High Level Architecture
Module 1
Basic Concepts

The Society for Computer Simulation

McLeod Institute of Simulation Sciences
California State University, Chico

Roy Crosbie
John Zenor

California State University, Chico

High Level Architecture
Module 1
Basic Concepts

Lesson 4
Basic Concepts of HLA Simulations

Continuous vs. Discrete Simulations

Continuous

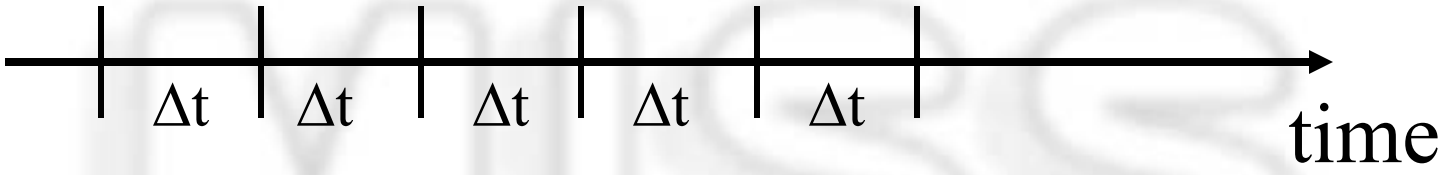
- Continuously advances time and system state.
- Time advances in increments small enough to ensure accuracy.
- State variables updated at each time step.

Discrete

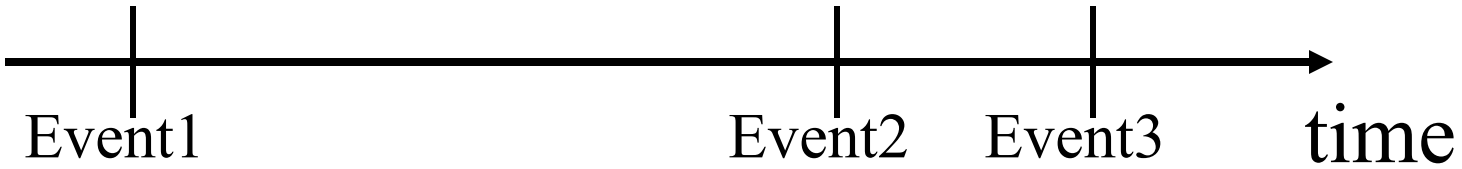
- System state changes only when events occur.
- Time advances from event to event.
- State variables updated as each event occurs.

