Analytical Assessment Methods to Directly Measure Impact and Resilience of Mission Assurance

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Mike Darby, CSEP
Sr. Systems Engineer
Idaho National Laboratory

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Idaho National Laboratory

Presentation is Unclassified

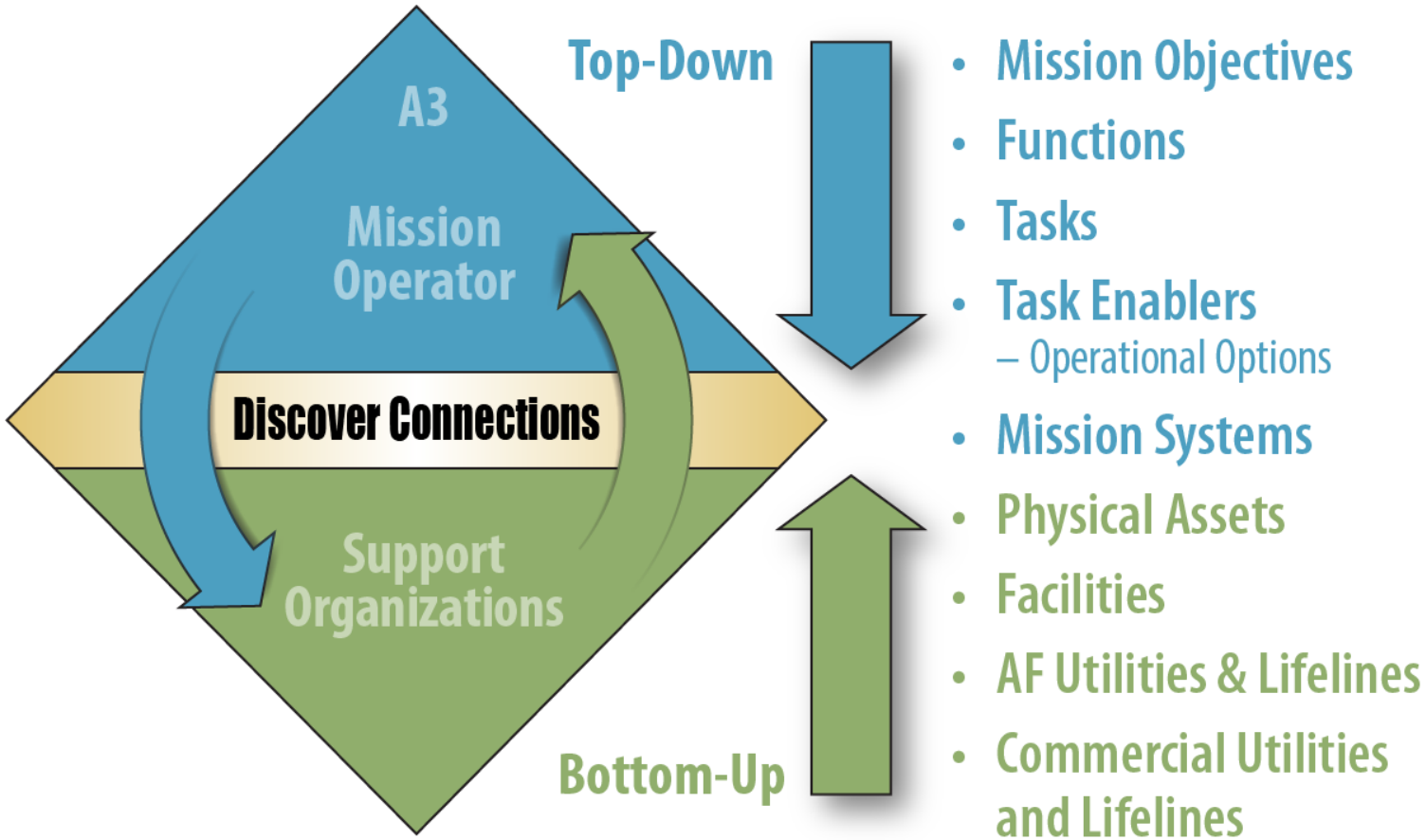
Agenda

- **Background:**
  - USAF problem statement & challenge to Idaho National Laboratory (INL)
  - Mission Assurance Tiger Team (MA-TT)
- **Process:** Overview of the Decomposition for Energy Assurance and Electrical Power Resilience (DEEPR) process [Mission Thread Analysis]
  - DEEPR Analytical framework
  - Mission Availability Assessment
    - Single Point of Failure analysis
    - Dynamic Analysis from threat-Informed Scenarios
    - Task Enabler Gap analysis
    - Course of Action (COA) assessment
  - MA-TT Modeling Tool
  - MA-TT Analysis Tool
- **Continuing Advancements**

AF Problem Statement & Challenge to INL

- Air Force is reliant on networked systems and that makes them potentially more vulnerable to power interruptions
- Interdependency of installations and systems expose the enterprise to greater risks
- Current assessment approaches focus solutions on installation's assets and do not account for other methods to resolve mission impacts
- Analysis of Alternatives (AoA) are too focused on power infrastructure as the way to improve resilience
- Need for a method/metric that values resilience to the mission
  - Understand As-Is resilience value
  - Enables a return on investment (ROI) value for COA/alternatives

DEEPR Approach Enables Impact Measurement to Mission's Objectives From Supporting Elements

