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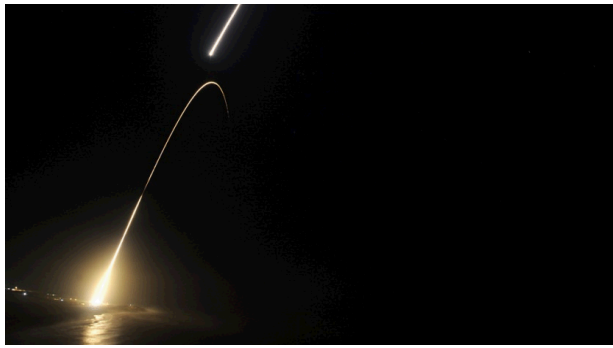

SIMDIS for Real-Time Hardware-in-the-Loop Simulation Visualization of Rocket Systems

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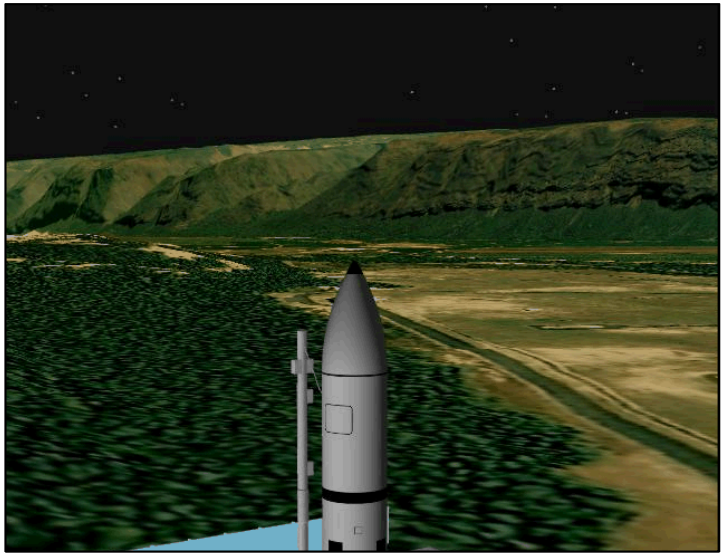
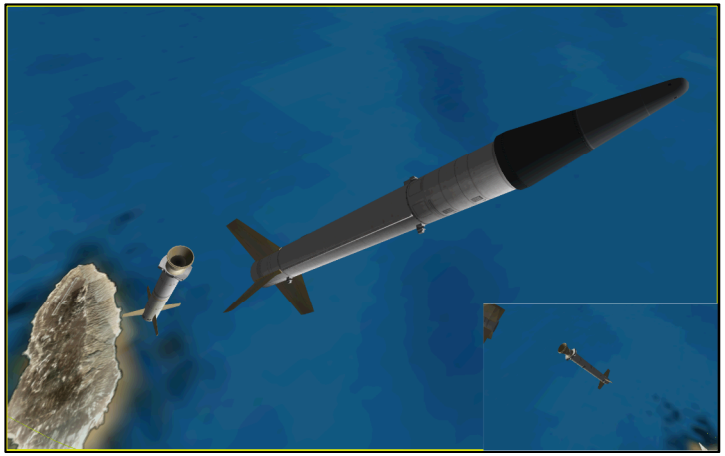
Overview

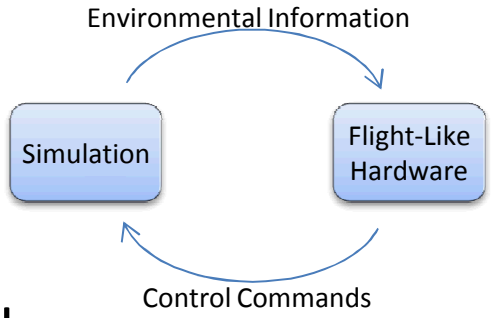
- Introduction
- SIMDIS overview
  - Displaying data with SIMDIS
  - Separation example
  - Operating modes
- Interfacing in real-time
  - Data flow
  - Display options
- Benefits and conclusion





