



Market System Evaluation

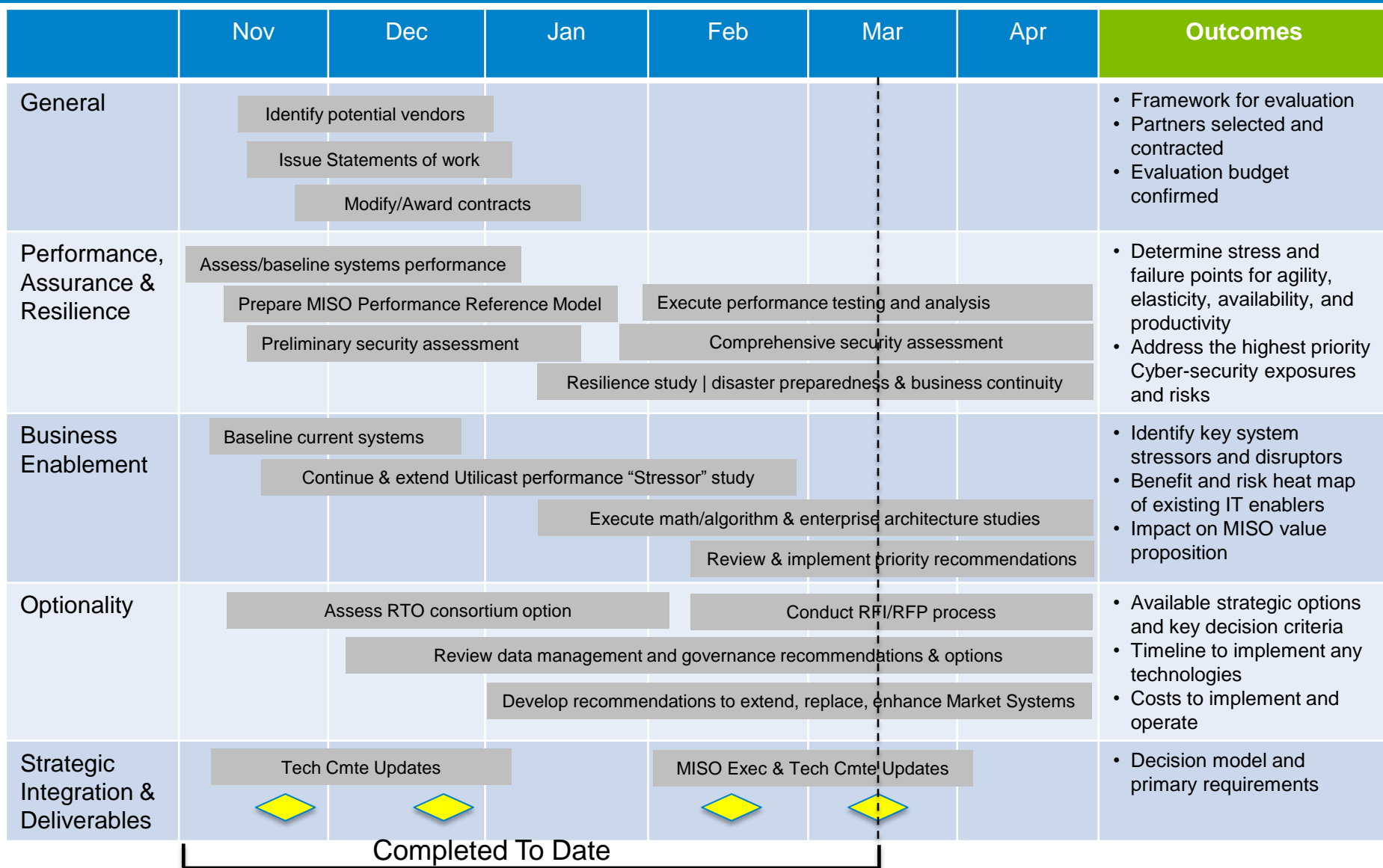
March 2017

Executive Summary

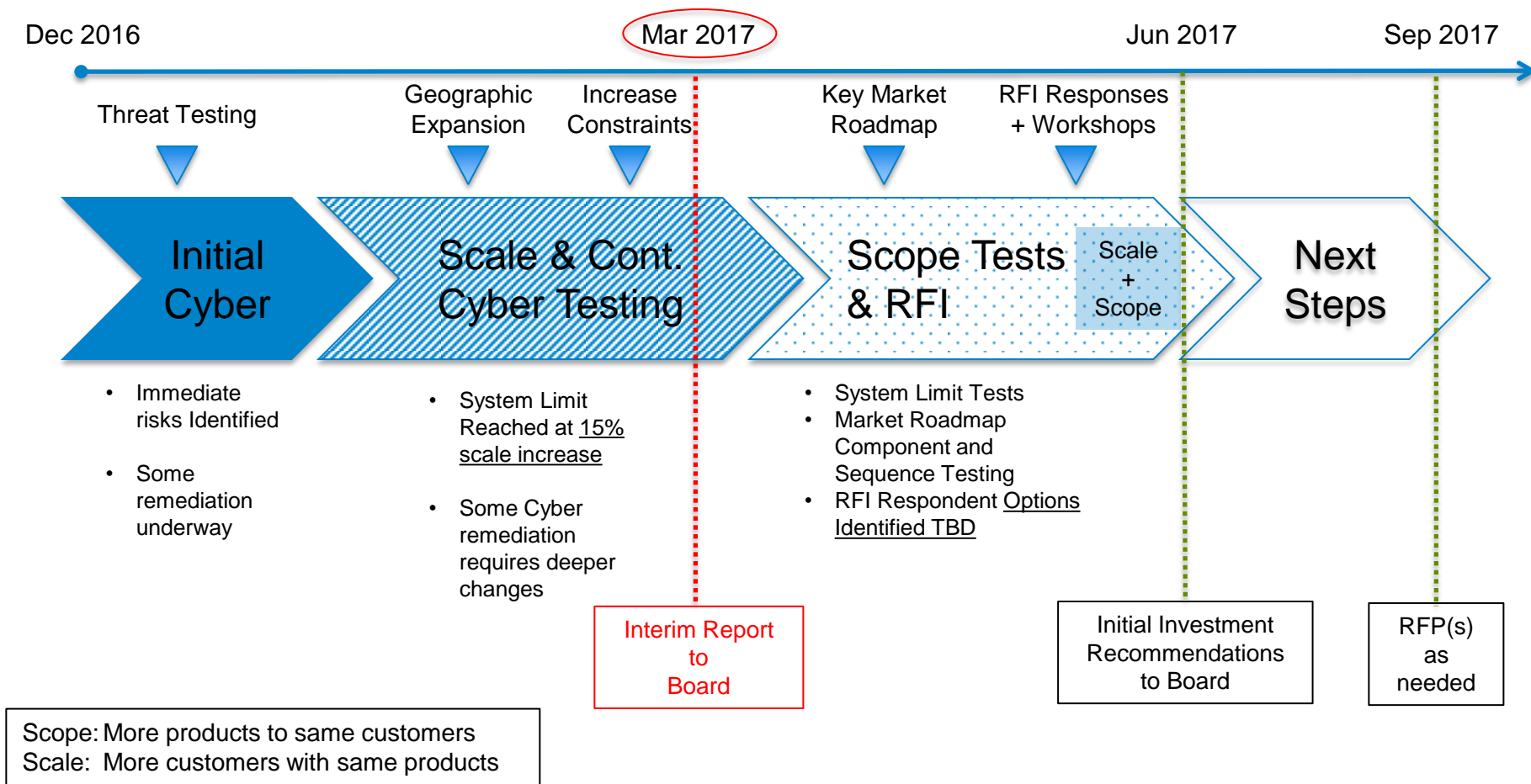
MISO's ability to execute its strategy is predicated upon having secure systems providing the tools and information required.

- Last fall we initiated a study to evaluate the security and capabilities of our critical operating system over time looking at:
 1. Performance, assurance and resilience,
 2. Business enablement, and
 3. Optionality.
- Preliminary results indicate:
 - Systems will accommodate a modest increase in complexity providing roughly a 5-7 year time horizon to obsolescence,
 - Incremental investments can be made to enhance capability and extend this timeline,
 - Increasing security and NERC CIP requirements are outpacing the ability of our platform to adapt, requiring near-term investment, and
 - Ongoing vendor support for our legacy platform will diminish as focus shifts to the next generation of system development.
- Continued analysis will confirm our findings, complete a dashboard to monitor system performance and outline our recommended path forward.

