SYSTEMS ENGINEERING
Research Center

Georgia Tech Research Institute

Application of Portfolio Management Techniques to Software-Heavy Systems of Systems

RT-147 building on RT-112

By
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OVERVIEW

1. RT-112: FACT Portfolio Management Capability
2. Portfolio Management Analysis Tool
3. RT-147: Application of Portfolio Management Techniques to Software-Heavy Systems of Systems

RT-112: FACT Portfolio Management Capability

BACKGROUND

In 2014, SERC supported Marine Corps Systems Command (MARCORSYSCOM) in review of the Global Combat Support System – Marine Corps (GCSS-MC) via RT-112. In that task, GTRI:

1. Developed an evaluation framework utilizing portfolio management strategies to support the War Room in evaluation of portfolio alternatives to solve the GCSS-MC challenge.

2. Defined a plan for a Portfolio Management Analysis Tool with comprehensive capabilities for (1) capturing and iterating on a problem statement and defining requirements, (2) managing data, (3) analyzing data and exploring portfolio alternatives.

3. Began development of the PMAT completing a portion of the planned modules.

PORTFOLIO ANALYSIS MANAGEMENT TOOLSET (PMAT)

- Framework for portfolio development and analysis
  - —Model-Based Systems Engineering standards
  - —Browser-based front-end
  - —Web hosted
  - —Open source software
- User and facilitator work together
- Process separated into modules
  - —State the problem and define requirements
  - —Manage data
  - —Analyze and explore options

PMAT: REQUIREMENTS

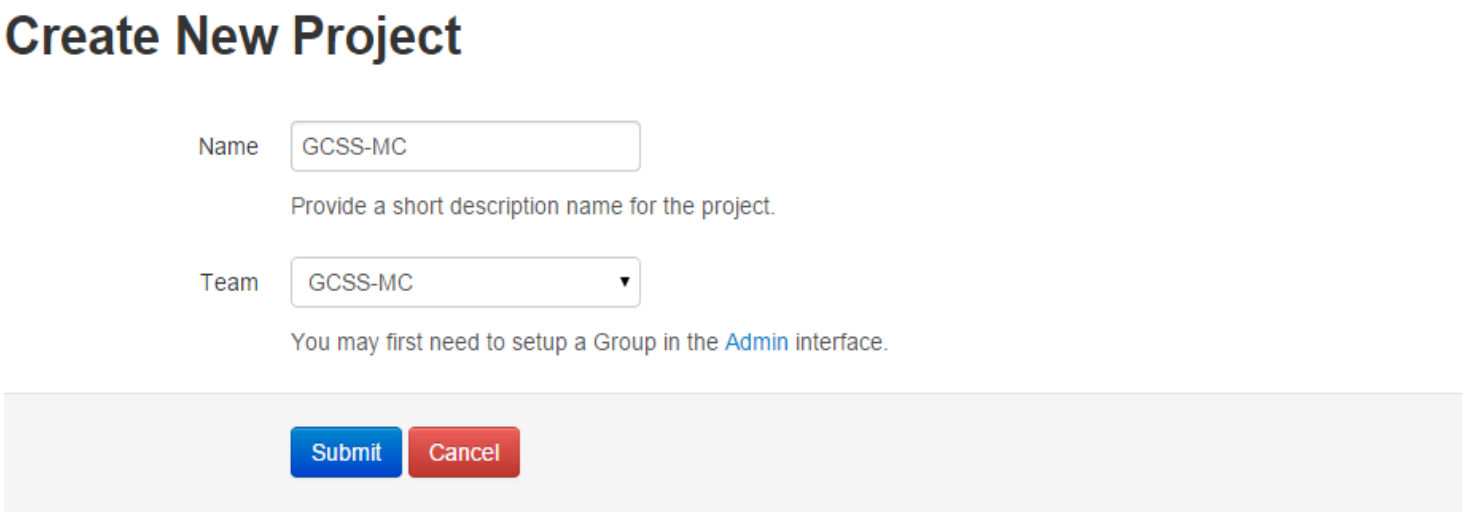
- The Requirements module develops
  - —Problem statement
  - —High-level capabilities
  - —Well-defined requirements
- Track history of drafts and revisions
- Make notes
- Refer to external documents
- Add important terms to a glossary
- Assign responsibilities
- Prioritize requirements according to a user-defined scale (e.g. blocker, critical, major, minor, trivial)