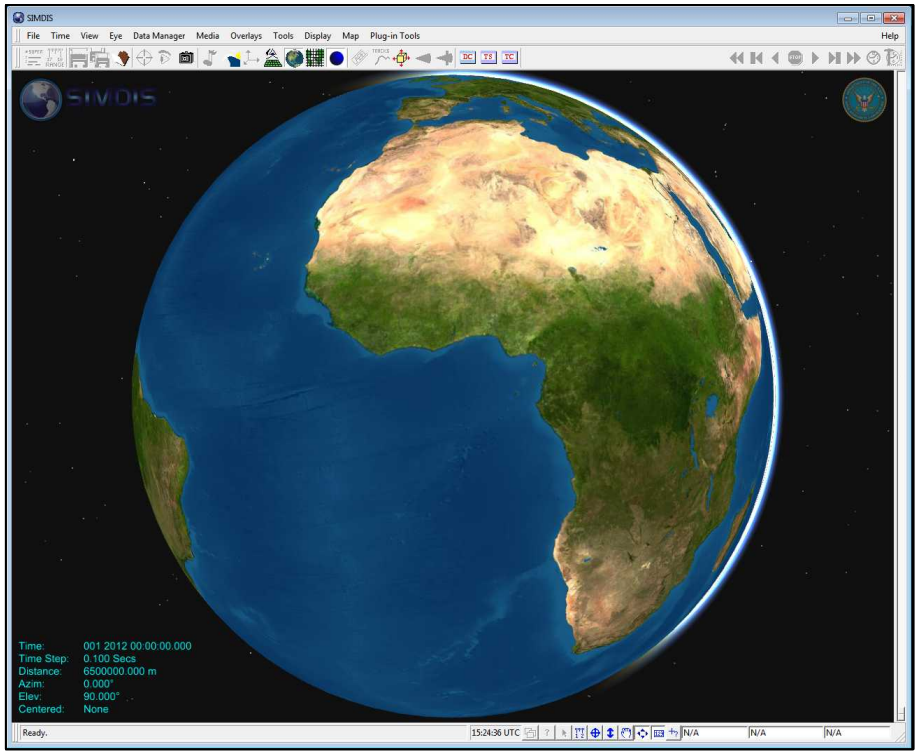
Introduction

- SNL NGC department designs, models, and launches
  - Spin-stabilized sounding rockets
  - Thrust vector controlled missile systems
- Hardware-in-the-loop (HWIL) simulator developed for each mission
  - High-fidelity
  - Flight-like hardware
  - Flight software verification and validation (V&V)
- Need method for visualizing difficult multi-body dynamics
  - Homegrown visualization tool difficult to support and evolve
  - Off-the-shelf tool desired



SIMDIS Overview

- SIMulation analysis and DISplay
- Two- and Three-dimensional
- Real-time and post-processed data
- Developed by the US Naval Research Laboratory (Government off-the-shelf)
- Large user base
- Runs on commercial-off-the-shelf (COTS) hardware
- Available for Linux and Windows operating systems



