Embedding Command and Control, Information Assurance, and Other Decision Points in Model-Based Systems Engineering (MBSE) Analyses

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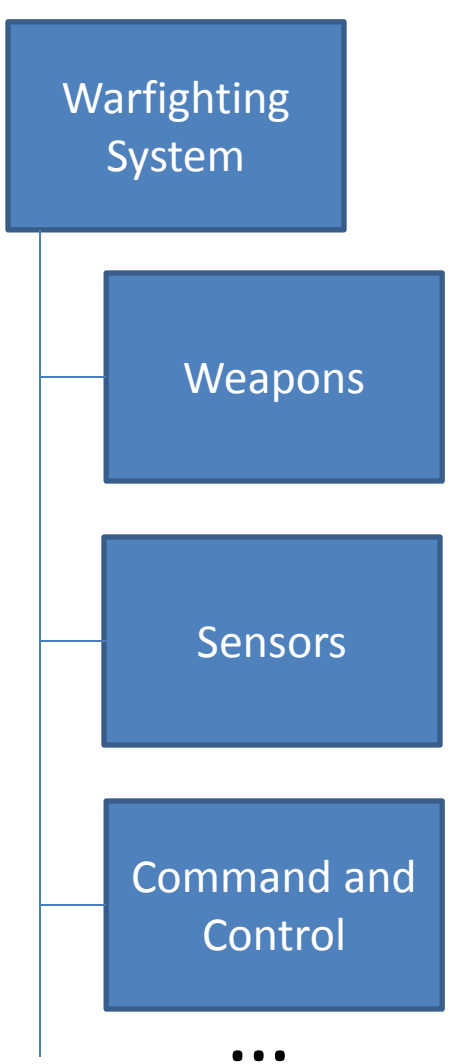
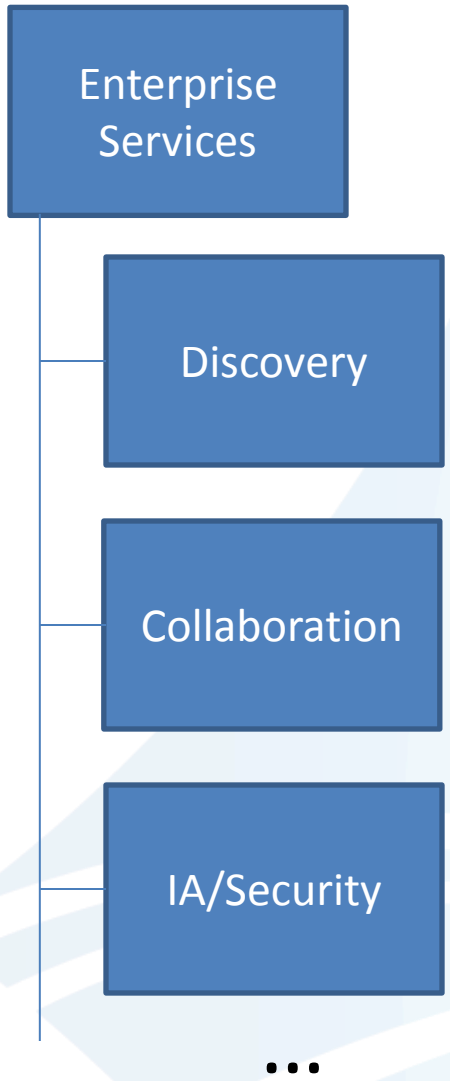
Overview

- What is the Problem with C2/IA Modeling?
- LML Sequencing
- Tool Needs
- Summary

WHAT IS THE PROBLEM WITH C2/IA MODELING?

How Do People Usually Decompose Systems?





What's wrong with these pictures?

What's Wrong with This?

- By beginning with separating out command and control, or information assurance at the top level, it becomes harder to build in these essential capabilities into the other components of the system
- The interfaces become complex, speed of execution is reduced, and "holes" in the system become common

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How Can We Do It Better?

- Do not decompose C2 and IA/Security at the top level
- Let those aspects of control come out of the functional analysis
- Then identify and allocate those functions to the C2 participants and organizations

- *But the current languages do not help the situation, because they do not capture all the decision points explicitly as functions*

