Clustered Monte Carlo on Cloud Systems

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Overview

- What Are Some of the Key Issues with Simulators today?
- What is a Monte Carlo Simulation?
- How Are Monte Carlo Simulations Useful to DoD?
- What Are Some of the Key Issues with Scaling Monte Carlo Simulations?
- How Have We Implemented Monte Carlo?
- How Can We Visualize the Results?
- Summary

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What Are Some of the Key Issues with Simulators today?

- Most users are forced to run one-time discrete event simulators as few SE modeling tools have a Monte Carlo capability
- Many users choose not to run simulations as their set up is complex and (in discrete event) their results are inaccurate
  - Often ignoring the 10% chance they fail
- Monte Carlo simulations are computationally expensive and are user time-consuming

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What Is A Monte Carlo Simulation?

- Modern version came from Los Alamos during the late 1940s
  - Stan Ulam, Nick Metropolis, and John Von Neumann
- Repeatedly samples random distributions to calculate non-deterministic problems
  - Critical as most measures have significant variances, which we capture as distributions
- Used in fluid dynamics calculations (e.g., aerodynamics), sensitivity analyses, and quantitative risk analysis

This technique has proven very useful for DoD problems

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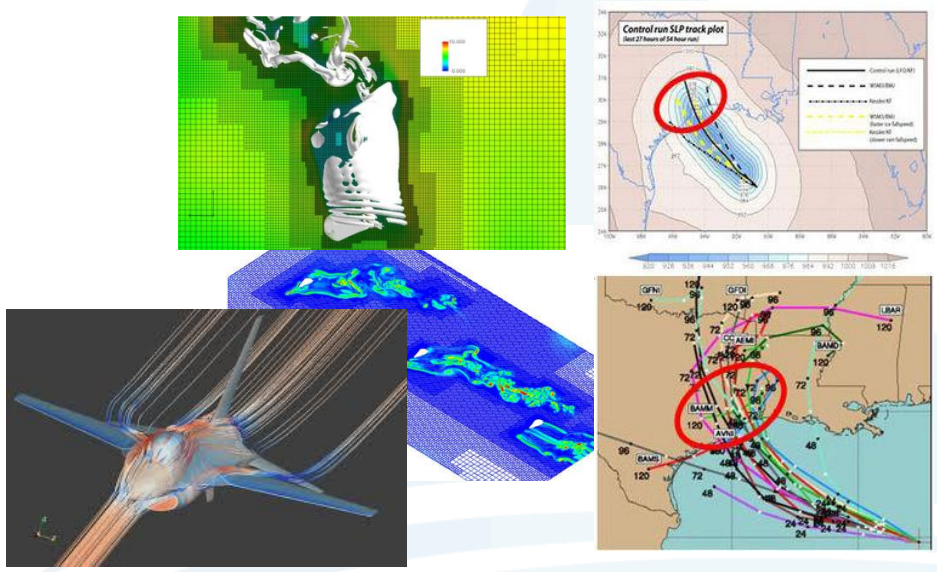
How Is Monte Carlo Useful to DoD?

- Statistical many-on-many engagement models
- Weather prediction/forecasting
- Support to V&V of complex, expensive systems
- Weapons effects modeling
- Cost estimation
- Fault-tree analysis
- …



New applications emerge every day

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What Are Some of the Key Issues with Scaling Monte Carlo Simulations?

- Most Monte Carlo simulators are single threaded
- Almost all are designed for a single desktop or server
- All resources of a single desktop or server are cannibalized; reducing worker productivity

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How Have We Implemented Monte Carlo?

- We developed a multi-thread, modularizing simulator
- The simulator scales automatically to use as many servers as needed for a particular problem
- Statistics are calculated in real time
- Uses advanced, scalable database technologies