Simulation Time Steps

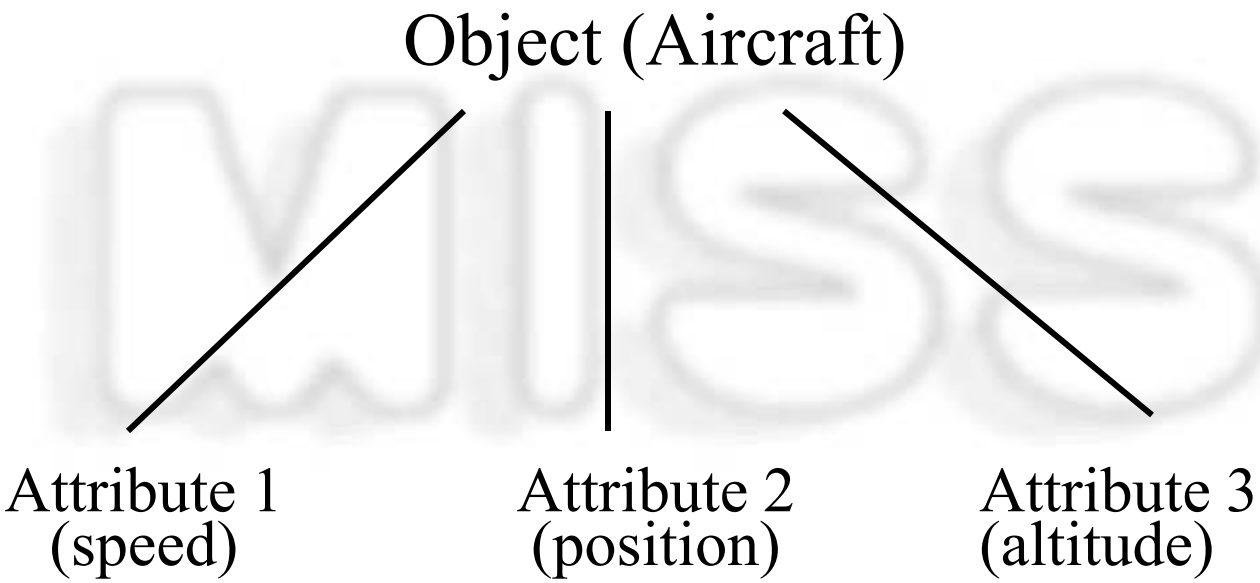
Continuous



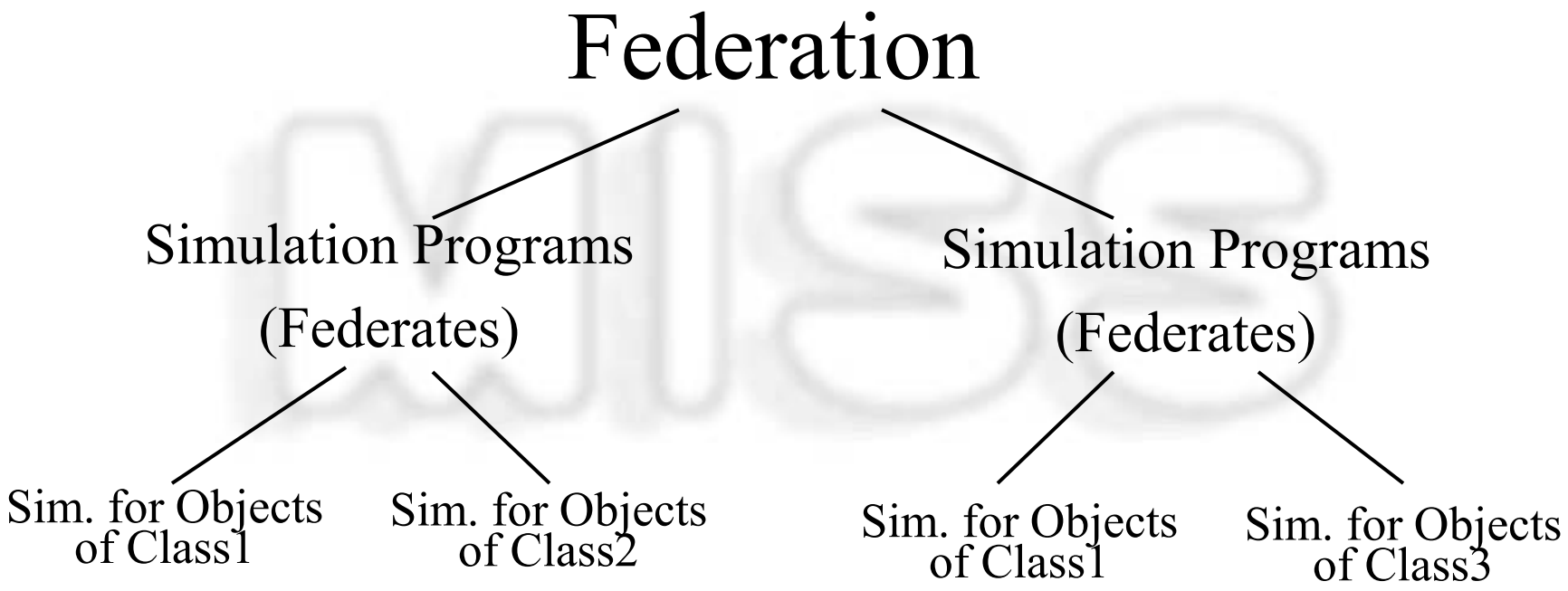
Discrete



Simulation Objects



Simulation Structure



HLA Messages -- Updates

Updates

- Send/Receive new values of attributes at end of each time-step.
  - Send: *Update Attribute Values*
  - Recv: *Reflect Attribute Values*†
- Controlling unnecessary message traffic:
  - Update:
    - *Enable/Disable Attribute Relevance Advisory Switch*
    - *Turn Updates On/Off for Object Instance*†
  - Reflect:
    - *Enable/Disable Attribute Scope Advisory Switch*
    - *Attribute In/Out of Scope*†