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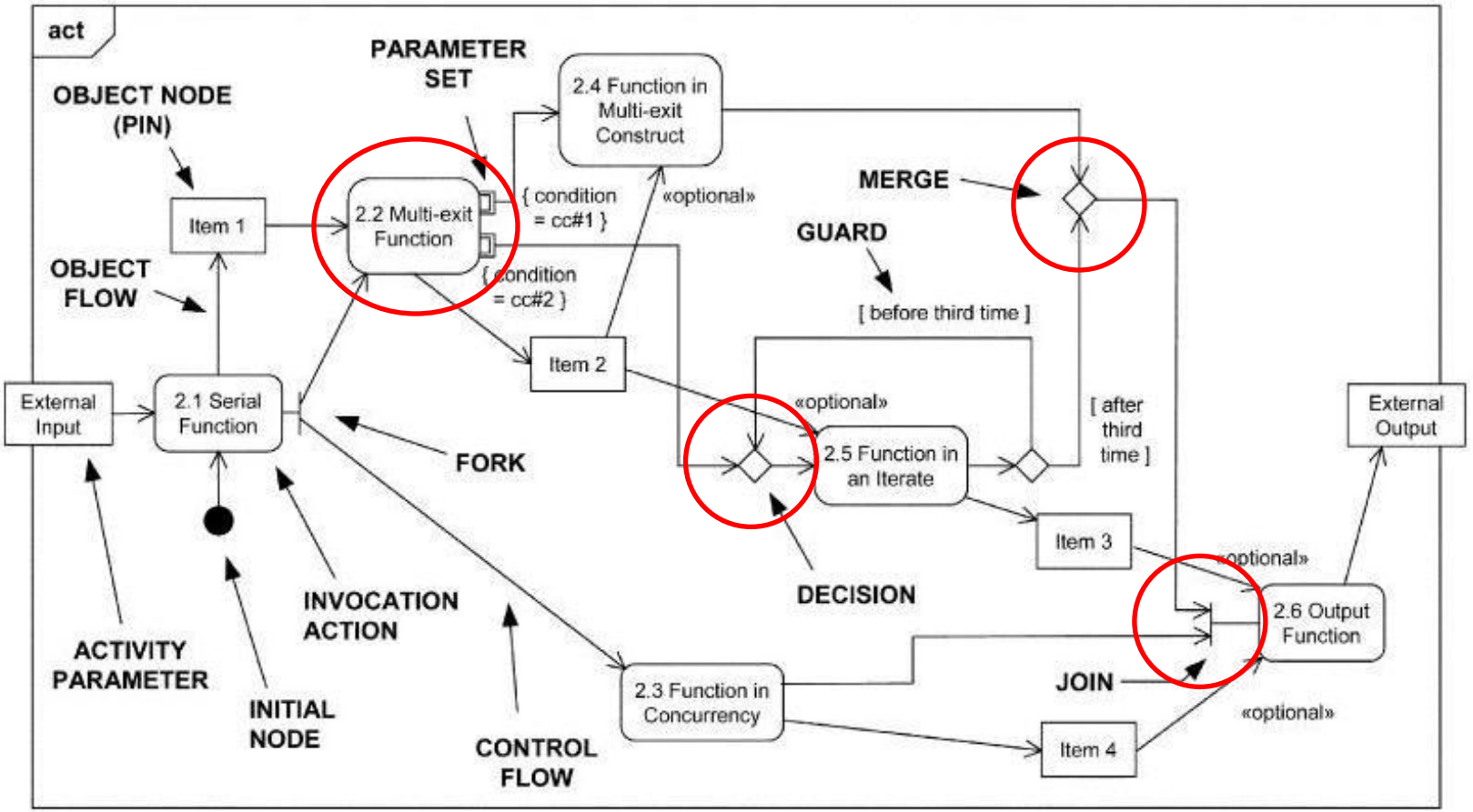
Source: http://www.mel.nist.gov/msidlibrary/doc/sysmlactivity.pdf

Example: SYSML

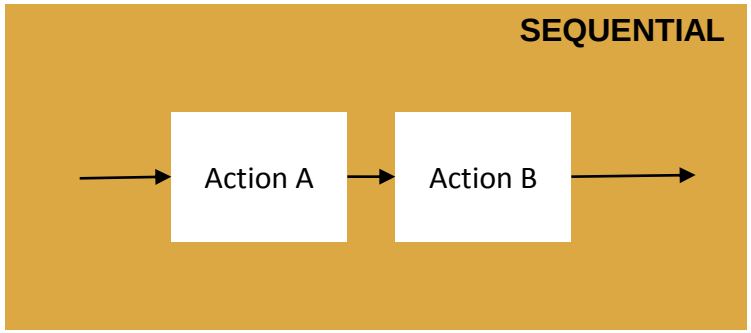
Decision Points

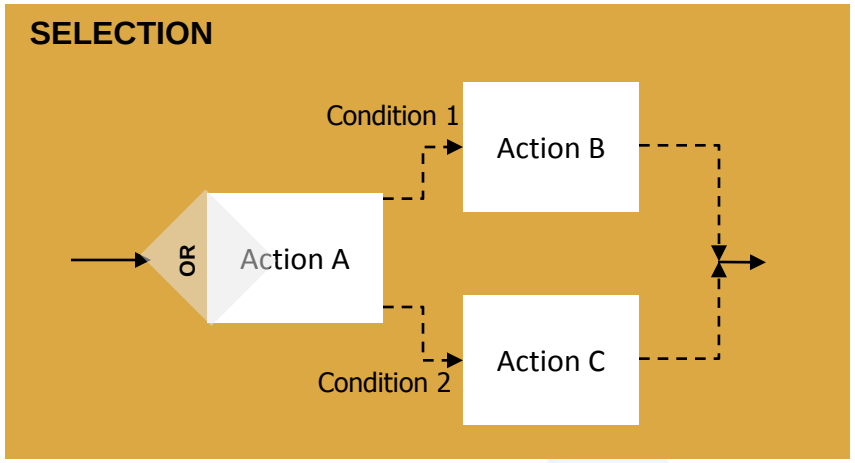


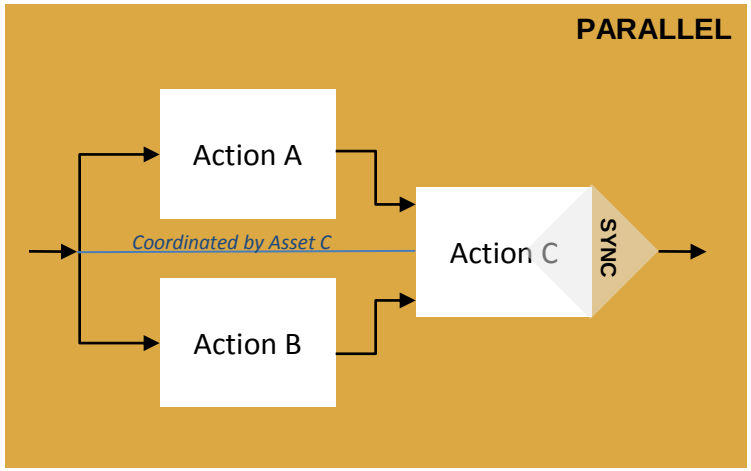
How are decisions captured by these diagrams?

