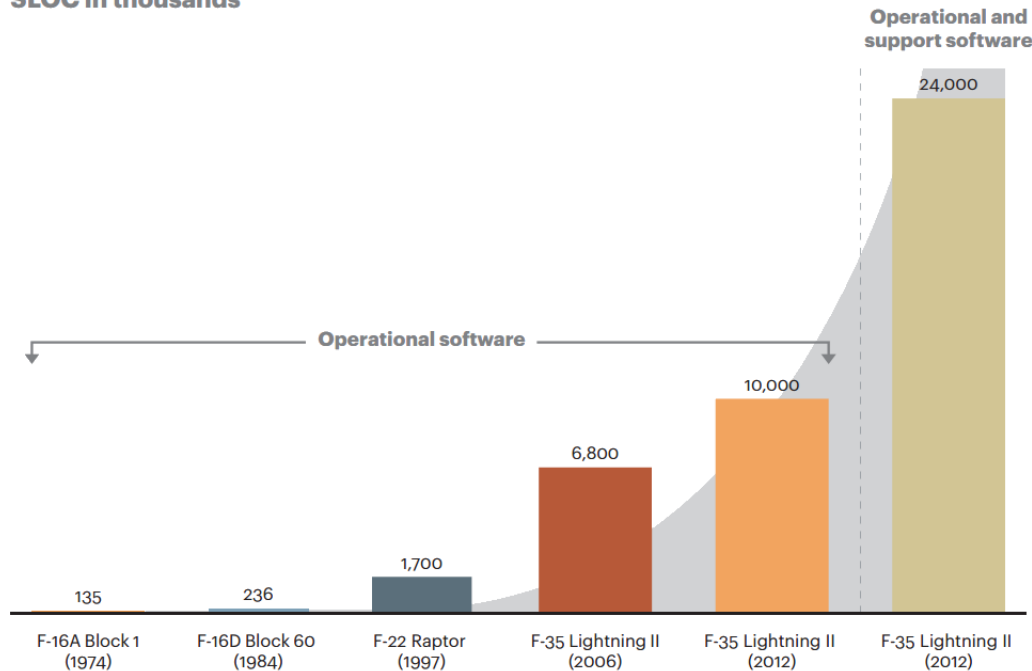# Connecting Cost, Schedule, and Performance Data for More Effective Simulation

Christopher Ritter, Robert Sperlazza

Why Accurate Program Management Is Important?

SPEC INNOVATIONS

DoD Systems are Complex

SLOC in thousands

Operational and support software

24,000

Operational software

10,000

6,800

1,700

135 236

| F-16A Block 1 (1974) | F-16D Block 60 (1984) | F-22 Raptor (1997) | F-35 Lightning II (2006) | F-35 Lightning II (2012) | F-35 Lightning II (2012) |

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

SPEC INNOVATIONS

Cost of Low SE Investment
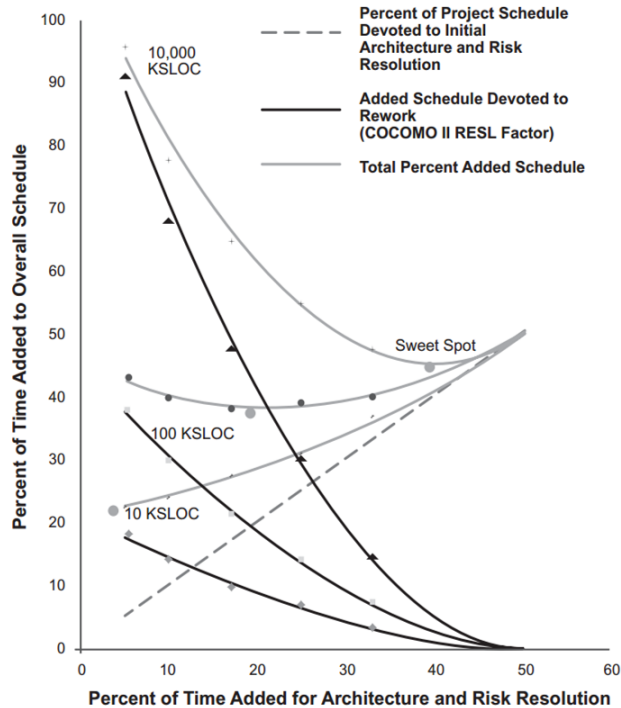
Source: Spiral Acquisition of Software-Intensive Systems of Systems