PMAT: Well-Defined Requirements

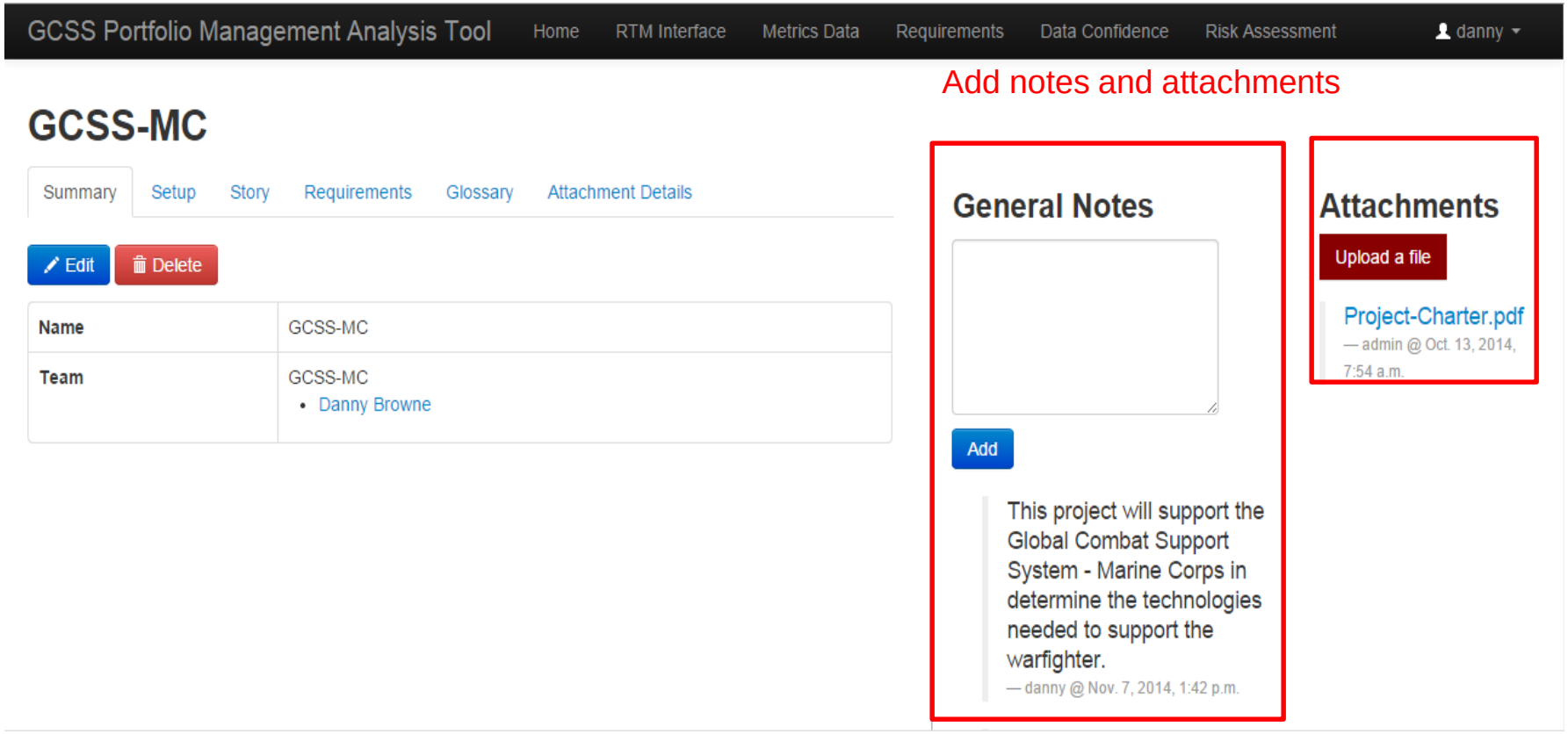
Characteristic	Explanation
Unitary (Cohesive)	The requirement addresses one and only one thing.
Complete	The requirement is fully stated in one place with no missing information.
Consistent	The requirement does not contradict any other requirements and is fully consistent with all authoritative external documentation.
Non-Conjugated (Atomic)	The requirement does not contain conjunctions.
Traceable	The requirement meets all or part of a business need as stated by stakeholders and authoritatively documented.
Current	The requirement has not been made obsolete by the passage of time.
Unambiguous	The requirement is concisely stated and expresses objective facts, not subjective opinions.
Specify Importance	The requirement must specify a level of performance.
Verifiable	The implementation of the requirement can be determined through basic possible methods: inspection, demonstration, test (instrumental) or analysis (to include validated modeling and simulation).

PMAT: REQUIREMENTS

1. Create new project and assign it to a user group



PMAT: REQUIREMENTS



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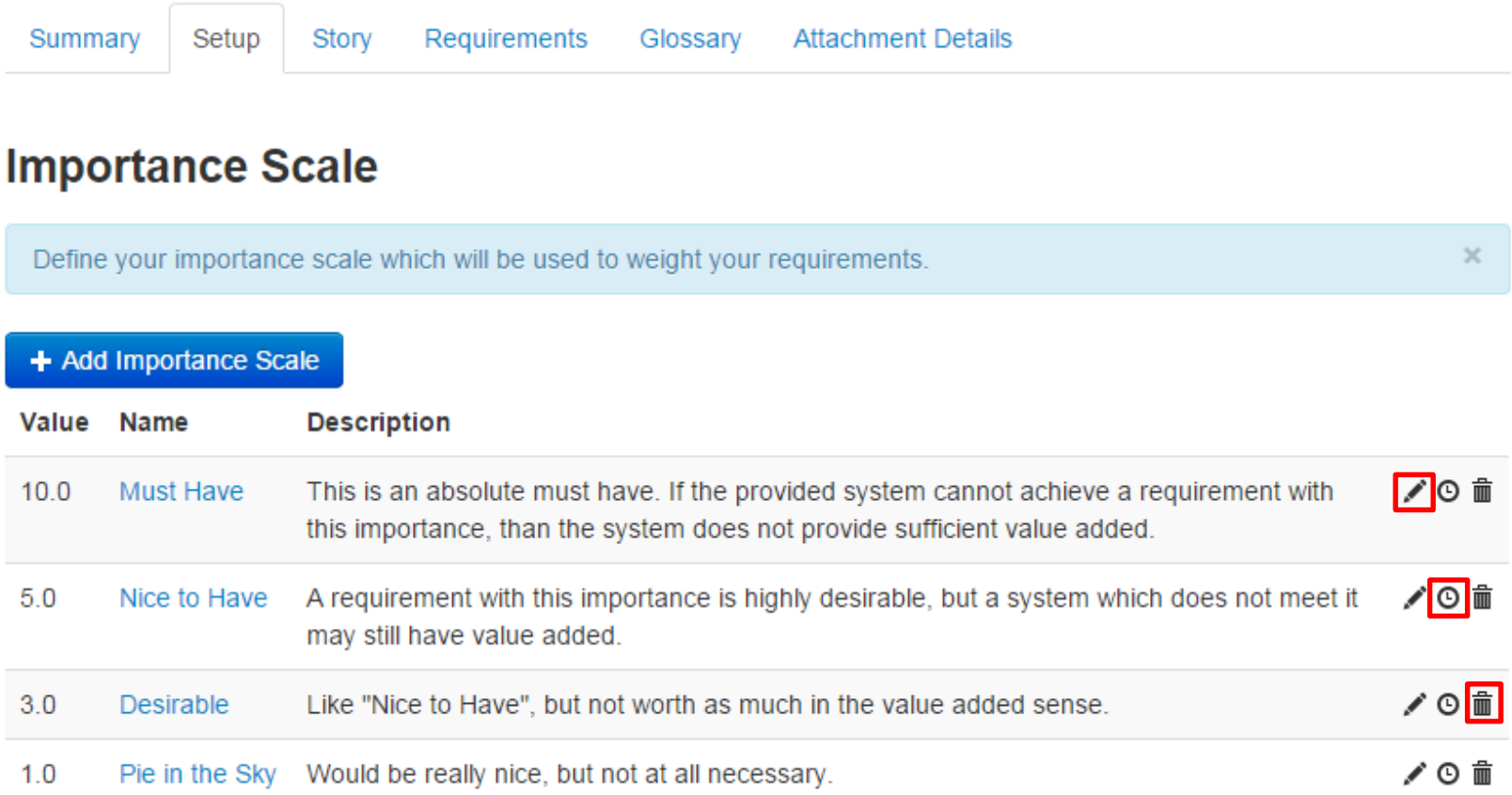