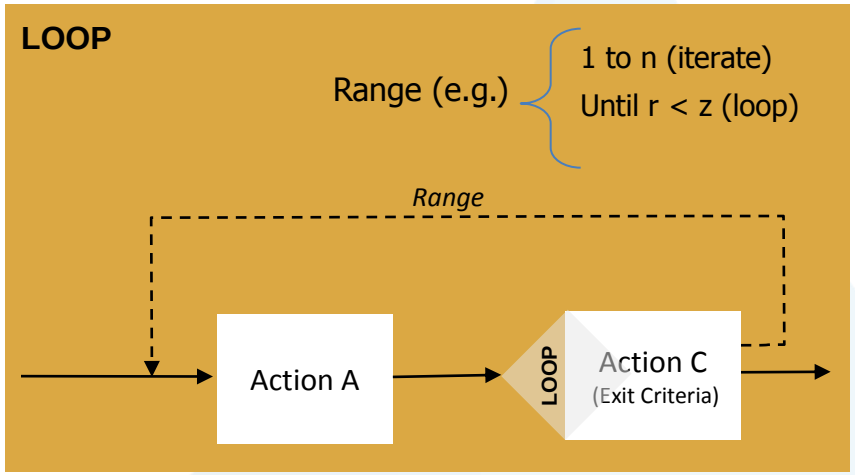
LIFECYCLE MODELING LANGUAGE SEQUENCING

LML Sequencing



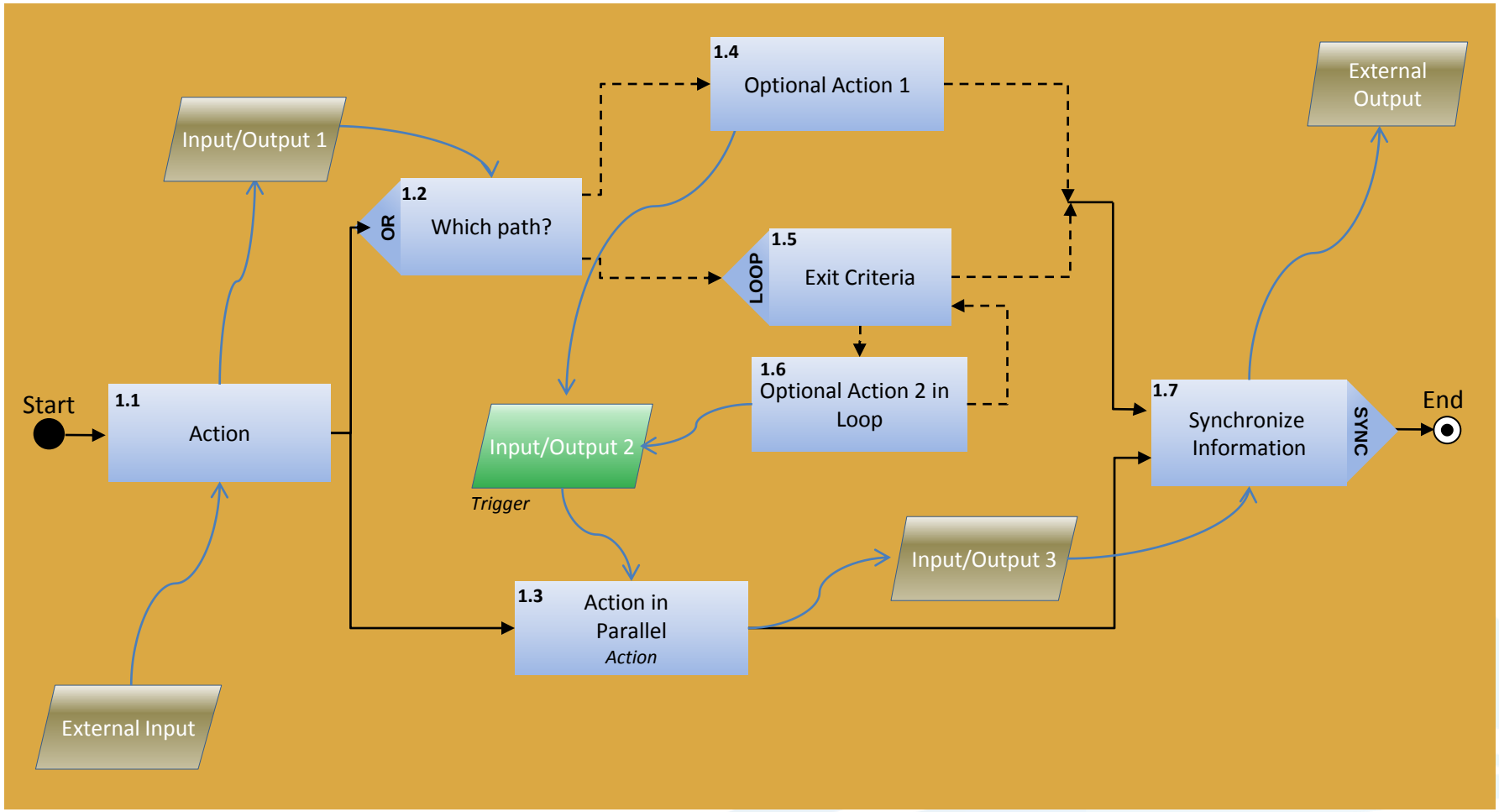






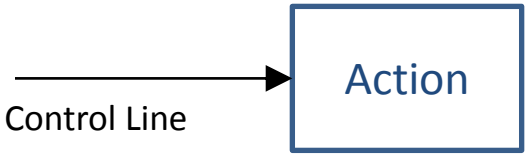
No constructs – only special types of Actions – ones that enable the modeling of command and control/ information assurance to capture the critical decisions in your model

