Component-based Simulation using HLA

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Simulation Components (1)

What is a simulation component?

Simulation components:

- Building block describing static and dynamic properties of a system (attributes, behavior)
- Can range from a fine granular building block inside a COTS up to an executable simulation model
- Should be self contained and have some well defined interface to communicate with other simulation components

Simulation components can be hierarchically put together to form a simulation model which itself can be considered a simulation component

Simulation Components (2)

Why should components be used to built simulations?

Cost and time reduction:

Reuse of existing components instead of building a new monolithic single-purpose model each time a simulation problem needs to be solved saves time and money

Modularity improves maintainability

Complexity of models built from individual components decreases, because components can be tested individually and should provide a well-defined interface to other components

Problems to enable Component-based Simulation

Problems (1)

Simulation models are typically developed in COTS simulation systems

- Closed architectures
- No access to source code of simulators
- C and socket interfaces only access to "outside world"

The objective for component-based simulation must be to enable simulation components developed in different COTS to interact.

Towards this objective methods known from component based software development not straight forward applicable
(although some progress has been made already during the seminar!)

Problems to enable Component-based Simulation

Problems (2)

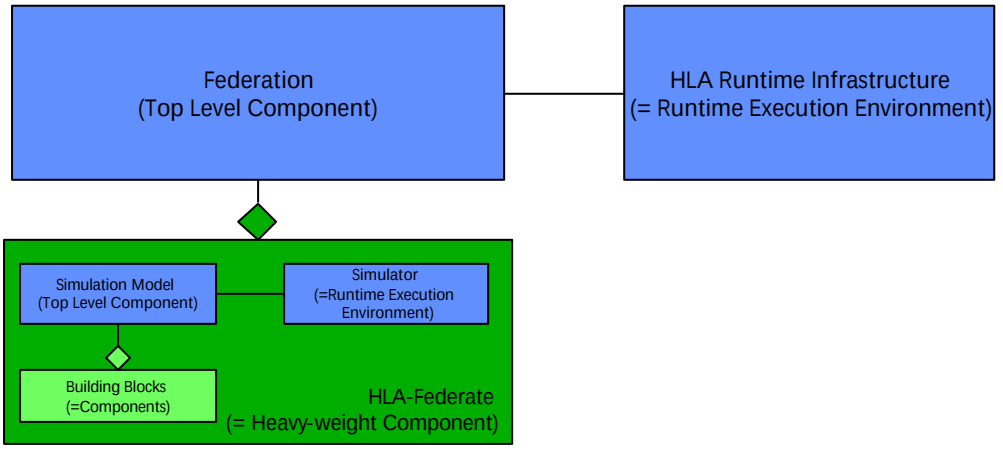
Simulation components need to exchange data at runtime and need to synchronize their local simulation clocks

- Synchronization non-trivial, but algorithms exist (conservative, optimistic)
- COTS need to allow access to internal time advance mechanism, e.g., event list, to allow component interoperability

Simulation components developed in different simulation packages (COTS) cannot be easily linked to one monolithic model.

They can only run as individual components which interact at runtime.

How does HLA fit in here and which problems can it solve?



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Using HLA as a framework for Component-based Simulation across different COTS

High Level Architecture for Modeling and Simulation (HLA)

The state of the art in distributed simulation since 1997

Architecture for combining individual simulations (federates) into a coordinated ensemble (federation)

Architecture to support Interoperability and Reusability of different kinds of programs

DMSO has developed
- HLA Standard
- Infrastructure Software (Runtime Infrastructure)
- Support Tools

HLA is defined by
- HLA Rules
- HLA Object Model Templates (OMT)
- HLA Interface Specification

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Using HLA as a framework for Component-based Simulation across different COTS

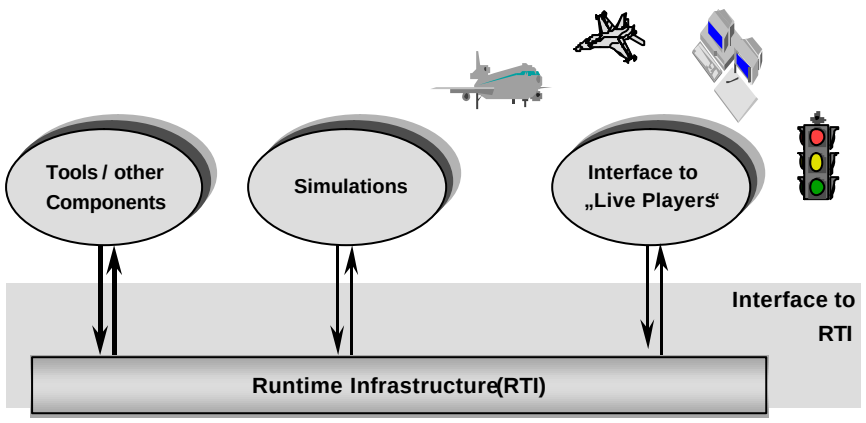
High Level Architecture for Modeling and Simulation (HLA)

The state of the art in distributed simulation since 1997

HLA exceeds

- Predecessors like DIS and ALSP because of it is not limited to a certain type of simulation
- Related technologies (e.g., CORBA, DCOM) because of its simulation specific services

