High Level Architecture
Module 1
Basic Concepts

McLeod Institute of Simulation Sciences
California State University, Chico

The Society for Computer Simulation

Roy Crosbie
John Zenor

California State University, Chico
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Lesson 1
Introduction to HLA
HLA Components

• **HLA Rules**
  – Ensure proper interaction of federates in a federation
  – Describe the responsibilities of federates and federations

• **Interface Specification**
  – Defines Runtime Infrastructure (RTI) services and interfaces
  – Identifies “callback” functions each federate must provide

• **Object Model Template (OMT)**
  – Prescribes the format and syntax for recording information
  – Establishes the format of key models
    • Federation Object Model (FOM)
    • Simulation Object Model (SOM)
    • Management Object Model (MOM)
Federation Rules

1. Federations shall have a FOM, documented in accordance with the OMT.

2. All representation of objects in the FOM shall be in the federates, not in the RTI.

3. During a federation execution, all exchange of FOM data among federates shall occur via the RTI.

4. During a federation execution, federates shall interact with the RTI in accordance with the HLA interface specification.

5. During a federation execution, an attribute of an instance of an object shall be owned by only one federate at any given time.
Federate Rules

6. Federates shall have a SOM, documented in accordance with the OMT.

7. Federates shall be able to update and/or reflect any attributes of objects in their SOM, and send and/or receive SOM interactions externally, as specified in their SOM.

8. Federates shall be able to transfer and/or accept ownership of attributes dynamically during a federation execution, as specified in their SOM.

9. Federates shall be able to vary the conditions under which they provide updates of attributes of objects, as specified in their SOM.

10. Federates shall be able to manage local time in a way which will allow them to coordinate data exchange with other members of a federation.
Runtime Infrastructure (RTI) Overview

• What is the RTI?
  – Software that provides common services to simulation systems
  – Implementation of the federate initiated services in accordance with the HLA Interface Specification
  – An architectural foundation encouraging portability and interoperability
RTI Services

- Separate simulation and communication
- Improve on older standards (e.g., DIS, ALSP)
- Facilitate construction and destruction of federations
- Support object declaration and management between federates
- Assist with federation time management
- Provide efficient communications to logical groups of federates
Interface Specification
Management Areas

- Federation Management
- Declaration Management
- Object Management
- Ownership Management
- Data Distribution Management
- Time Management
Object Model Template

• **Object Model Template (OMT)**
  – Provides a common framework for HLA object model documentation.
  – Fosters interoperability and reuse of simulations and their components.

• **Required Information**
  – Object Class Structure Table
  – Object Interaction Table
  – Attribute/Parameter Table
  – FOM/SOM Lexicon

• **Optional Information (OMT Extensions)**
  – Component Structure Table
  – Associations Table
  – Object Model Metadata
Object Models

• **Federation Object Model (FOM)**
  – One per federation
  – Introduces all shared information (e.g., objects, interactions)
  – Contemplates inter-federate issues (e.g., data encoding schemes)

• **Simulation Object Model (SOM)**
  – One per federate
  – Describes salient characteristics of a federate
  – Presents objects and interactions that can be used externally
  – Focuses on the federate’s internal operation

• **Management Object Model (MOM)**
  – Universal definition
  – Identifies objects and interactions used to manage a federation
An Example of HLA: HelloWorld

HelloWorld math model:

Rate of population increase = constant * current population
(Initial population = P0)

Expressed as a differential equation

\[ \frac{dP}{dt} = K \times P, \text{ where } P = P_0 \text{ at } t = t_0 \]
HelloWorld (continued)

An approximate solution of the differential equation is

\[ P_{\text{new}} = P_{\text{old}} + K \times P_{\text{old}} \times \Delta t \]

- \( P_{\text{old}} = \) population at time, \( t \)
- \( P_{\text{new}} = \) population at time, \( t + \Delta t \)
- \( \Delta t = \) time step for advancing simulation
- \( K = \) fractional rate of increase of population