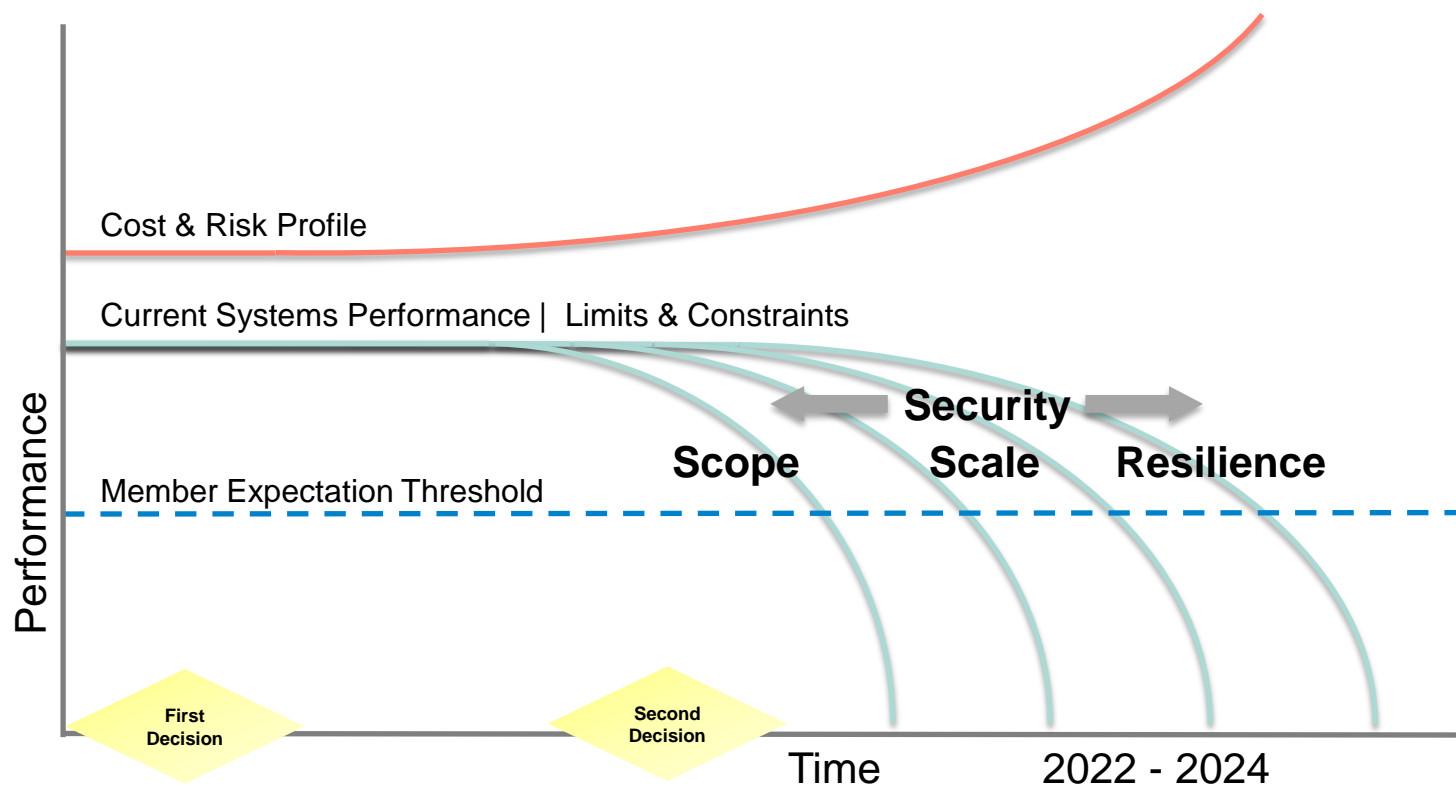
The 180-Day Critical Path



Significant Threat and Stress Testing Has Been Designed and Conducted



Our hypotheses and studies identified several cost and risk factors ...



Consequently, we are exploring alternative pathways to assure performance, mitigate risk, and control costs.

We need to decide on a set of extension and research investments to further the life of our current systems under an acceptable cost and risk profile...

Potential Investments

**First
Decision**

Current System Extension

- Cyber
- Network Model Management
- Data Management
- Infrastructure/Hardware

Future System Enablement

- Dedicated Future Systems Test Environment
- Algorithm Research
- RFI Identified Vendor/Partner Early Stage Platform Development


By June, we will propose a strategy and set of business cases to incrementally buy-down and operate within a more tolerable risk profile.

Next Generation Market Platform Decision Factors

Looking ahead, we've also defined several criteria and considerations to guide the selection of our new market platform...

Platform Decision Factors

1. Repurpose extension capability investments
2. Adopt a modular, component-based, and adaptable architecture
3. Readily anticipate and accommodate changing business scenarios, models, and conditions – emphasis on security, scale, and scope
4. Limit vendor, technology, and service-model risk and constraints
5. Smooth the cost/spend profile



**Second
Decision**

We also will follow up with you in June to share our insights about the vendor landscape and longer term future technology options identified for investigation that we've gained from our RFI process.