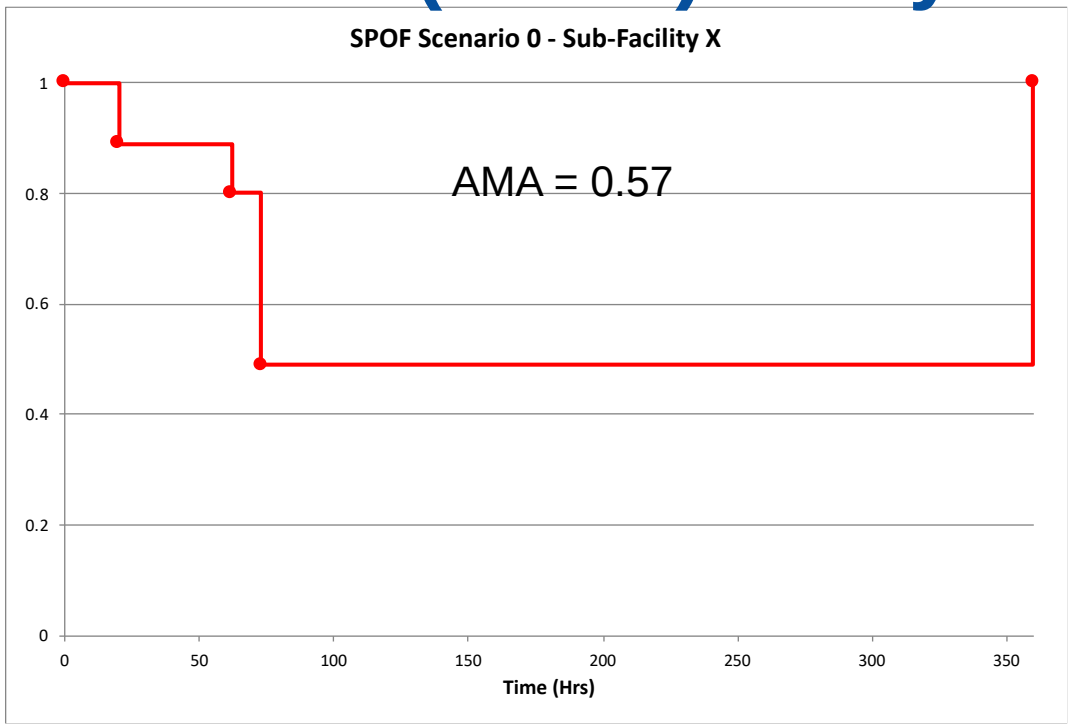


- Data from GIS database, one-line diagrams, interviews, other database sources
- Uses a decomposition method to connect elements with required logic
- Measures mission impact from failures and adverse conditions over time
- Connects infrastructure inside and outside "fence"
- Defines resulting high priority Task Enabler gaps
- Measures COA effectiveness to improving resilience and supports ROI evaluations

Mission Degradation from Use of Operational Options

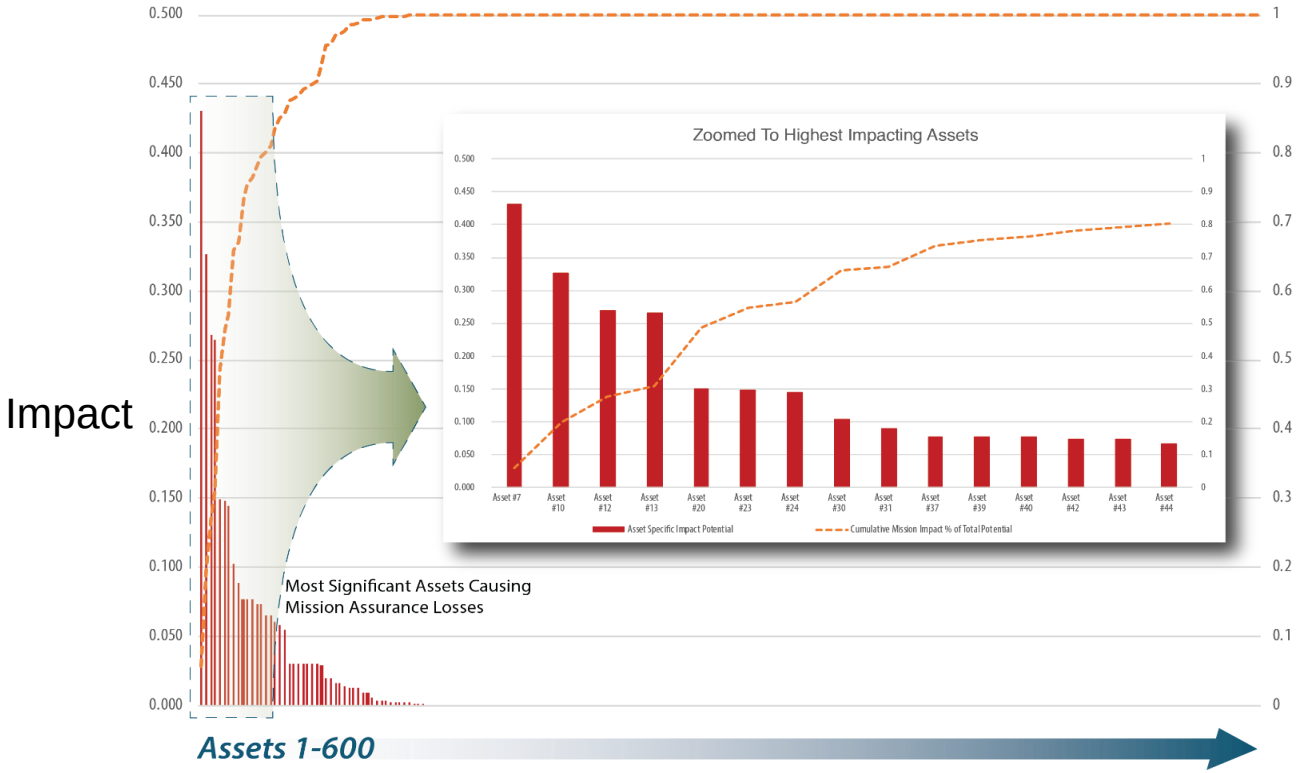
- No Impact : Option has same performance level as primary path
- Very Small: Barely noticeable mission effectiveness to at least one objective
- Small: Noticeable impact to an objective
- Moderate: Noticeable impact to multiple objectives
- Significant: Sufficient mission degradation that there may be outcomes that require additional mitigation
- Catastrophic: Can not do imperative function, mission in serious jeopardy, “showstopper”

DEEPR Process Enables Systematic Single Point of Failure (SPOF) Analyses



- Turn off one Facility/Physical Asset at a time.
- Each SPOF Scenario results in an event timeline. AMA (average mission availability over the event timeline) represents the magnitude of mission impact for each SPOF scenario.
- Evaluating over a given amount of time allows comparison between each scenario.

Dynamic SPOF analyses are performed to identify Facilities/Physical Assets with the highest impact to mission availability



