

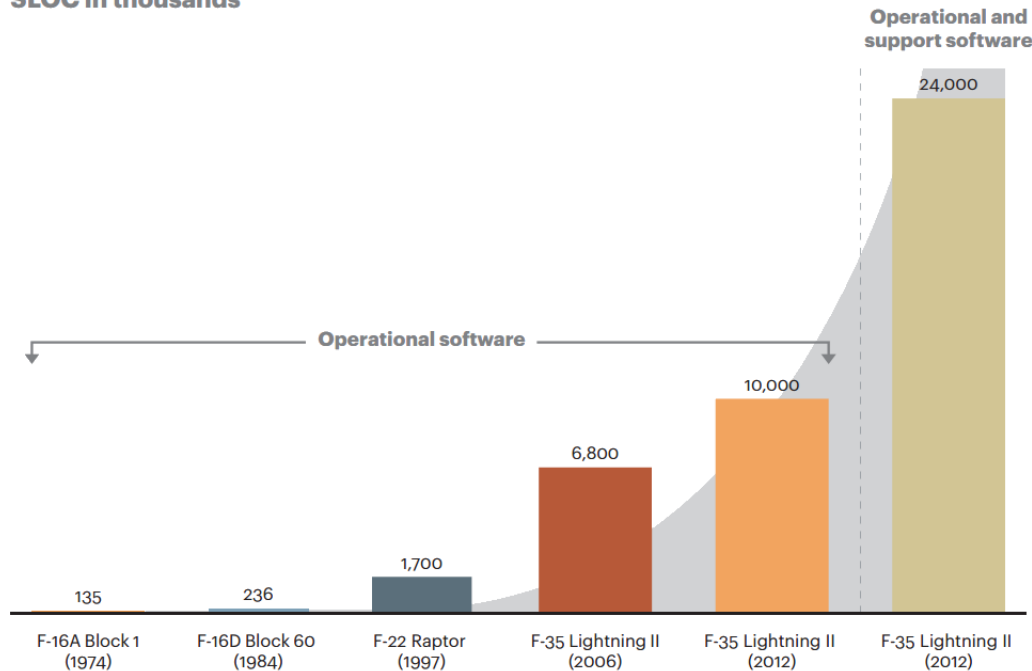
Connecting Cost, Schedule, and Performance Data for More Effective Simulation

Christopher Ritter, Robert Sperlazza

Why Accurate Program Management Is Important?

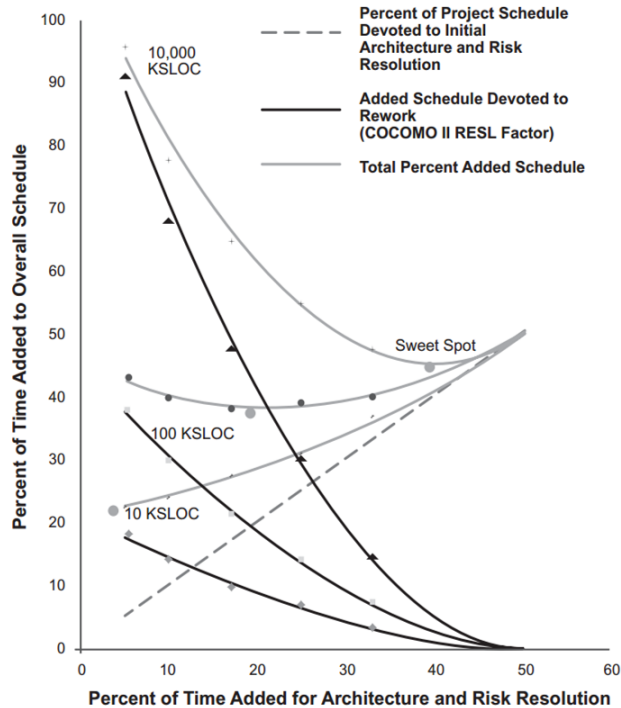
DoD Systems are Complex

SLOC in thousands



- **~12x increase** in code from F-16a to F-22
- **~14x increase** in code from F-22 to F-35 Lightning

Cost of Low SE Investment



Source: [Spiral Acquisition of Software-Intensive Systems of Systems](#)

- 10 KSLOC project average **18% rework**
- For a 10,000 KSLOC project: **91% of schedule is rework**

How is a Program Typically Managed Today?

