Simulation Interoperability Standards Organization

"Simulation Interoperability & Reuse through Standards"

Workshop theme for 2019: "Simulation for the Next Generation"

Developing Space Reference FOM Federation Agreements

2019-SIW-Presentation-024

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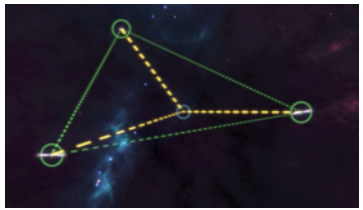
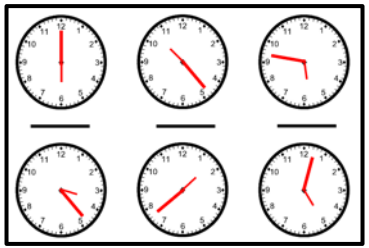
Developing a Distributed Simulation for the Space Domain



Reference Frames
Spatial Representation
Space Navigation
Entry, Descent, Landing
Rendezvous

Space Vehicles
Lunar Rovers
ISS
Launch Sequence
Thermodynamics



Time representation
Epochs
Soft & hard real-time
Initialization
Monte Carlo simulation

Astronaut models
Space Medicine
Communications
Atmospheric models
Robotic Missions

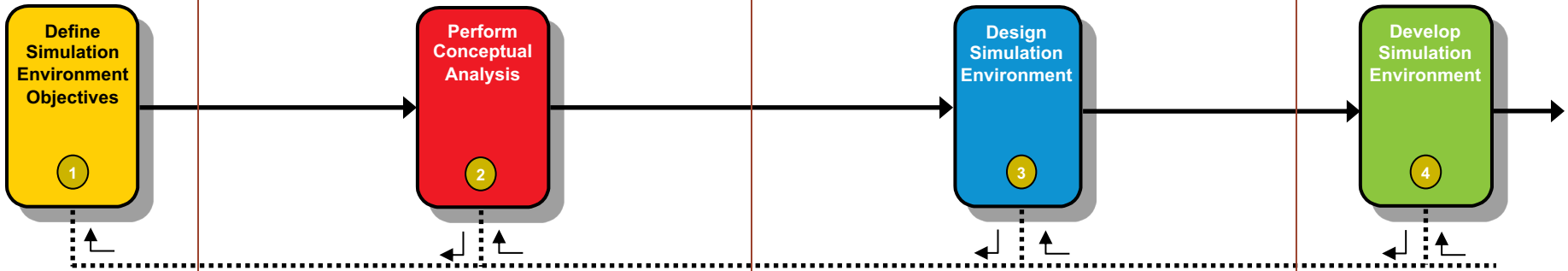
And much more!

- **There are quite a few things to consider!**
- **This presentation gives advice on how to get started with the Space Reference FOM, which will help you with some of these topics**

Why use the Space FOM? Why use Standards?

- Don’t re-invent the wheel
- Be a priori interoperable
- Reuse
- Join an eco-system
- Solve political problems
- Join a community

Start with the DSEEP Process (IEEE 1730)