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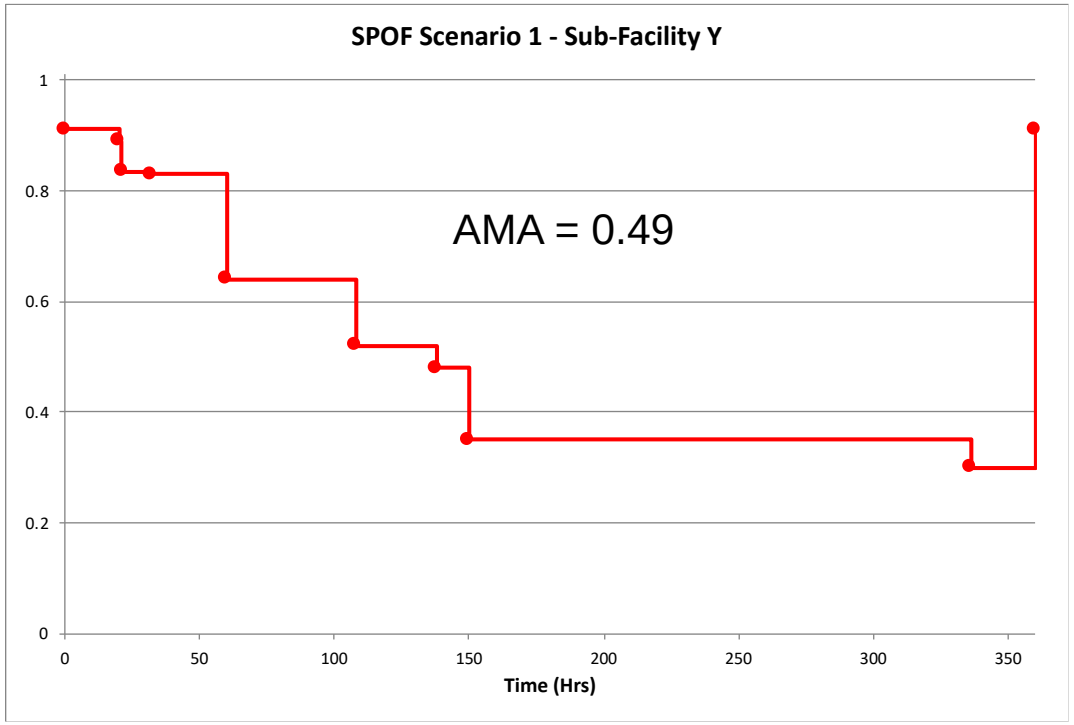
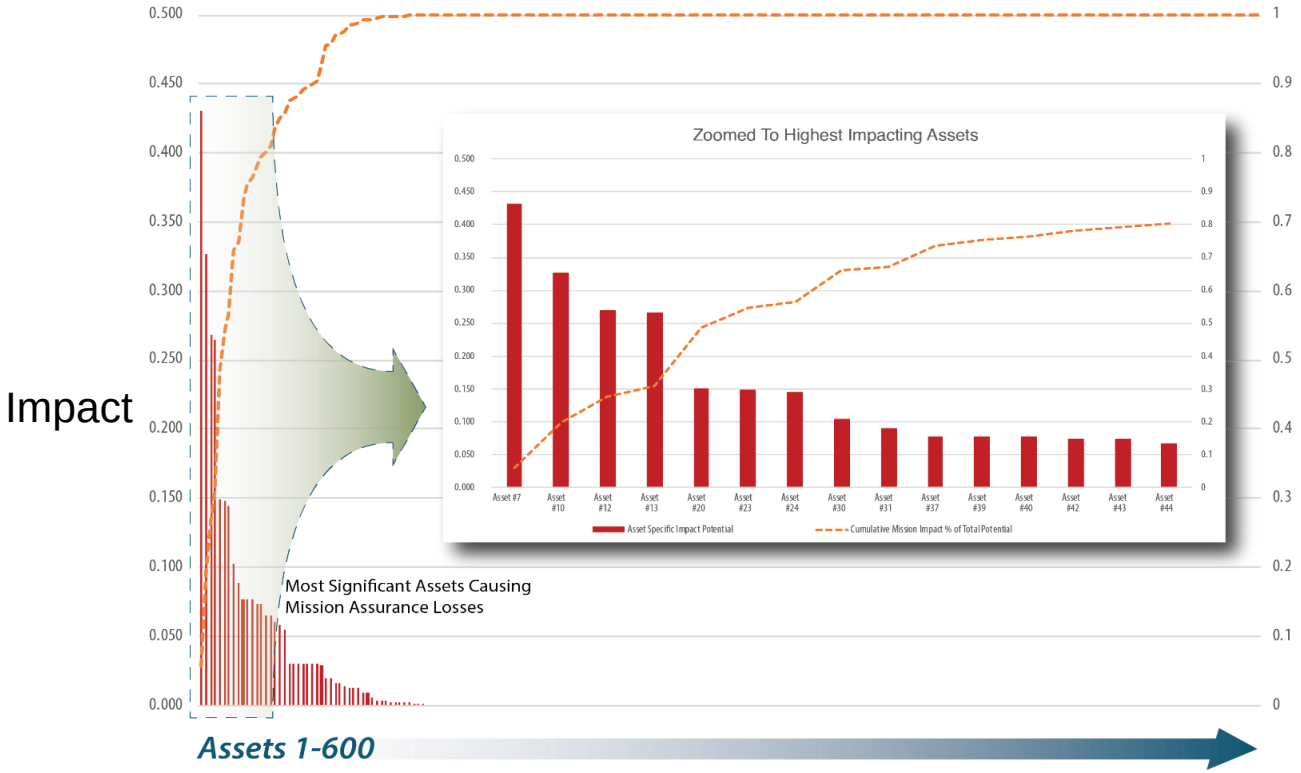
SPOF Analyses with Stressed System



Run SPOF analysis with different initial conditions:

- No commercial power available
- No external base communications (POP) available
- No resupply
- Water shortage
- Combination of the above

Dynamic N-1, N-2, and N-3 SPOF analyses are all compared to identify Facilities/Physical Assets with the highest impact mission availability



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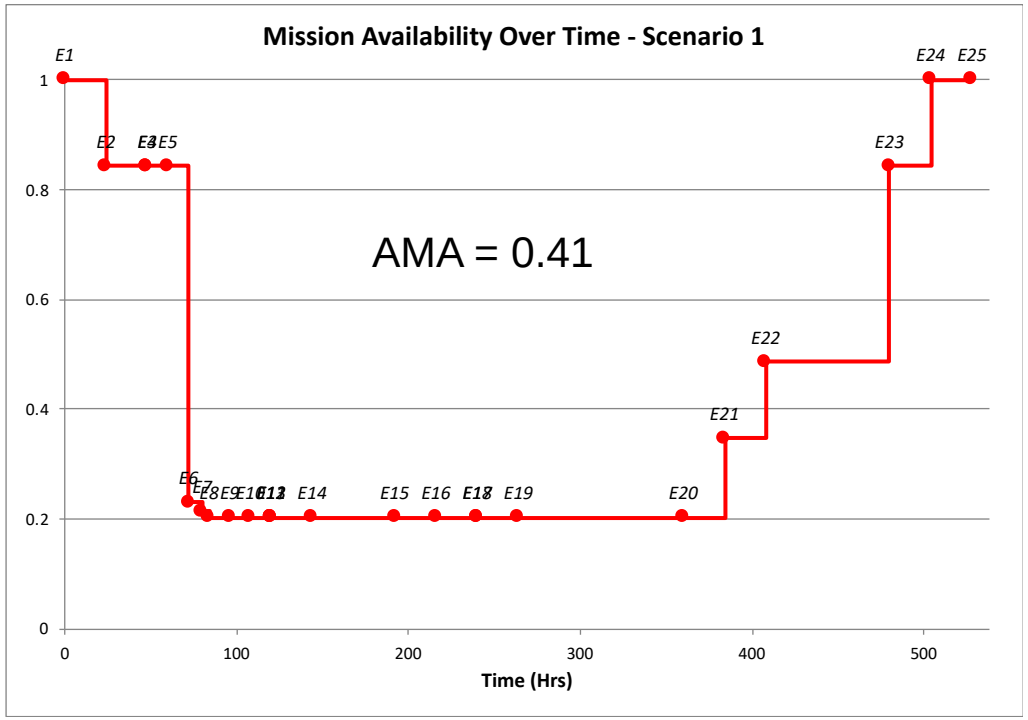
Threat-Informed Scenarios Provide Opportunity for Dynamic Analyses