Displaying Data with SIMDIS

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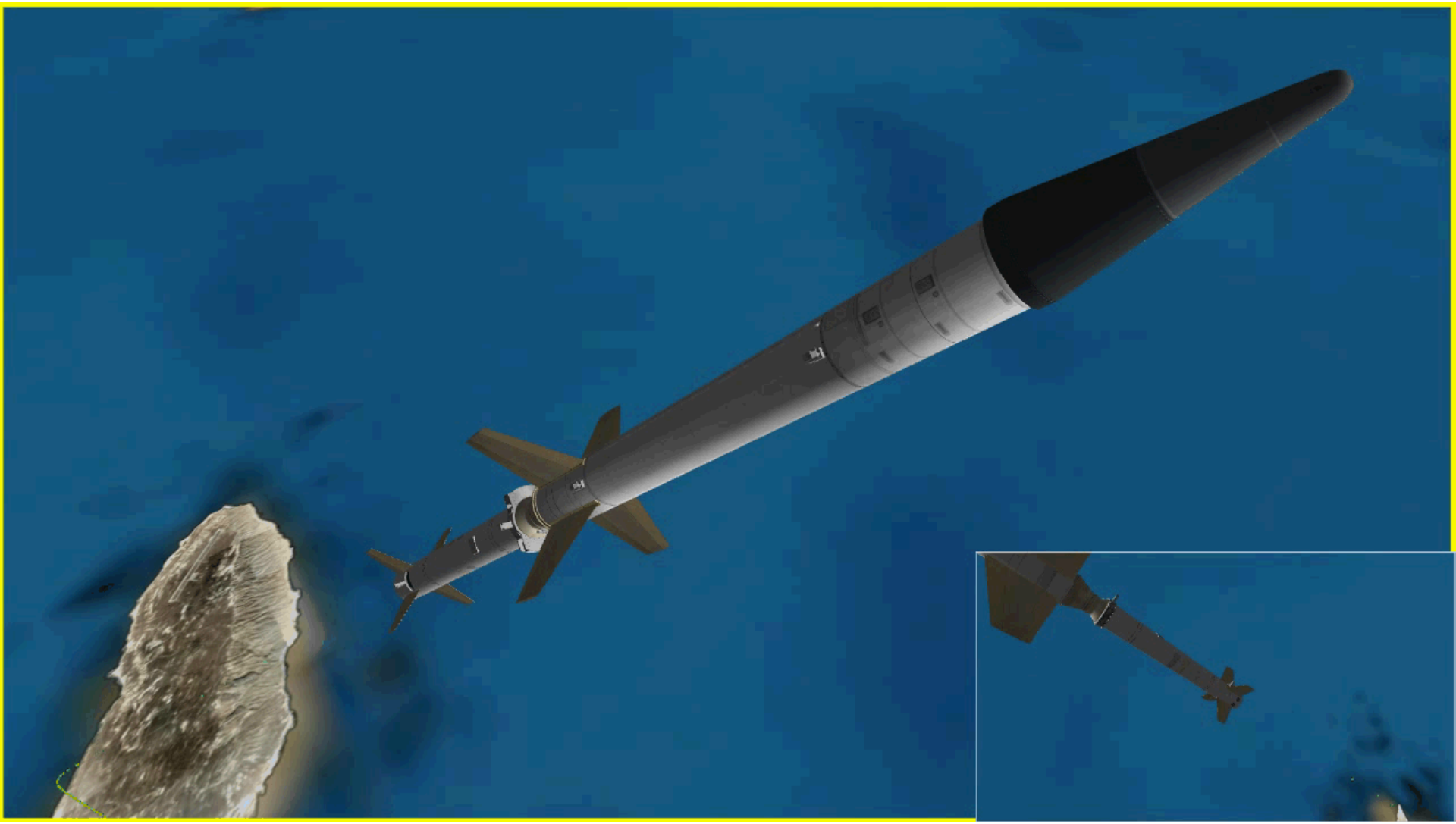
- Four different object types
  - Platforms (primary focus)
  - Beams
  - Gates
  - Lasers
- Platform components
  - Time
  - Position
  - Orientation
  - Velocity
  - Acceleration
- Generic data can be added to platforms
  - Hot and cold gas plumes
  - Varying platform color, size, transparency
  - Adding vapor trails
  - And more…
- Multiple ways to represent a staged vehicle with platforms

