

The UCEF Approach to Tool Integration for HLA Co-Simulations

Thomas Roth

Universal CPS Environment for Federation

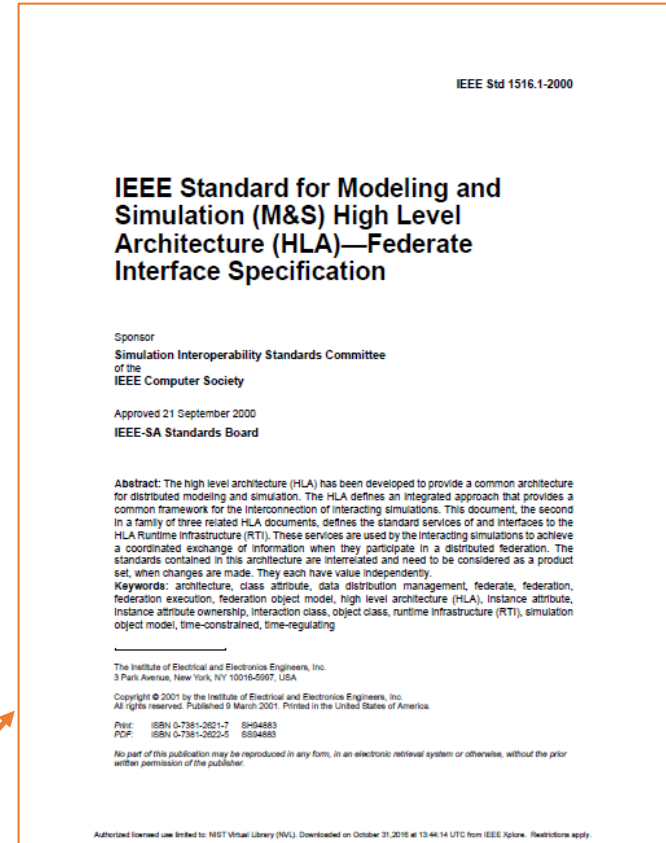
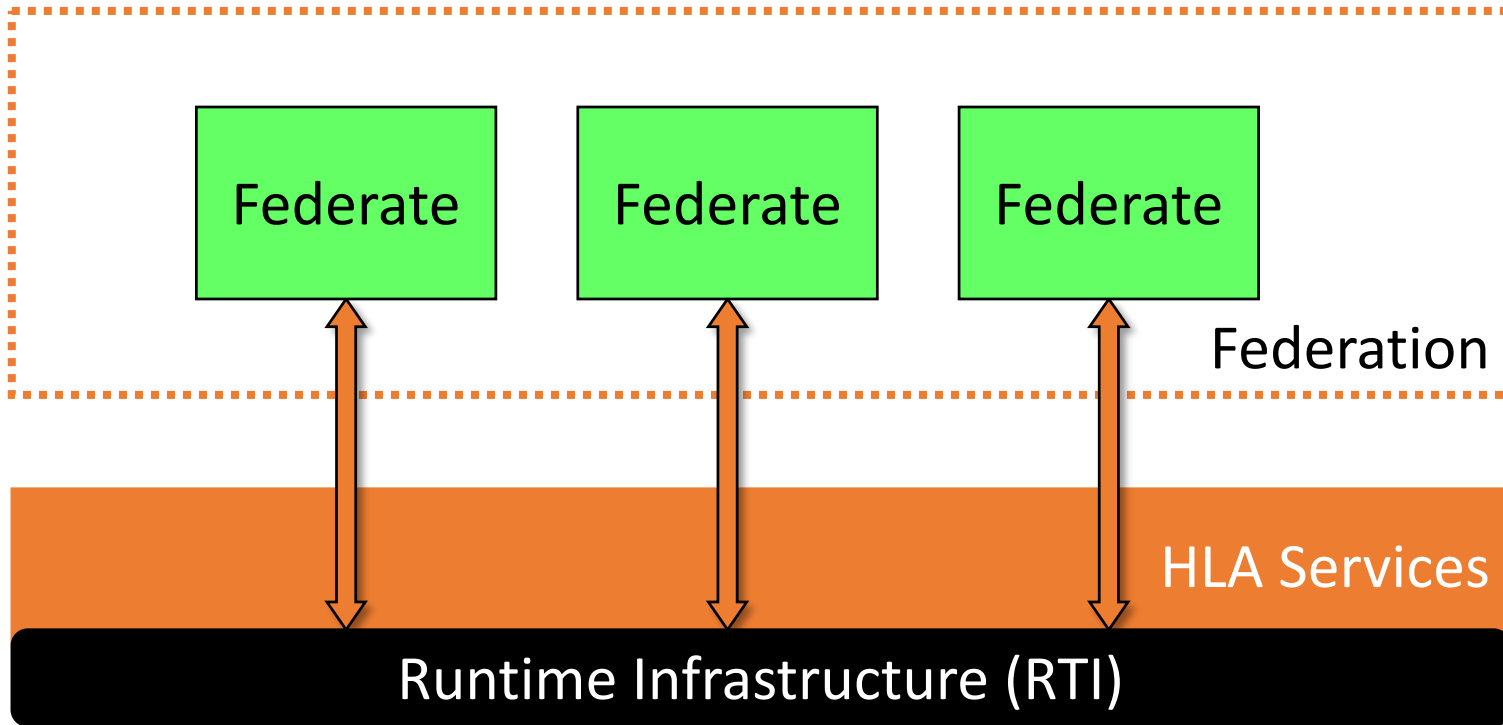
An open-source development environment for federated experiments intended to make co-simulation more accessible