LML Action Diagram Captures Behavior



Example: Sync Execution Logic

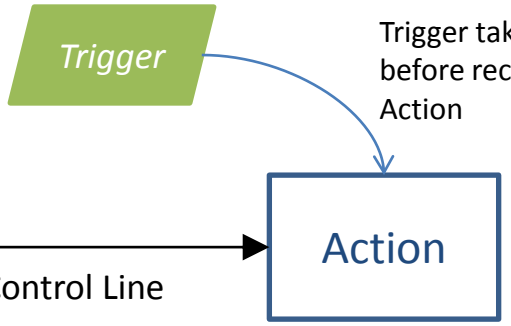
Action Diagram



Duration = x sec

Timeline

No trigger: Action enabled and will execute



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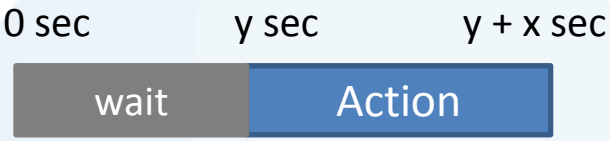
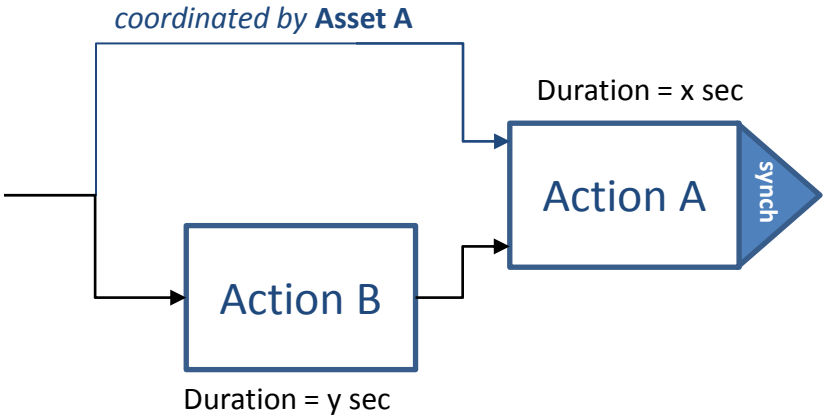


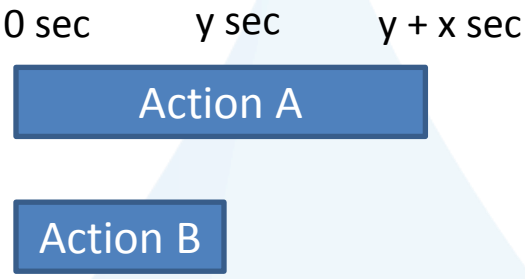
With trigger: Action enabled, but will not execute until trigger received

Execution Logic – Concurrency No Trigger; No Coordination Action

Action Diagram



Timeline

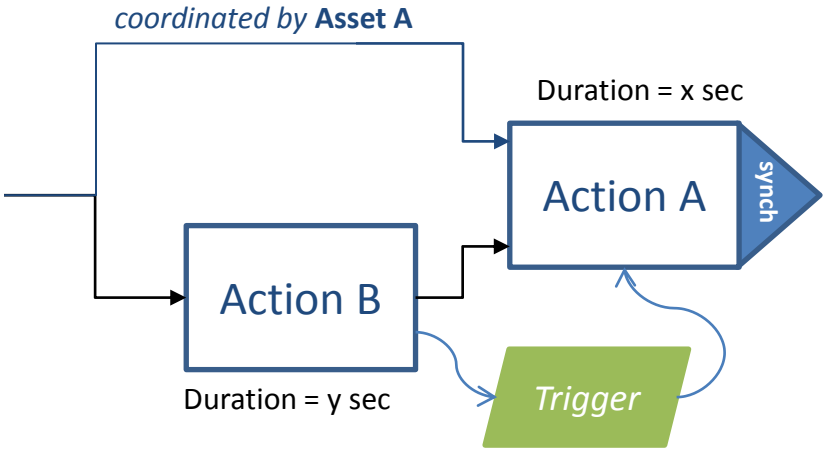


No trigger: Action A enabled and will execute; Asset A performs Action A

Start to Start (SS) between A and B

Execution Logic – Concurrency With Trigger; No Coordination Action

Action Diagram



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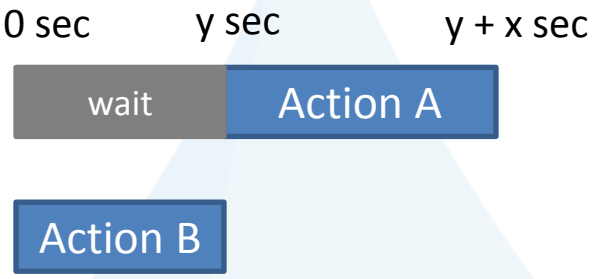
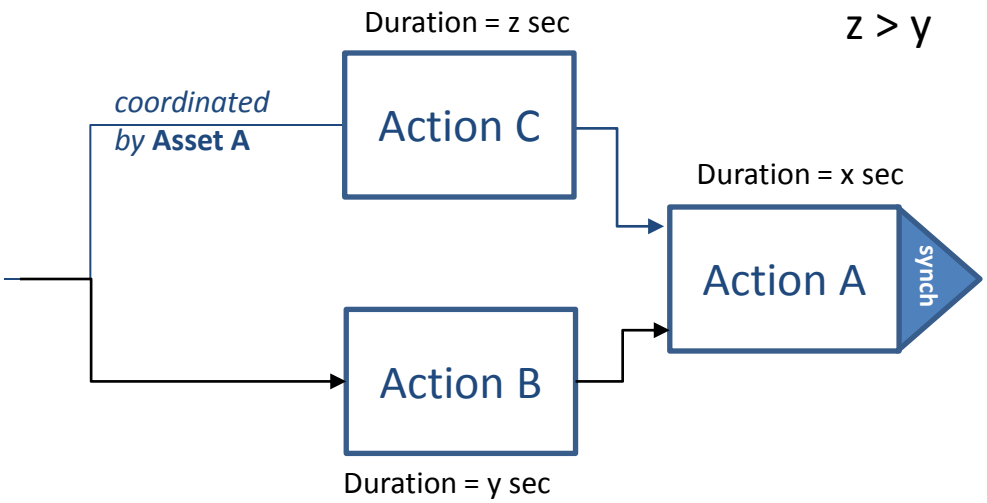


