A Distributed Simulation Standard: High Level Architecture (HLA) (Part 8)

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A Distributed Simulation Standard: High Level Architecture (HLA) (Outline)

- Introduction to Distributed Simulations
- Introduction to HLA
- HLA Interface Specification:
  - Federation Management
  - Declaration Management
  - Object Management
- Conclusion

Distributed Simulation

- An integrated simulation that is partitioned into a number of smaller simulations over different computational units (e.g. processors, computers).
- Provides higher scalability and multi user interaction.
- A system, whose performance improves proportional to the computational capacity added, is said to be a scalable system.

Distributed Simulation

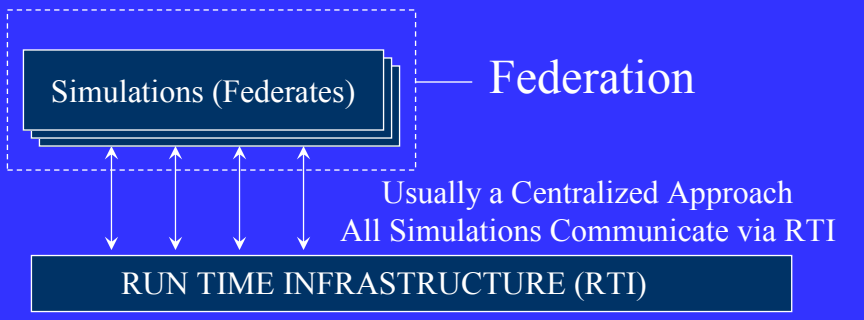
High Level Architecture (HLA)

- An IEEE (1516) Distributed Modeling & Simulation Standard
- Developed By DMSO
  - Current technology was not providing tools necessary to achieve DoD M&S Master Plan.
  - A Standard was Needed For the Interoperability of Developed Simulations.

What is HLA?

- A service that provides:
  - Major functional elements,
  - Interfaces,
  - Design rules,
  - A common framework for communication of simulations.

The Structure of HLA

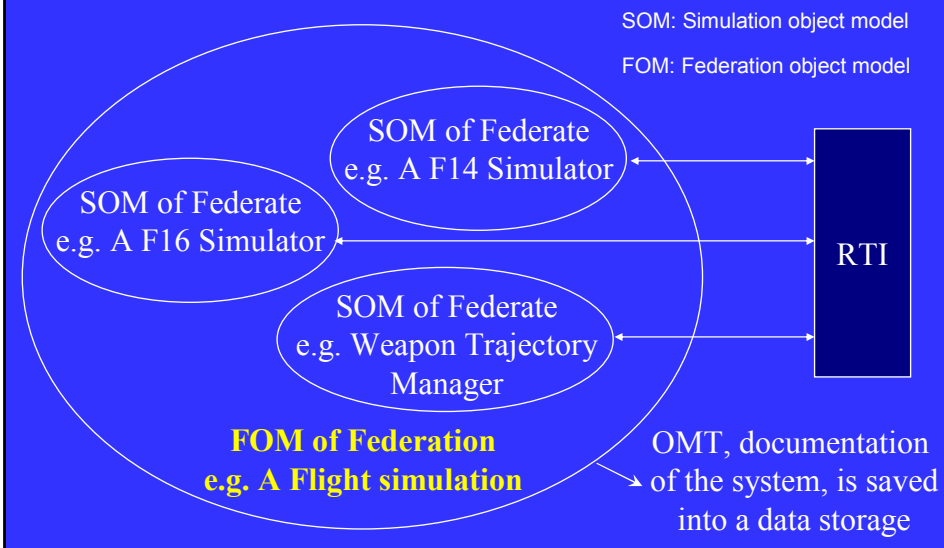


- Federation Management
- Declaration Management
- Object Management
- Ownership Management
- Time Management
- Data Distribution Management

Defining the HLA

- The HLA is composed of three elements:
  - HLA Rules:
  - A set of rules which must be followed to achieve proper interaction of simulations in a federation
  - Interface Specification:
    - Definition of the interface functions between the RTI and the simulations subject to the HLA
  - Object Model Template (OMT):
    - The prescribed common method for recording the information contained in the required HLA Object Model for each federation and simulation

HLA Object Models



HLA Rules

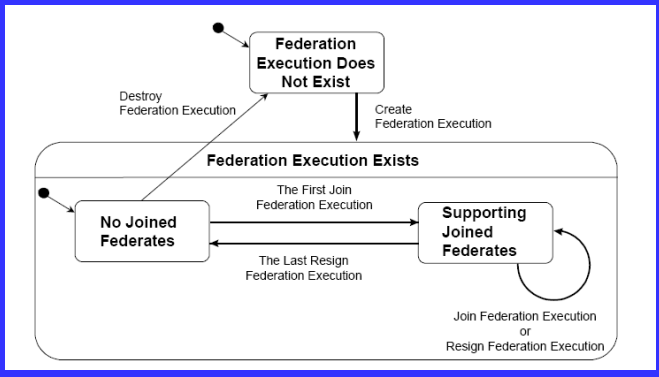
- Federation Rules:
  - Federations shall have an HLA Federation Object Model (FOM), documented in accordance with the HLA Object Model Template.
  - In a federation, all representation of objects in the FOM shall be in the federates, not in the runtime infrastructure (RTI).
  - . . . . .
- Federate Rules:
  - Federates shall have an HLA Simulation Object Model (SOM), documented in accordance with the HLA Object Model Template.
  - Federates shall be able to update and/or reflect any attributes of objects in their SOM and send and/or receive SOM object interactions externally, as specified in their SOM.
  - . . . . .