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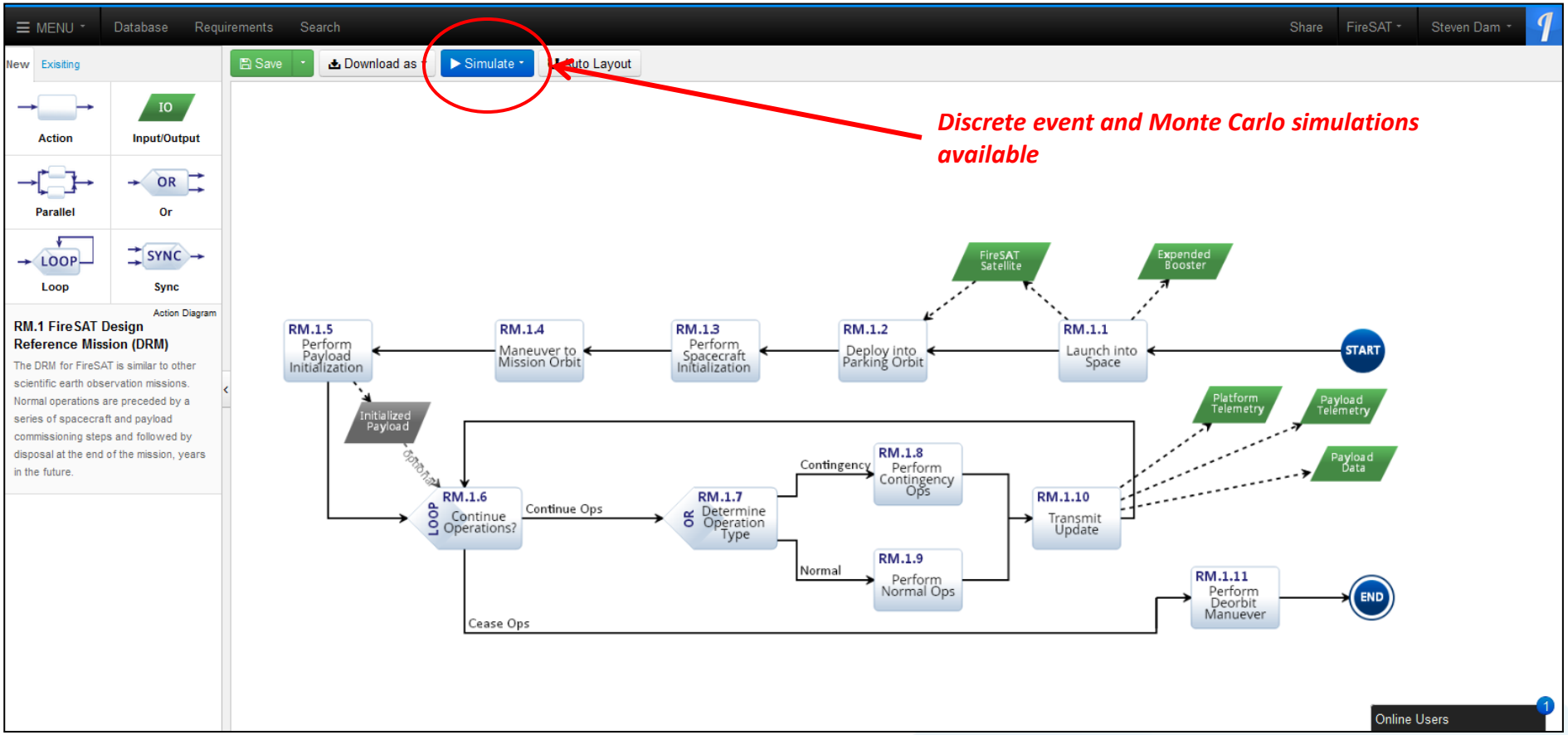
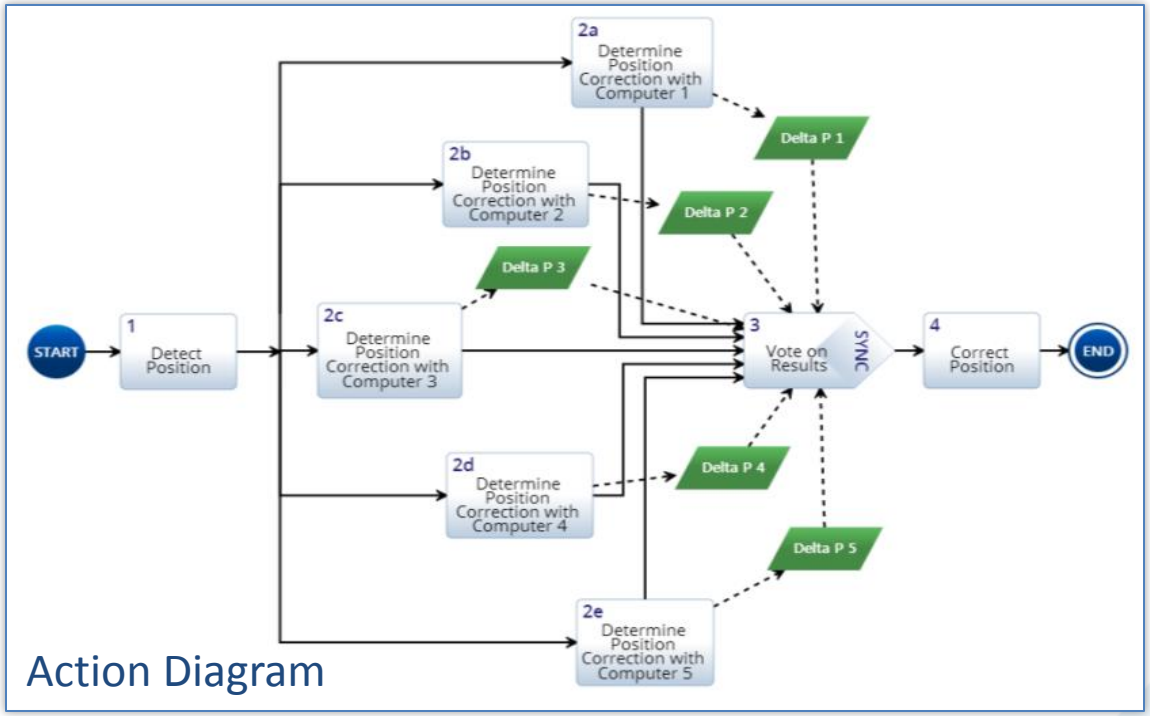
Action Modeling (Functional View)