HLA – Functional Overview



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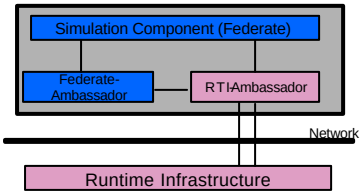
Requirements for a component to participate in a distributed simulation under HLA

Data Exchange and Representation
- Compatibility of Data Types
- Local vs. global data objects
- Accessibility of global data objects

Synchronization
- Coordination of time advances necessary
- Time-stepped vs. event-driven approaches
- Conservative vs. optimistic protocols



Requirements resulting from conformance to the HLA programming paradigm
- Ambassador Paradigm: HLA Interface Specification mandates communication via two objects (C++, Java, ADA)

Possible Solutions for enabling component based simulation using HLA

HLA for interfacing components

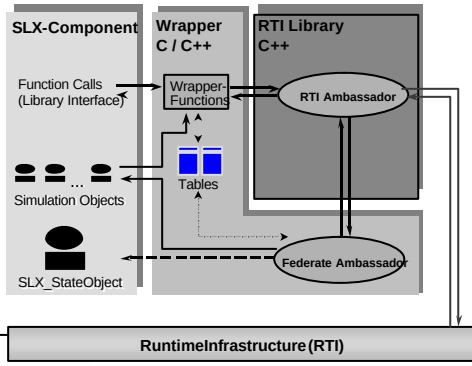
Integration of Simulation Systems into HLA by developing simulation system specific HLA interfaces which constitute the interface of the simulation component

Intelligent HLA interfaces help meeting the requirements by
- Solve technical problems
- Implement ambassadors (model independent !)
- Provide HLA API which perfectly fits simulation tool
- HLA interface can be made “intelligent”
- Automation of certain tasks (e.g., synchronization, updates)
- Data type mapping and name mapping

Case studies: HLA interface for SLX

HLA for interfacing components

- Usage of the library interface (Windows DLL) to access a wrapper library around the RTI
- Explicit access of HLA functionality in the model



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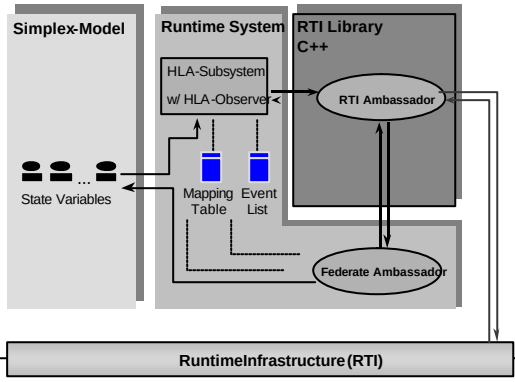
Case studies: HLA interface for Simplex III

HLA for interfacing components

- Extension of the source code of the runtime system
- HLA functionality is accessed implicitly



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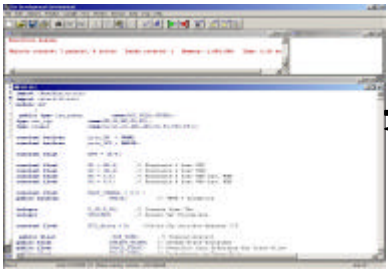
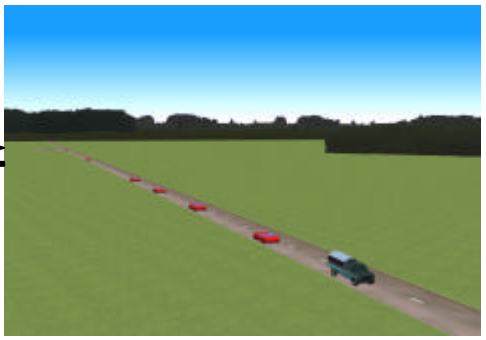
Application Examples: Distributed Driving Simulation

Combination of a real-time driving simulator with an event-based traffic simulation



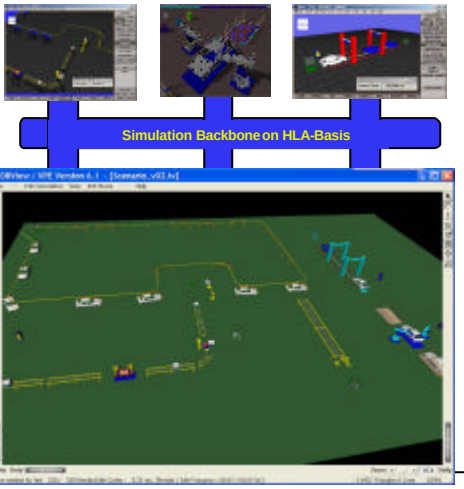


SLX/Windows NT/PC

C++/SGI/Irix

Application Examples: Composing Digital Factory simulations from components in QUEST and IGRIP

Combination of material flow components (QUEST), robot cells (IGRIP) and an overall visualization in VR (DBView)



Summary: Interoperability between simulation components across different COTS is possible

HLA as an IEEE standard is still the most relevant technology for enabling component based simulation across different COTS

A component-based approach for building complex simulation models with heterogeneous simulation systems is non-trivial.

- Well-known techniques from component-based software development cannot directly be applied

HLA can constitute the underlying technology for enabling component-based simulation (across different COTS)

- Re-use of existing models by re-combining them
- Combination of physically distributed models becomes possible

It is still a long way towards plug-and-play for simulation components

Thank you for your attention…

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