HLA Interface Specification

Category	Functionality
Federation Management	Create and delete federation executions Join and resign federation executions Control checkpoint, pause, resume, restart
Declaration Management	Establish intent to publish and subscribe to object attributes and interactions
Object Management	Create and delete object instances Control attribute and interaction publication Create and delete object reflections
Ownership Management	Transfer ownership of object attributes
Time Management	Coordinate the advance of logical time and its relationship to real time
Data Distribution Management	Supports efficient routing of data

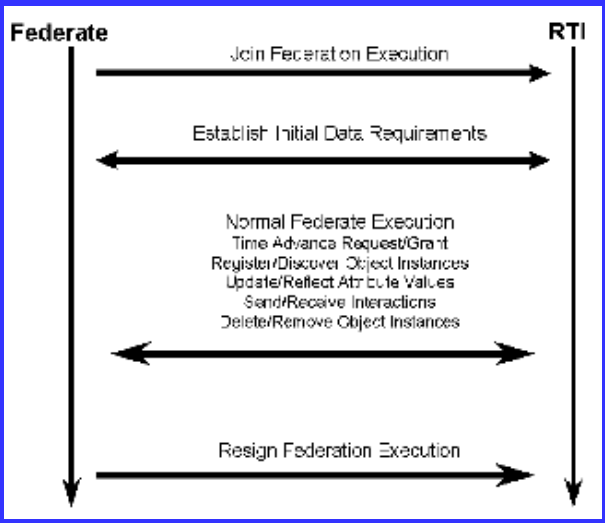
Federation Management

- Federation management refers to the creation, dynamic control, modification, and deletion of a federation execution.



Basic steps of federation execution

Federation Management



Overview of Federate To RTI Relationship

Federation Management
(Initialization/Finalization of a Federate)

- CreateFederationExecution
- JoinFederationExecution

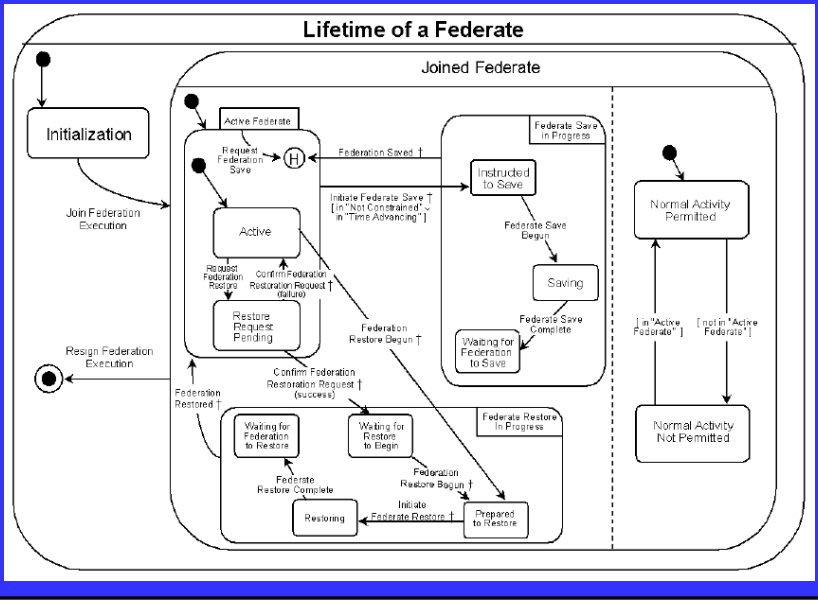
} Initialization of a federate

- ...
- Normal federate execution....
- ...

- ResignFederationExecution
- DestroyFederationExecution

} Finalization of a federate

Federation Management (Lifetime of a Federate)



Declaration Management

- Federates use Declaration Management services to declare their intention;
  - To generate information, and
  - To receive information.
  - A joined federate shall invoke appropriate Declaration Management services
    - Before it may register object instances, update instance attribute values, and send interactions.

Declaration Management

- PublishObjectClass
- UnpublishObjectClass

Declares which classes it is planning to use in order to create object instances of these classes.

- SubscribeObjectClassAttributes
- UnsubscribeObjectClass

Declares which classes (and their attributes) it is planning to use in order to receive information of object instances of these classes.