available at <https://github.com/usnistgov/ucef>

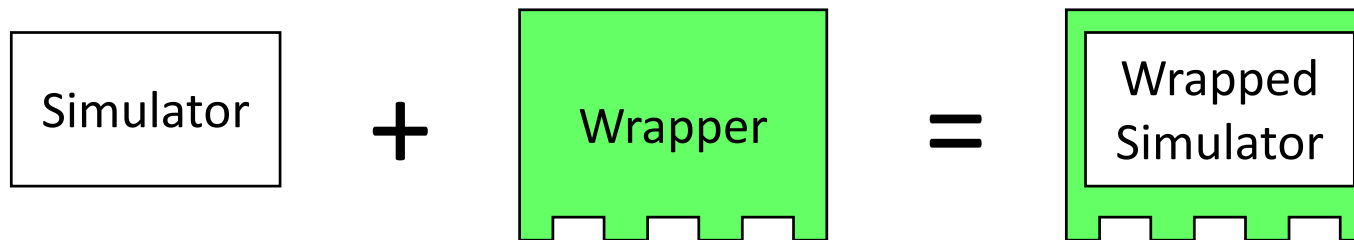
Federation in the High Level Architecture

UCEF uses the **High Level Architecture (HLA)**, an IEEE standard that defines the services a set of *federates* can use in a *federation*.