We use the Discrete Event Simulation to test out paths and algorithms – we then use the Monte Carlo to gather statistically relevant information

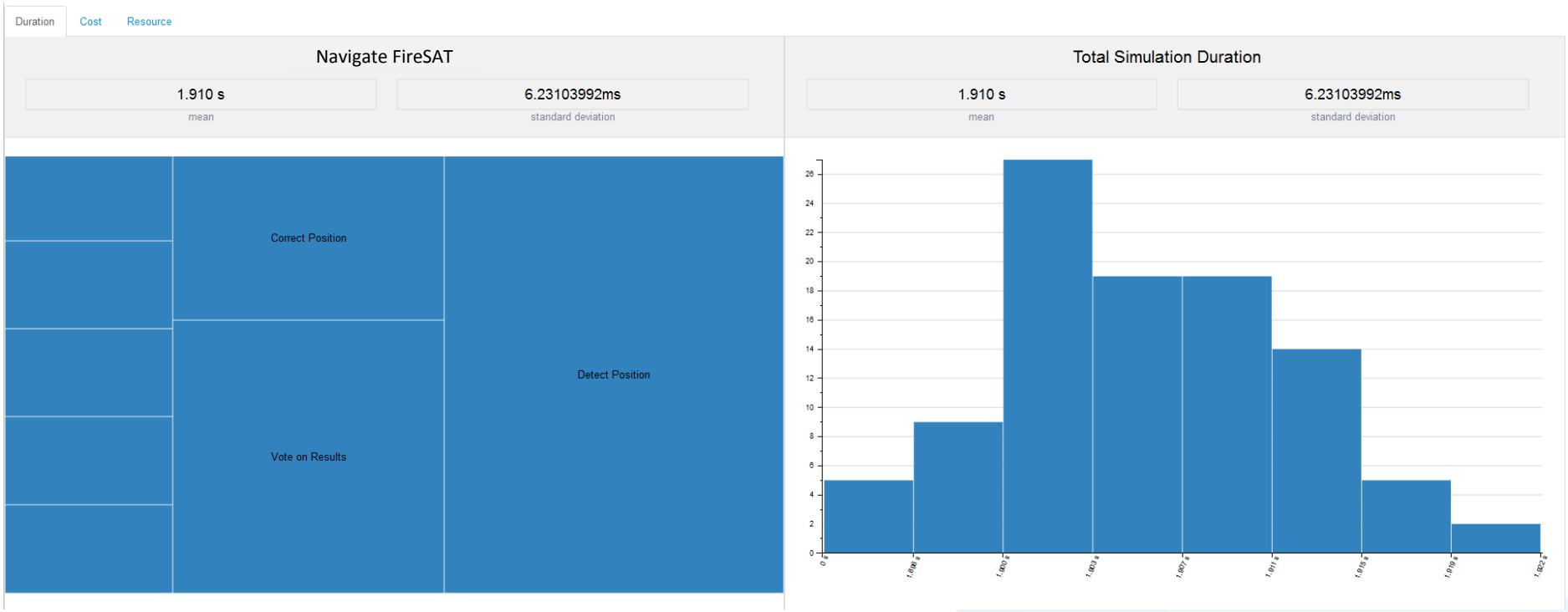
Voting Computers



Action Diagram

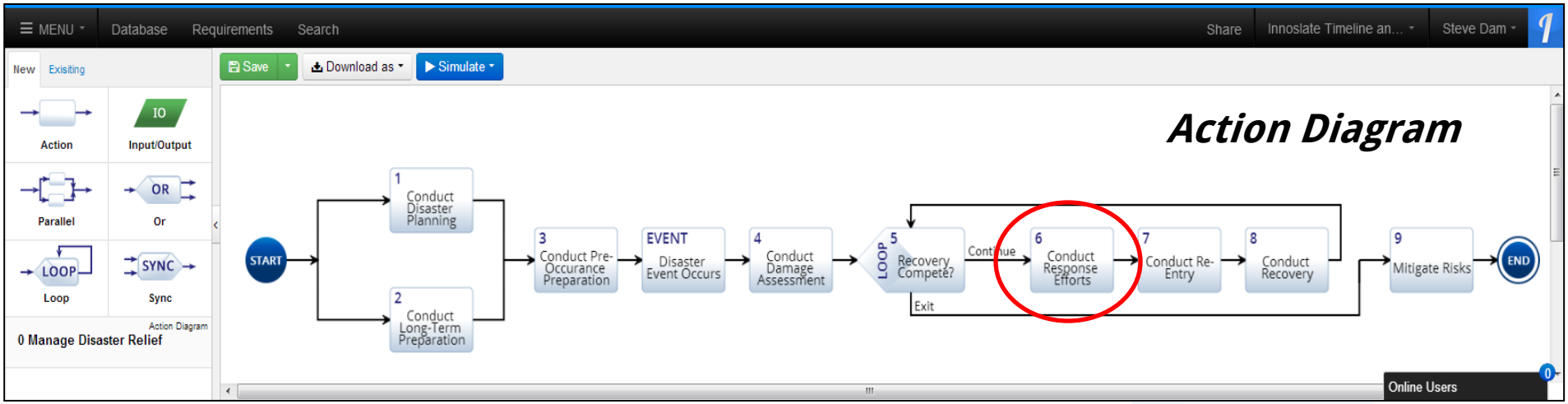
- Functional model equivalent using Action Diagram
