Introduction to HLA

Module 1: Introduction and Overview
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Course Modules

- **1: Introduction and Overview**
  - Interoperability, reuse, HLA topology, HLA services

- **2: What's in a federation**
  - Models, RTI, federates, FOM, scenario, management

- **3: Objects and interactions**
  - More FOM, data types, publish, subscribe, etc

- **4: Simulation time**
  - Real-time, logical time, time-stamps, time advance

- **5: Playing with HLA tools**
  - RTI GUI, object modeling, object oriented HLA, data logging, management and monitoring

Why Modeling and Simulation?

- Models – a way to understand the world
- Verify a hypothesis
- Analyze new concepts and ideas
- Design and engineer a new product
- Entertain
- Train people to master tasks
- Train people in a more cost-effective way
- Safely simulate dangerous situations
- Test equipment in a simulated world
- (Add your own suggestions and ideas here)

Interoperability

- Make systems and ultimately organizations work together

- Combine the people, capabilities, expertise, systems and models of different
  - Countries
  - Organizations
  - Departments

- Combine systems into a Federation
  - Group of potentially independent systems

- Achieve an overarching goal

- Exchange services

Interoperability = Sending Bits and Bytes?

- It is more than sending and receiving bits and bytes
- What does it mean if I send "00101000" to you
  - Could mean "40" (8 bit integer)
  - Age or temperature?
  - Fahrenheit or Celsius?
  - Indoors or outdoors?
  - Where? What terrain database do you use?
  - What am I expected to do with this data?

- There are "Levels of Conceptual Interoperability" (LCIM)
  - Technical, syntactic, semantic, dynamic, contextual, etc

Reuse

- Good simulation models are developed based on expertise

- If we developed a good simulation model we want to reuse it in many contexts and combinations

- To minimize the effort to reuse we need to
  - Minimize the impact on the reused simulation
  - Minimize the impact on the other simulations
  - Use standardized communication interfaces
  - Agree on what data to send and receive, format and semantics, and document this
  - Have additional agreements (synchronization, etc)
  - Allow systems (and the information model) to evolve over time

HLA – The High-Level Architecture

- Connects simulations in a Federation

- Any domain, any data model

- Rich set of services
  - Data exchange
  - Synchronization
  - Management

- Many ways to handle simulation time

- Enables interoperability and reuse

Who uses HLA?

- **Started in the defense area by US DoD**
  - From pilot training to command and control

- **Expanded into the Aerospace area**
  - Space simulation, air traffic management, etc

- **Civil-military peace support exercises**

- **Growing use in civilian domains**
  - Energy, manufacturing, medical, railroad, etc

- **Used in more than 40 nations**

HLA is an open international Standard

- Developed by SISO, published by IEEE
  - Anyone can participate in the development

- The standard consists of documents, not software implementations
  - Anyone is free to develop their own software implementations

- HLA is a prescribed standard in NATO

- Standards enable a marketplace for systems that can be bought & sold, reused, combined in new ways, etc.
  - Reduces cost, time and risk.

Comparing Two Topologies
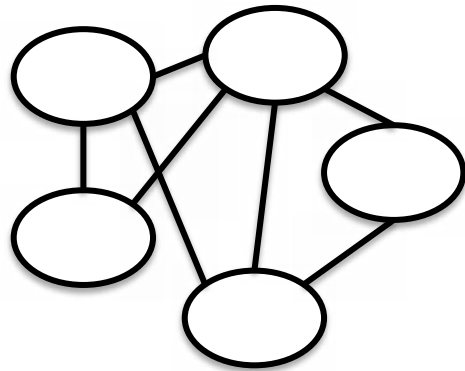
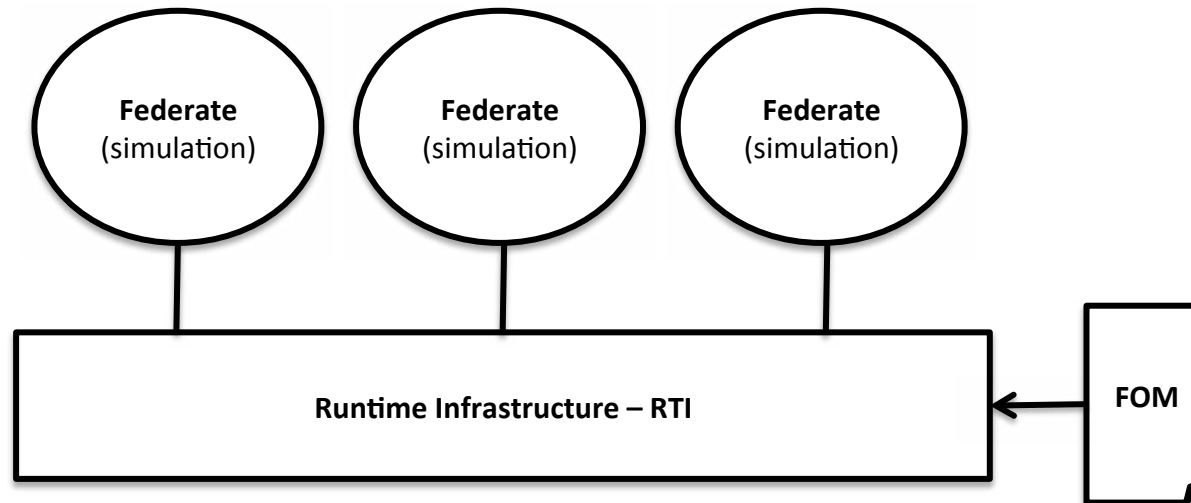**Pair-wise Integration**
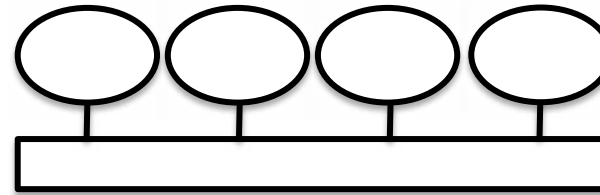
Service Bus