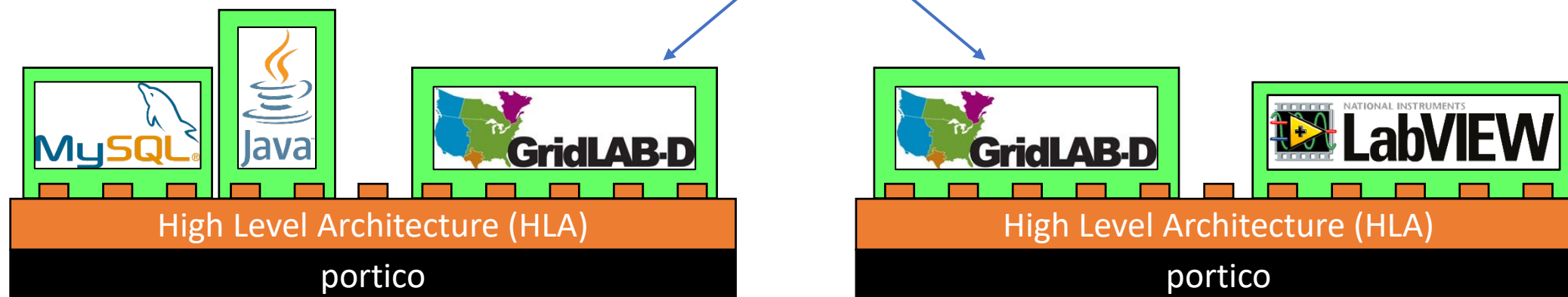


Software wrappers integrate new things

- A **wrapper** is software that defines the method of *time synchronization* and *data exchange* used for a simulator in a federation.



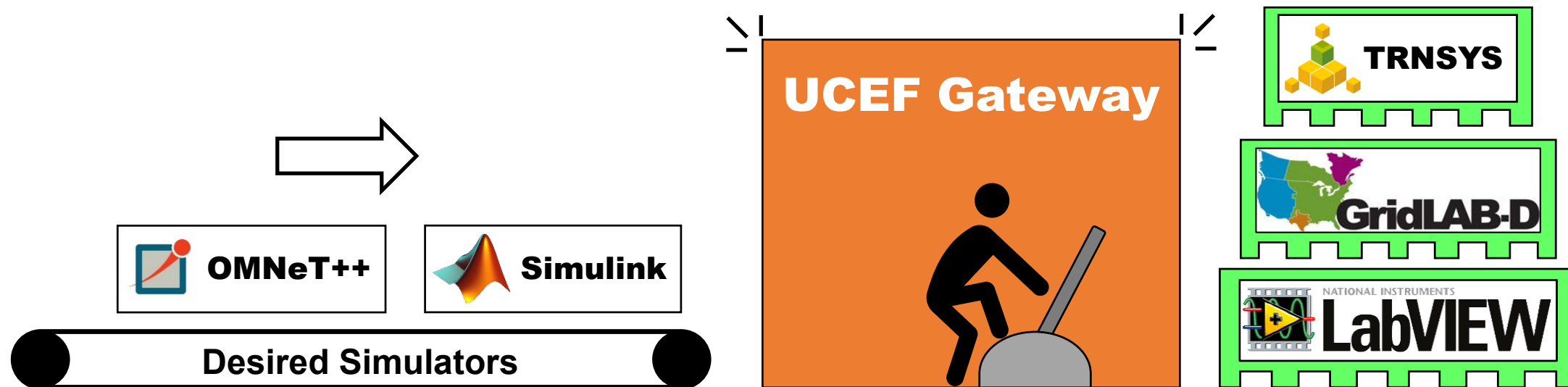
- A simulator with a wrapper can be *re-used* in multiple federations:



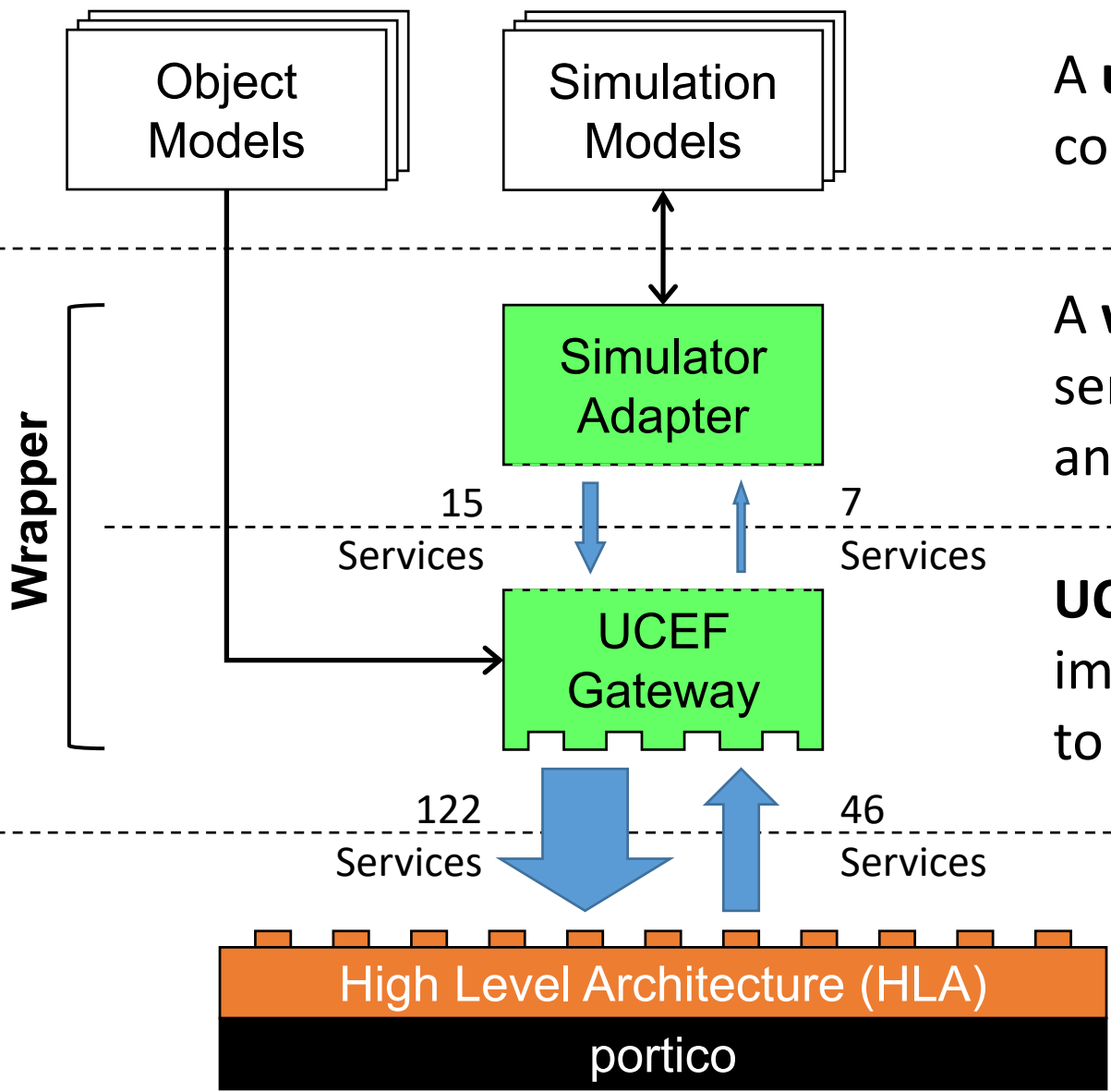
UCEF Gateway is used to create wrappers

A *Java library* designed to be:

- Usable with limited HLA expertise
- ***Easily integrated with new things***
- Agnostic to the federation data model