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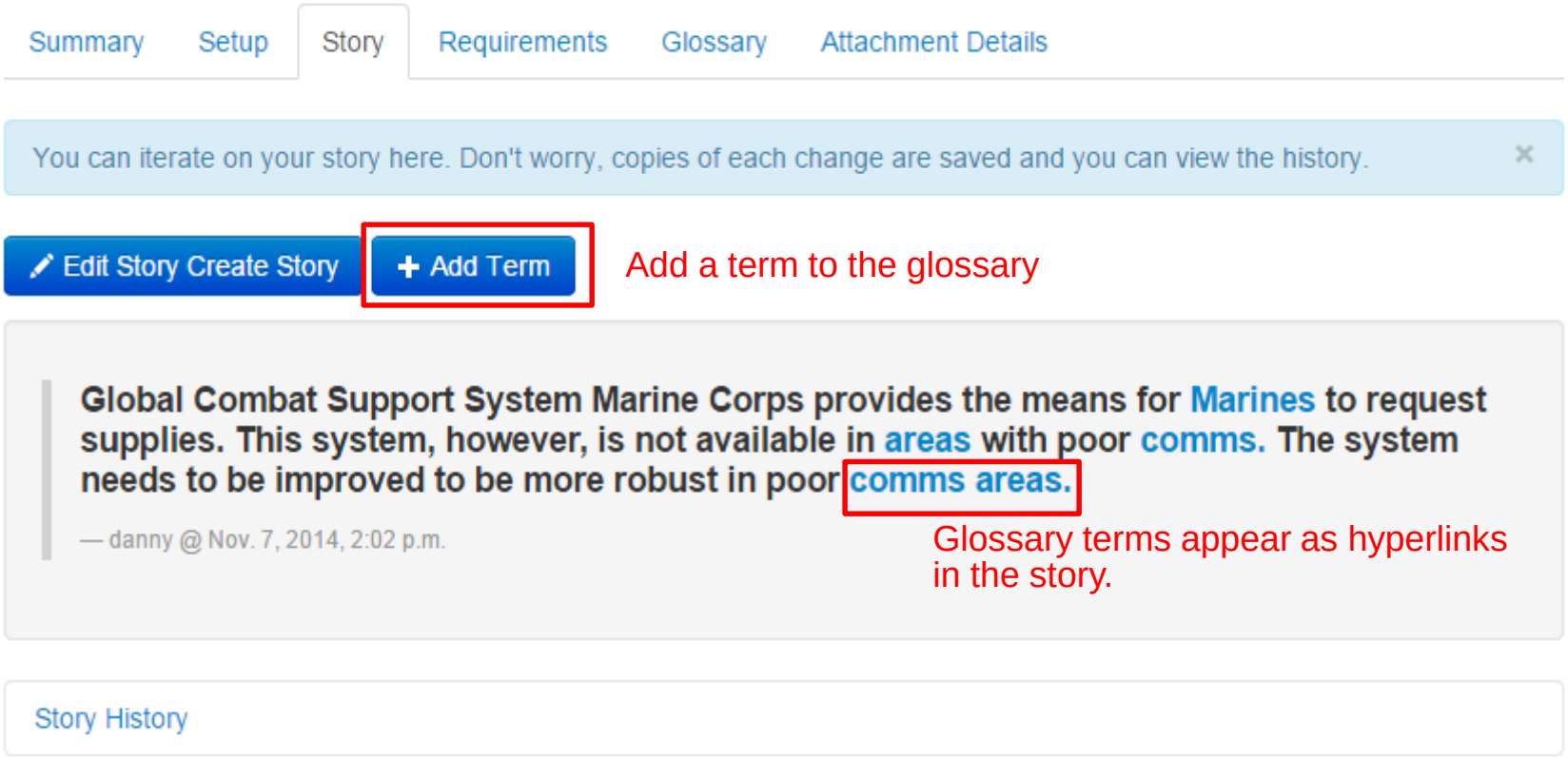