- HLA is a Service Bus

- Reduces number of connections

- Avoids updating many existing systems when adding a new

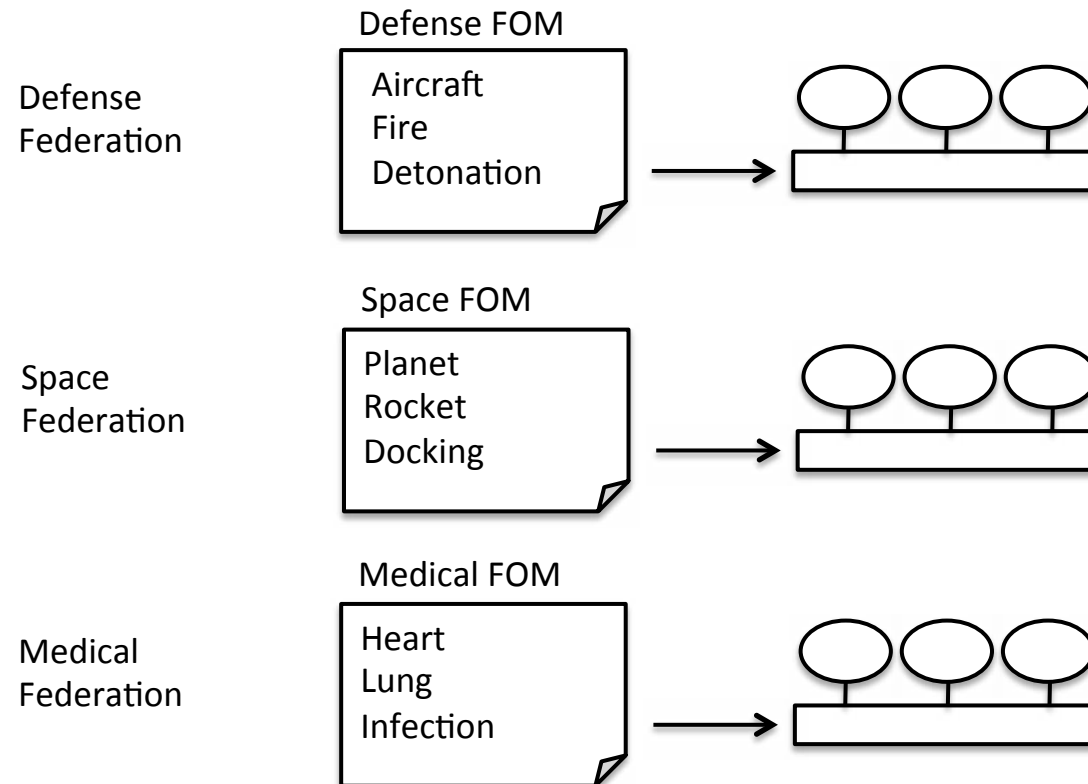- Connect to one infrastructure using one general design