Appendix

Study Plan Focus Areas & Objectives

The \$1.8M proposed out of pocket cost will be used to cover a series of studies conducted by independent/third party experts teamed with MISO subject matter experts. The study will leverage industry experts to baseline, review and confirm the performance models, metrics, measures, and methods that MISO utilizes to ensure reliability, availability, and productivity:

- **Performance, Assurance & Resilience:** Baseline MISO performance models, metrics, measurements, and methods. Validate scope of efforts and needs to address business assurance. Confirm business cases for new initiatives to address exposure, issues, and risks associated with cyber security, resilient operations, disaster preparedness and response, and business continuity. (Estimated \$650K)
- **Business Enablement:** Assess and identify gaps in ability to execute priority initiatives with high value business cases against performance of current market systems and projected capabilities of “bridge” to the future systems. Initiatives tested will cover market roadmap product extensions and MISO scale expansion. (Estimated \$500K)
- **Optionality:** Explore, identify, test, and recommend additional alternatives and options for MISO’s Market System. Consider accelerating hardware upgrades and other short-term initiatives to address critical issues detected and/or confirmed by these studies. The options will include formal vendor evaluations including a Request for Information (RFI) / Proposal (RFP) phases. MISO will also consider improvements to enablers including people, process and technology. (Estimated \$450K)
- **Strategic Integration & Deliverables:** Ensure that findings, conclusions and recommendations reflect and reinforce the interdependencies across each focus area. (Estimated \$200K)

Market System Studies | Summary View

Focus Area	Study Name	Study Hypothesis	Study Objectives	Partner Expert
Performance, Assurance & Resilience	Performance Review Security Assessment	<ul style="list-style-type: none"> • Meaningful and significant opportunities to recalibrate/fine tune business operations to improve availability and productivity. • Considerable sensitivity and risk associated with increasing levels of exposure and vulnerability due to systems and platform design and evolution. 	<ul style="list-style-type: none"> • Confirm models, metrics, measures, and methods to assure availability and productivity.* • Identify binding and limiting performance conditions, constraints, stressors and disruptors. • Identify and determine investments required to address highest priority Cyber-security exposures and risks.* 	Utilicast Cigital
Business Enablement	Sustain Business Operations and System Viability	<ul style="list-style-type: none"> • Limited capability and capacity to support current business operations, address changing business conditions, and create/capture new value. 	<ul style="list-style-type: none"> • Reconfirm core and critical business needs and priorities. • Determine architectural requirements and implications.* 	Utilicast
Optionality	Architecture Review	<ul style="list-style-type: none"> • Current systems and platform nearing end-of-life with limited ability to extend capability and capacity. • Range of architecture opportunities exist to extend system and platform viability and value. 	<ul style="list-style-type: none"> • Baseline current systems. • Confirm/create initiatives and investments to extend and enhance systems capabilities and capacity. 	SEI Symphono
	Platform Vendor Engagement	<ul style="list-style-type: none"> • Direct and active engagement with platform vendors will help to signal and refine requirements, identify near-term extensions/enhancements, and provide lead time to help streamline and smooth re-platform migration. 	<ul style="list-style-type: none"> • Conduct preliminary assessment of vendor products and services. • Develop capability and cost comparison criteria and models. 	Glarus Group Quanta Olivine Utilicast
	Enterprise Information Management	<ul style="list-style-type: none"> • Significant opportunity to leverage data for business intelligence to increase value of current systems and platform, and provide the foundation for future bridge and re-platform initiatives. 	<ul style="list-style-type: none"> • Define data and business intelligence initiatives and investments. • Key requirement for off-ramp to any future alternative platform. 	Purdue

Market System Studies – Findings & Recommendations

Findings, conclusions, and recommendations from each study will be reviewed and used to inform initiative and investment decisions about current system extensions/enhancements, bridge opportunities, and whether, when, and how best to re-platform market systems...

Focus Area	Study Name	Study Findings	Initiatives & Investments	Schedule	Budget & Resources
Performance, Assurance & Resilience	Performance Review Security Assessment				
Business Enablement	Sustain Business Operations and System Viability				
Optionality	Architecture Review				
	Platform Vendor Engagement				
	Enterprise Information Management				

Notional

Business Performance Reference Model

The DART Performance Reference Model (PRM) will define MISO's core models, metrics, measures, and methods – it will help to determine the limits on current systems capability and capacity.