Four Standard Scenarios Plus Unique Scenarios provide mission impacts testing environment

Represents events/conditions to show resilience to:

Scenario Conditions	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Power Outage Type	Base power off.	Base power off.	Base power off. Power outage for 45mi radius.	Base power off. Regional Interconnect power outage
1. Duration	30 days	30 days	30 days	30 days
2. Resupply Availability	Resupply available.	No resupply for first 14 days.	No resupply for first 21 days.	No resupply for 30 days, personnel relocation unavailable.
3. Equipment repair	Equipment repaired normally.	Equipment repair delayed 14 days.	Equipment repair delayed for 21 days.	Equipment repair delayed for 30 days.
4. Commercial Communications			• ISPs off line after 8 hours. • Cell phones fail after 48 hours. • Landlines fail after 7 days.	• ISPs off line after 8 hours. • Cell phones fail after 48 hours. • Landlines fail after 7 days.

Each Scenario produces an event timeline showing the Mission Availability over time with an Average Mission Availability (AMA)



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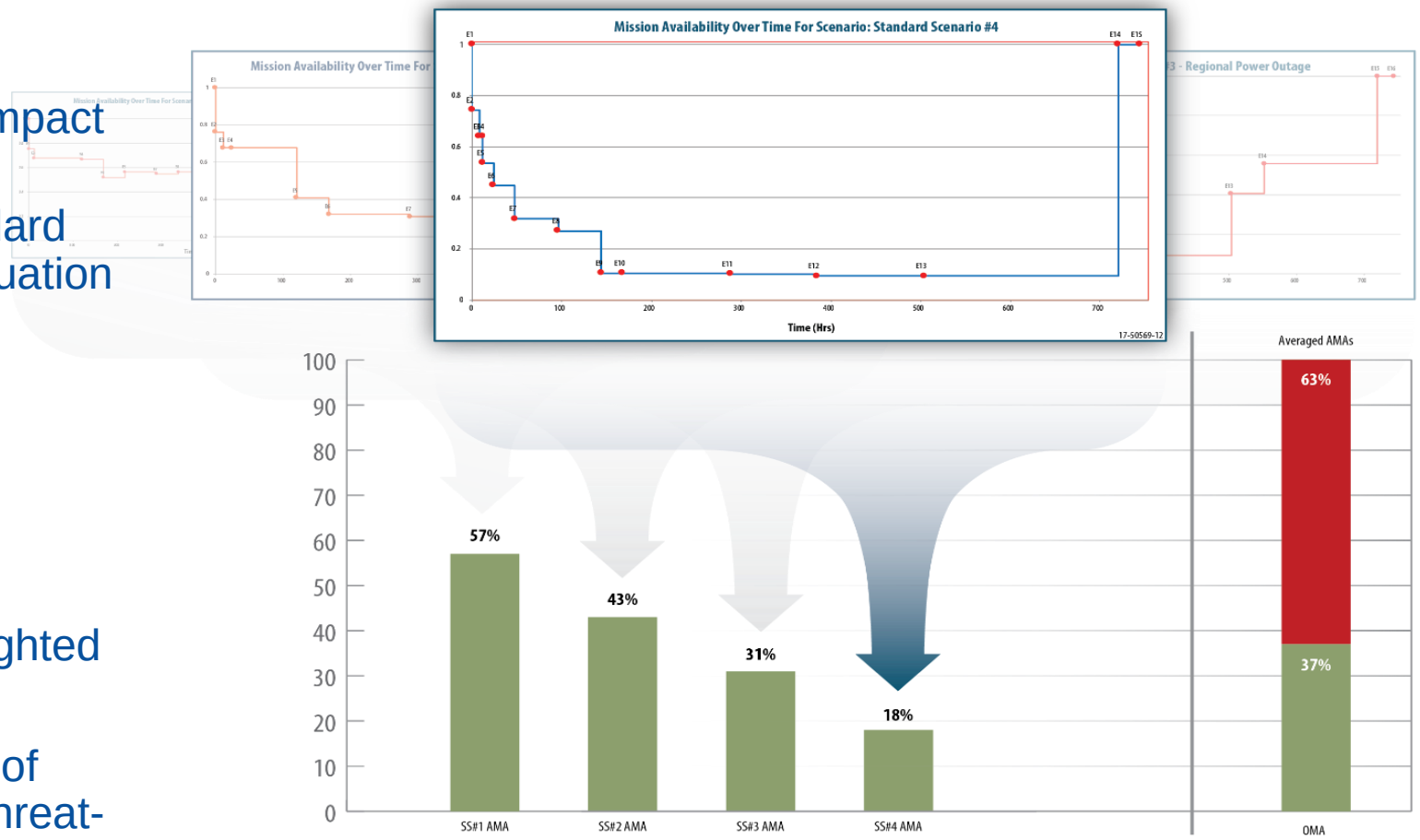
Specific Threats – Unique Scenarios

- Define threats and threat levels in model
  - Example: EMP, Flooding
- Each Facility/Physical Asset can be susceptible to threats at associated levels
  - Data Import and Queries allow adding threats to current data
  - Can overlay environmental data (i.e., flooding levels)
- Threats can be applied to Facilities/Physical Assets individually, by groups, by type, by organization, or by region.
  - Defining an event in the dynamic scenario to ”turn on” threat
- Unique Scenarios can evaluate desired threats to evaluate resilience against

DEEPRs Aggregation of Threat-Informed Scenarios Supports More Complete Understanding of the Problem

- AMA (average mission availability) represents the magnitude of mission impact given each applicable scenario
  - Missions all tested against standard scenarios which provide an evaluation basis
  - Unique scenarios test threats specifically applicable to the installation
- OMA (overall mission availability) represents the average AMAs across applicable scenarios (Can also be weighted average)
- OMA also represents the current level of mission resilience against applicable threat-informed scenarios