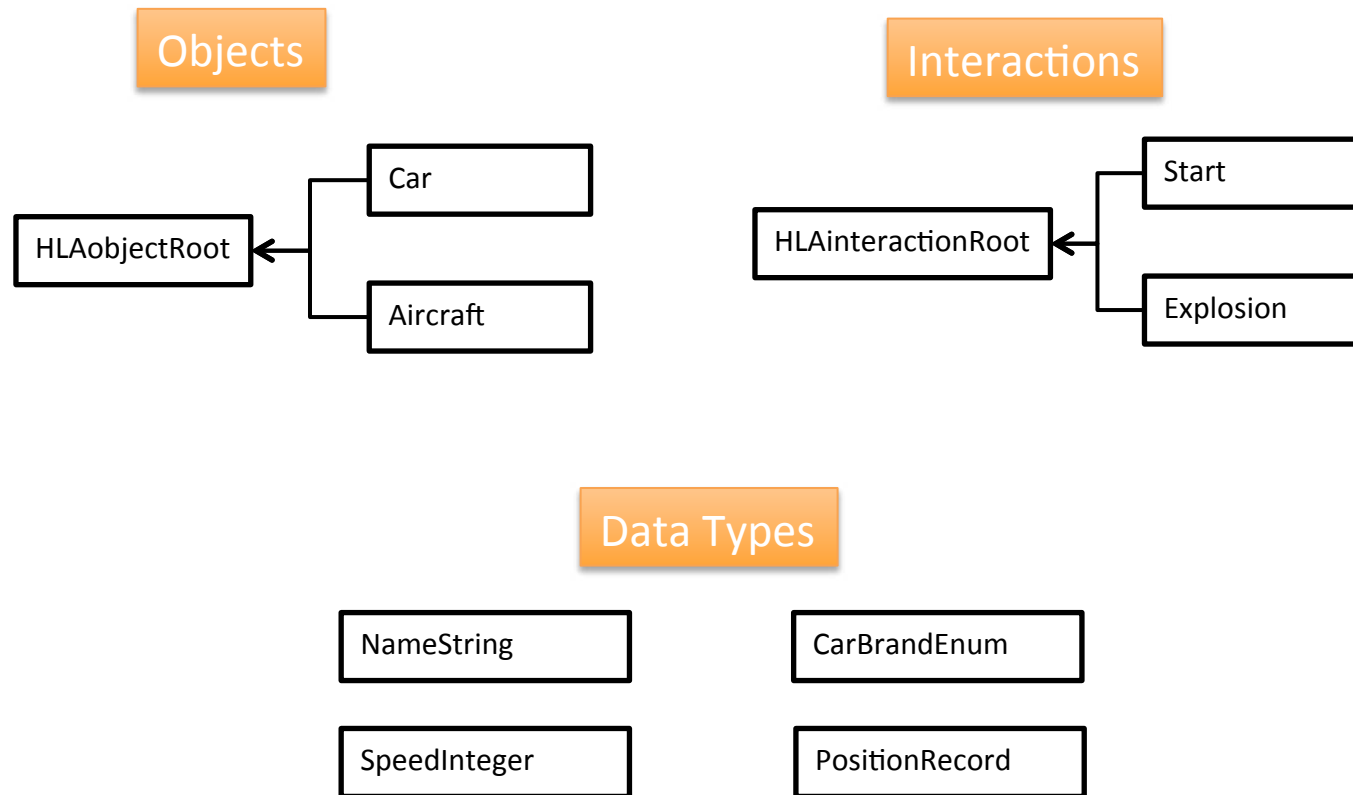# The HLA Federation – "Lollipop diagram"

IMPORTANT PICTURE

- FOM = Federation Object Model
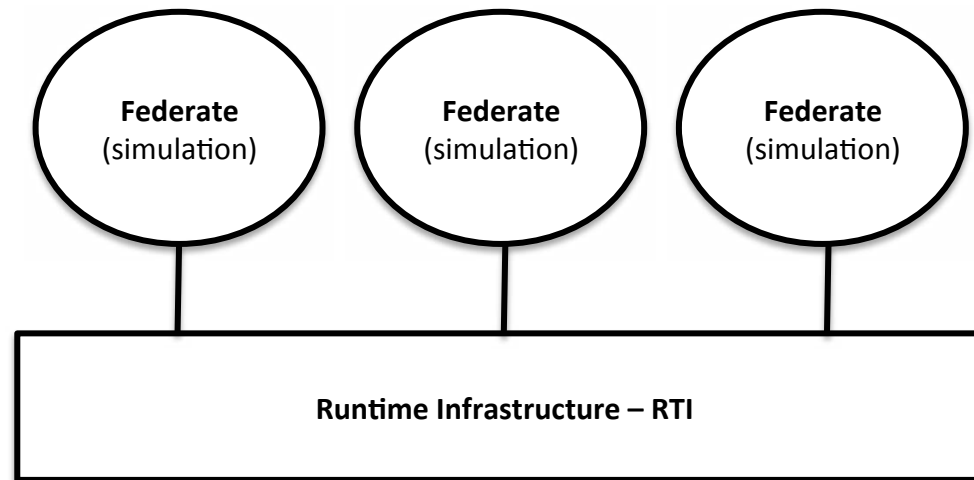 - The language of the federation