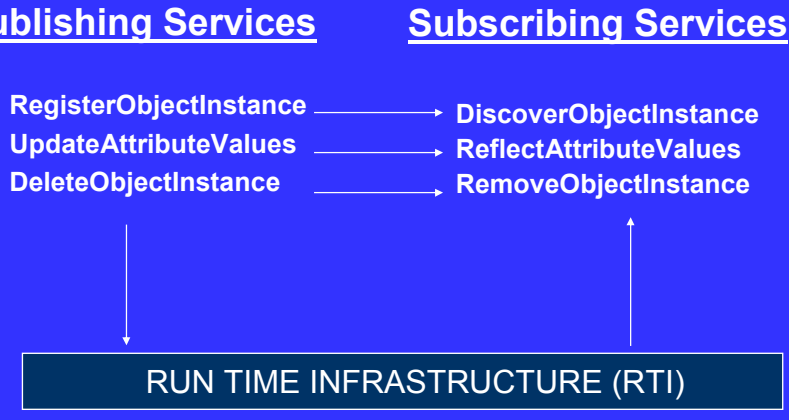
Object Management

- Deals with;
  - The registration, modification, and deletion of object instances, and
  - The sending and receipt of interactions.
- Object instance discovery is the prime concept in this service group.

Object Management

- When a joined federate either;
  - Uses the *Register Object Instance* service to register an object instance or
  - Receives an invocation of the *Discover Object Instance* to discover an object instance,
- That object instance becomes known to the joined federate.

Object Management



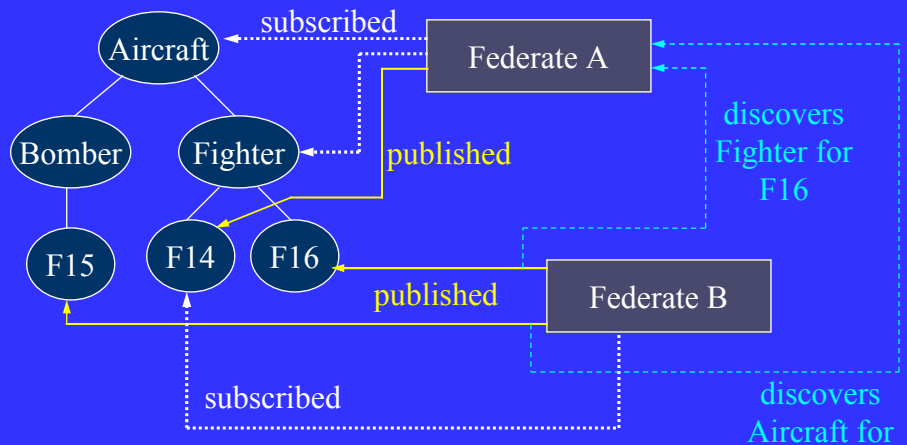
Support Services

- GetObjectClassHandle
  - All the classes defined in the FOM has a unique name and handle.
  - This function returns the handle given the name of the class.
    e.g. “Aircraft.bomber.F15”
- GetAttributeHandle
  - All the attributes of classes defined in the FOM has a unique name and handle.
  - This function returns the handle given the name of the attribute.
    e.g. “Aircraft.bomber.F15.x”

Class Hierarchy and Publish/Subscribe Mechanism

- Classes are defined as a hierarchy such as:
  - Aircraft [Attributes: Type,X,Y,Z,H,P,R,V]
    - Bomber [Attributes: NumOfFullBombs]
      - F15 [Attributes: WingsOn]
    - Fighter [Attributes: NumOfFullRightPylons, ...]
      - F14 [Attributes: WingsOn, GearsOn]
      - F16 [Attributes: FiringGun]
- Federates can publish and/or subscribe to one or more arbitrary classes and attributes on the hierarchy.
- RTI should filter the data and send to the federates only what they are interested in.

Example: Discovering Instances



Federation Execution Data File (FED File)

```
(FED
(Federation FederationName)
(FEDversion v1.3)
 (spaces )
 (objects
   (class ObjectRoot
     (attribute privilegeToDelete  reliable timestamp)
     (class RTIprivate)
 (class Aircraft
    (attribute X best_effort receive)
    (attribute Y best_effort receive)
    (attribute Z best_effort receive)
 (class Fighter
    (attribute NumOfFullRightPylons best_effort receive)
    (attribute NumOfFullLeftPylons best_effort receive)
 (class F16
    (attribute FiringGun best_effort receive)
 )
 . . . . . .
```

FED file defines:
- classes,
- attributes of classes,
- interactions,
- parameters of interactions,
- routing spaces,
- dimensions of spaces,
- ...

of a FOM

Conclusion

- COTS RTI implementations have a Centralized Architecture.
- If RTI fails,
  - Whole simulation will fail.
- If a federate fails,
  - The simulation continues unless a synchonized timing approach is used.