- 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?**
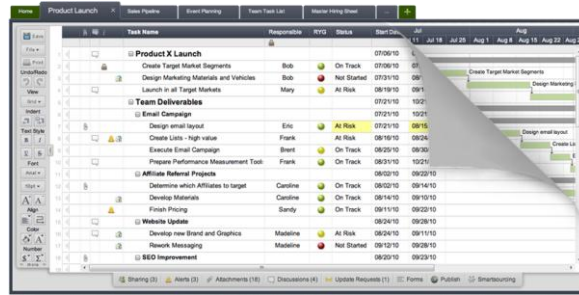
50-100% anonymouse respose range

"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."

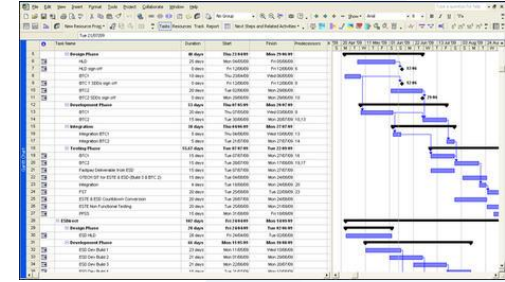Source: How To Be An Estimating Superhero by Elizabeth Harrin

SPEC INNOVATIONS

Popular Tools
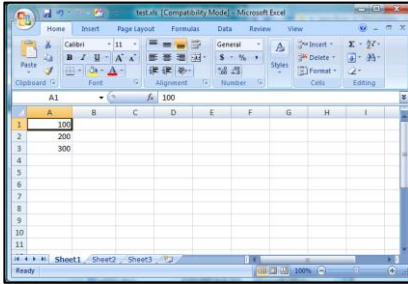
Microsoft Excel

Smartsheet

Microsoft Project

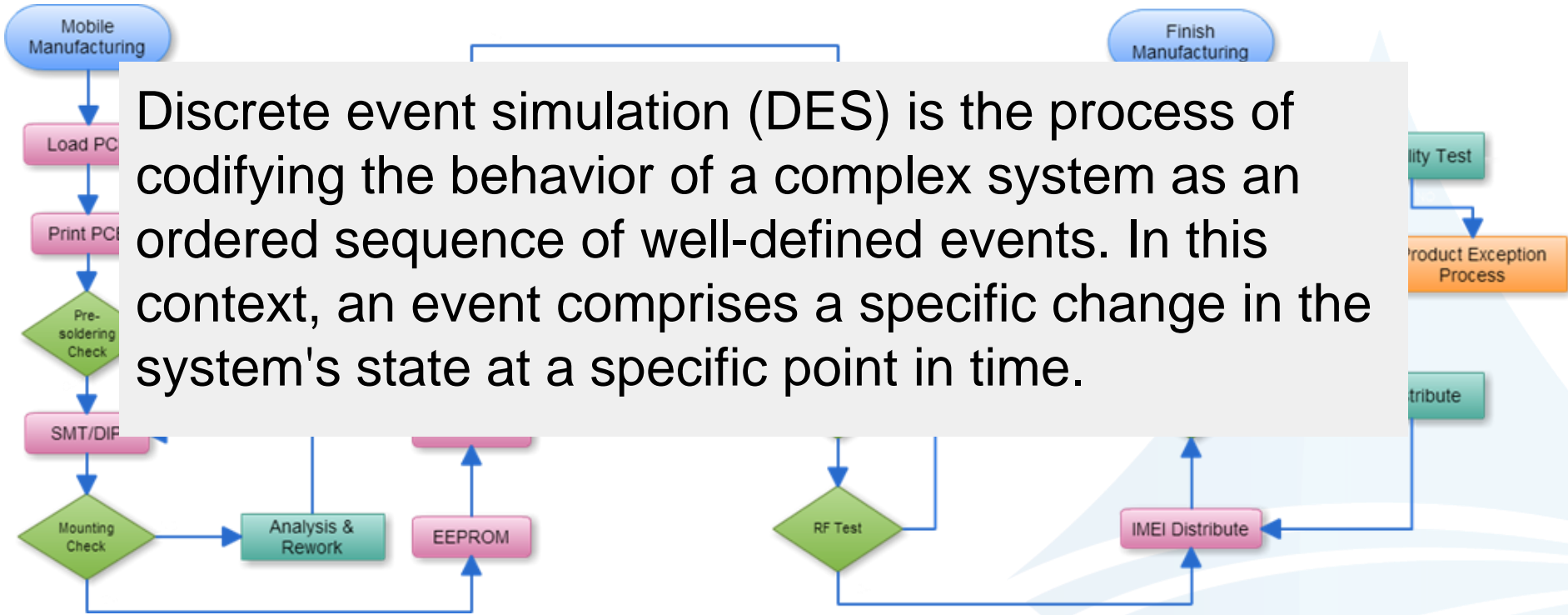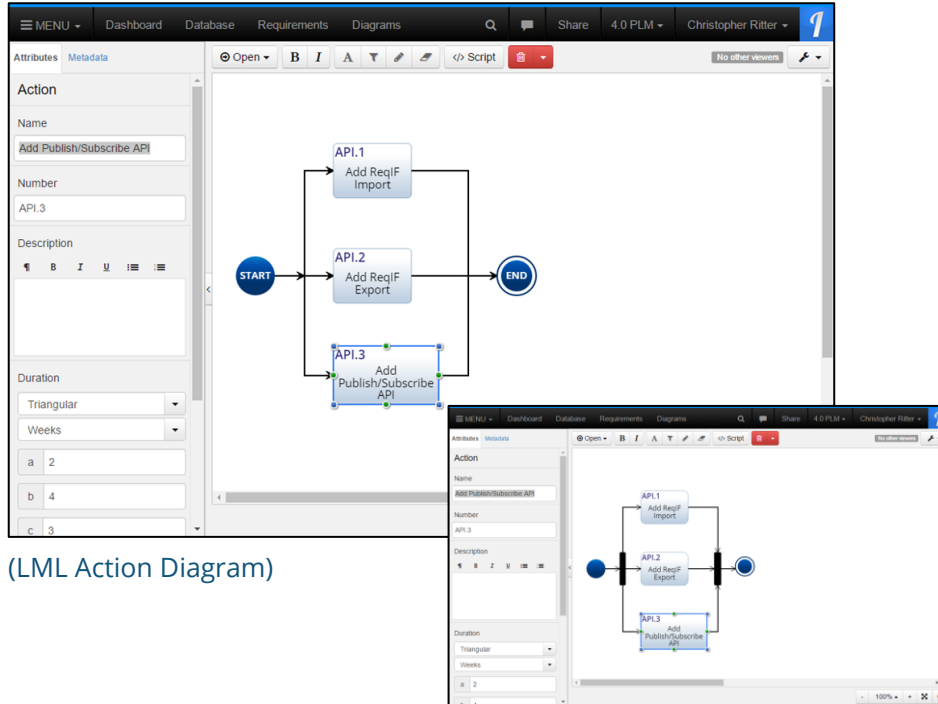# What's Wrong with Spreadsheet PM?

- **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?

- **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)

Discrete Event Simulation

Discrete event simulation (DES) is the process of codifying the behavior of a complex system as an ordered sequence of well-defined events. In this context, an event comprises a specific change in the system's state at a specific point in time.

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

Relating Performers (Workers)

Simulating the Model

🖼 Diagrams: FireSAT

⊕ New Diagram

Existing Diagrams Sort ▾
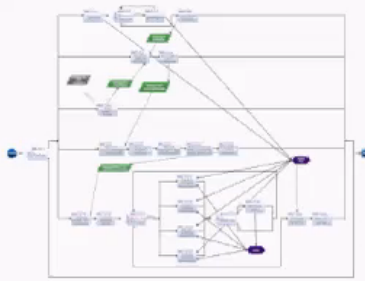
| All 37 | LML 18 | SysML 10 | General 9 |

Find a Diagram... 🔍

Action Diagrams (2)

‖ ▭ ‖

Last Saved Oct 25, 2016

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.