Standard and Installation-Unique Scenarios

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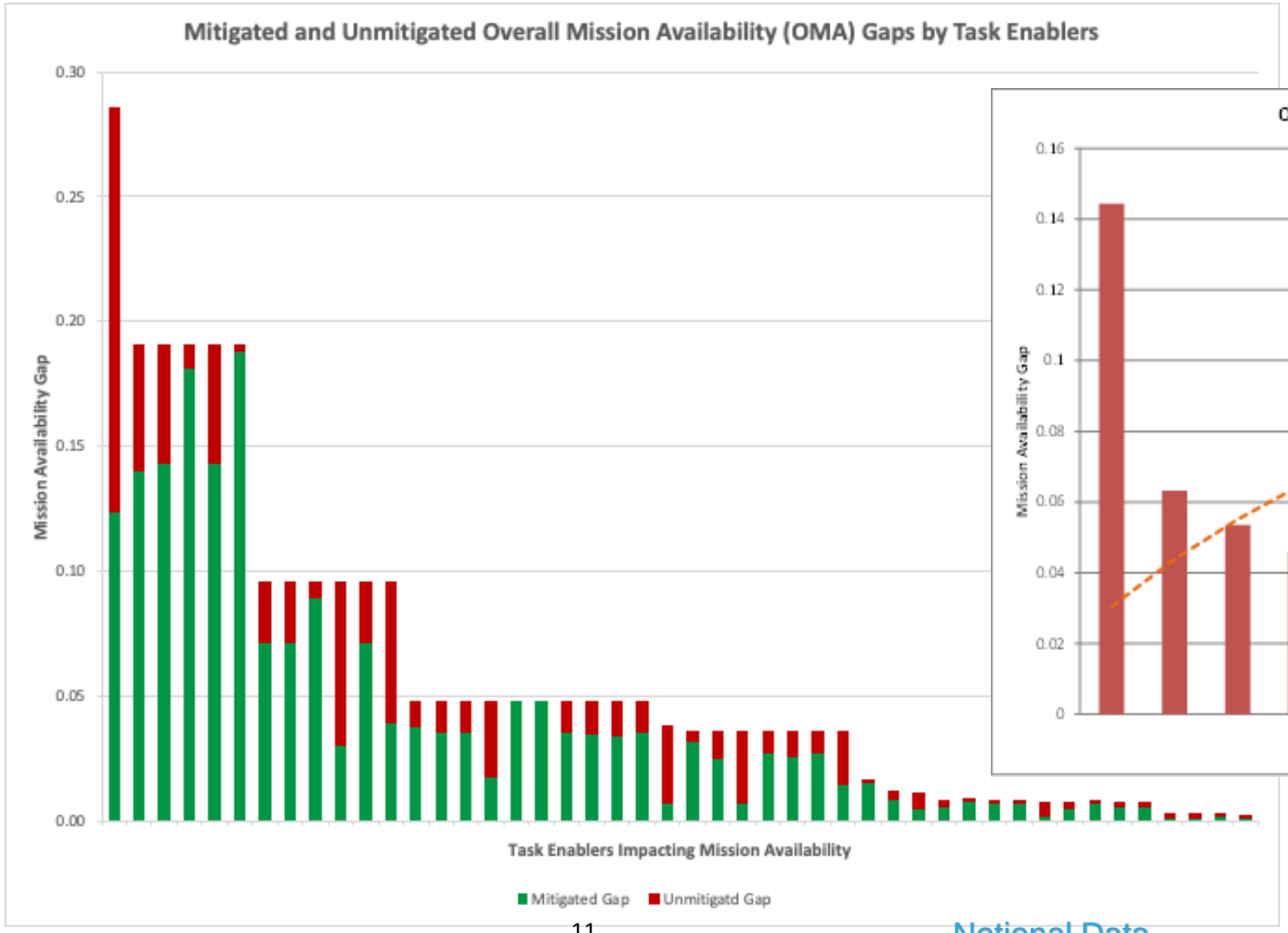
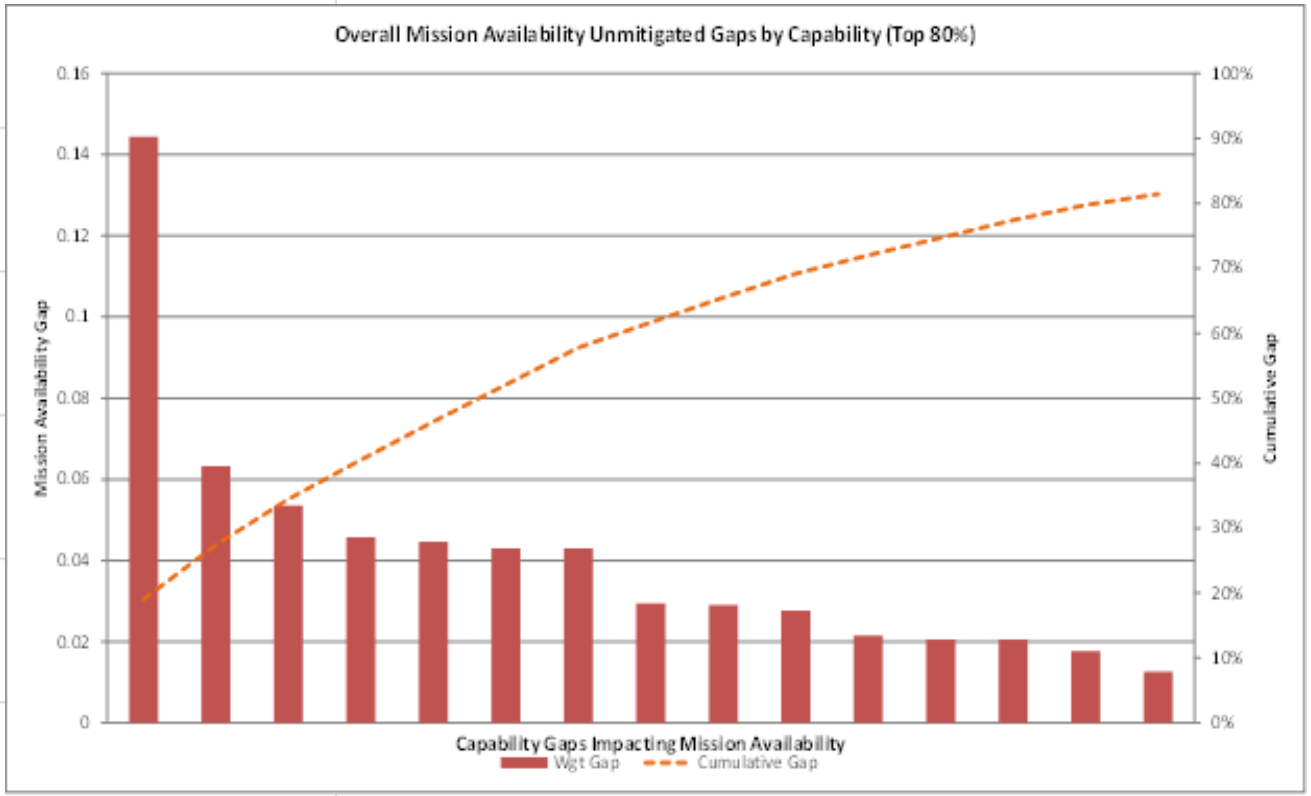
Task Enabler Gaps