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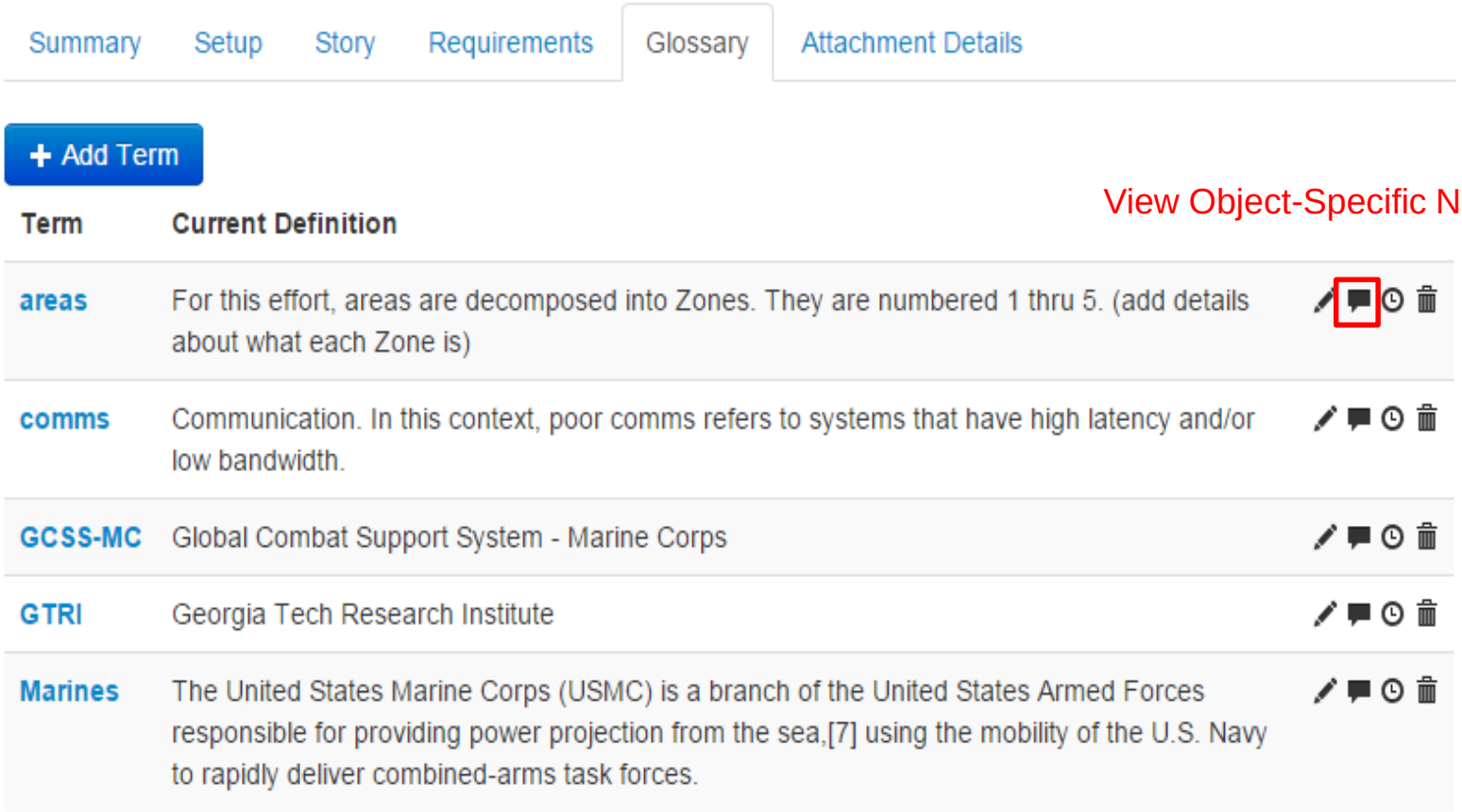
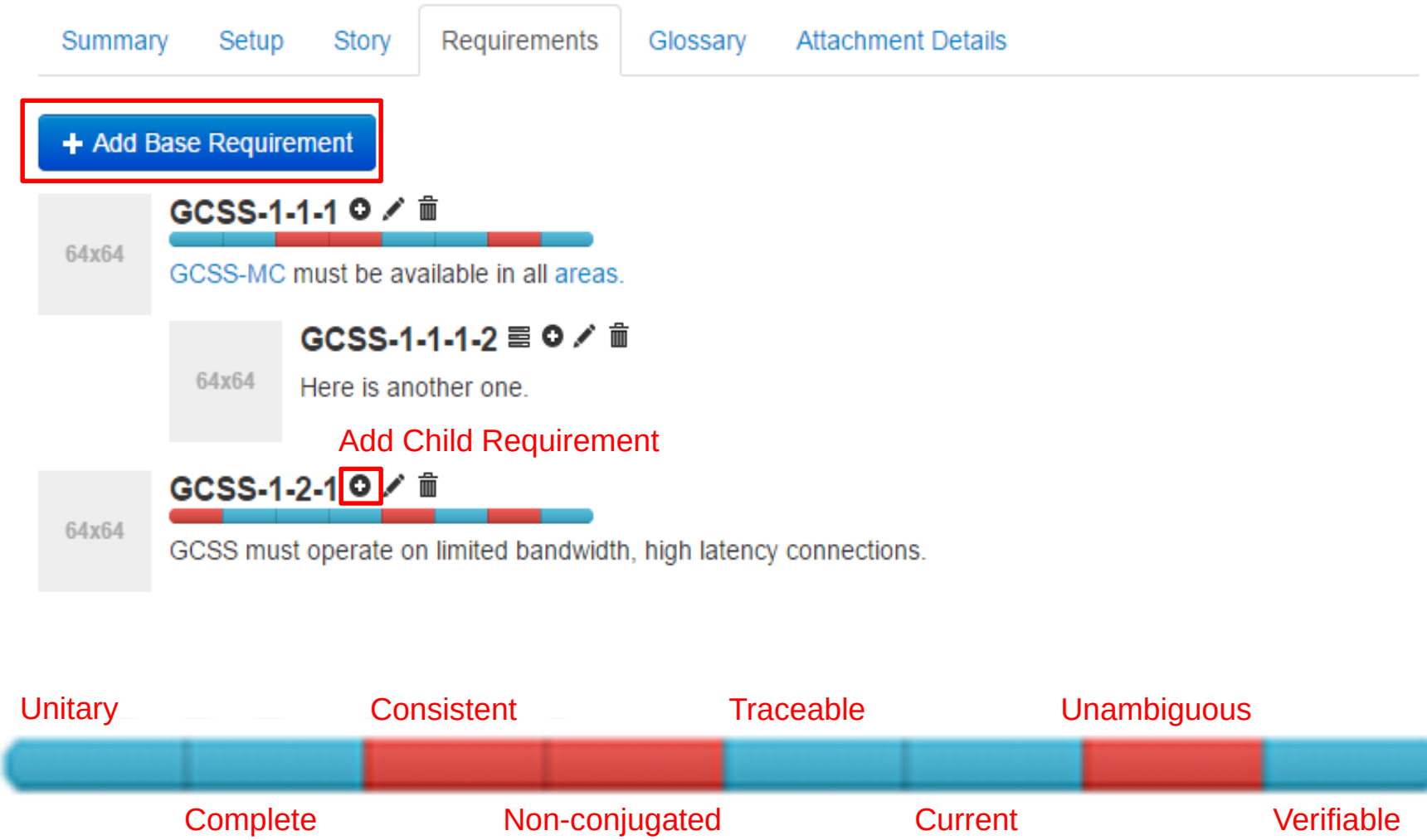