Trigger: Action A enabled, but must wait to execute; Asset A performs Action A

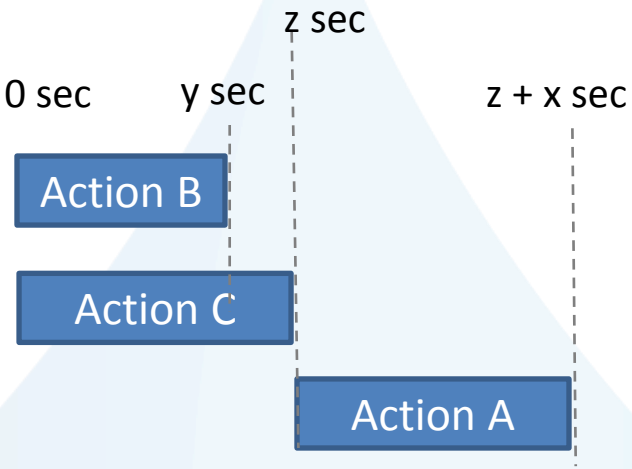
Finish to Start (FS) between B and A

Execution Logic – Concurrency No Trigger; With Coordination Action

Action Diagram



Timeline

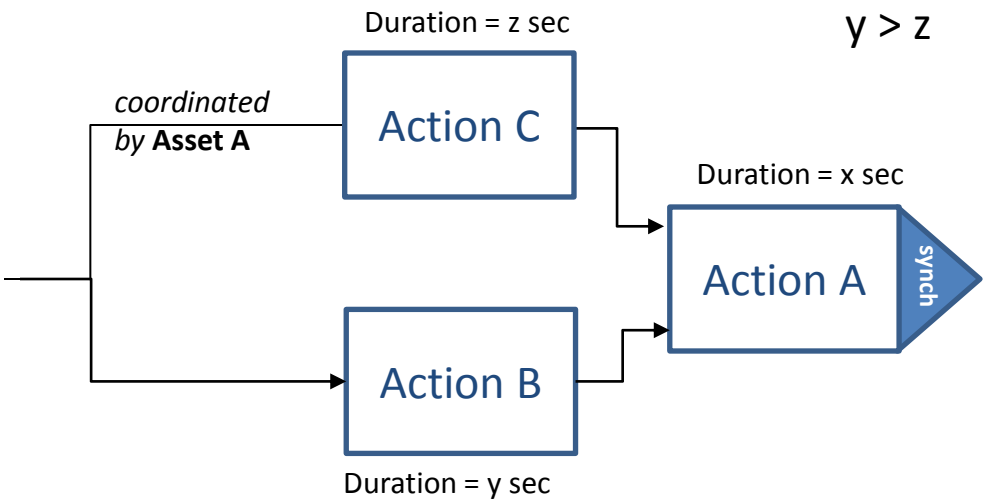


No trigger: Action C enabled and will execute; Asset A performs Action A and Action C

Finish to Start (FS) between C and A

Execution Logic – Concurrency No Trigger; With Coordination Action

Action Diagram



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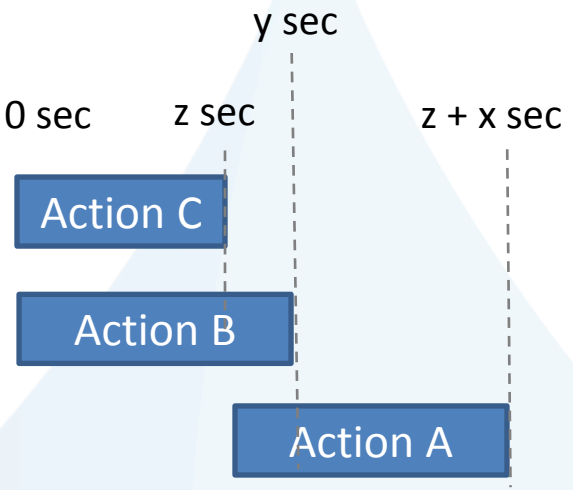