Dynamic analysis defines mission impact from task enablers and size of enabler's gap



Unmitigated Gap is loss to MA due to loss of Task Enabler (i.e., which Task Enabler's have the largest affect on MA)



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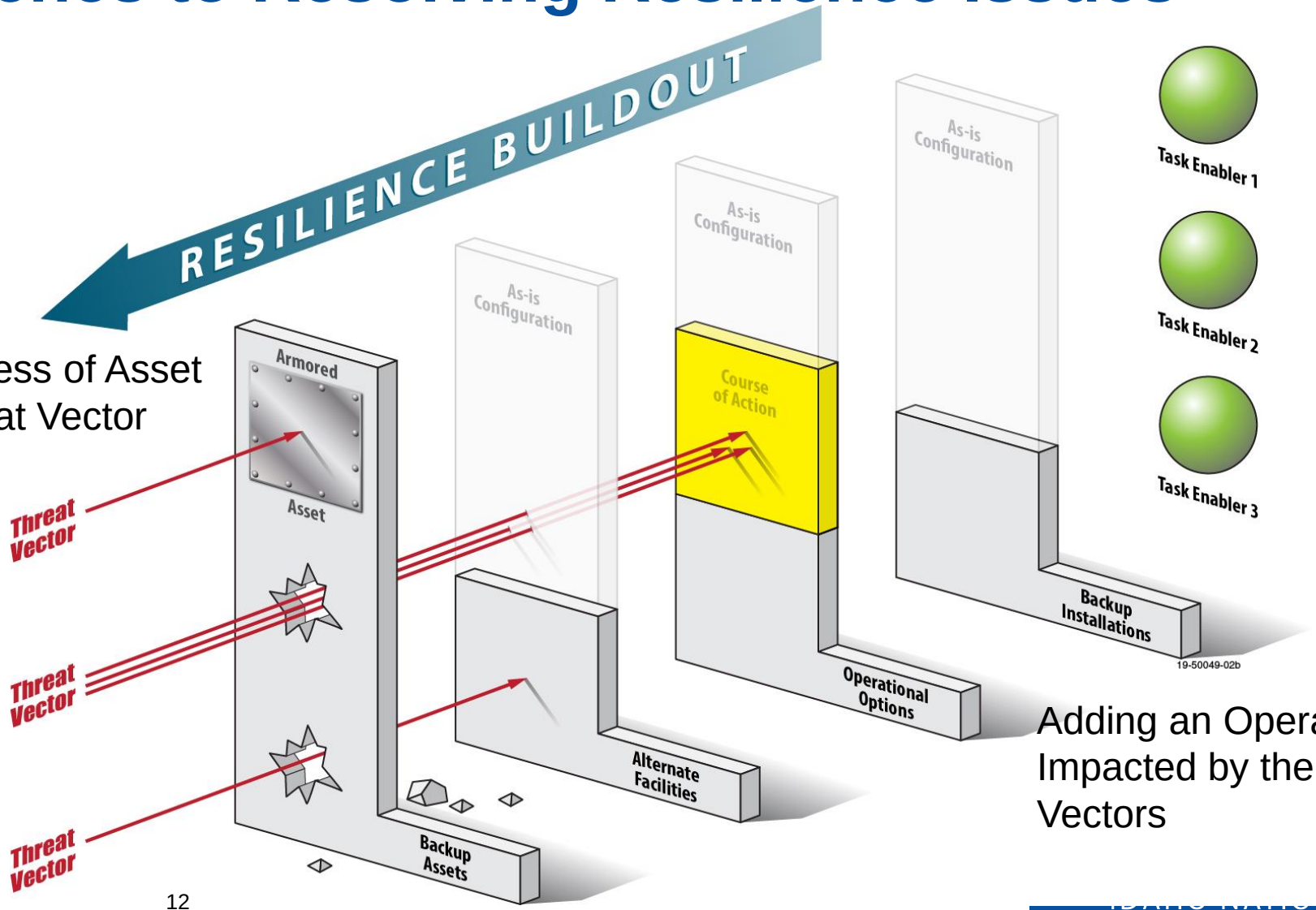
DEEPR's Analytical Framework Provides Multiple Approaches to Resolving Resilience Issues