Survey of Program Managers

How confident do you
strive to be when
estimating your projects?

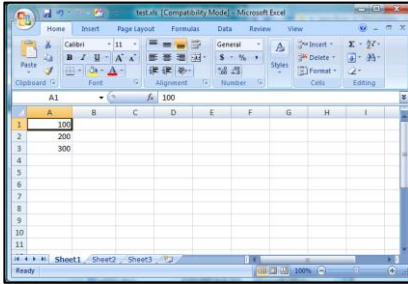
50-100%

anonymous
response
range

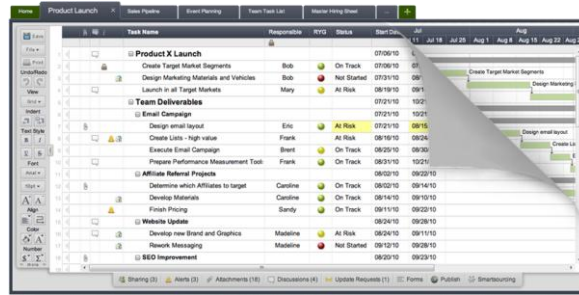
“But none of these project managers calculated their **confidence levels**, and their sponsors had no idea how much **risk** they were assuming by approving their project budgets and schedules.”

[Source: How To Be An Estimating Superhero by Elizabeth Harrin](#)

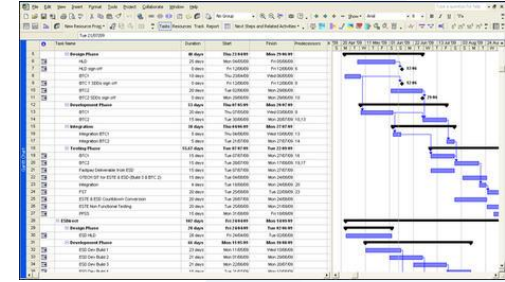
Popular Tools



Microsoft Excel



Smartsheet



Microsoft Project

What's Wrong with Spreadsheet PM?

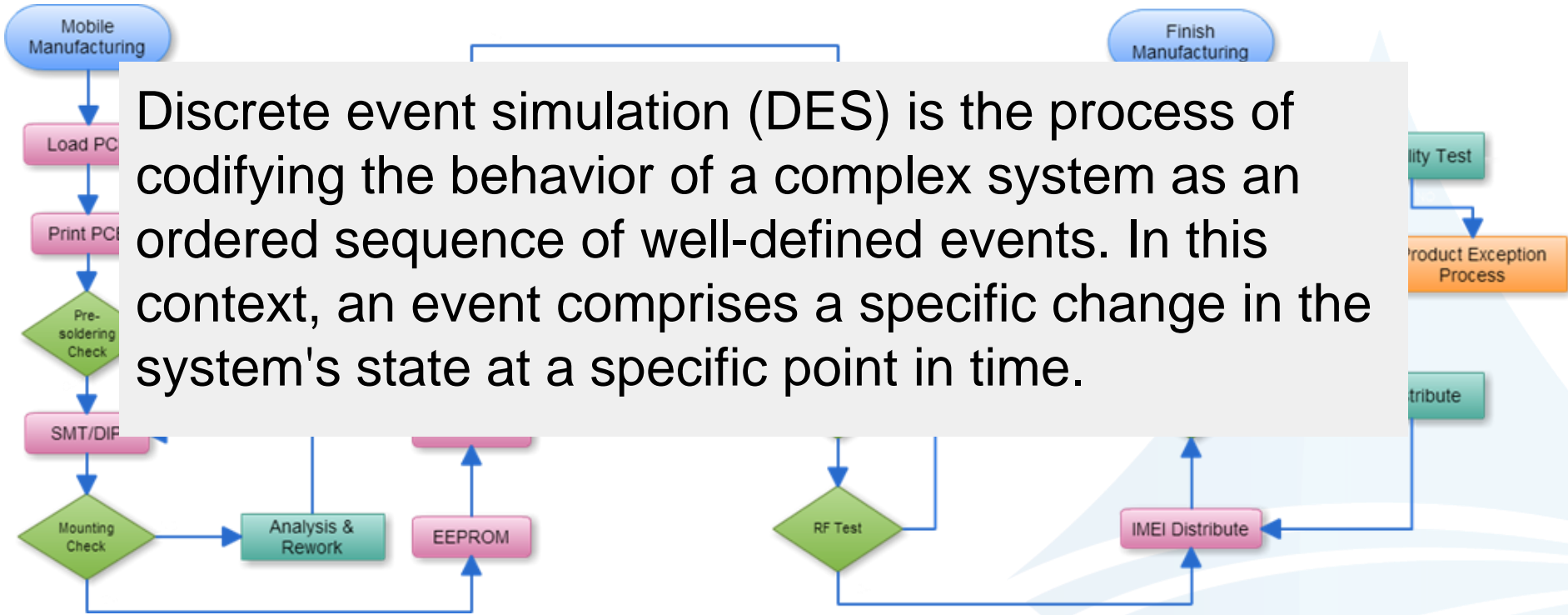
- **Variance** - Spreadsheet tools do not account for the variance in a project schedule that **will occur**
 - What is the best case scenario?
 - What is the worst case scenario?
 - How confident are you about the average scenario? (standard deviation)