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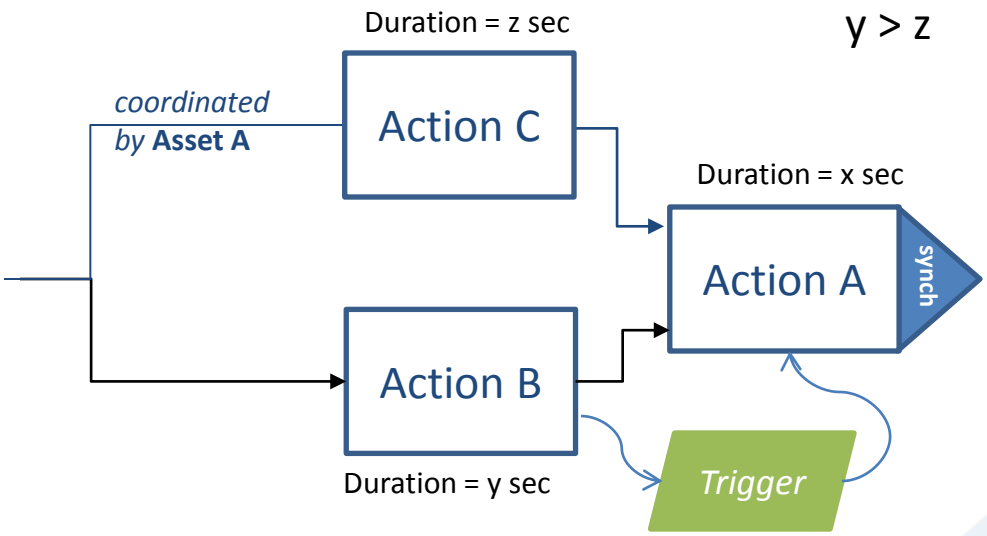
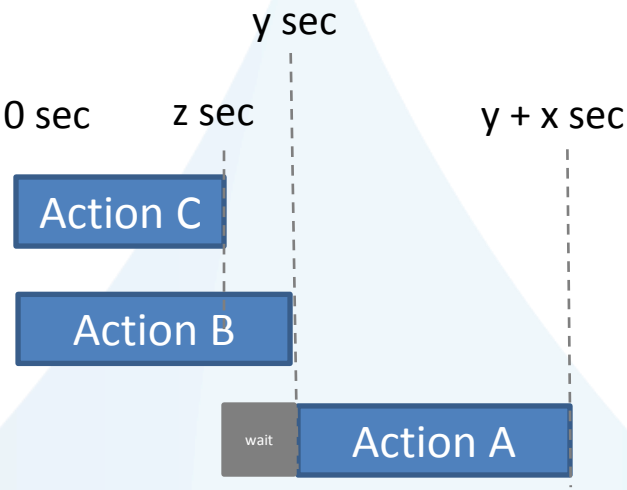


Timeline



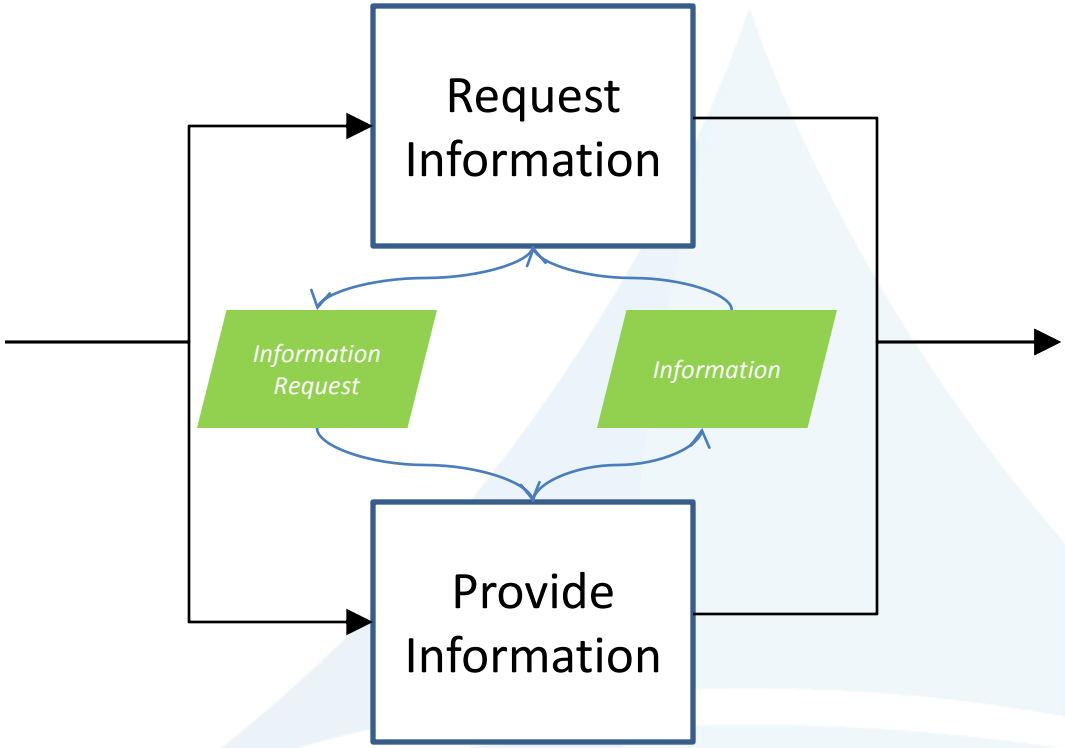
No trigger: Action C enabled and will execute; Asset A performs Action A and Action C