- Timing provided for each computer can be a random distribution, as can failure modes

Monte Carlo Simulation of Action Diagram



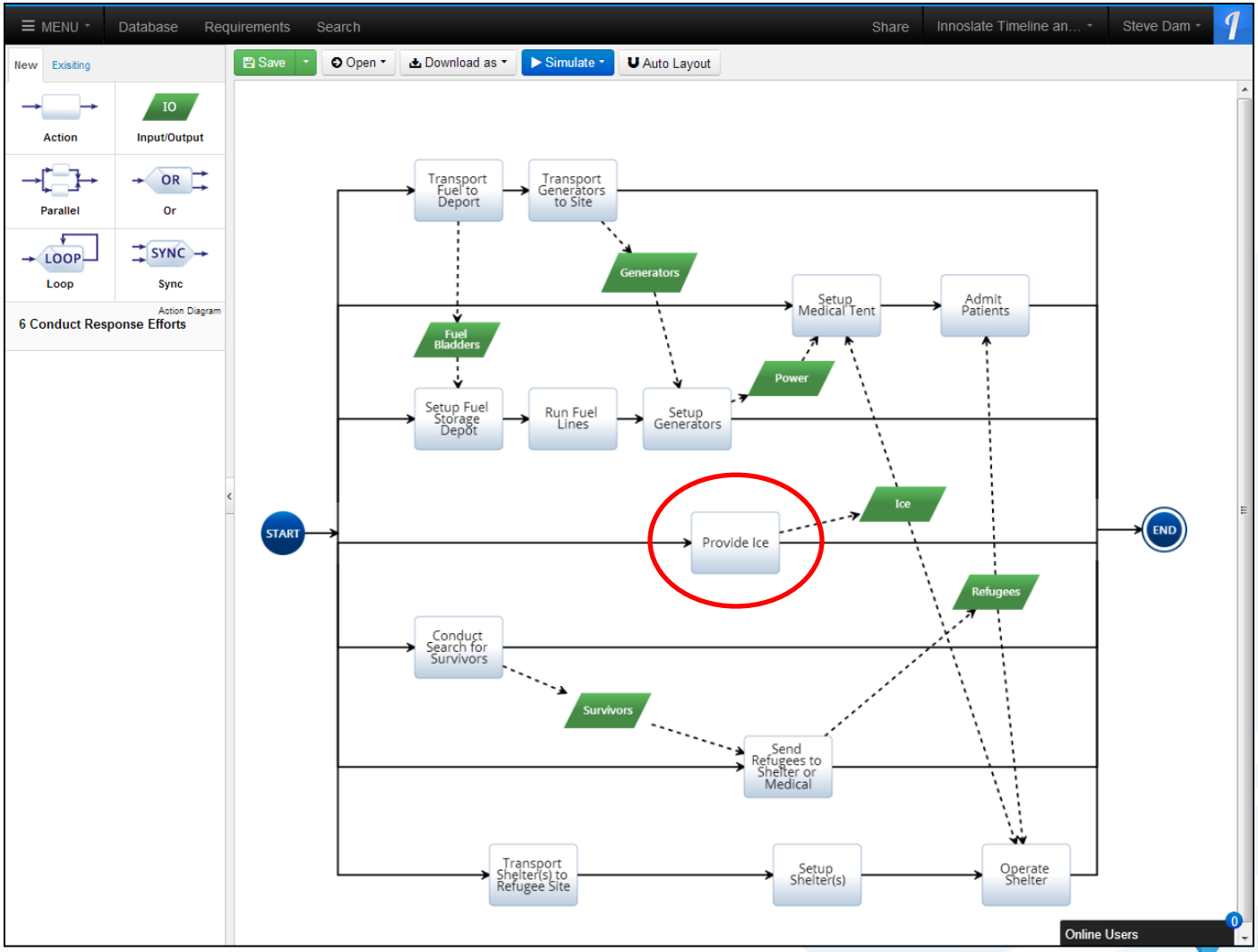
- Executing the model with random time distributions provides way to derive key metric requirements