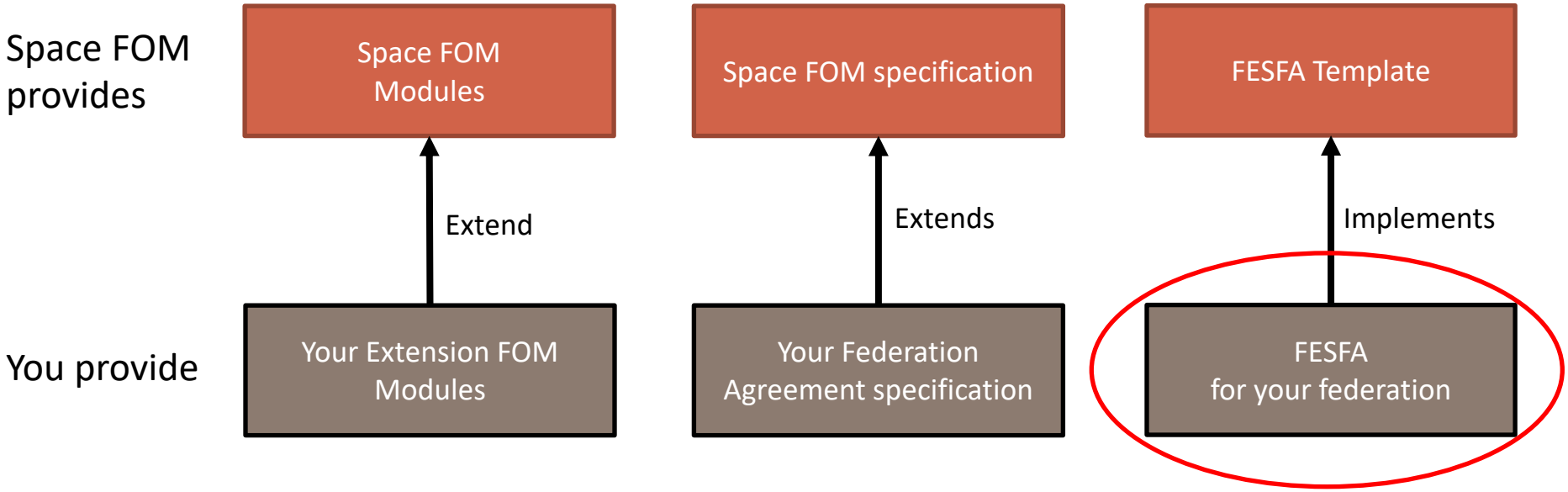


Objectives	Scenarios	Conceptual Model	Allocate Responsibilities to Federates	Develop Federation Agreement	Develop/ Reuse Federates
Sponsor: "Develop a high-fidelity engineering federation, …"	"Space Vehicle enters the Mars atmosphere and then…"	• Space Vehicle • Planet • Atmosphere • Astronaut	Federate A: • Solar System • Atmospheres Federate B: • Space Vehicles Check out FCDs	• Produce Federation Agreement • Fill in FESFA • Extend Space Reference FOM	• Adapt existing federate A • Develop new federate B

Let's look at the Space Reference FOM templates for FESFA and FCD

Federation Execution Specific Federation Agreement – FESFA

- **The FESFA provides specific parameters for your federation execution, for example time steps and initialization phases**



Federate Compliance Declaration – FCD

- The FCD describes Space Reference FOM compliance and related capabilities of a particular federate
- Use FCDs to assess federates when composing your Space FOM Federation
- FCD Template provided in the standard