How can MBSE and Simulation do better?

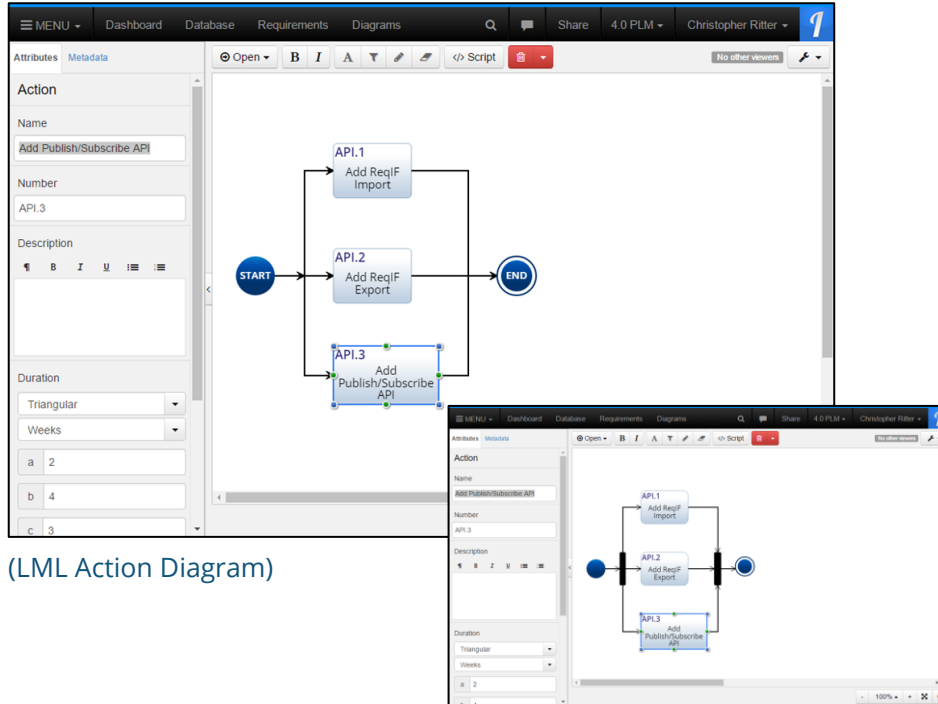
What's Wrong with Spreadsheet PM?

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Discrete Event Simulation



Functional Model



(LML Action Diagram)

(SysML Activity Diagram)

- Distribution of time:
 - 2 weeks minimum
 - 4 weeks maximum
 - 3 weeks expected

Relating Cost to the Functional Model

New Cost

Name

Number

Description

Amount

Units

Rate

Category

Contract Type

New Cost

Name

Number

Description

Amount

Units

Rate

Category

Relating Performers (Workers)

The screenshot displays a software development tool interface with a sidebar on the left and a main workspace. The sidebar contains a search bar with the text "Change", a list of labels (Activity, Capability, Function, Mission, Process, Program, Project), and a "New Label" button. The main workspace is divided into several sections:

- Attributes:** Fields for Name (Add User Groups), Number (LDAP.2), Description (with a rich text editor), Duration (Triangular, Weeks), and Percent Complete (0%).
- Relationships:** A list of relationships including "decomposed by Children", "decomposes Parents 1", "generates Input/Output", "performed by Asset 1", "Software Developers", "receives Input/Output", and "traced from Statement".
- Comments:** A text area for "New Comment...".