UCEF Gateway Overview

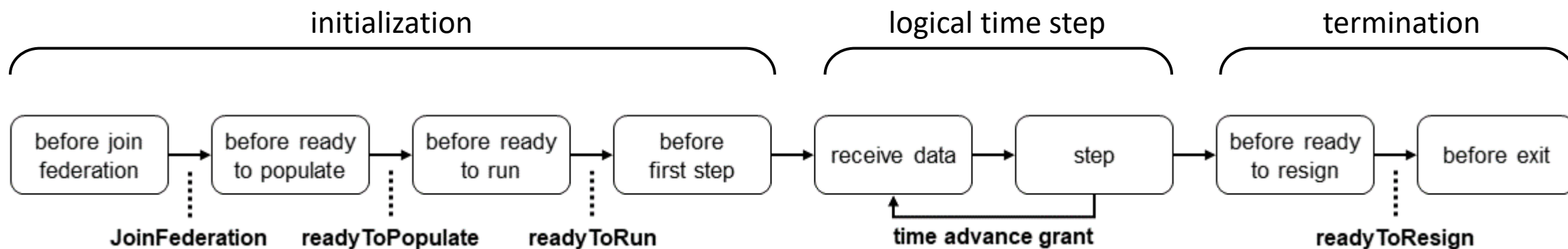


A **user** provides a simulation model and configuration file.

A **wrapper developer** implements HLA services related to time synchronization and data exchange.

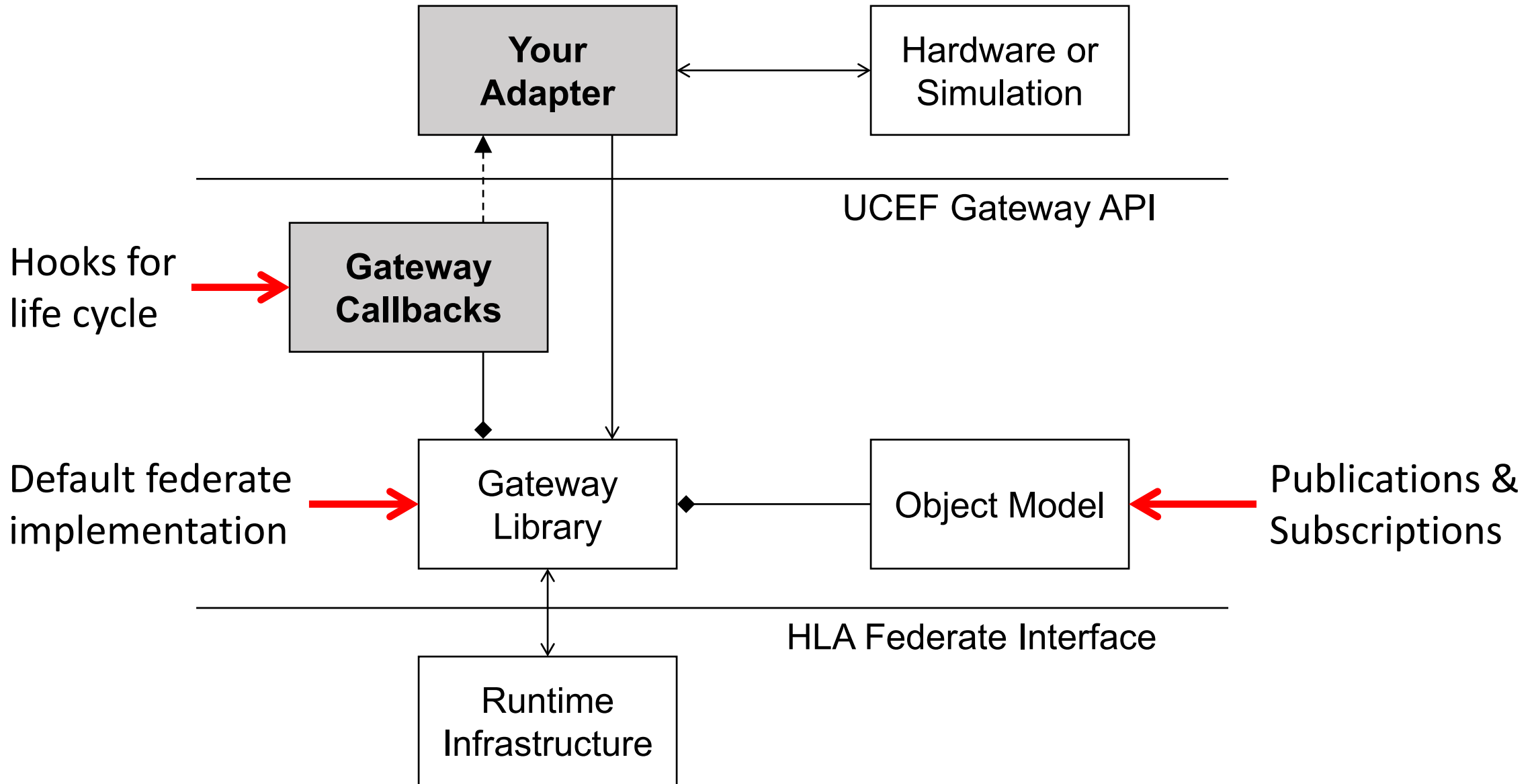
UCEF Gateway provides a default implementation for most HLA services to simplify wrapper development.

