An Evaluation of The High Level Architecture (HLA) as a Framework for NASA Modeling and Simulation

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Introduction

- Mission-oriented organizations increasingly rely on simulators to reduce risks and costs
- Need to reduce the costs and increase the capabilities of simulations
  - Move to component-based architectures
  - Integrate disparate simulators into larger simulation systems
  - Distribute computing
  - Separate infrastructure from simulation operations
- The DoD developed the HLA to address these issues
- NASA has simulation needs similar to the DoD's

What is the HLA?

- The High Level Architecture (HLA) is a DoD and IEEE standard (IEEE-1516) framework that supports modeling and simulation
- "The HLA is the glue that allows you to combine computer simulations into a larger simulation."[1]

1. F. Kuhl, R. Weatherly, and J. Dahmann, *Creating Computer Simulation Systems: An Introduction to the High Level Architecture,* p. 1, Prentice Hall PTR, 1999.

What the HLA Is

- Object-based software architecture
- Component-based software architecture
- Integration system
- Communications and data sharing system
- Synchronization and time management system
- Distributed computing environment

What the HLA Is Not

- *Not* a simulator
- *Not* a modeling tool
- *Not* a test tool
- *Not* a telemetry generator
- *Not* a data display and analysis tool
- *Not* a user interface
- *Not* a “plug and play” system

Role of the HLA

- Provides a standard architecture for simulation systems
- Facilitates distributed and multi-platform computing in simulation systems
- Integrates separate and remote applications
- Supports collaboration
- Facilitates reuse

HLA Terminology

- Federate
  - An individual HLA-compliant simulator application
- Federation
  - A simulation system composed of two or more (often many more) federates that "play" together

Components of the HLA

- A set of rules
  - Govern the overall simulation
  - Govern each participating simulator
- A Runtime Infrastructure (RTI) specification
  - COTS/GOTS software that manages the simulation and integrates the simulators
- An Object Model Template (OMT)
  - A standard for defining and documenting the form, type, and structure of data shared within a simulation

The Runtime Infrastructure (RTI)

- Part of the IEEE-1516 specification
- Software system
  - Object-based API
  - Set of daemons
- Provides six types of services to the federation
  - Federation Management
  - Declaration Management
  - Ownership Management
  - Object Management
  - Time Management
  - Data Distribution Management (DDM)

Object Modeling

- Federation Object Model (FOM)
  - Describes the “universe”
  - The common object model that defines the data that federates share within the federation
  - Documented in accordance with the OMT
- Simulation Object Model (SOM)
  - The object model which defines the data that an individual federate shares with a federation
  - Also contains some other interfacing information
  - Documented in accordance with the OMT

HLA Objects

- Analogous to objects in an OOP language
- Have state (in *attributes*)
- Represent the “actors” or entities that the simulation models
- Containers for persistent data
- Mechanism through which federates share data
  - Uses a *publish and subscribe* paradigm
- Federates create and destroy them at will
- Defined in the FOM and SOMs