Another Example: Disaster Response

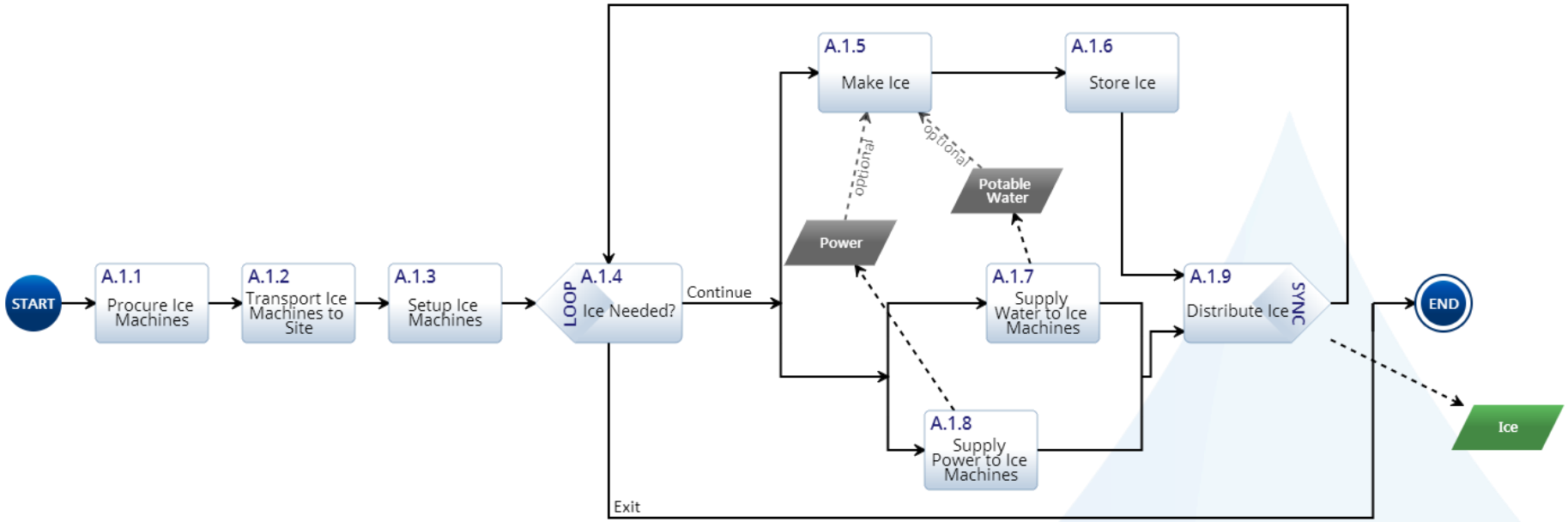


- Usually, a significant amount of disaster management planning has been done
  - Supplies are pre-positioned by State and National organizations (e.g., FEMA)
  - Detailed roles and responsibilities, MOU, contracts, etc. have been negotiated
- Focus on "Conduct Response Efforts"

Decomposed "Conduct Response Efforts"



Alternative 1: Make Ice Locally



- Adds complexity as significant amount of fault tolerance occurs on-site
- Less expensive option

