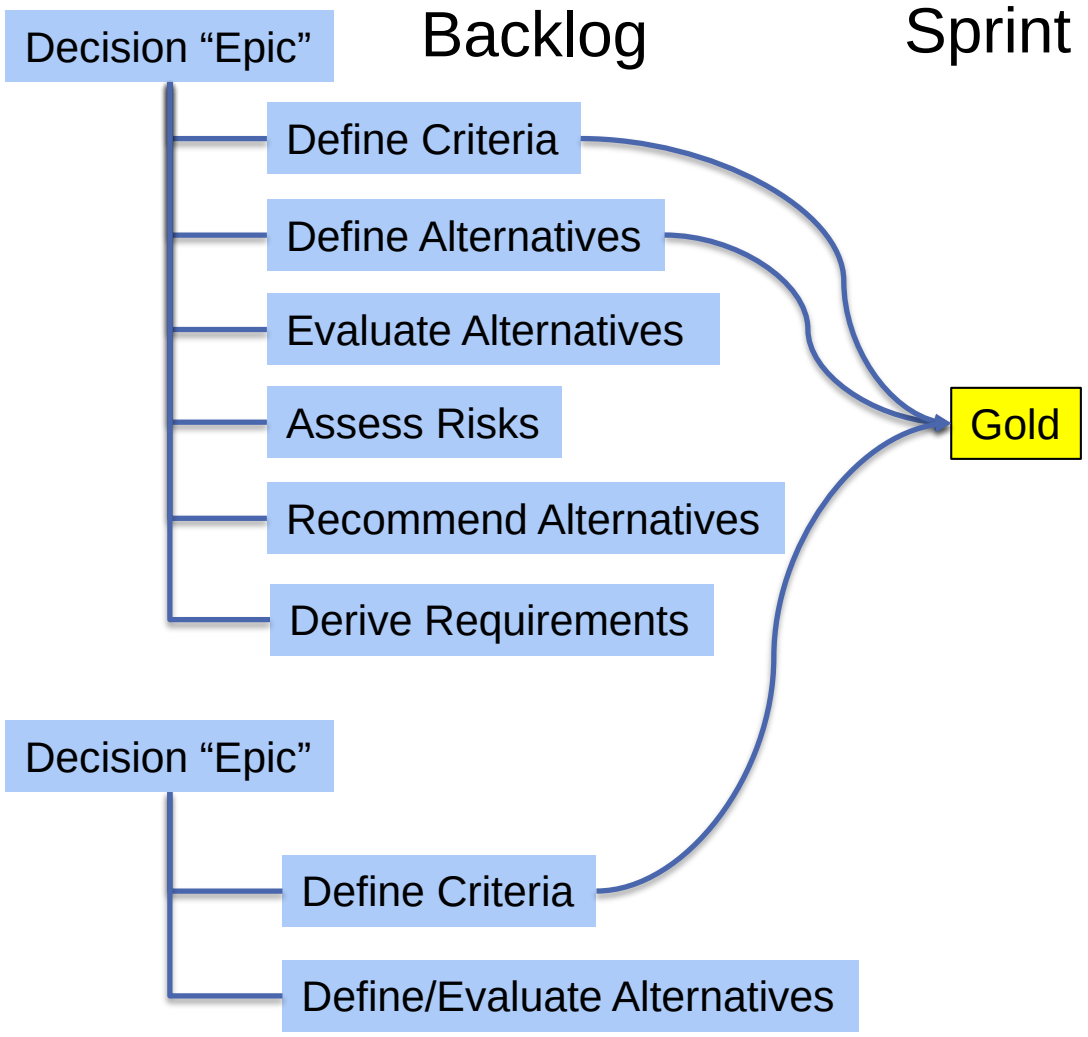
Agile buries architectural decisions, tradeoff analyses and the research behind them in exploratory Spikes

But the same **fundamental questions demand an answer** concerning the system and how it will deliver value, regardless of development lifecycle/method

Why not manage an explicit Decision Backlog based on holistic, proven decision patterns?

But as an integrative mechanism, decisions don't fit as nicely into 2 week sprints as software tasks

- 10 -> 200 hours of analysis
- Many part-time contributors and delays in gathering information
- Many dependencies



What about Requirements?