FESFA and FCD Contents

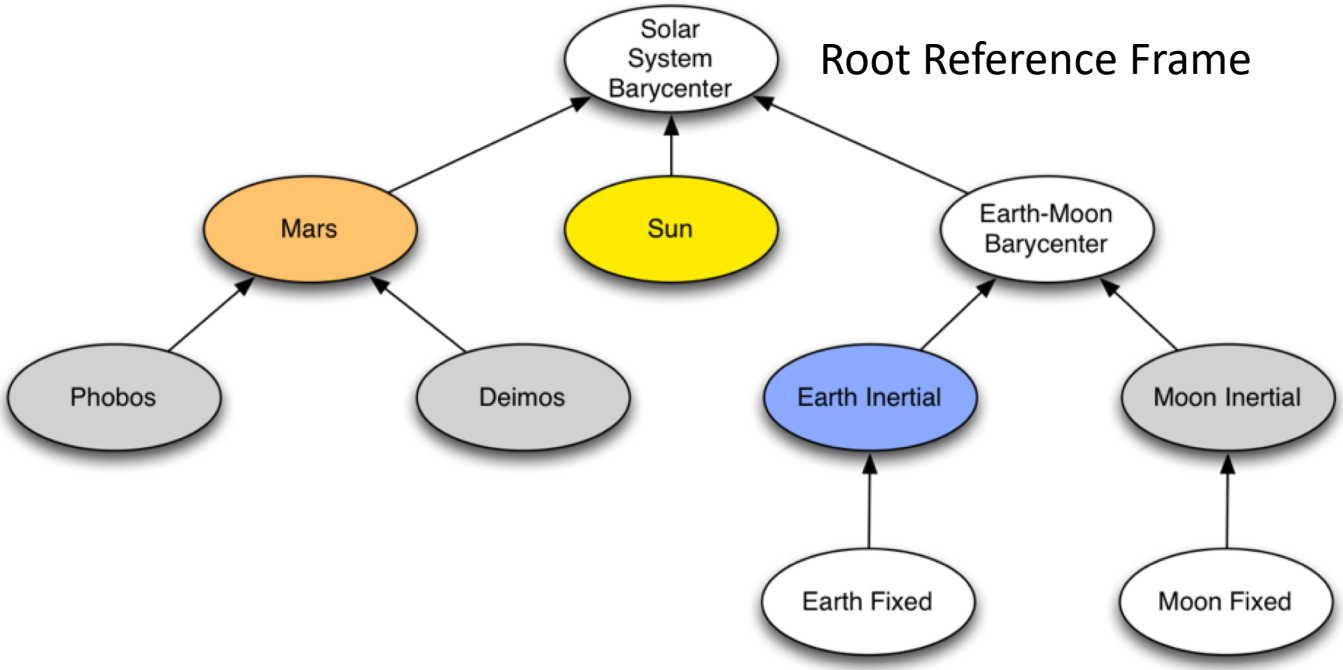
FESFA

1. Identification
2. Federation Composition
3. Time Management
4. Reference Frames
5. Object Management
6. Initialization
7. Additional Technical Information

FCD

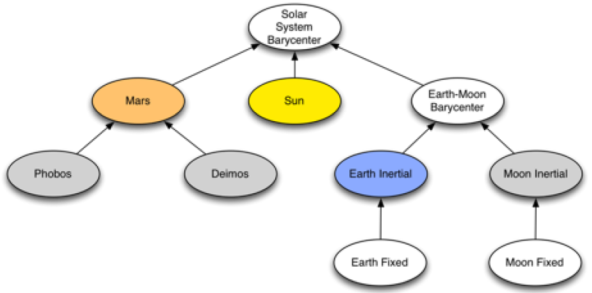
1. Identification
2. Roles supported
3. Time Management
4. Reference Frames
5. Object Management
6. Initialization
7. Additional Technical Information
8. Compliance statement

Space FOM Reference Frame Recap



Federate Roles in Space Reference FOM

- **Master Role**
  - Manages startup and initialization
  - Manages state transitions: initializing, running, freeze, shutdown
- **Pacer Role**
  - Manages the relationship between real time and scenario time
- **Root Reference Frame Publisher**
  - Provides the root of the reference frame tree



Federate Composition in FESFA and FCD

Sample FESFA for ”Federation 2021”

- **Master Federate:**
  - Space Master
- **Pacing Federate**
  - Space Master
- **Root Reference Frame Federate**
  - SeeEnvironment
- **Additional Required Federates**
  - NASArover
  - PlutoEnvironment

Sample FCD for ”Space Master”

- **Can act as Master Federate**
  - Yes
- **Can act as Pacing Federate**
  - Yes
- **Can act as Root Reference Frame Publisher**
  - No

Time Management in Space Refererence FOM

- **The Space Reference FOM supports many types of time management**
  - No pacing (as fast as possible)
  - Scaled pacing
  - Real-time pacing – elastic, unlimited overruns
  - Real-time pacing – elastic, limited overruns
  - Real-time pacing – strict/conservative
- **Involves HLA time management and in some cases Central Timing Equipment (CTE), providing a shared ”hard real-time” clock**
- **A common federation time step is used for pacing**
  - Internally, federates may use a smaller or bigger time step
- **Standard HLA 64 bit time representation, interpreted as microseconds**

Time Management in FESFA and FCD

Sample FESFA for ”Federation 2021”

- **Epoch (Truncated Julian Date)**
  - 11644.0
- **Pacing Federate Time Step (µs)**
  - 1 000 000
- **Least Common Time Step (µs)**
  - 60 000 000
- **Supported Time Management types**
  - Scaled Pacing
  - Real-time, elastic, unlimited overruns
- **CTE federates exist**
  - No
- **CTE specification**
  - None