Increasing Robustness of Asset Against Upper Threat Vector

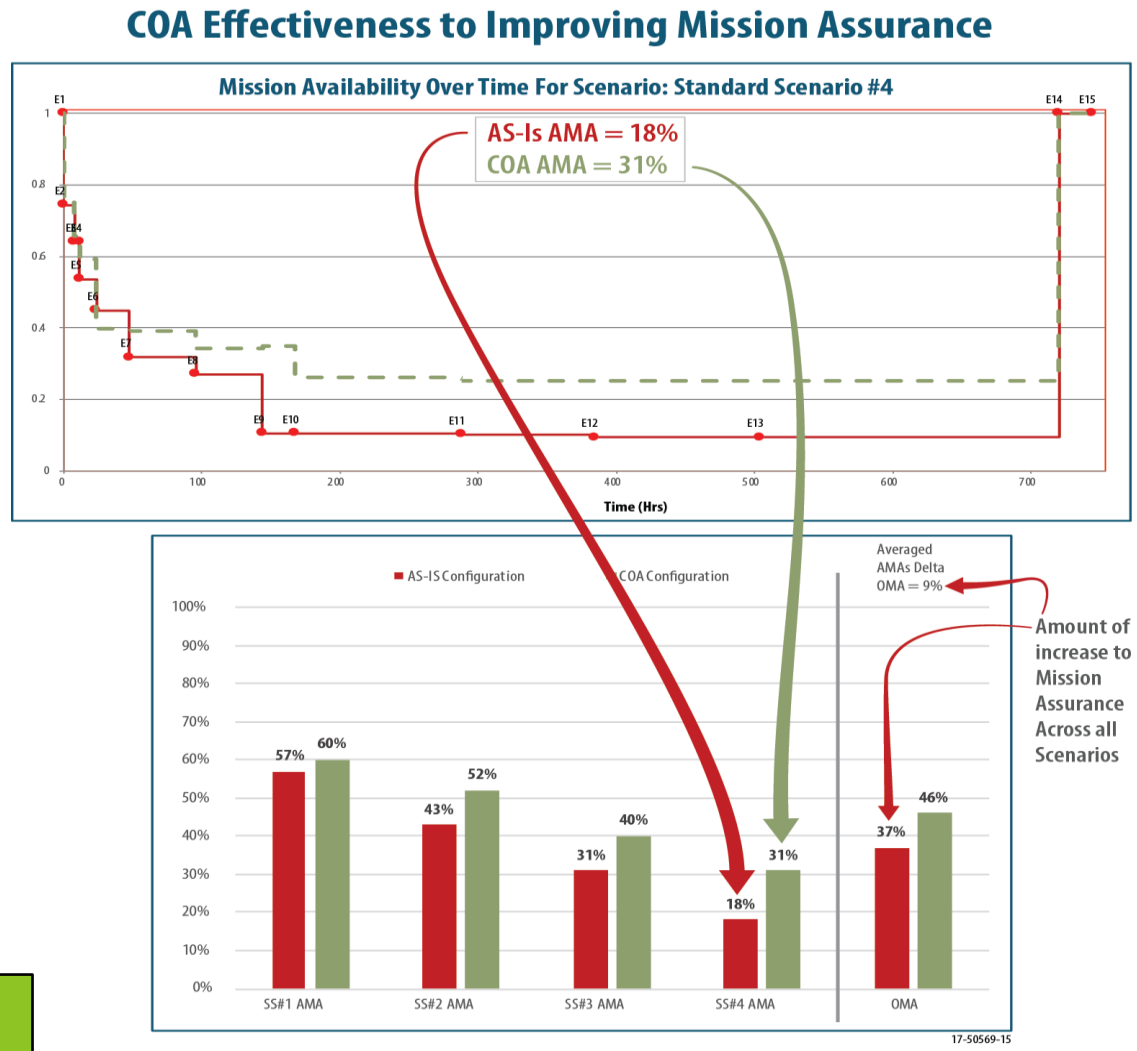


Adding an Operation Option Not Impacted by the Central Threat Vectors

DEEPR Measures Resilience Values for Alternatives and Courses of Action

- Multiple scenarios provide “Bigger picture” problem definition
  - Increases solution creativity
  - Avoids point solutions
- Evaluate Alternatives/COAs using same scenario set
  - Scenario prioritization capable
  - Delta OMA provides resilience value (e.g. input to ROI analysis)
- Evaluate for a beneficial system of solutions
  - Complimentary solutions provide compounded benefits
  - Competitive solutions would not yield compounded benefits

All mission supporting organizations can work together to identify what each should do to improve mission resilience



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DEEPR Tools

MA-TT Modeling Tool:

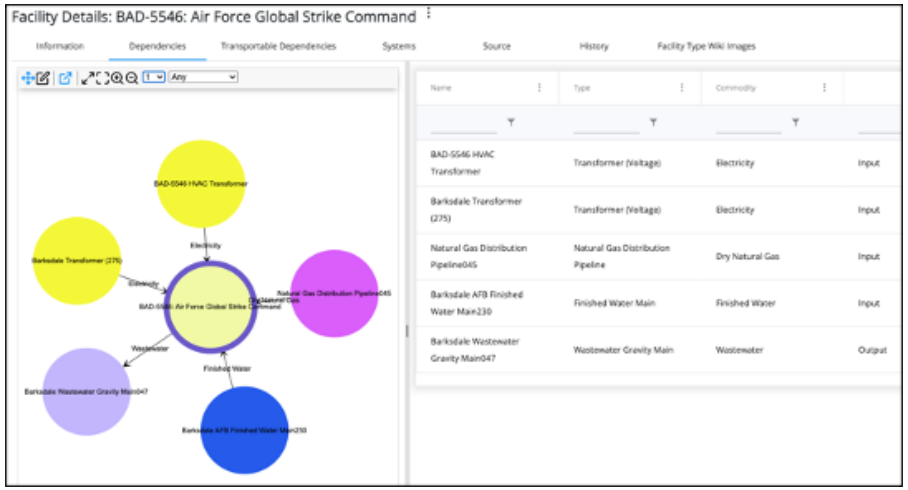
- Infrastructure (utilities, facilities, subfacilities) overlayed on GIS view
- DEEPR architecture
- Dynamic SPOF Analysis
- Apply defined threats over geographic regions or areas
- Run scenarios and calculate Mission Availability over time for each element in the DEEPR architecture
- Export the SPOF, task enabler gap, and scenario data for use in the MA-TT Analysis Tool

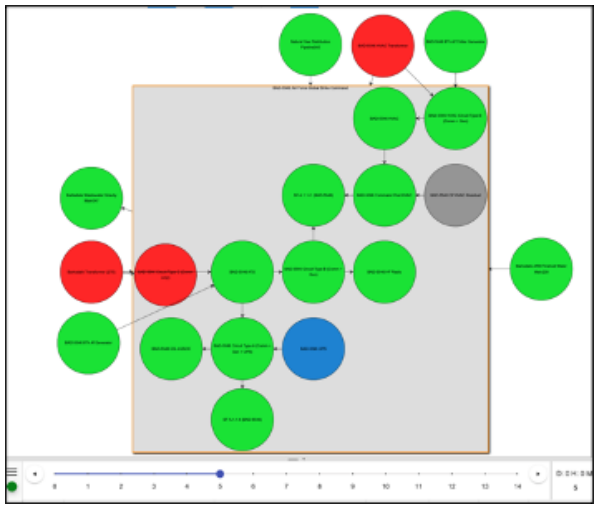
MA-TT Analysis Tool:

- Imports the data from the MA-TT Modeling Tool
- Displays the mission architecture in a tree view, showing the entire mission dependencies
- Displays SPOF and scenario data in both the tree view and scenario dashboard
- Provides a way to display the resulting analysis in meaningful graphics