UCEF Gateway Life Cycle

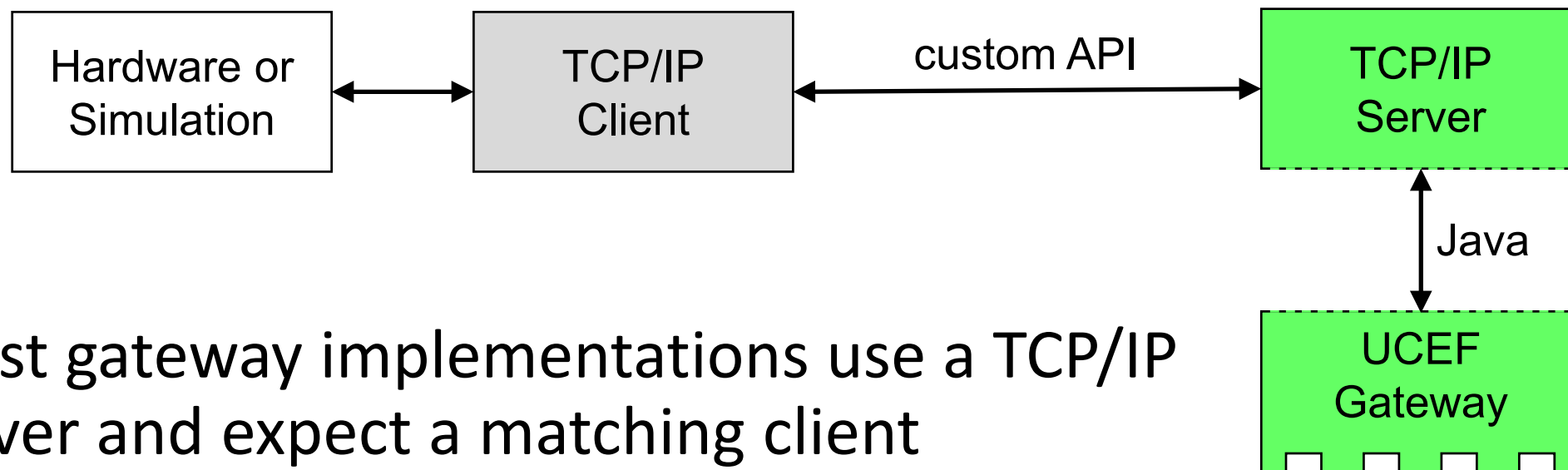


- Defines *hooks* where a wrapper developer implements code
- Progresses logical time using a configurable step size
- Uses 3 federation-wide synchronization points