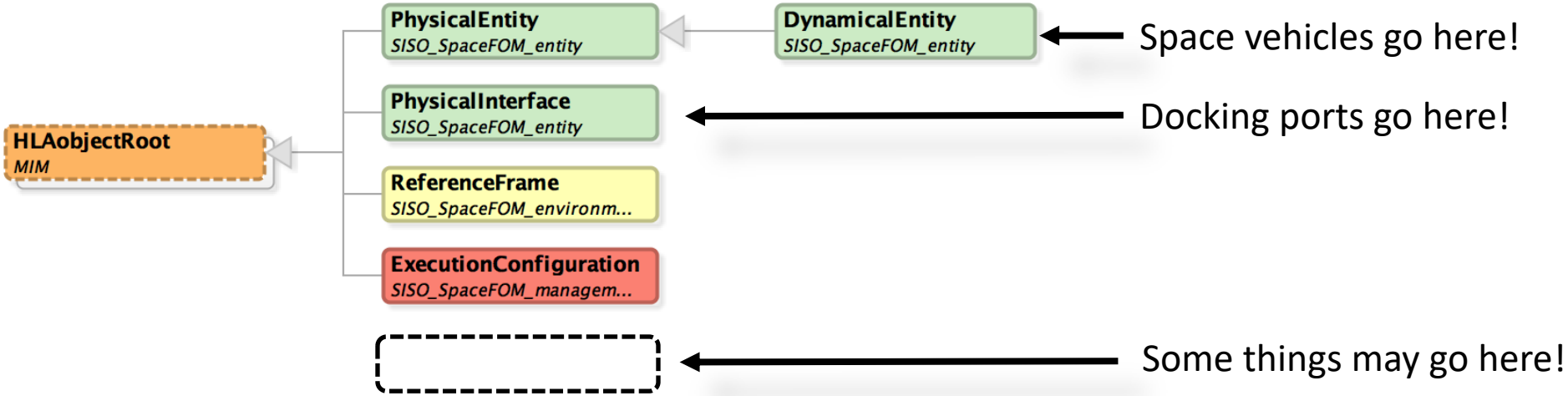
Sample FCD for ”Space Master”

- **Valid operating range (TJD)**
  - 11644.0 to 48069.0
- **Time step support (min/nom/max)**
  - 1 / 1 000 000 / unlimited
- **Supports Early/Late joining**
  - Yes / No
- **Regulating/constrained**
  - Regulating, constrained
- **Supported time management types**
  - Scaled Pacing
  - Real-time, elastic, unlimited overruns
- **Required CTE**
  - None

More items in FESFA and FCD

- **Reference Frames**
  - FESFA: Root Reference Frame, Additional reference frames
  - FCD: Root Reference Frames it can publish. Other published or required reference frames
- **Object Management**
  - FESFA: FOM modules, Key object instances. Naming convention. Type and Status tags.
  - FCD: FOM modules, publishes or required object instances, Naming convention, Type and Status tags
- **Initialization**
  - FESFA: Use of Multi-phase Initialization. specification document
  - FCD: Use of Multi-phase Initialization. specification document
- **Other**
  - FESFA: Non-standard RTI switches. Common data and databases, etc
  - FCD: Common data and data bases. etc

Extending the FOM – Sample



FESFA: Thoughts and Comparisons

- **The Space Reference FOM is a generic, baseline federation agreement**
  - The FESFA provides parameters to make it technically complete
  - A helpful template where you ”fill in the blanks”
- **To produce a complete federation agreement, an additional document and FOM modules are usually needed**
  - Consider looking at other federation agreements
  - The ”HLA Tutorial” on www.pitch.se has an appendix with a simplistic federation agreement
- **SISO-STD-012 Standard for Federation Engineering Agreements Template (FEAT) provides an xml-based template**

FCD: Thoughts and Comparison

- **The FCD describes the compliance and capabilities of a federate**
  - From a Space Reference FOM perspective only
  - From an external (federation) perspective only
  - Object and interaction classes, instances/data, service usage/design patterns
- **An HLA Simulation Object Model (SOM) describes capabilities based on object and interaction classes only**
- **NATO ”Interoperablity capability badges” (MSG-134) may describe semantically richer capabilities**
  - Interoperability Design Patterns Badges
  - Simulation Domain Specific Badges (e.g. Platform simulation)
  - Performance Badges (reliability, scalability, fault tolerance)

Summary and Conclusions

- **Standards enables us to develop more interoperable and reusable distributed simulations at lower cost and risk**
- **The DSEEP standard provides a proven process for developing and executing a distributed simulation**
- **The Space Reference FOM provides a baseline for space simulations. It provides readily available patterns for time, space, initialization and more. In addition to this you should:**
  - Specify parameters for your federation in the FESFA
  - Understand which federates that you can reuse, using the FCD
  - Add you own object and interaction classes and agreements
- **More work on federation agreements and federate capability descriptions is needed within SISO.**


SISO
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Standards Organization
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QUESTIONS