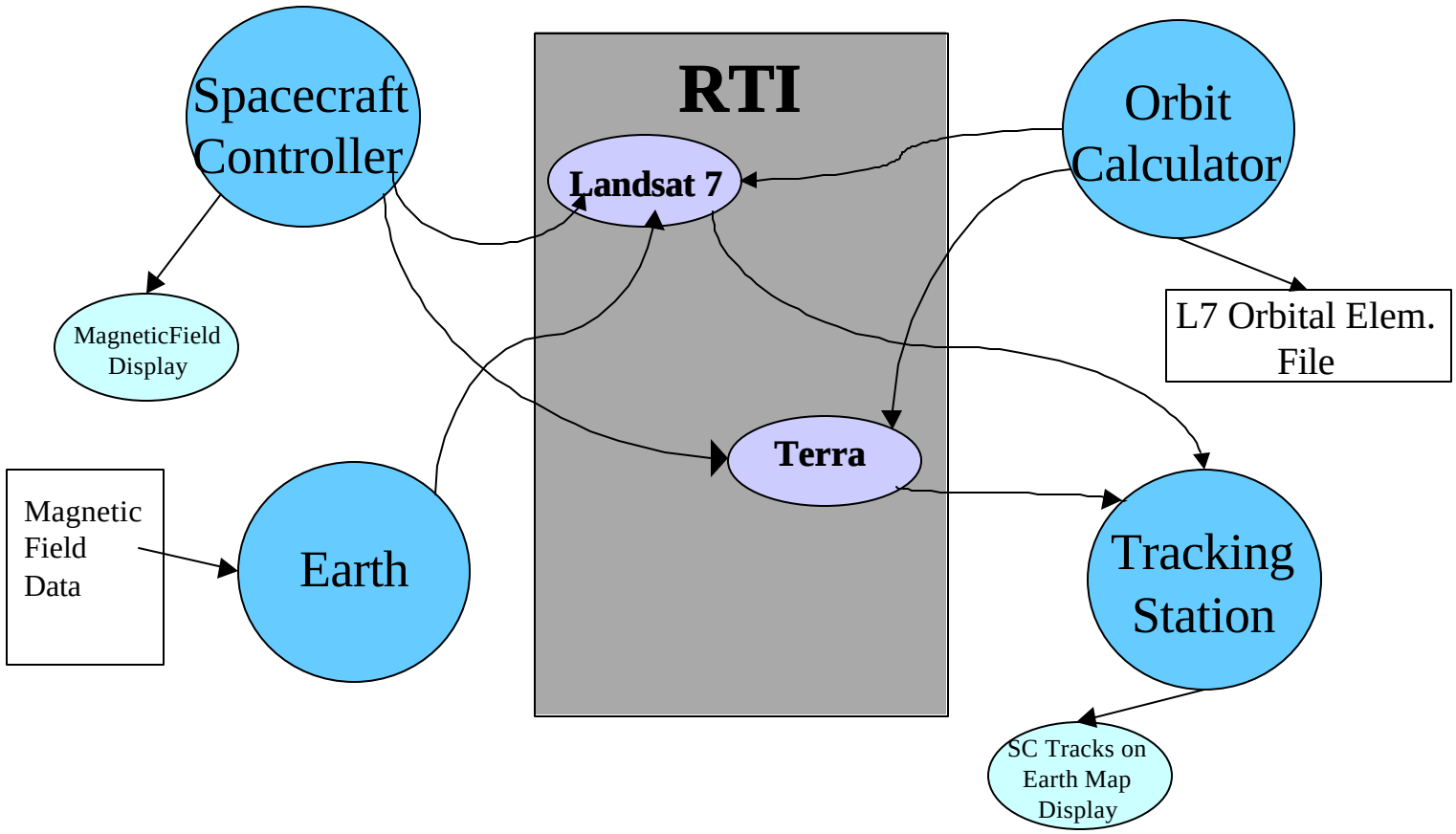
What the HLA Will Not Do

- *Won't* build your simulation for you
- *Won't* increase the fidelity of simulators
- *Won't* generate your data
- *Won't* display or analyze your data
- *Won't* provide a user interface
- *Won't* make "plug and play" a reality
- *Won't* eliminate programming

The R&D Prototype

- Developed a common HLA-interface library
  - Using C++ abstract base classes
- Created four fully HLA-compliant simulators
  - Spacecraft Controller
  - Orbit Calculator
  - Tracking Station
  - Earth
- Made the four simulators “play” together as federates in a federation
- A clock-driven simulation

The Federation



The HLA and NASA

- Integrating numerous specialized simulators into larger overall space mission simulations
  - Spacecraft and instrument simulators
  - Science data generators
  - Ground system simulators
- Formation flying
  - Multiple spacecraft and ground stations
- Modeling natural Earth or planetary geophysical systems
  - Weather systems and climatic factors
  - Geological, biological, and anthropogenic activities
  - Cosmic influences

Conclusions on the HLA

- A viable technology for certain types of simulations and modeling
  - Game-like simulations
  - Modeling a “universe” where numerous actors interact with each other and come and go
  - Distributed systems
  - Systems involving different computing platforms
- Not appropriate for all simulation applications
  - Single component or single task simulators
  - Integrating hardware components