UCEF Gateway Class Diagram

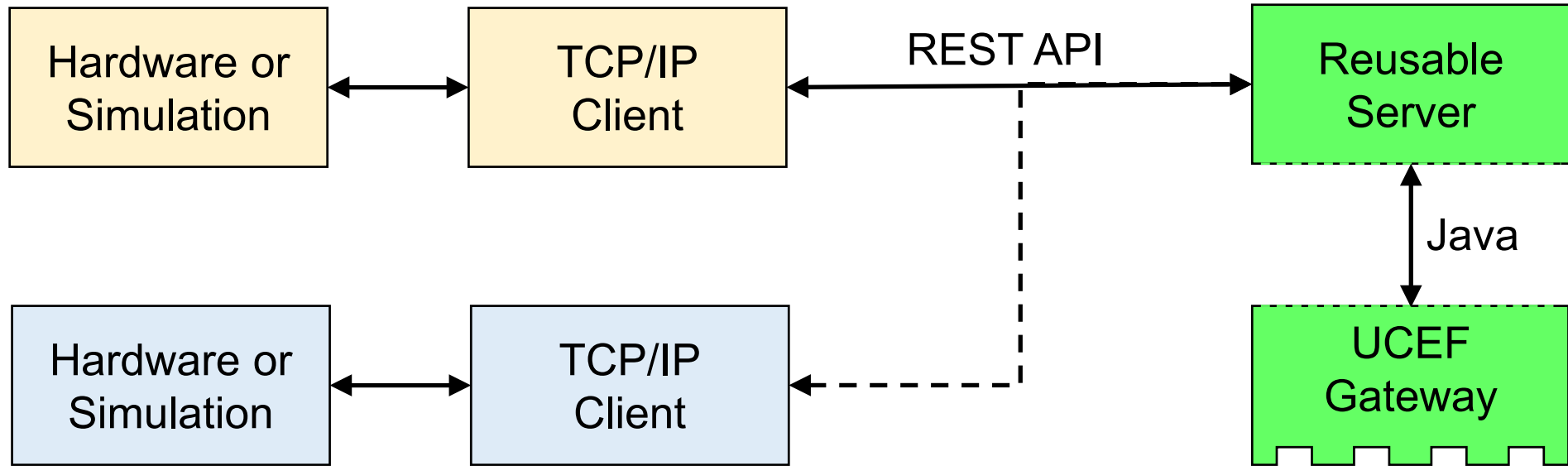


Common TCP/IP gateway implementation



- Most gateway implementations use a TCP/IP server and expect a matching client
- The TCP/IP servers tend to implement an API dedicated to support a specific simulator