DART business performance is a multi driver model for both day-ahead and real-time processes with key components including:

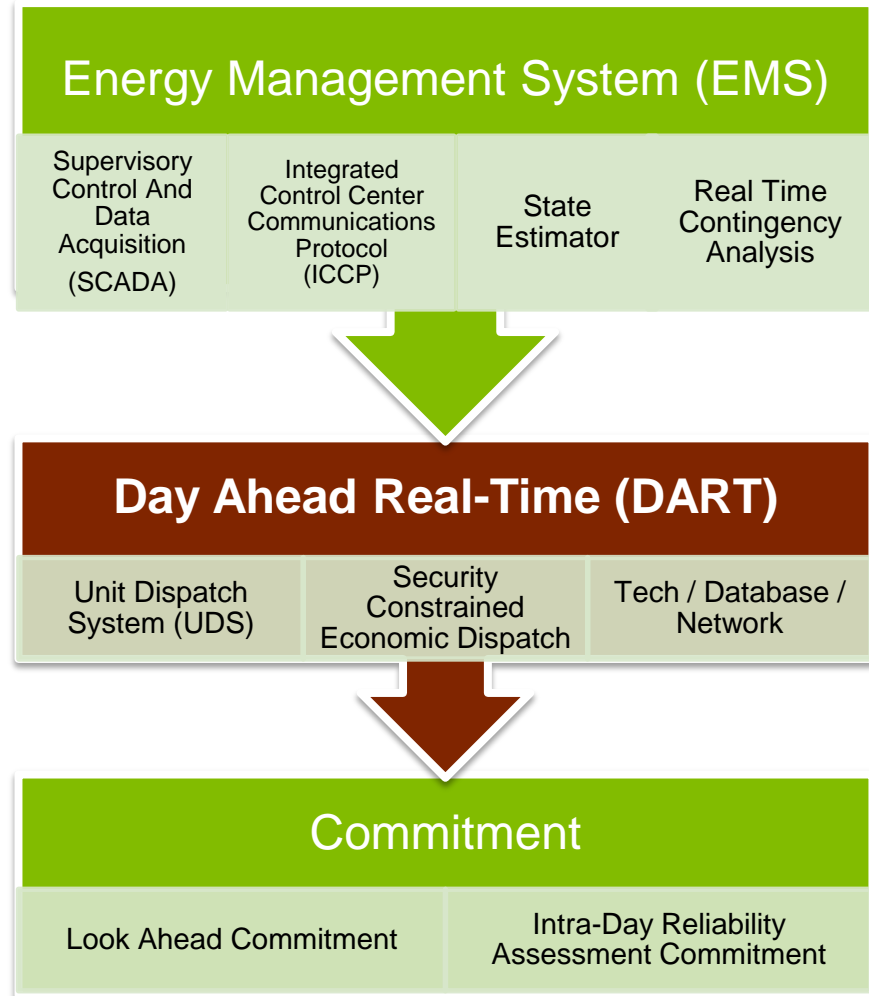
- Number of Transmission Lines
- Number of Buses
- Number of Contingencies
- Number of Elemental Pricing Nodes (EPNodes)
- Number of Aggregated Pricing Nodes (APNodes)
- Number of Commercial Pricing Nodes (CPNodes)

Test scenarios can also measure several operational stressors:

- Portfolio of Generators (mix of number & type in solution)
- Number of monitored constraints
- Number of buses
- Load sensitivities and impact (localized and footprint)
- Ramp constraints
- Zonal ancillary service constraints

To understand performance dynamics, a sensitivity analysis will be run on each performance driver. This will identify the impact or materiality of each driver as well as its limits. Building each sensitivity test will require a commercial network model and the appropriate bids and offers for each test.

Simplified Real-Time Market Process



Market Roadmap

Line of sight opportunities with heavy flexibility theme approach \$75 million in additional annual value (10-yr NPV = \$295 million)

Preliminary Estimated Value of Market Roadmap Projects¹
Annual Value (10-yr NPV), \$Millions

Multi-Day Financial Commitments

- Minimize inefficiencies due to routine cycling and must-run of long-lead generators



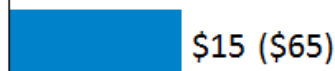
Virtual Spread Product

- Converge day-ahead and real-time prices



Enhanced Modeling of Combined Cycle Generators

- Production, dispatch and commitment savings



Voltage and Local Reliability (VLR) Commitment Pricing

- Improved reliability via appropriate price signals to warrant sufficient investment in assets by including VLR constraints in the dispatch



However, challenges to execute

- Enhancements must be aligned with Next Generation systems
- Balancing diverse stakeholder interests
- Significant value drivers include natural gas prices, capacity factors and virtuals influence



¹Annual benefit assumes sufficient technology capacity exists to achieve full benefit