RM.1.9 Perform Normal Ops

ASSE p. 77

⋮

⋮

Activity Diagrams (2)

Simulation Result 1

Simulation Result 2

Discrete Event Simulation Analysis

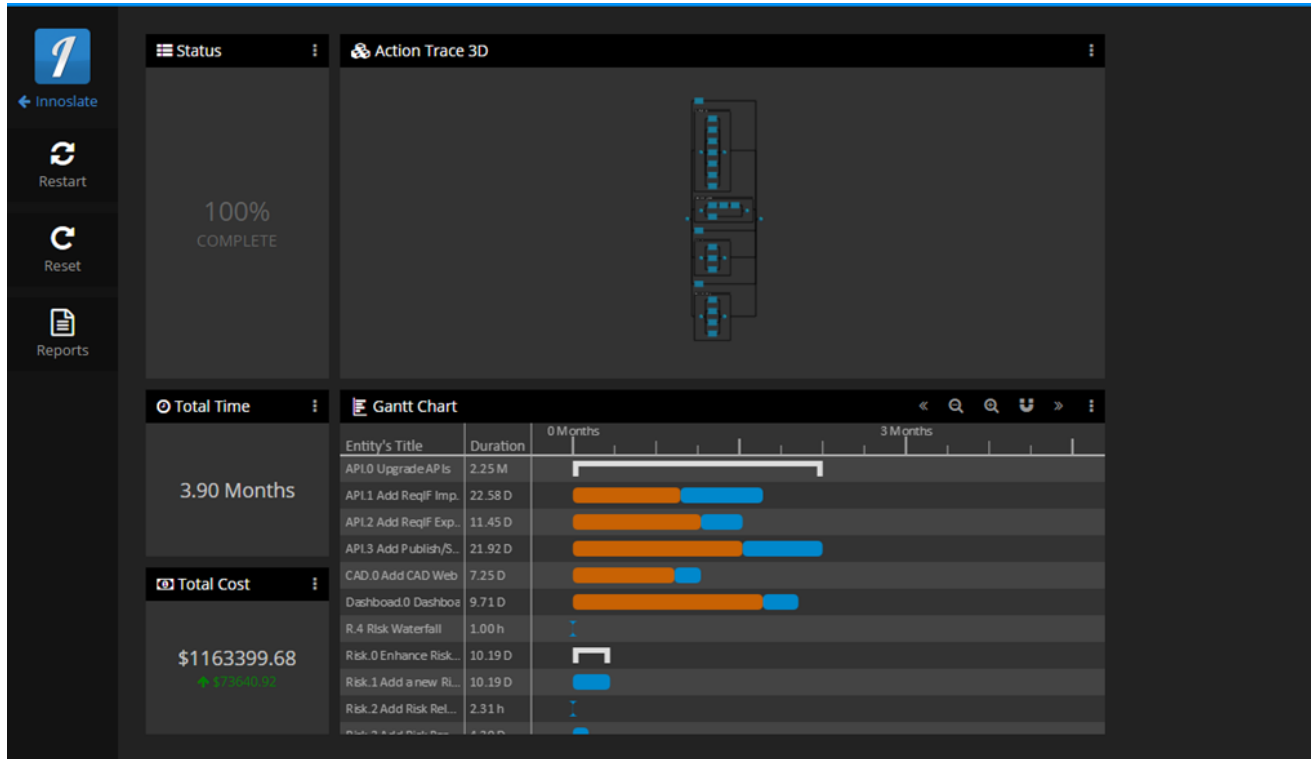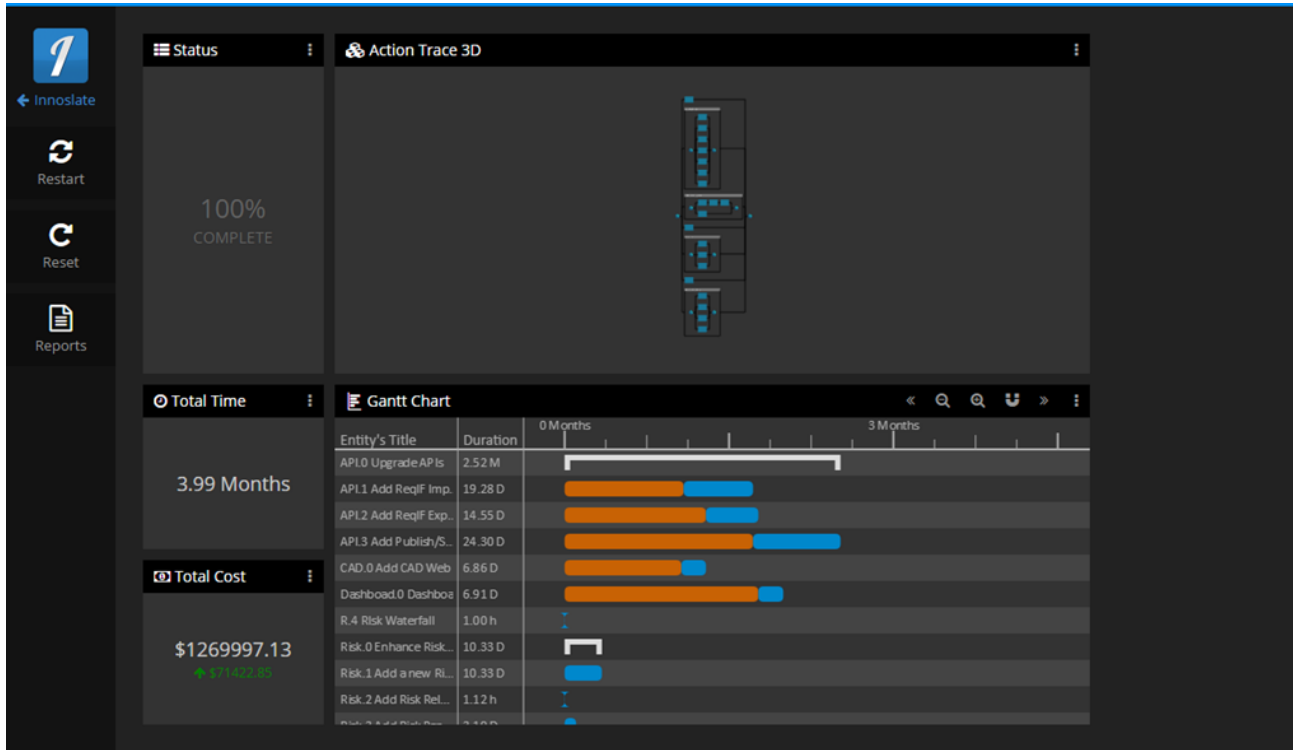- Each simulation run varies, as predicted, based upon **cost**, **schedule**, and logical conditions identified in the model