The glossary ensures the team is utilizing the same vocabulary.

PMAT: REQUIREMENTS



External Data

- Incorporate external data into the analysis
  - —GCSS-MC Requirements Traceability Matrix
  - —Option metrics data
  - —Oracle database reports
- Automatically parse files with custom formats
- Focus on data quality instead of simple transformation

Data Exploration

DIMENSION 1: 3

DIMENSION 2: 4

SELECT A SLICE OF THE DATA

	METRIC 1	METRIC 2	METRIC 3
ITEM 1	*0.00*	*0.00*	MISSING VALUES
ITEM 2			ARE RED
ITEM 3	*0.00*	*0.00*	*0.50*

- Option metrics data is 4-dimensional
  - Solution Option
  - Metric
  - Bandwidth Demand
  - Network Latency
- Inspect 2-dimensional slices
- Works for any multidimensional data set

Data Confidence

- Some data (e.g. vendor surveys) are not necessarily trustworthy
- Is *this vendor* exaggerating the response to *this question*?

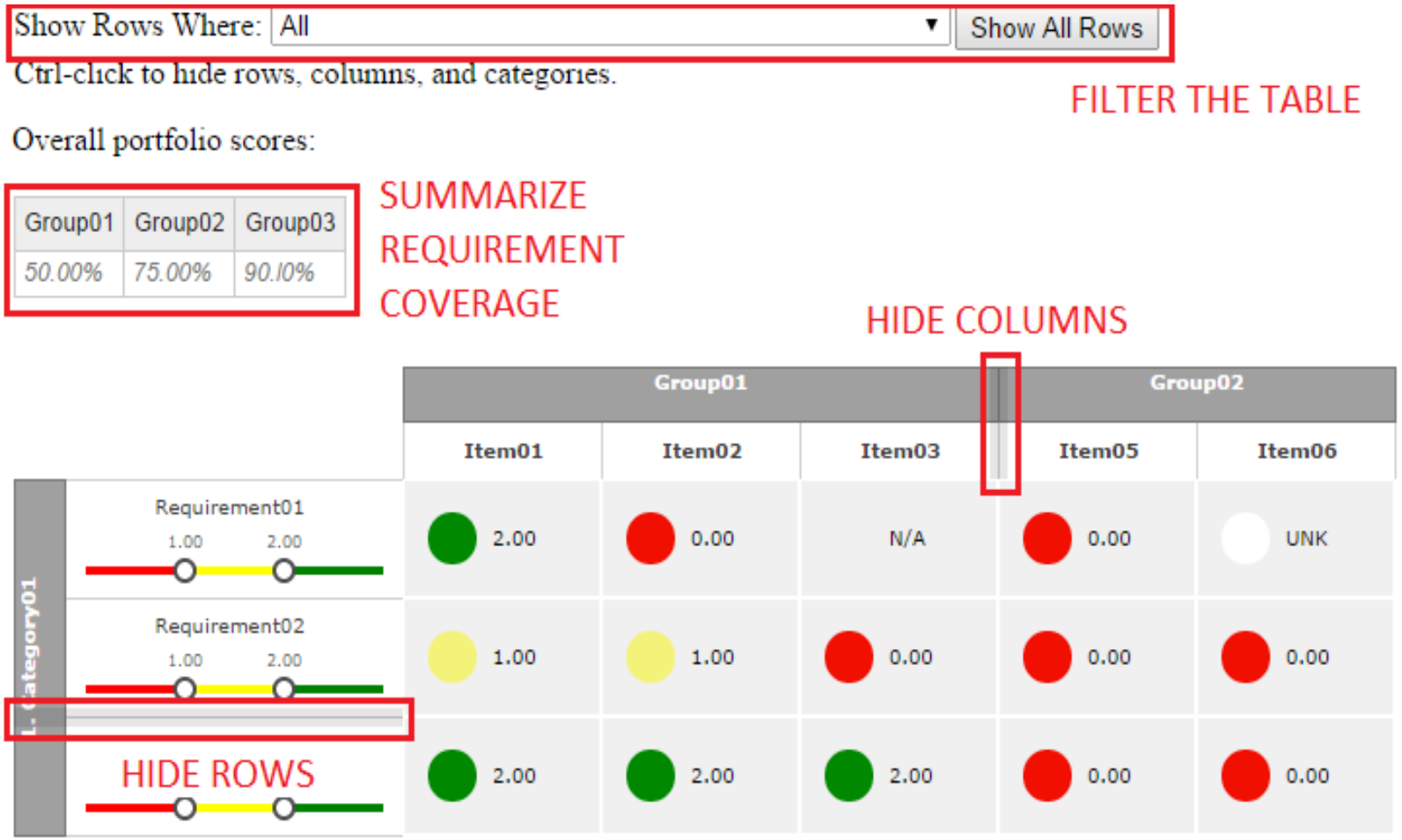
1. How trustworthy is each vendor?
2. How specific (unambiguous) is each question?