A modal dialog titled "performed by Attributes" is open, showing a dropdown menu set to "Value" and a text input field containing the number "2". A "Done" button is visible at the bottom right of the dialog.

Simulating the Model

The screenshot displays the Innoslate software interface for simulating a model. The interface is divided into several sections:

- Left Sidebar:** Contains navigation and control icons: a blue '1' logo, 'Innoslate', a green play button labeled 'Play', a step icon labeled 'Step', a speed icon labeled 'Speed', and a document icon labeled 'Reports'.
- Status Panel:** A list of actions including 'Build Relational Table View', 'Update Gantt Chart', 'Finalize EVM', 'Add Calendar Clock Option', 'Add Microsoft Project Export', 'Add Critical Path Analysis', 'Add All Path Option', 'Add Resource Timeline Panel', and 'Add Contributor'.
- Action Trace 3D:** A 3D visualization of a project network with nodes and connecting lines.
- Total Time:** A summary box showing '1.98 Days'.
- Total Cost:** A summary box showing '\$501057.93' with a green upward arrow and '\$501057.93' below it.
- Gantt Chart:** A table with a timeline from 0 to 1 hour. It lists tasks with their durations and corresponding blue bars on the timeline.

Entity's Title	Duration
R.4 Risk Waterfall	1.00 h
Risk.2 Add Risk ReL...	2.31 h

Diagrams: FireSAT

[+ New Diagram](#)

Existing Diagrams

Sort ▾

All 37

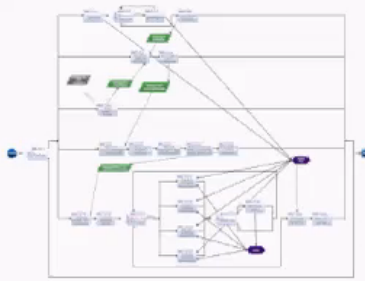
LML 18

SysML 10

General 9





Action Diagrams (2)



Last Saved Oct 25, 2016


RM.1.9 Perform Normal Ops
ASSE p. 77



Last Saved Oct 25, 2016

RM.1 FireSAT Design Reference Mission (DRM)

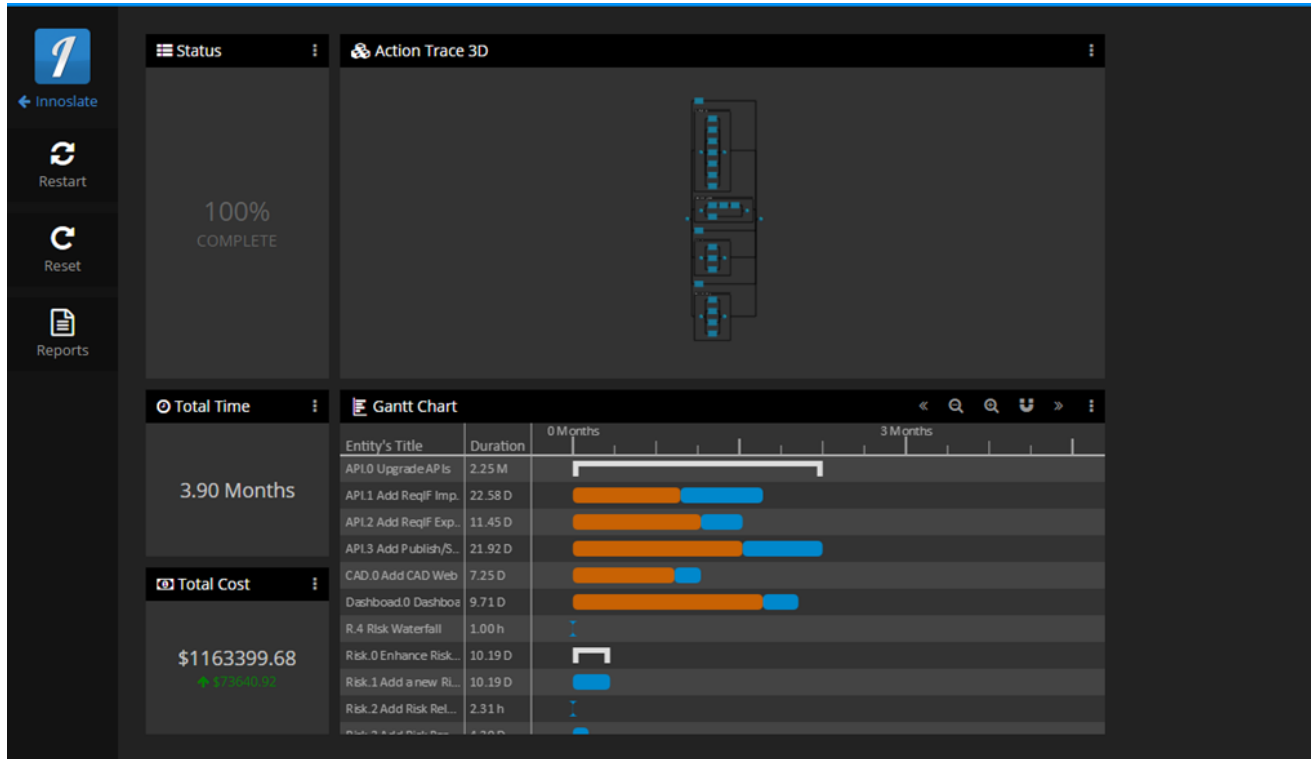
The DRM for FireSAT is similar to other scientific earth observation missions. Normal operations are preceded by a series of spacecraft and payload commissioning steps and followed by disposal at the end of the mission, years in the future.