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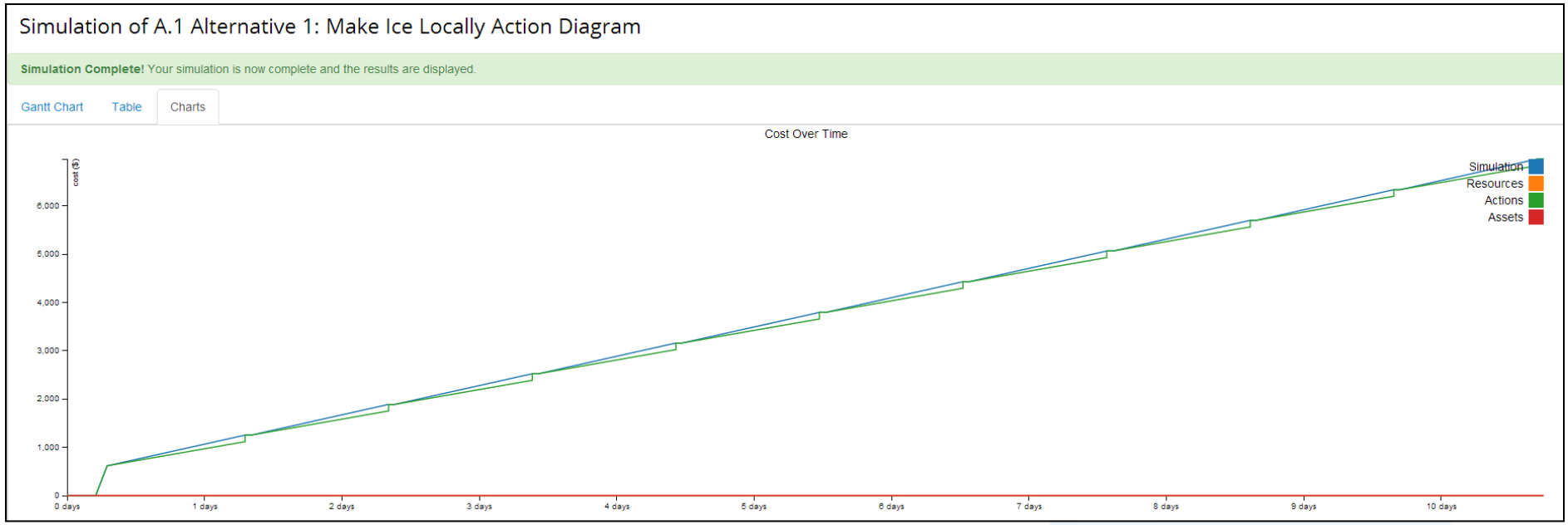
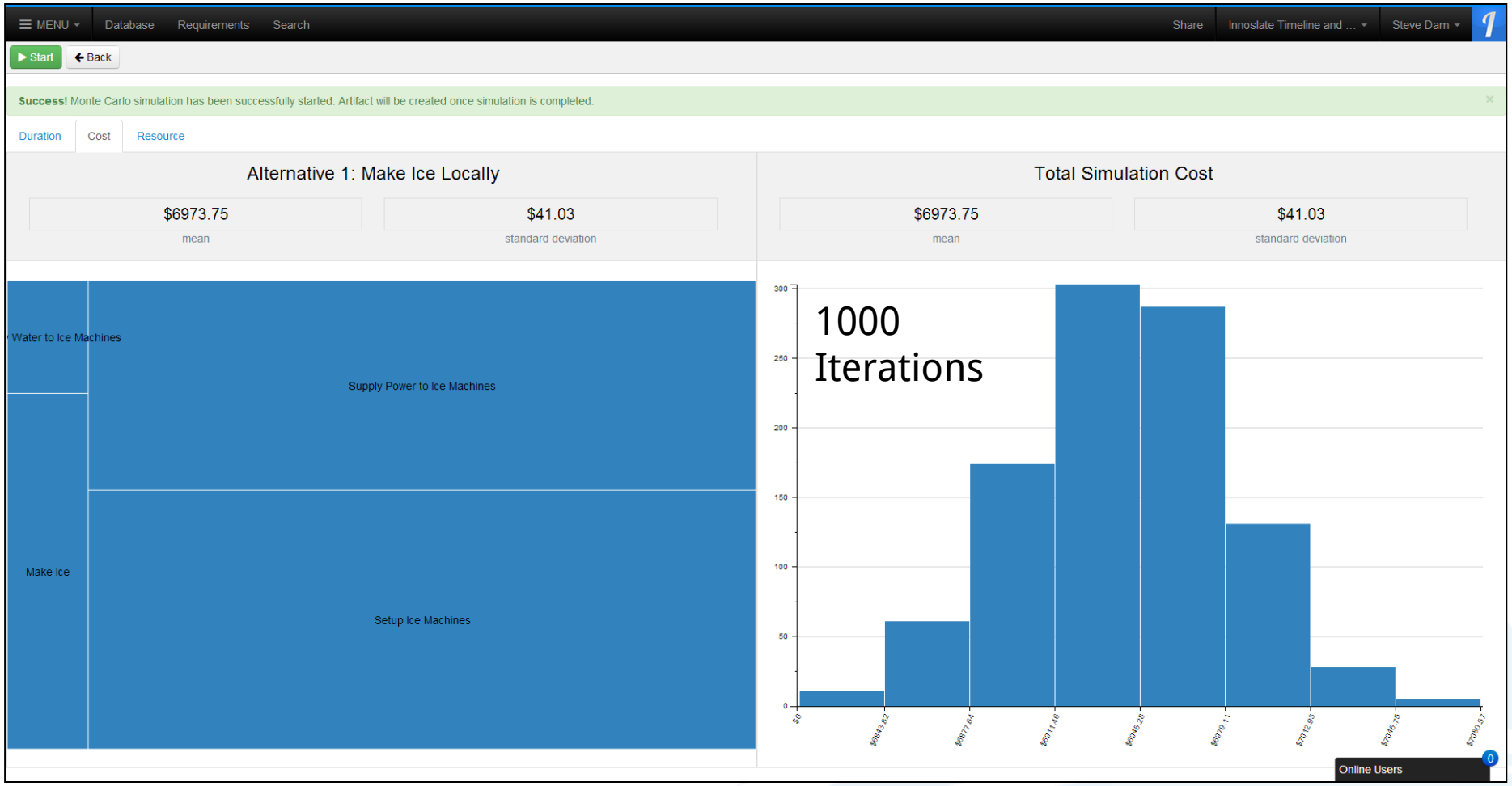
Discrete Event Simulation Results