Different FOMs for different Domains

Defense
Federation

Defense FOM

Aircraft
Fire
Detonation

Space
Federation

Space FOM

Planet
Rocket
Docking

Medical
Federation

Medical FOM

Heart
Lung
Infection

Contents of a FOM

Objects

```
                   ┌─── Car
  HLAobjectRoot ◄──┤
                   └─── Aircraft
```

Interactions

```
                       ┌─── Start
  HLAinteractionRoot ◄──┤
                       └─── Explosion
```

Data Types

NameString	CarBrandEnum
SpeedInteger	PositionRecord

RTI Services

Federate (simulation) — Federate (simulation) — Federate (simulation)

Runtime Infrastructure – RTI

- Information services

- Synchronization services

- Coordination services

RTI – Information Services

Federate A   Federate B   Federate C

Car.Name

Car.Position
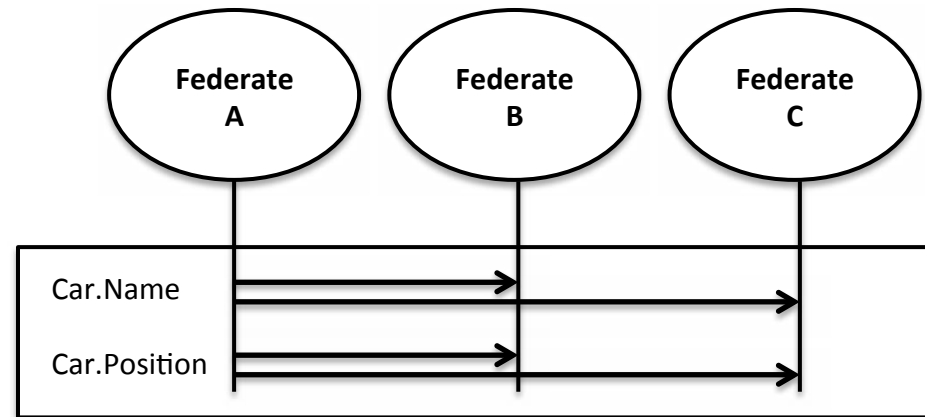
- Send and receive Objects and Interaction data as specified in the FOM

- Will be covered in much greater detail later

RTI – Synchronization Services

- Time-stamping of data

- Coordination of data and time advance

- Synchronization points

- Save & Restore

RTI – Coordination Services

- Management of federation executions and federates

- Transfer of modeling responsibility
  - "ownership"

- Advanced inspection and management of the federation

The HLA Standard

- **Three documents**
  - No particular software implementation

- **IEEE 1516-2010 Framework and Rules**

- **IEEE 1516.1-2010 Federate Interface Specification**
  - "Programmers reference"

- **IEEE 1516.2-2010 Object Model Template Specification**
  - "Object Model developers reference"

- **These are Standards: Exact, unambiguous, dry**

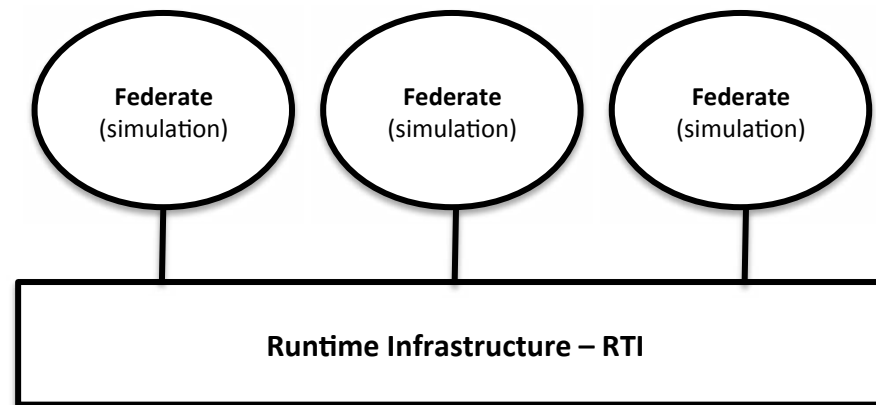- **To get started try "The HLA Tutorial"**
  - www.pitch.se/hlatutorial

End of Module 1
It's time for a Quiz!

Quiz for Module 1

- What is the nick-name for this type of diagram in HLA?

- Hint:

Leader in Standards-Based
Distributed Simulation Solutions