HLA Messages -- Interactions

Interactions

- Send/Receive Parameters describing the event when an event occurs.
  - Send: *Send Interaction*
  - Recv: *Receive Interaction*†
- Controlling unnecessary message traffic:
  - *Enable / Disable Interaction Relevance Advisory Switch*
  - *Turn Interactions On/Off*†

Object and Interaction Registration

Objects

- Publish/Subscribe
  - *Publish Object Class*
  - *Subscribe Object Class*
- Object Registration
  - *Register Object Instance*†
  - *Discover Object Instance*†
- Controlling Instance Registration:
  - *Enable/Disable Class Relevance Advisory Switch*
  - *Start/Stop Registration for Object Class*

Interactions

- Publish/Subscribe
  - *Publish Interaction Class*
  - *Subscribe Interaction Class*

Message Order

Two types of Message Ordering

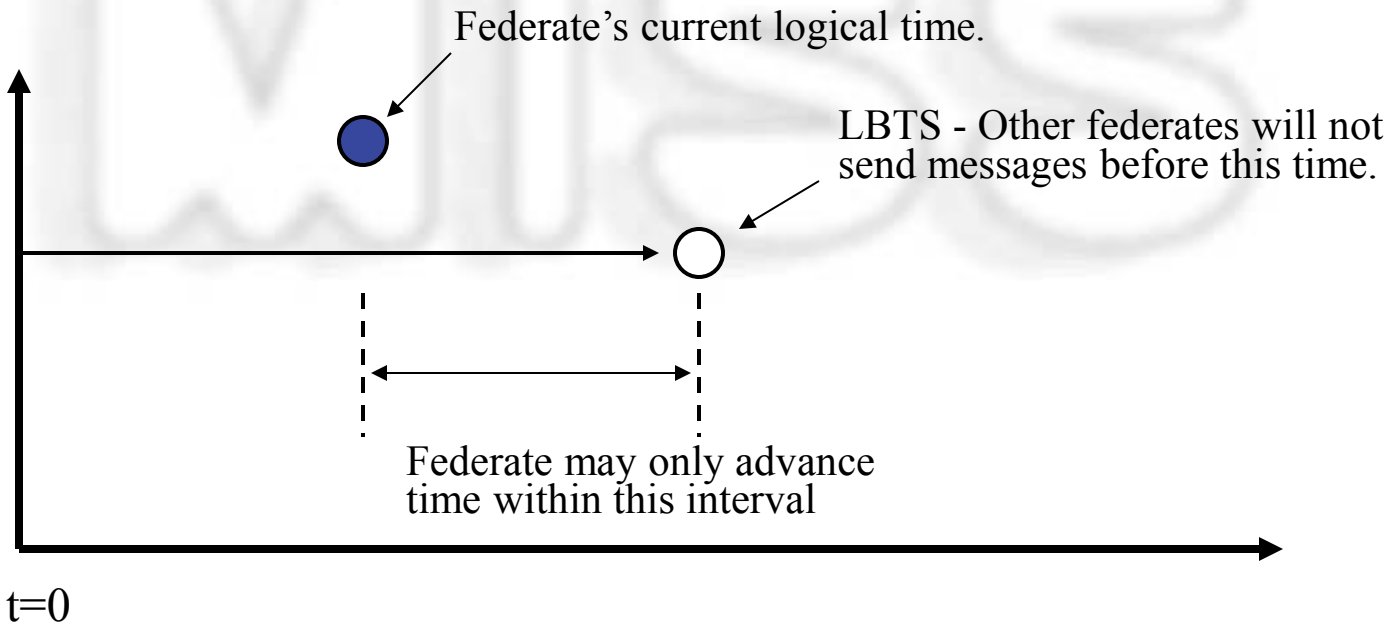
- **TSO** (Time Stamped Order)
  - Messages delivered to federate in order of time stamp
  - RTI guarantees that no messages will be received from past
- **RO** (Receive Order)
  - Messages delivered to federate in order received

Regulating and Constrained Federates (1)