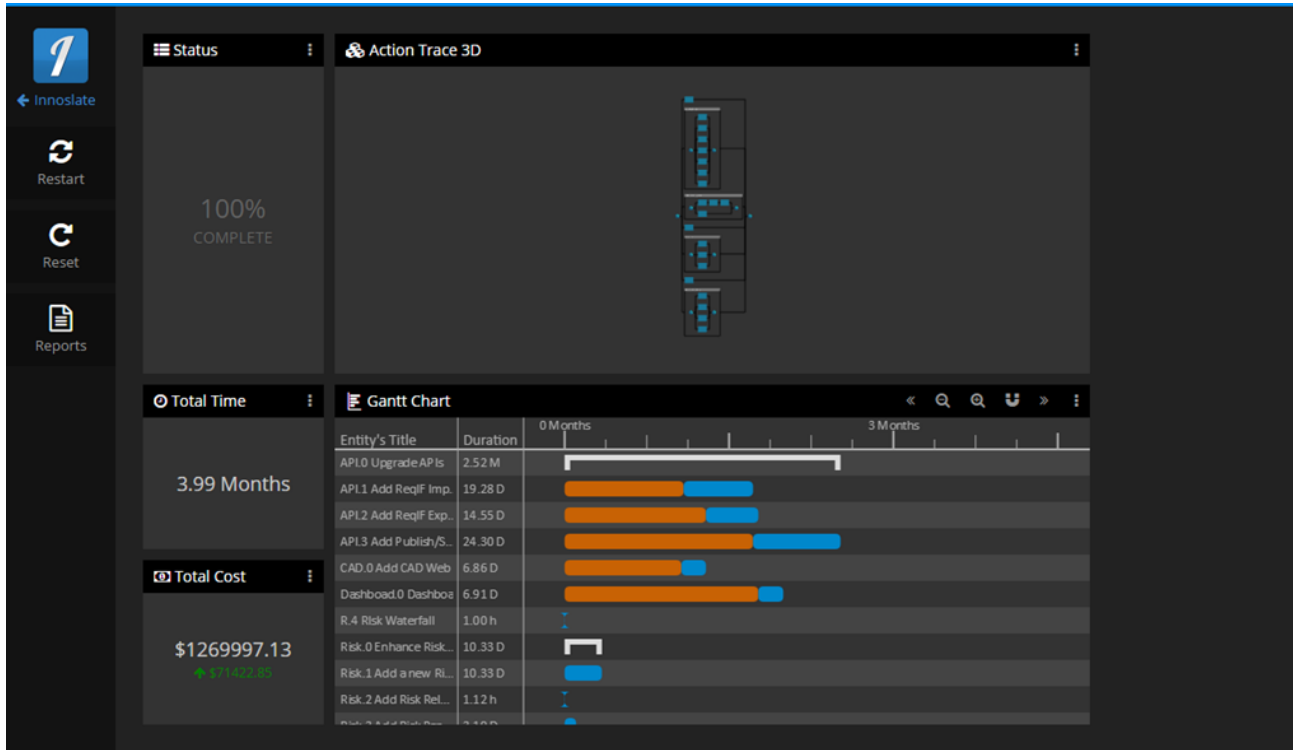
Activity Diagrams (2)