Separation Example



SIMDIS Operating Modes

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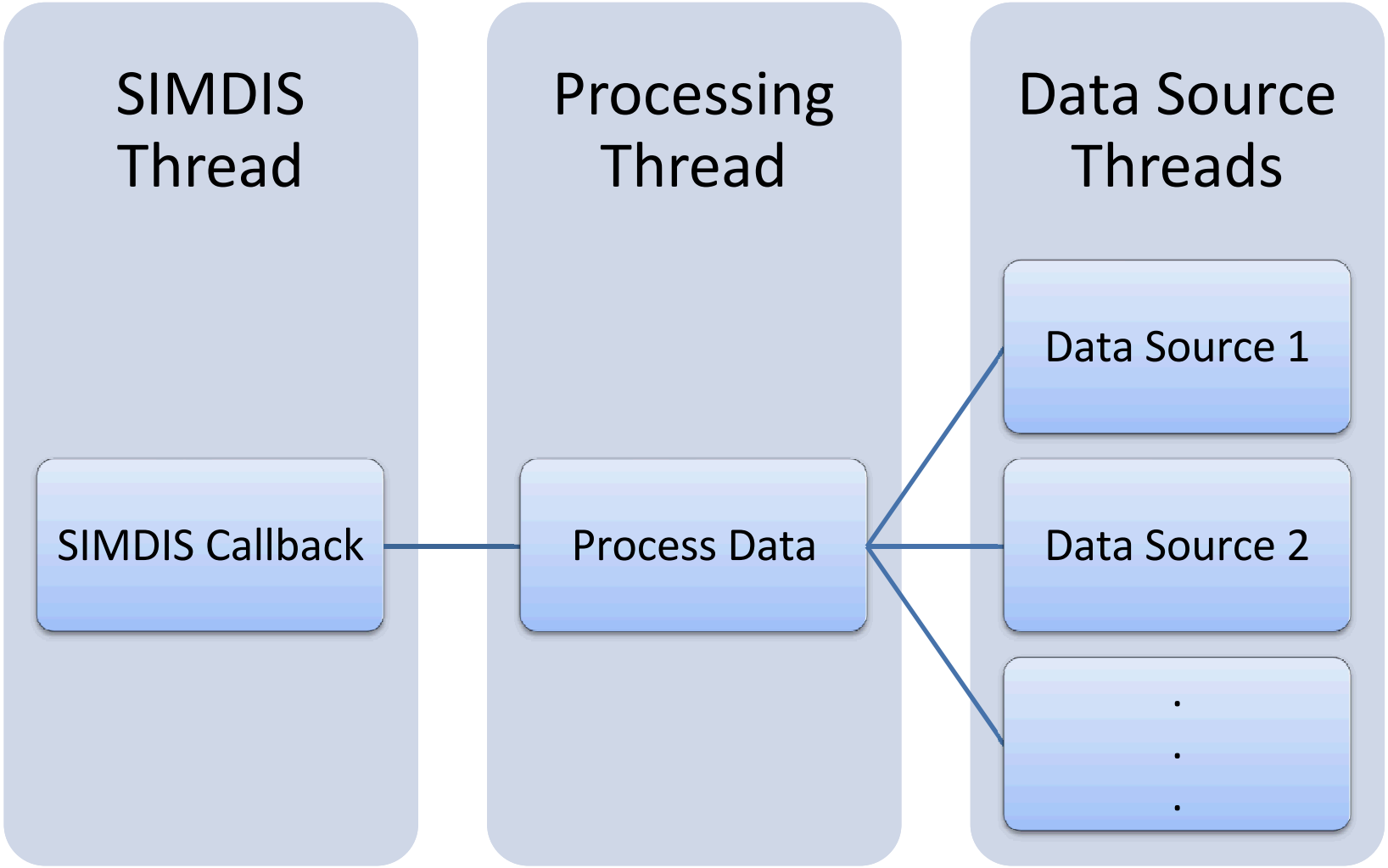
- Recorded data playback
  - Review previously recorded or generated data at any speed (including reverse)
  - Default mode SIMDIS starts in
  - Data from any source can be easily output into an ASCII scenario input file
- Live data capture
  - Used for HWIL simulation real-time display
  - Must be invoked by a plugin
  - Some plugins available out-of-the-box
  - Application programming interface (API) available for custom plugin development