- To receive TSO messages in Time Stamped Order, Federate must declare itself **Time Constrained.**
- To send TSO messages, Federate must declare itself to be **Time Regulating** .
- By default, Federates are **neither** time constrained nor time regulating.
- To become time constrained, use RTI service *Enable Time Constrained.*
- To become time regulating, use RTI service *Enable Time Regulation.*

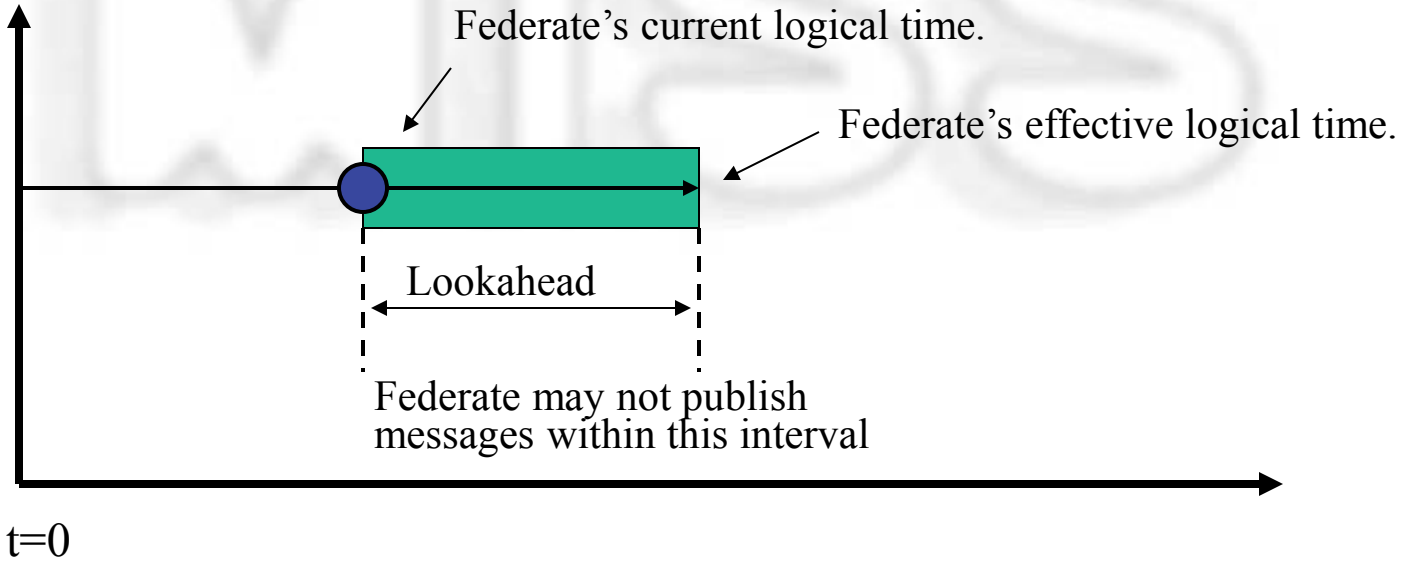
Time Constrained Federates

Time Constrained Federates subscribe to time stamped (TSO) data, with messages delivered in order of time-stamps.