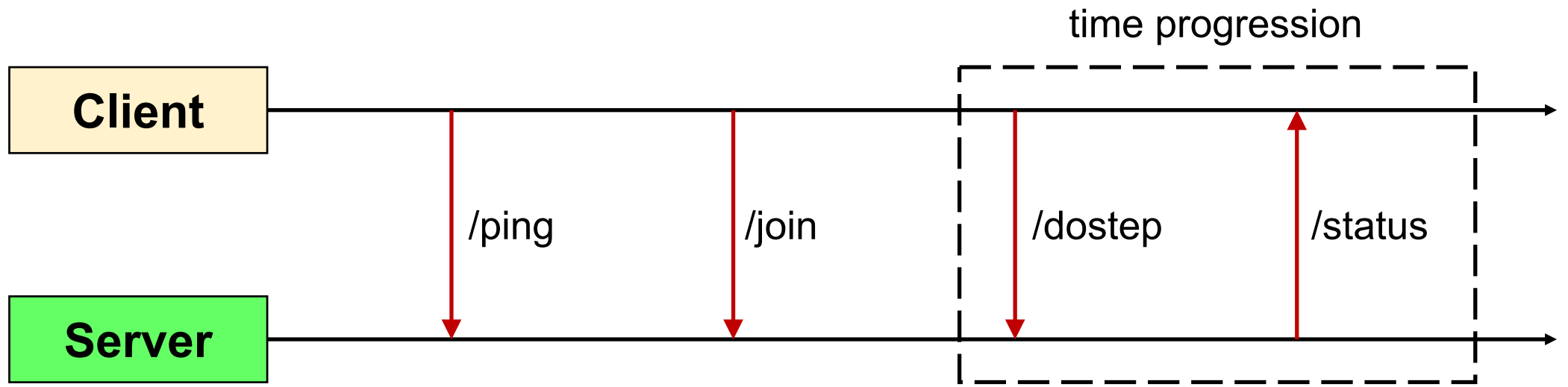
Reusable TCP/IP server with a REST API



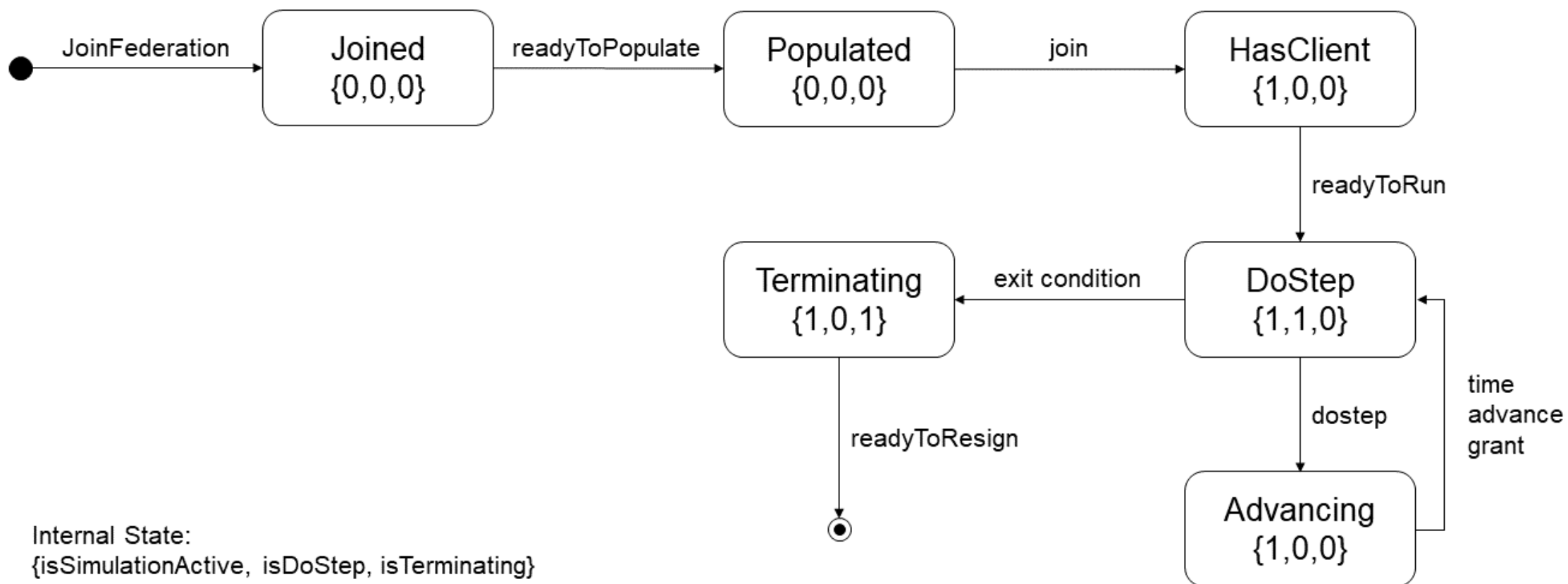
A REST API was used to implement a reusable TCP/IP server

The REST API

Endpoint	Method	Request Format	Response Format
/status	GET	(none)	FederateStatus
/join	POST	ClientPost	FederateStatus
/dostep	POST	ClientPost	FederateStatus
/ping	POST	(none)	200 OK



State machine for the REST server



Conclusion

- UCEF is an open-source HLA development environment
- A Java library called the UCEF Gateway uses a fixed life cycle and default service implementations to integrate simulators
- The most common implementation of the UCEF Gateway is a paired TCP/IP client and server unique to each simulator
- NIST is working on a new REST API built on the UCEF Gateway to provide a reusable TCP/IP server implementation