“Welcome changing requirements, even late in development”

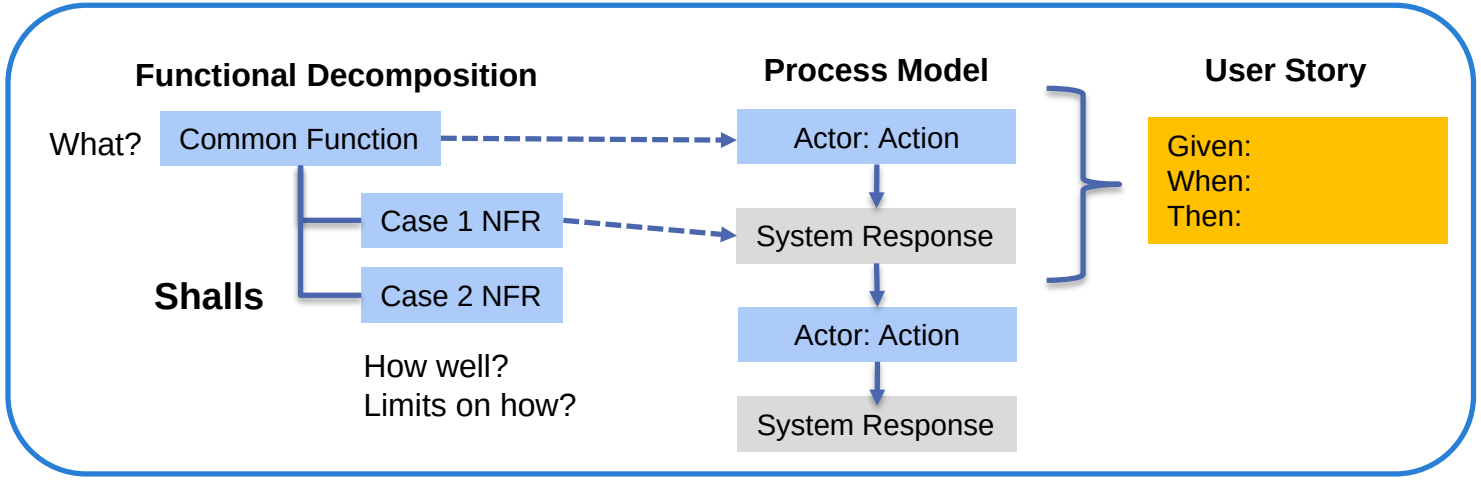
- https://www.agilealliance.org/agile101/12-principles-behind-the-agile-manifesto/
- Common sense admission of our lack of omniscience, but what % of requirements can’t be known early in the project and when does the cost of iteration exceed the cost of upfront analysis?

Functional decomposition vs user stories

- How do we design-for-commonality with a focus on operational user stories?
- Where do Non-functional Requirements (NFRs) reside?
- What happened to my use cases?
- Role of functional/component tests vs automated operational (user story) testing?

Requirements styles

- Shalls vs Given-When-Then
- Textual vs Process models



Conclusions (Early Takeaways)

- Challenging to concurrently backfill a decade of lost knowledge & traceability, build process & tools and execute a very large, mission-critical project
  - **Pareto** everything
- Adopt the best parts of Agile (e.g. Backlog grooming, sprints, rapid feedback), but keep a **holistic view** of the System
  - Use **System of Interest** and clear **decision framing** to set context and provide focus to teams
  - Leverage **Decision-to-Requirements traceability** to reduce the scope/effort associated with new discoveries
- Manage your **decision backlog** before your software development backlog
  - Accelerate **cycles of learning** through a turn-the-crank decision process
  - Create meaningful **decision metrics** for the managers
- Difficult to create inter-company Agile handoffs across diverse tool chains
  - Agree on a **lean information architecture** first
- Organizational change management is a big task
  - Be prepared to **listen**, listen, listen and **educate**, educate, educate

Questions?

Contact Information

Scott Turner
sturner@misoenergy.org

Scott Turner has over 11 years of experience in Grid-scale power system management. He has spent his career developing innovative solutions for challenges faced analyzing and operating systems of this size and complexity. Scott is new to Systems Engineering, having recently completed an MIT Professional Certificate in Architecture & Systems Engineering, but his Bachelors in Computer Engineering, Masters in Business Administration, and deep curiosity about how interactions between systems leads to emergent behaviors has made it a natural fit. Scott is currently leading the Systems Engineering effort at MISO and is partnering with John Fitch to deploy this capability and the associated culture changes to the organization.

John Fitch
jfitch@misoenergy.org

John Fitch has over 30 years of experience in Systems Engineering, engineering management and methods consulting. He is a leading innovator in the fields of Requirements Management, Decision Management and Strategic Roadmapping and has been certified as an Expert Systems Engineering Professional (ESEP). He has championed the use of Decision Driven® Design and decision patterns to accelerate solution development across a wide range of industries. John is currently using this experience to stand up a lean and agile Systems Engineering capability as part of MISO's Market System Enhancement program.