Demonstration of the MA-TT Toolset

MA-TT Modeling Tool





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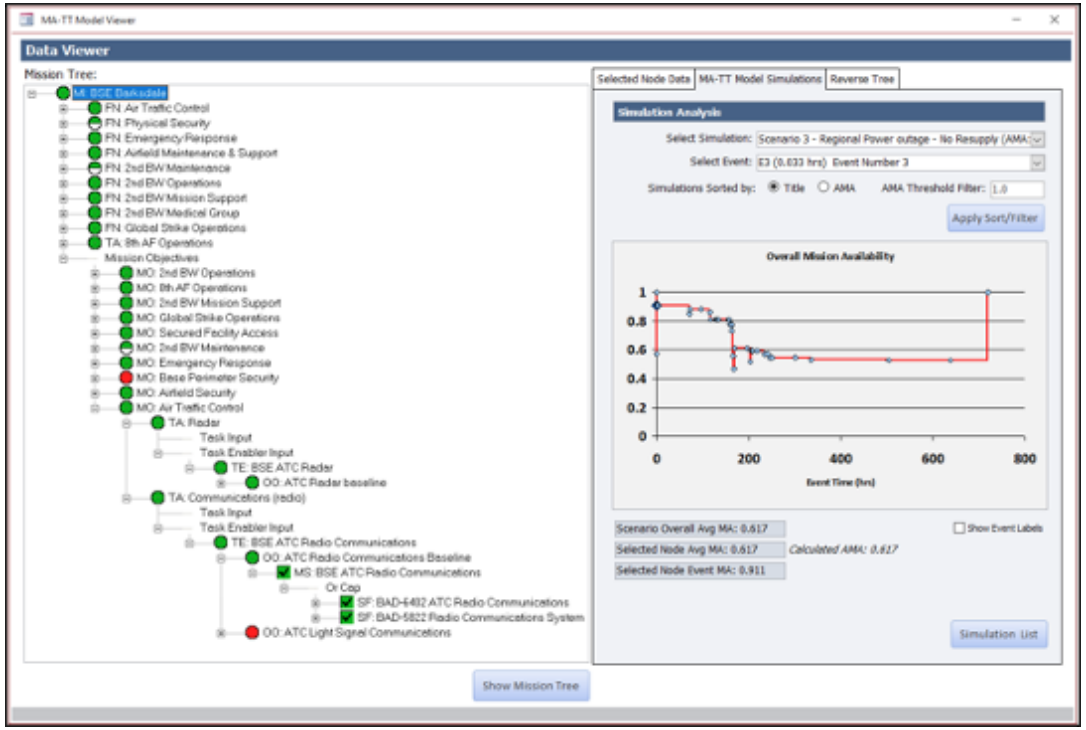
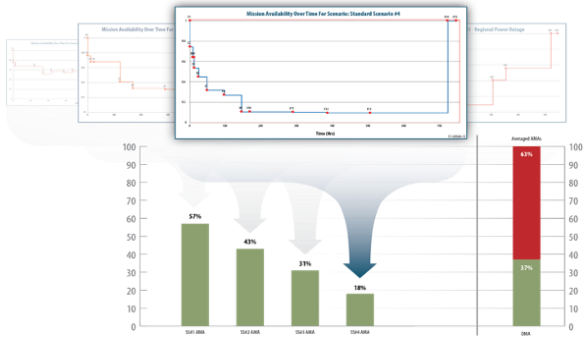
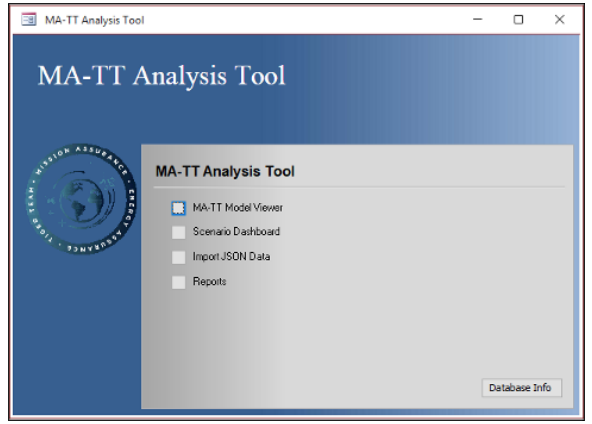
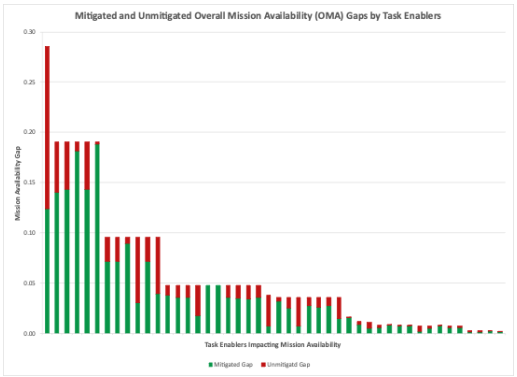
Demonstration of the MA-TT Toolset

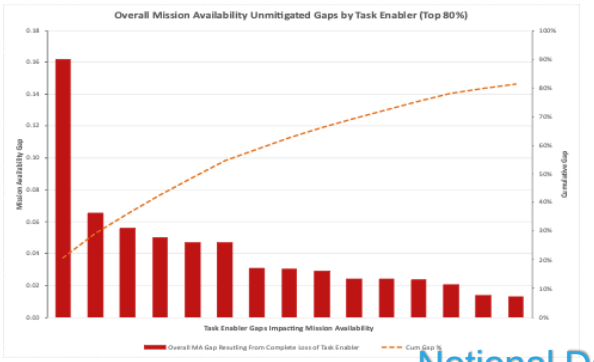
MA-TT Analysis Tool











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Continuing Advancements

- Integrate additional mission assurance elements as parallel enablers to power for mission availability
  - Water, security, wastewater services, etc.
- Consider additional threat-based scenarios such as climate-caused impacts or cyber-contested environments as important evaluations for resilience
  - Increasing water levels
  - Supply chain impacts
- Combine MTA process with Energy Resilience Readiness Exercise (ERRE) for a fully validated model
  - Can perform tabletop exercises to evaluate over longer outages that can be demonstrated by the ERRE (typically <16 hours)
  - Evaluate COAs among all organizations at an installation

Contact Information

Mike Darby

MTA Team Lead

Idaho National Laboratory

Systems Engineering & Analysis

UNCLASS: michael.darby@inl.gov

SIPR: michael.darby@Idaho.doe.sgov.gov

208-526-0737

Idaho National Laboratory

Backups

- DEEPR Architectural Elements & Descriptions

DEEPR Architectural Elements & Descriptions

Mission	Mission is decomposed into critical outcomes called Mission Objectives
Mission Objectives	Mission Objectives decompose into a logical set of Tasks (e.g. FFBD)
Functions	Functions are used to hierarchically organize Tasks
Tasks	Tasks convert inputs into products using Task Enablers
Task Enablers	Task Enablers provide the ability to perform a Task
Operational Options	Operational Options are alternative approaches to provide the Task Enabler with or without degradation
Mission Systems	Mission Systems are required to be available to provide the associated Operational Option
Physical Asset & Sub-Systems	Physical Assets & Sub-Systems required to provide Mission Systems availability
Facilities	Facilities contain the Physical Assets and Sub-Systems and connect to AF Utilities and Lifelines
AF Utilities & Lifelines	AF Utilities and Lifelines provide Physical Assets and Sub-Systems required enablers
Commercial Utilities & Lifelines	Commercial Utilities & Lifelines provide the AF Utilities and Lifelines