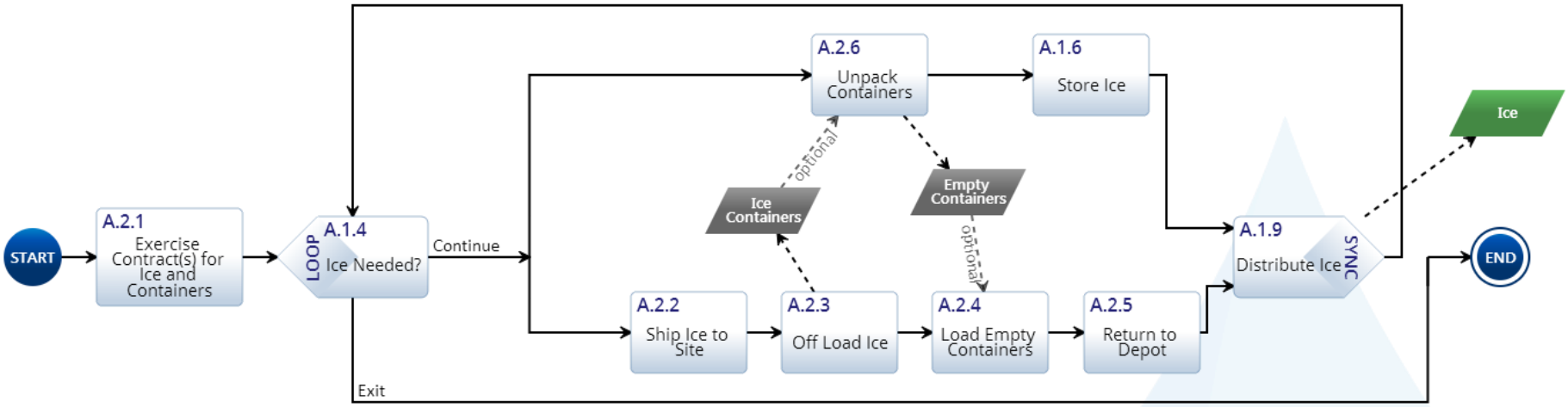
- Includes cost of setup, water and power needed to produce ice
- Total accumulated cost over 11 day <$7,000

Monte Carlo Simulation Results



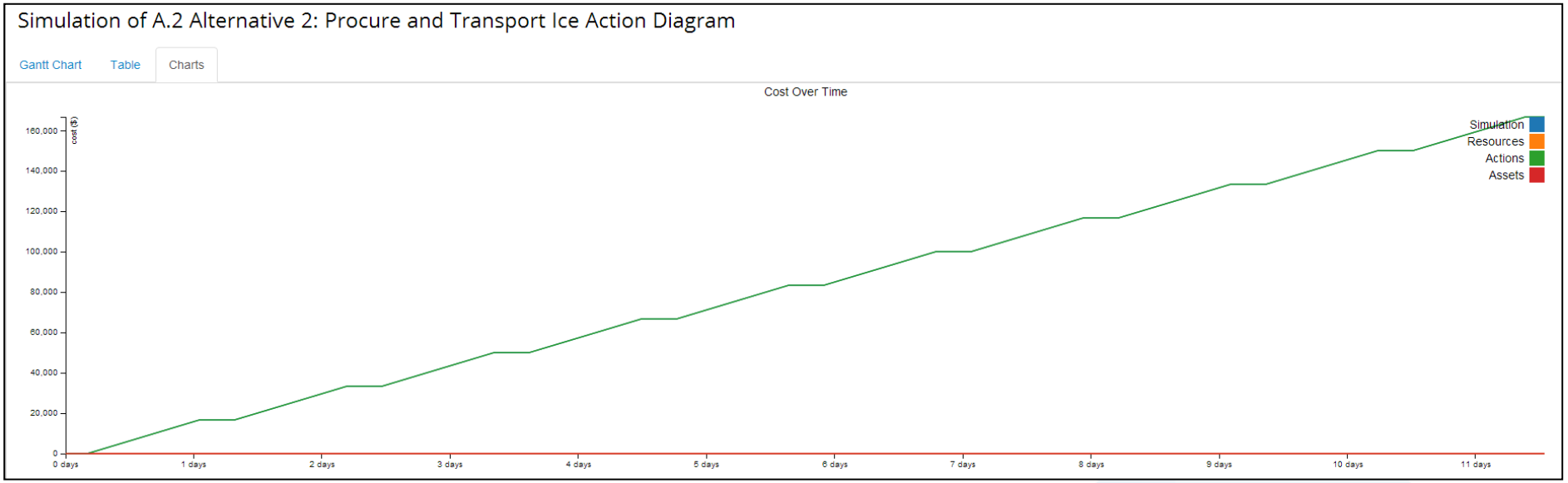
Note: Monte Carlo is only available on Pro Version