- How do we run this simulation 1000x and report those results easily?
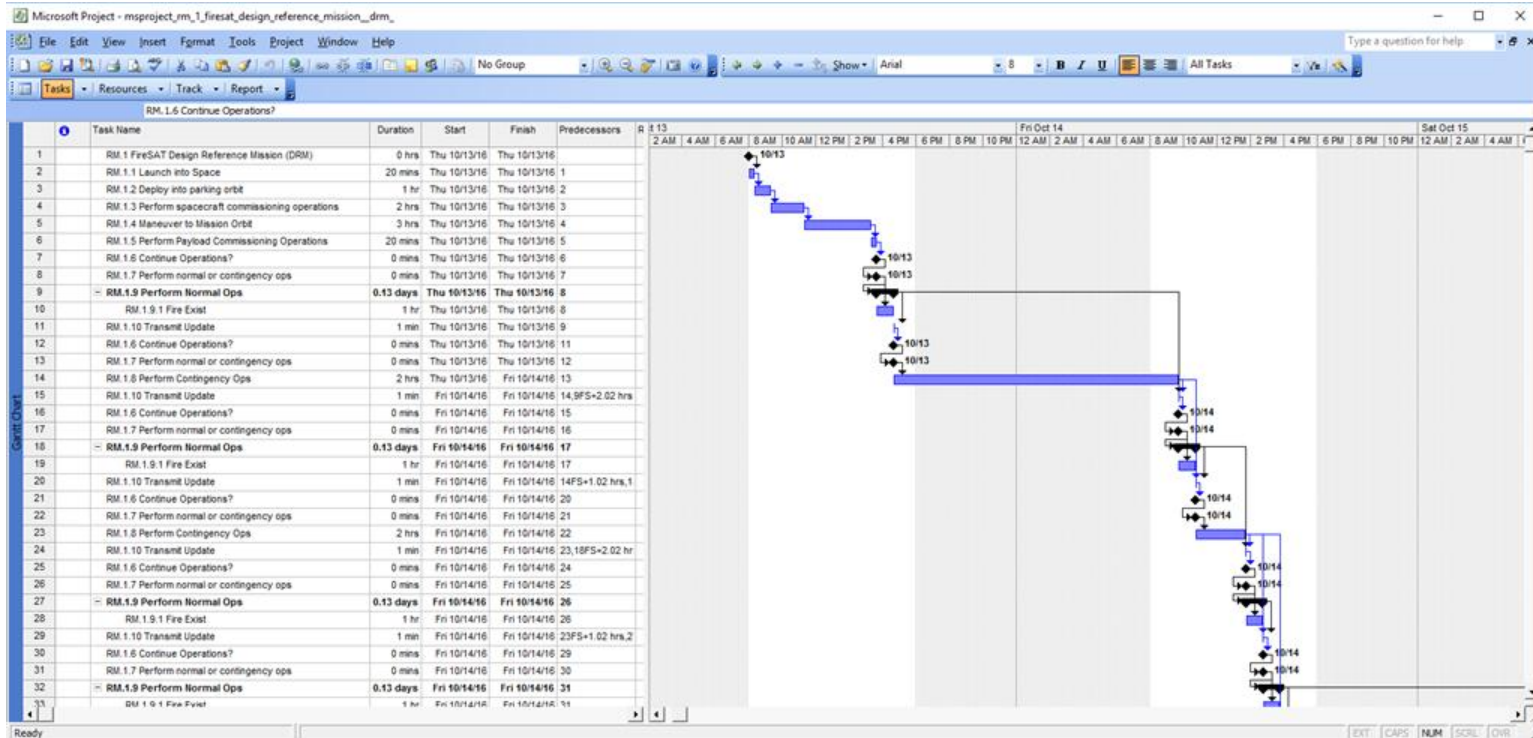
Monte Carlo Simulation