Time Regulating Federates

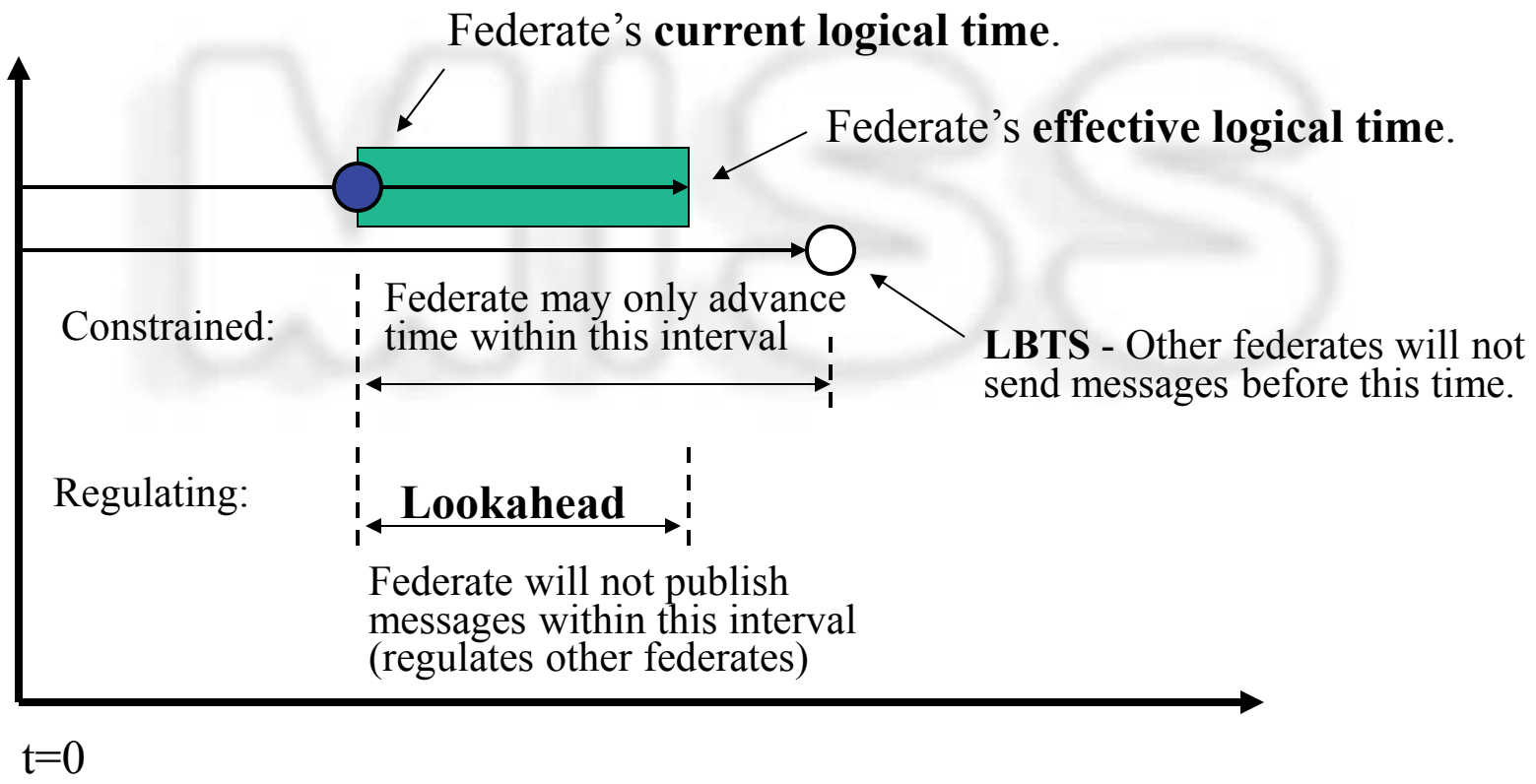
Time Regulating Federates publish time stamped (TSO) data, with messages delivered in order of time-stamps.



Requesting Time Advancement

- Continuous Simulations
  - To request an advance in time, use the RTI service: *Request Time Advance.*
  - RTI will notify when its ok to advance time by calling: *Time Advance Grant* †
- Discrete event simulations
  - The RTI service: *Next Event Request (t1),* requests time advancement to time of next event, or to *t1,* whichever occurs first.
  - RTI will notify when to advance time by calling: *Time Advance Grant* †, and will specify the amount of the granted time advance.

Federates That Are Both Time Regulating and Time Constrained



Time Regulating and Time Constrained

- If a Federate sends and receives TSO data, in TSO order, it must be both *time regulating* and *time constrained.*
  - *Time constrained:* RTI prevents this federate from advancing time until it has received all messages that may be sent by other federates up to the requested time.
  - *Time Regulating:* RTI prohibits other federates from advancing time until this federate has sent all the data that it is going to send before the requested time.

When Are Messages Received ?

Messages are only received when in a **time-advancing state.**

- A Federate is put into a **time-advancing state** by:
  - *Time Advance Request* OR
  - *Next Event Request*
- To enable receipt of RO messages at other times:
  - *Enable Asynchronous Delivery* (Prevents excessive delay for urgent events)