$$\begin{bmatrix} r_{1,1} & \cdots & r_{1,n} \\ \vdots & \ddots & \vdots \\ r_{m,1} & \cdots & r_{m,n} \end{bmatrix} = \begin{bmatrix} v_1 \\ \vdots \\ v_m \end{bmatrix} \times \begin{bmatrix} q_1 & \cdots & q_n \end{bmatrix}$$

$$m \times n \qquad m \times 1 \qquad 1 \times n$$

$$\text{Matrix of Response Confidence} = \text{Vector of Vendor Trust} \times \text{Vector of Question Specificity}$$

Display Requirement Coverage



Calculate the Requirement Coverage

Icon	Value	Description
2.00	2	The objective value of the requirement is achieved.
1.00	1	The threshold value of the requirement is achieved.
0.00	0	The requirement is not met.
N/A	0	The requirement does not apply.
UNK	0	The status of the requirement is unknown.

$$Portfolio\ Value = \max_{Components} \{Component\ Value\}$$

$$Portfolio\ Score\ (\%) = \frac{\sum_{Requirements} Portfolio\ Value}{2 \times Number\ of\ Requirements} \times 100$$

PMAT: Future Modules

- Survey Builder
  - —Convert well-defined requirements into a market survey
  - —Visualize survey responses
- Integration Risk Assessment
  - —Measure the risk inherent in combining a set of systems into a portfolio
- Metrics Analysis
  - —Calculate a portfolio score using the metrics for each system
- Document Library
  - —Store, share, and version reference material
- Data Citation
  - —Associate data with its authoritative source

RT-147: Application of Portfolio Management Techniques to Software-Heavy Systems of Systems

RT-147 CHALLENGE

After the work completed in review of GCSS-MC, another team has been chartered to conduct a review of the entire USMC Log IT Portfolio. The overarching goal of the effort is to identify the full set of basic functions required across the Log IT Portfolio, and develop alternative sets of software portfolios which reduces the number of unique systems required while offering equivalent or superior capability as the existing portfolio.

RT-147 RESEARCH DIRECTIONS

Three specific research directions have been identified to support the USMC LogIT Portfolio Review.

ONE System of Software Systems Evaluation Methodologies

TWO Functional Decomposition and Requirements Capture Tool

THREE Functional Coverage and Evaluation Comparison Visualizations

RESEARCH DIRECTION ONE

Build upon the work from RT-112 to develop new modeling approaches and methodologies that scale from one software system to a system of software systems.

Additionally, develop evaluation and scoring methods specifically geared towards software systems like those within the Log IT portfolio. Software attributes that will be considered as inputs to these evaluation methods will include:

- source lines of code (sloc)
- open systems architecture
- code quality
- modularity
- legacy

RESEARCH DIRECTION TWO

Design framework for capturing functional decomposition of Log IT portfolio, including parameter characterization and mapping of system attributes to function evaluation.

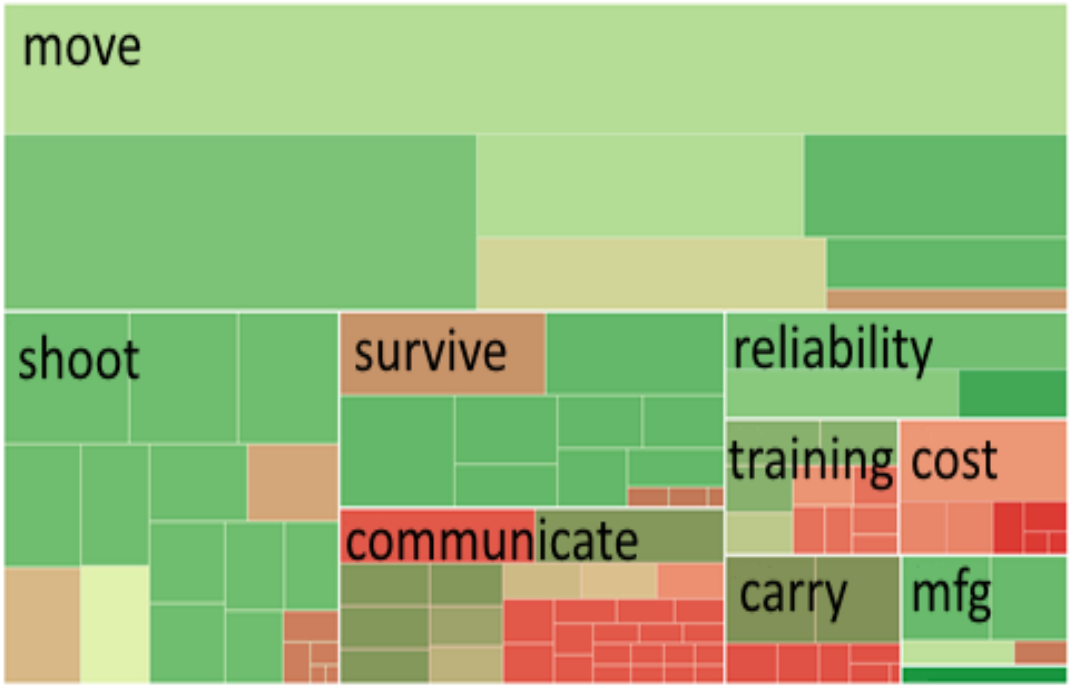
Proper execution of this task will ease the transition from functional decomposition to portfolio re-aggregation and evaluation.