Interfacing in Real-Time

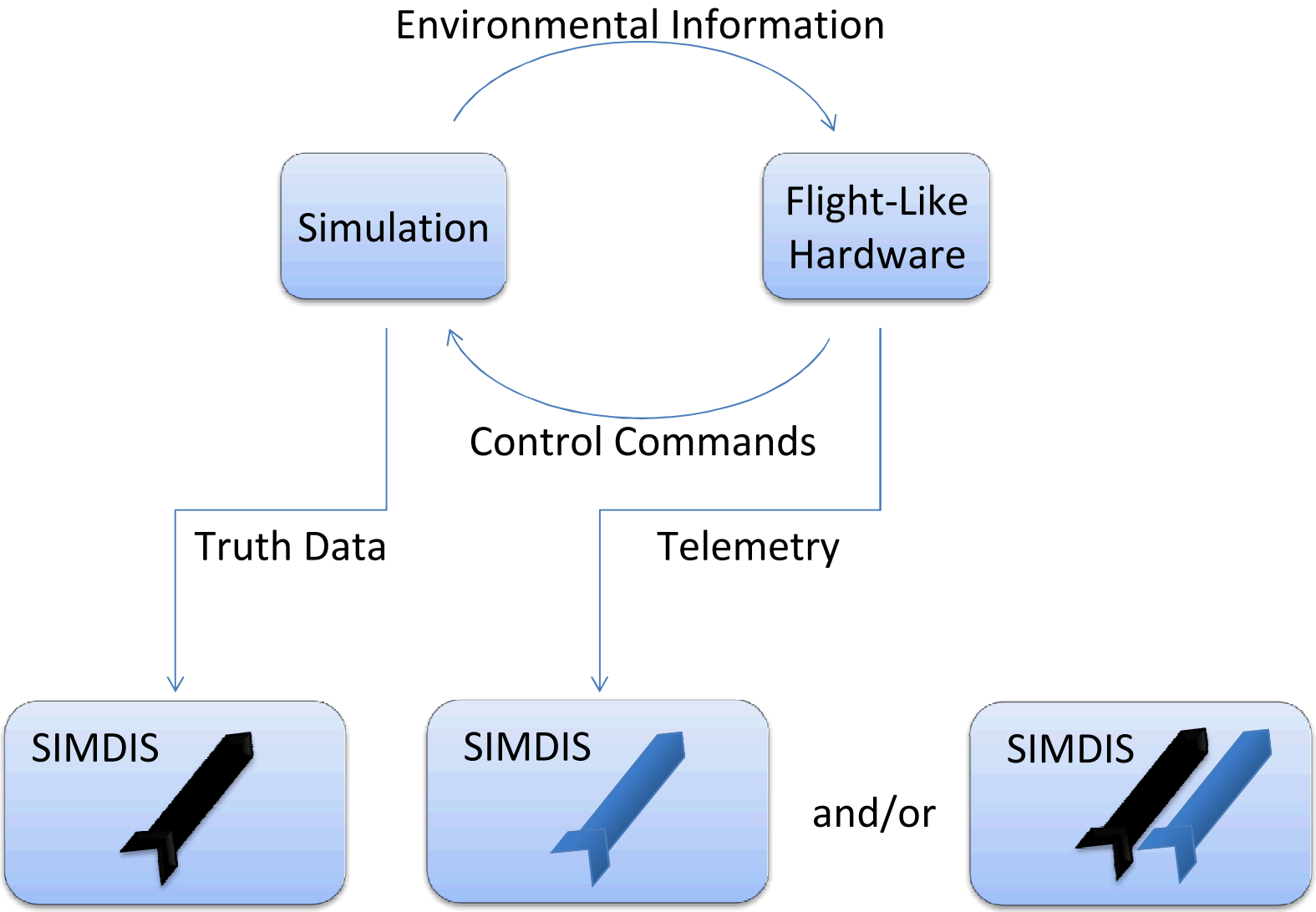
- Plugin developed to receive data from various sources
  - Flight-like hardware telemetry data
  - HWIL simulation truth data
  - Sources specified in extensible markup language (XML) file

- Found best plugin backend configuration
  - API specifies that for best results, all SIMDIS calls must be made from a thread that originated from SIMDIS itself.
  - Separate thread used to do data processing with data double-buffering

Data Flow


SIMDIS Thread
Processing Thread
Data Source Threads
SIMDIS Callback
Process Data
Data Source 1
Data Source 2
.
.
.

Display Options



Benefits and Conclusion

- 3D visualization of difficult multi-body dynamics
- Visualization of actuator or thruster polarity
- Quick-look sanity checks
  - Instances where visualization has revealed issues with models and even real-world configurations
- Conveying information to non-subject matter experts and program customers and sponsors
- Single tool (SIMDIS plus custom plugin)
- Minimal time effort (GOTS software on COTS OS and hardware)
- Accelerated flight software development, debugging, and V&V process