Alternative 2: Bring In Ice



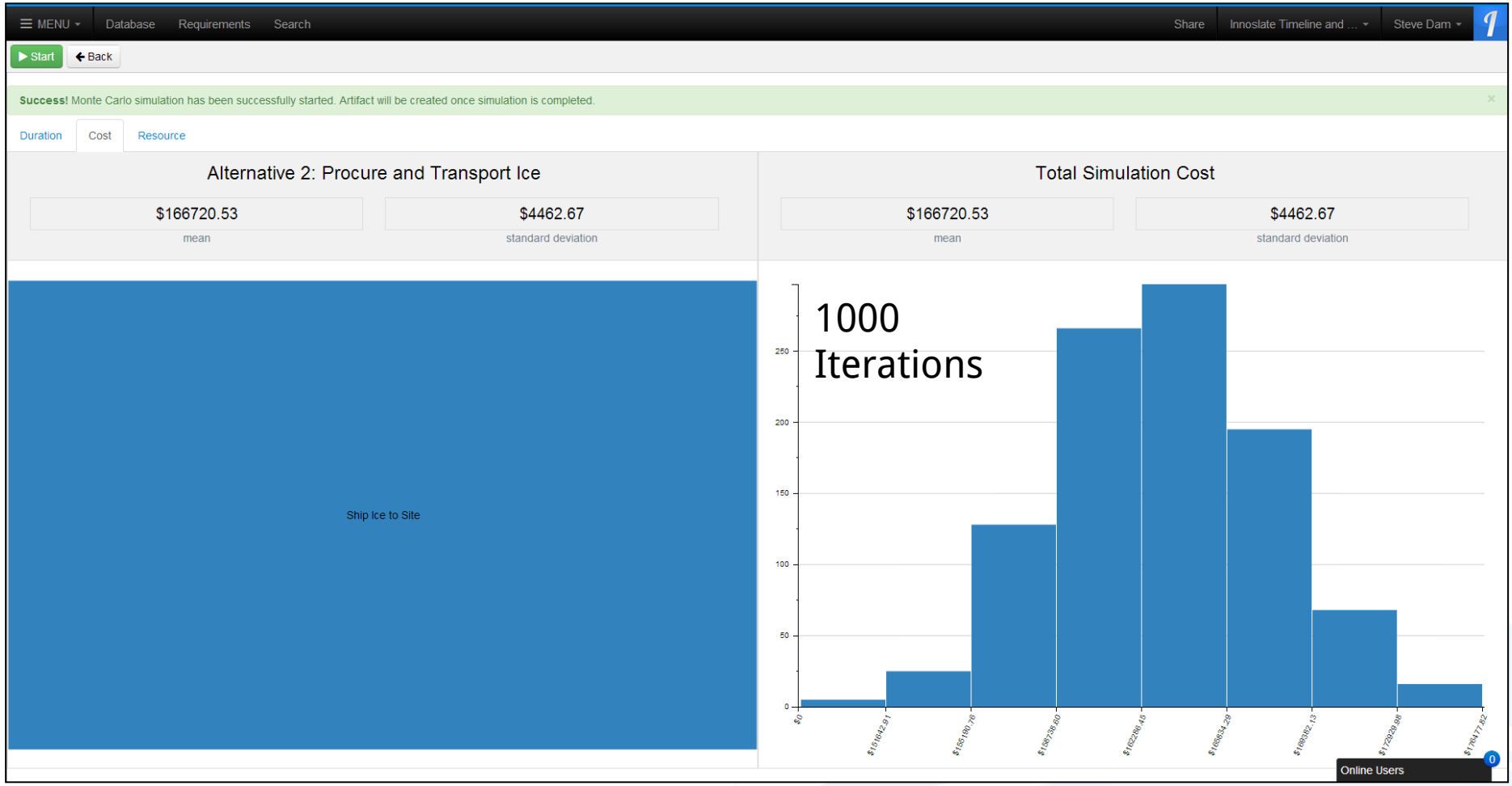
- Less complex process
- More expensive

Discrete Event Simulation Results



- Cost accumulated by process steps over 11 day period
- Total accumulated cost >$160k

Monte Carlo Simulation Results



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Summary

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- The cloud allows for Monte Carlo simulations that:
  - Scale automatically
  - Complete quickly
  - Increase worker productivity (the worker no longer has to wait for a simulation to finish to continue working)
  - Increased accuracy of model

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