RESEARCH DIRECTION THREE

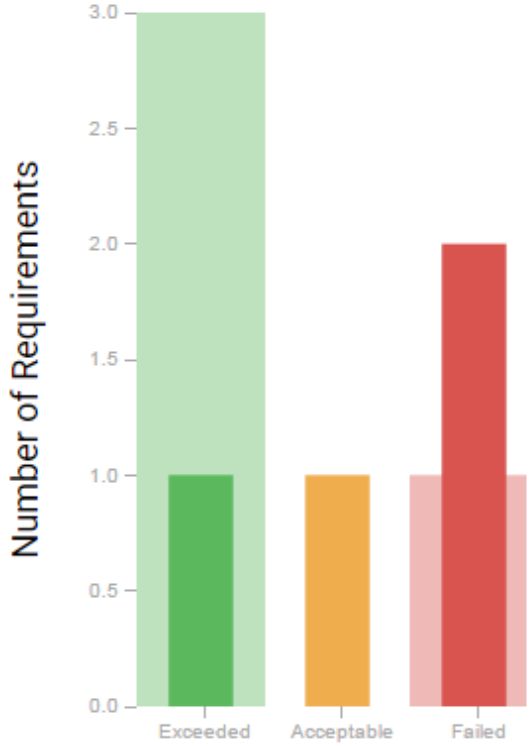
Design and implement data visualization techniques to offer insightful visualizations to decision makers. Visualizations will be required for inspecting the functional decomposition as well as the scoring methodology for the portfolio re-aggregation. Preferred implementation of these visualizations is within the same tool supporting the functional decomposition and data gathering.

RESEARCH DIRECTION THREE

Example visualizations developed under RT-117 for FACT 2.0.



Treemap showing requirements coverage.