Simulation Result 1



Simulation Result 2



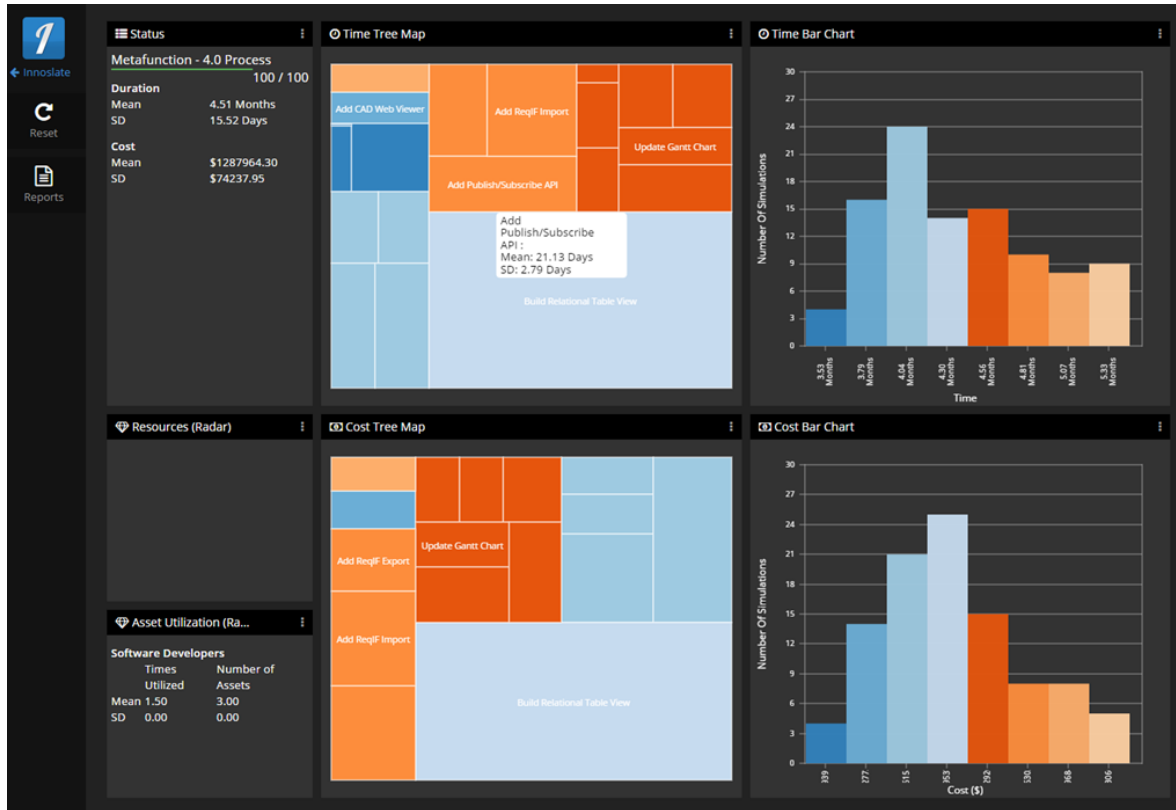
Discrete Event Simulation Analysis

- Each simulation run varies, as predicted, based upon **cost**, **schedule**, and logical conditions identified in the model
- How do we run this simulation 1000x and report those results easily?