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
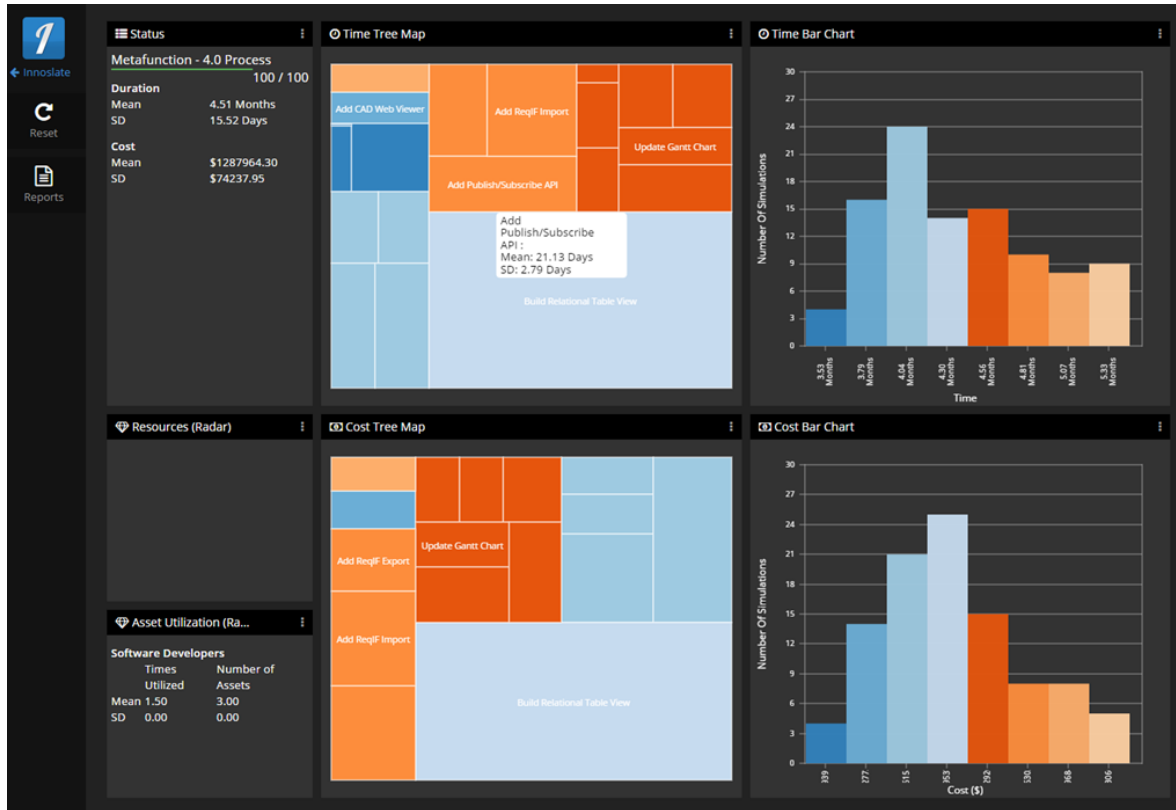
Reporting to Microsoft Project

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

Contact Information

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