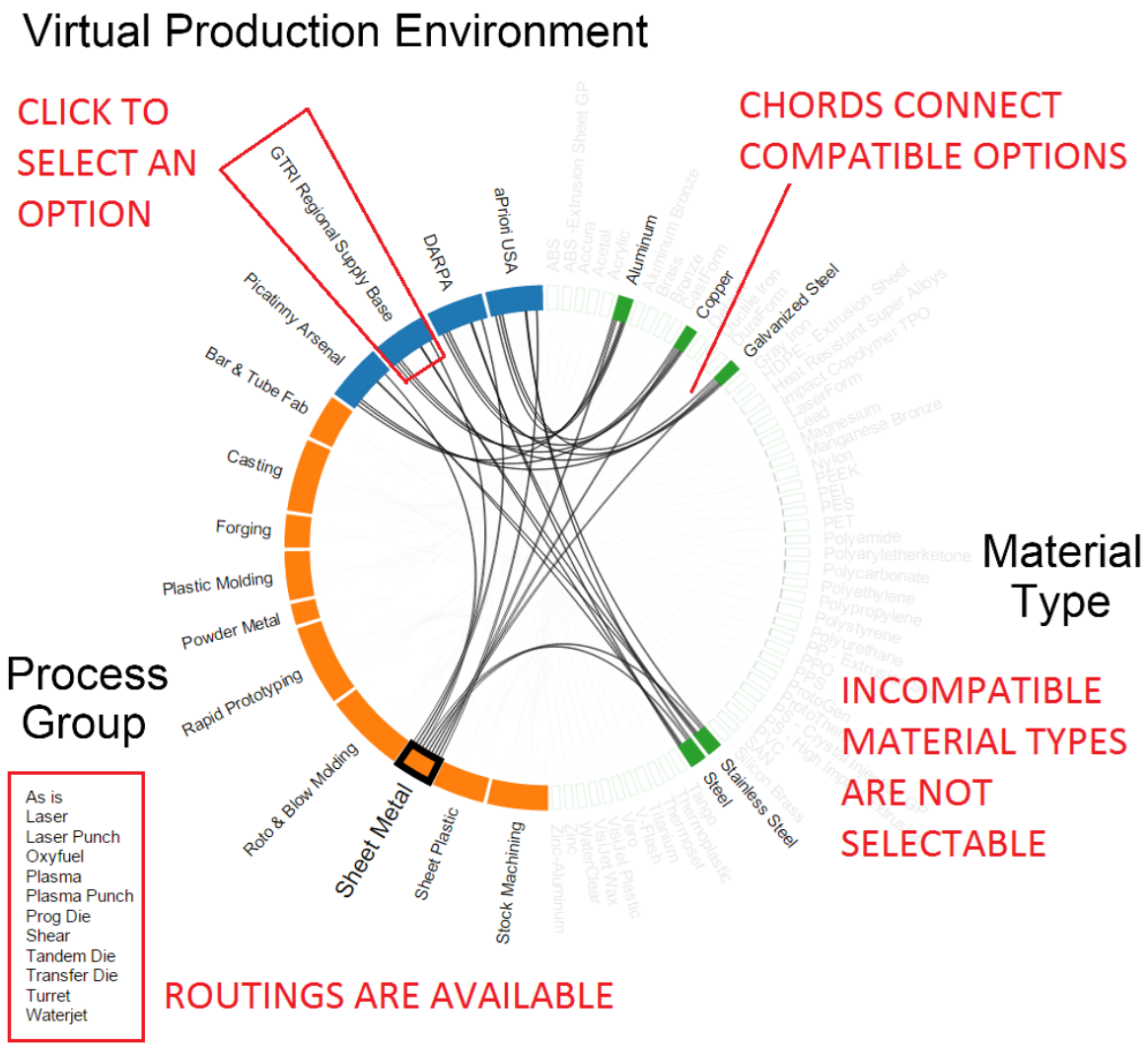


Layered bar chart for comparing two candidate solutions.

Example visualizations developed OSD DMS&T MANTECH

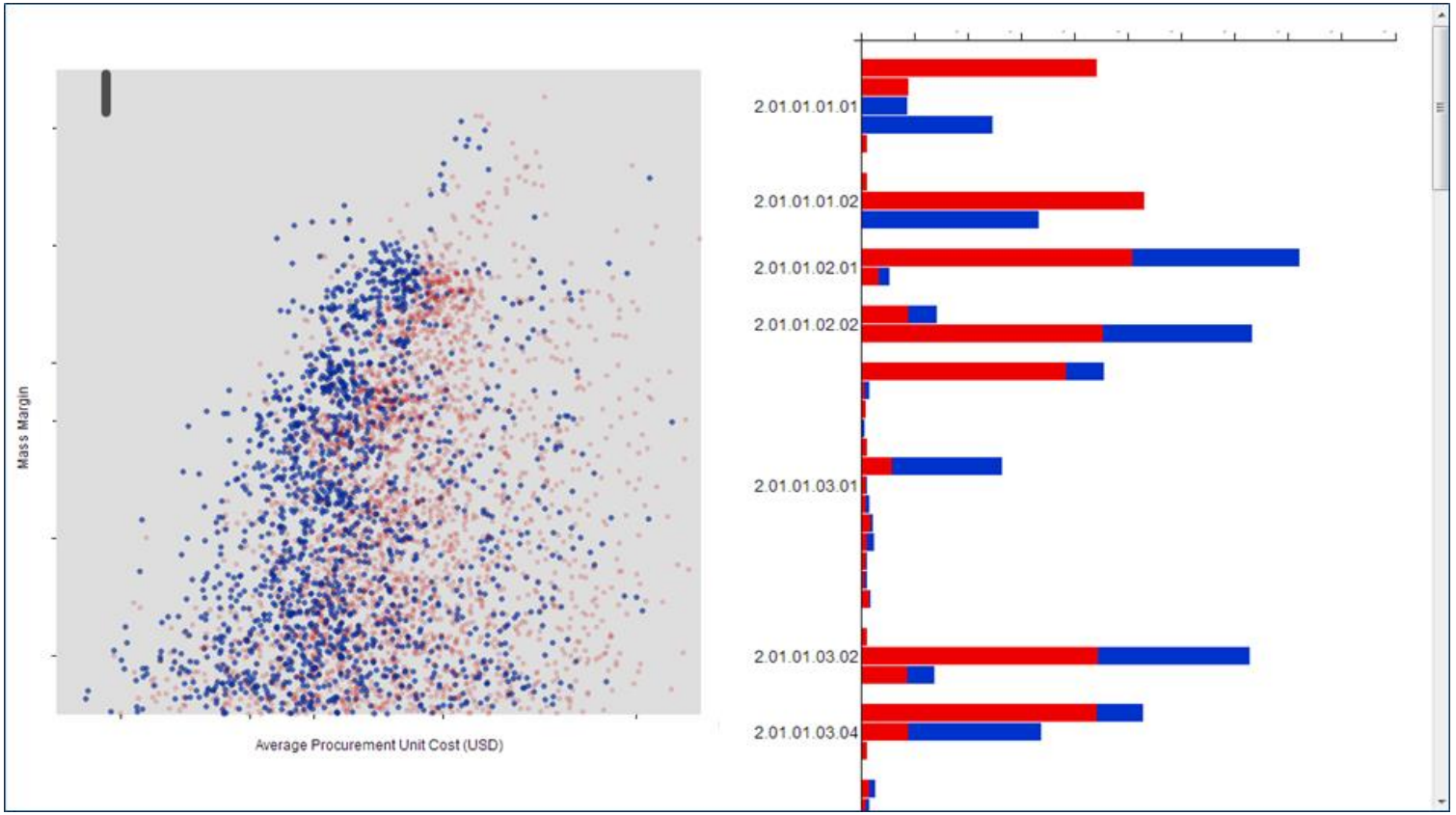
An interactive chord diagram offers a means to depict connections between alternatives from different categories.

If there are dependencies between alternatives from different categories, a chord diagram offers a means for an analyst to quickly identify invalid solution sets.



Example visualizations developed under early FACT work

This interactive coordinated scatterplot with bar chart offered a means identify the impacts of a specific alternative on the overall design, or vice-versa, identify alternatives that offered specific overall system cost or performance.



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