Finish to Start (FS) between B and A

Problem with not including synch

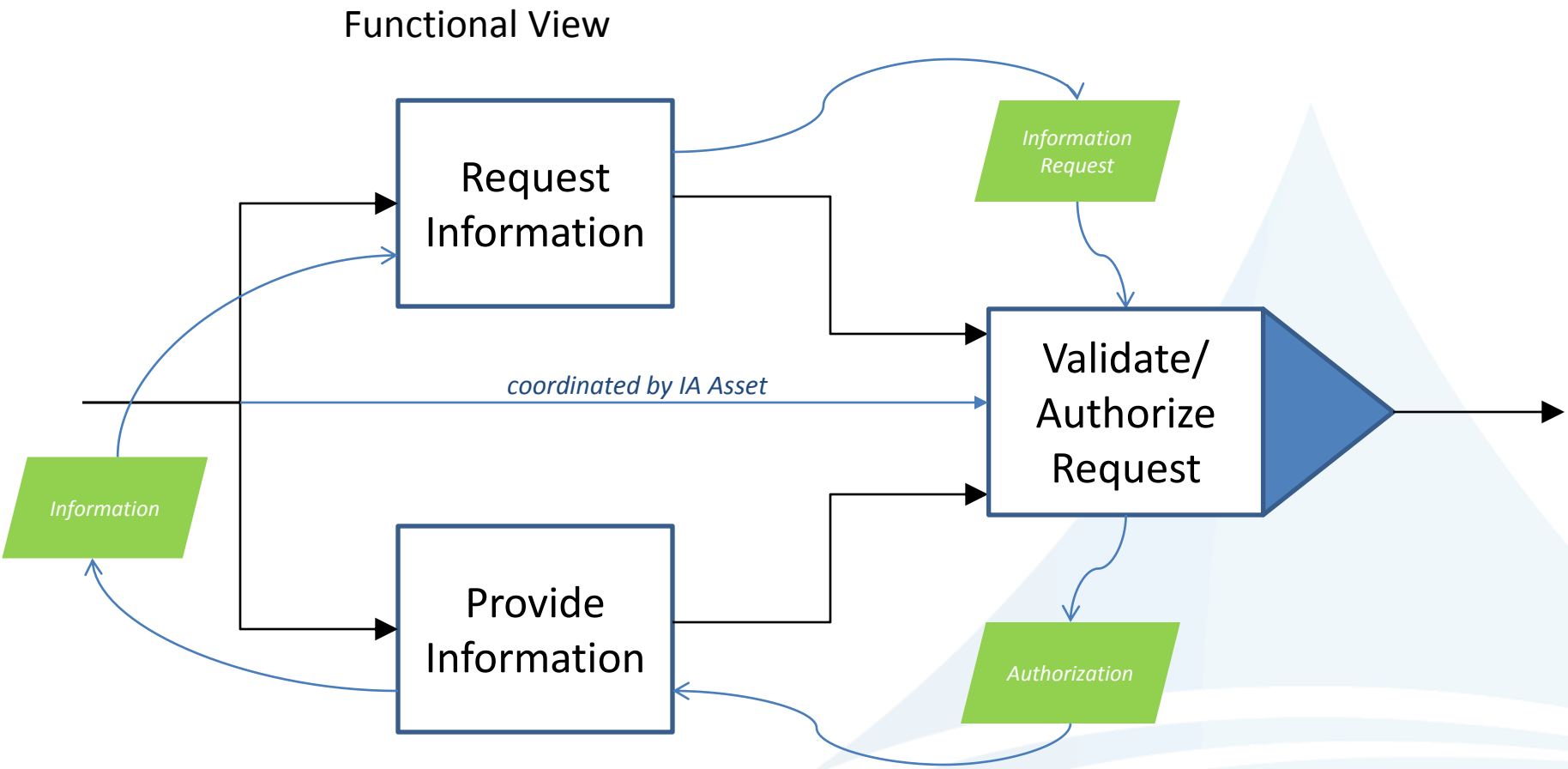
Physical View

Functional View



Deadlock occurs; no IA or C2 functionality

Problem with not including synch



Deadlock Relieved; IA functionality identified

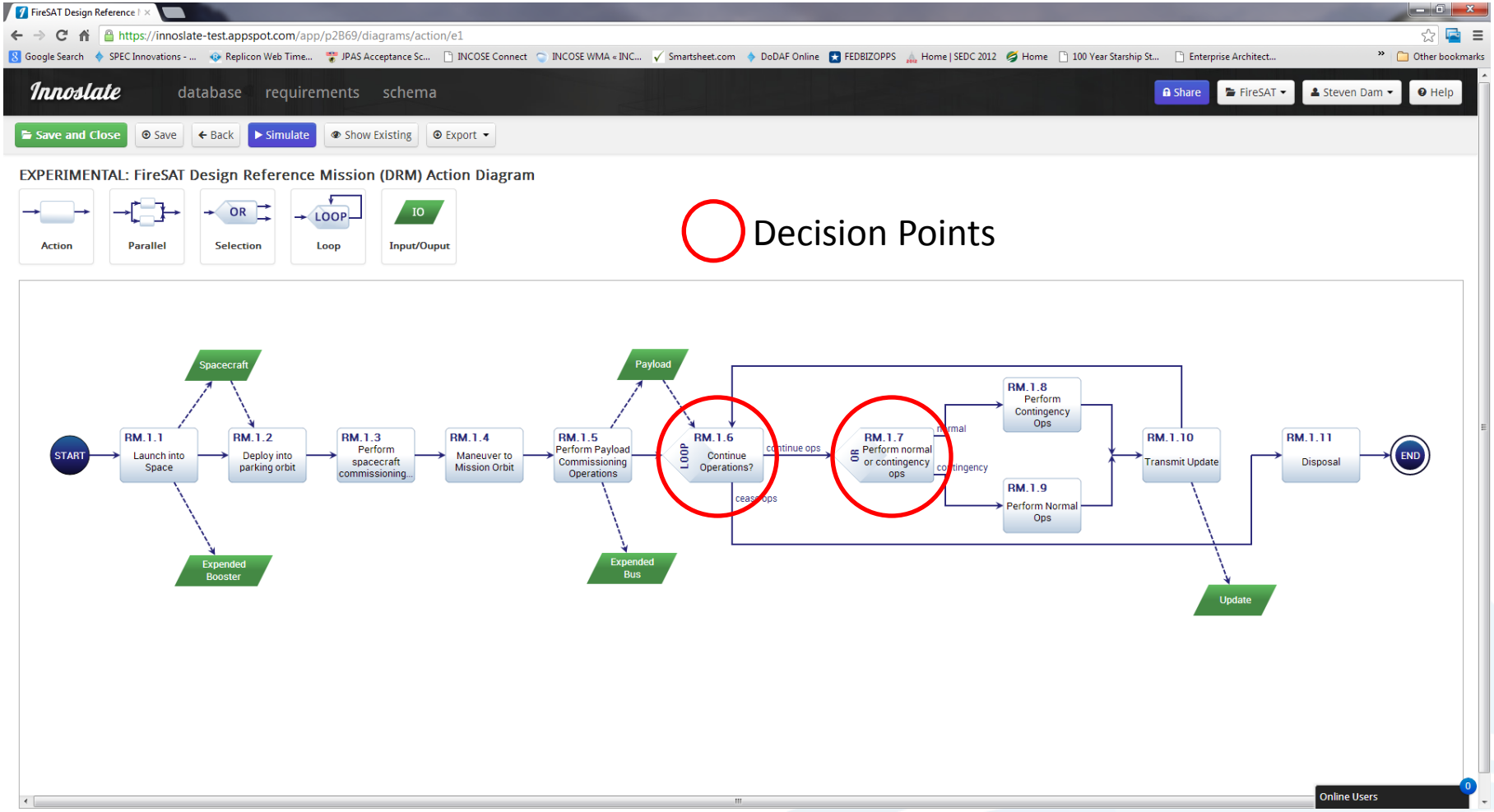
TOOL NEEDS

Innoslate®

- Innoslate 1.0 meets most of the LML Action diagram requirements
  - Synch is currently missing, but expected soon
- Since LML is designed as an open standard, we hope other tool vendors consider adding the Action diagram to their tools as well

SPEC INNOVATIONS

FireSAT Design Reference Mission

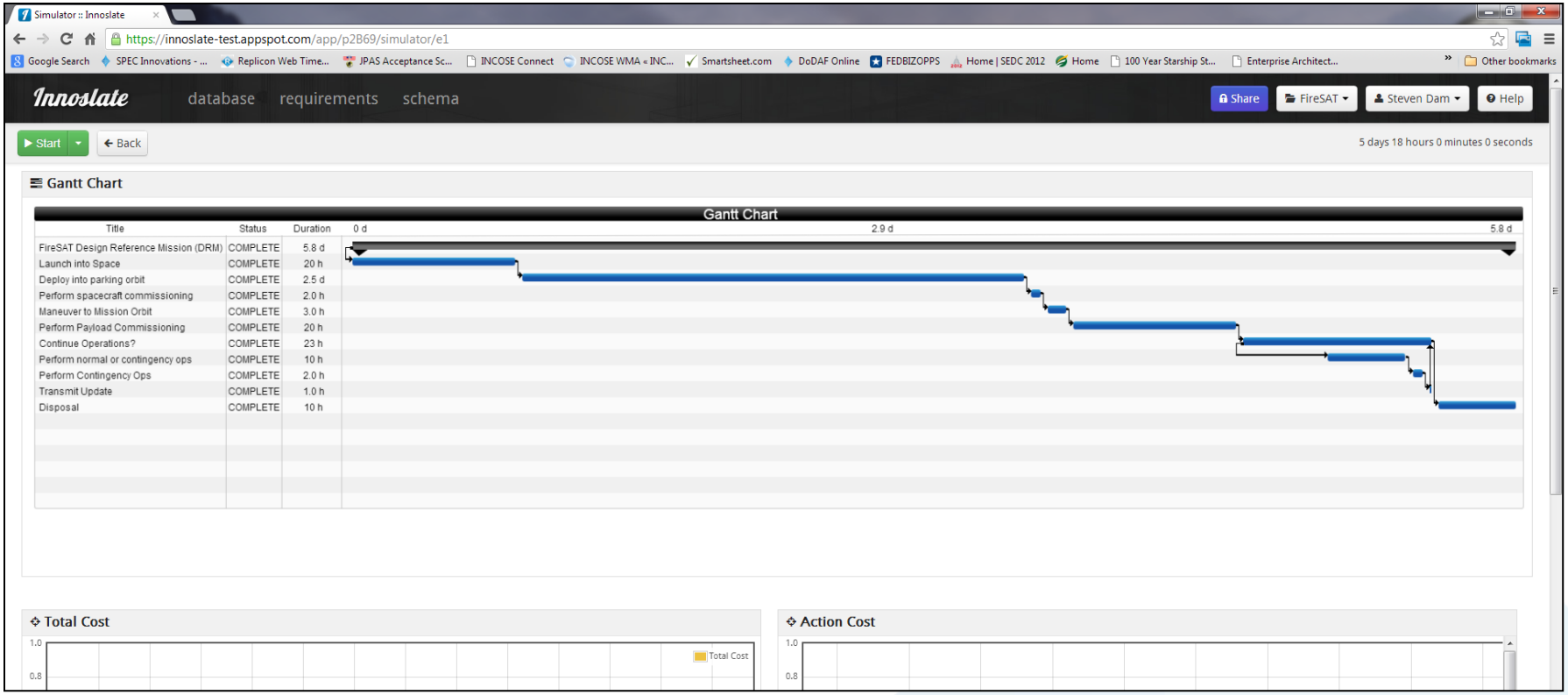


Simulation

- Integrated simulator (both continuous and discrete event) are needed for ensuring executability of design and operational procedures
- Innoslate has a first cut discrete event simulator built-in, but more work is needed
- Linking to other simulation tools (e.f. Satellite Toolkit) may be feasible in the future

SPEC INNOVATIONS

Innoslate Simulation of FireSAT Design Reference Model



Cost and Resources can also be captured in this simulation; each decision point can also be prompted for a user response

SUMMARY

Summary

- The problem with modeling C2, IA, Security and other decision points
- LML helps force the capturing of decision points

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Way Ahead

- Further work on modeling decision points of all kinds is needed to ensure that that information is captured as part of the design and analysis

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