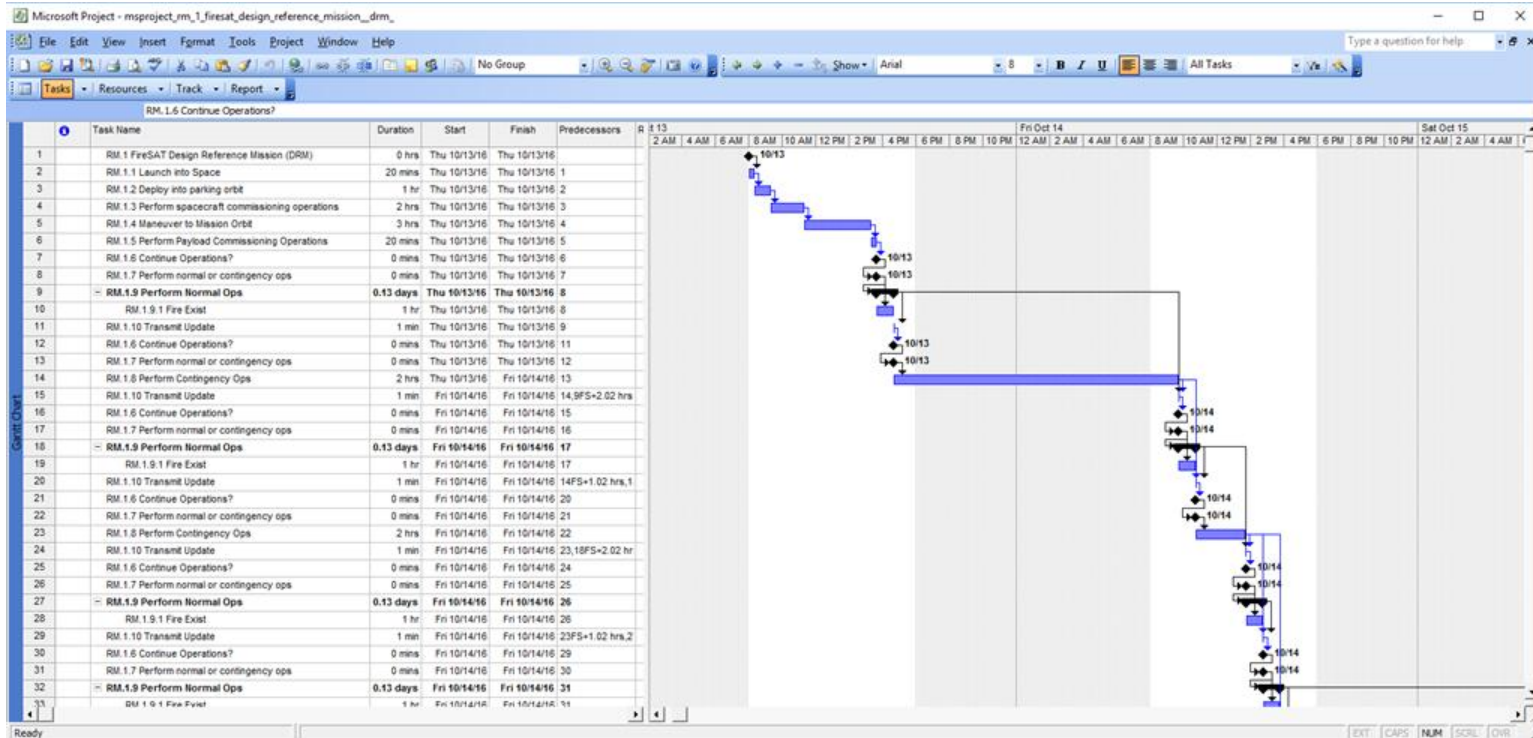
Monte Carlo Simulation

The monte carlo simulator utilizes the same modeling techniques and technologies of the 'Discrete Event Simulator' but removes inherent uncertainty. This is accomplished by running the simulation repeatedly with different, random seeds to achieve a more comprehensive view of the model

Monte Carlo Results



Reporting to Microsoft Project



Summary

- Monte Carlo simulation is extremely useful to account for natural **variance** in a project
- Existing modeling notations (LML Action Diagram; SysML Activity Diagram) can be used to convey the project schedule

Next Steps

- Anyone
 - Create a free Innoslate Account at innoslate.com
 - Create an Innoslate Enterprise Server on Amazon AWS Marketplace
- U.S. Government
 - Create an Innoslate account at the NSERC:
 - <https://nserc.nswc.navy.mil/> or
 - Request free a Innoslate Enterprise trial
- Academic
 - Sign up free with .edu on innoslate.com or
 - Use your university's existing Innoslate Enterprise installation

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