DAIMLERCHRYSLER

HLA-based Distributed Simulation as an Enabling Technology for the Digital Factory

Dr. Steffen Straßburger
Research & Technology
RIC/EP

Contents

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Passenger Cars Mercedes-Benz, smart

Passenger Cars and Trucks Chrysler, Plymouth, Jeep®, Dodge







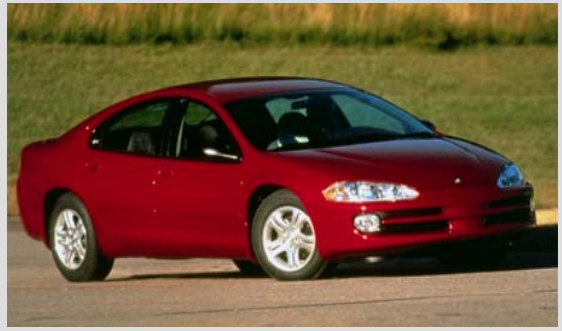


Passenger Cars and Trucks Chrysler, Plymouth, Jeep®, Dodge








DaimlerChrysler Research & Technology in Ulm (Germany)

Neue Struktur des Ressorts ab 1.1.2002

Research & Technology
RT
Prof. Klaus-Dieter Vöhringer

Research Areas			Other Directly Reporting Functions
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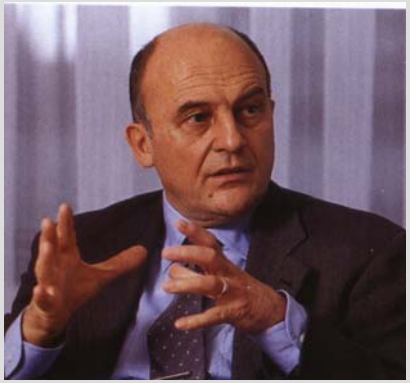
Motivation / User Requirements (1)



Helmut Petri
Board of Directors
Mercedes-Benz AG

(Source: Mercedes Magazin 1/2000)

- **Virtual Planing and Shaping of factories will will massively increase**
- **Intensive simulation of processes in advance**
- **Reduce start-up time by 50%**
- **Detailed planning and optimization of processes**

Motivation / User Requirements (2)

No production facility will be

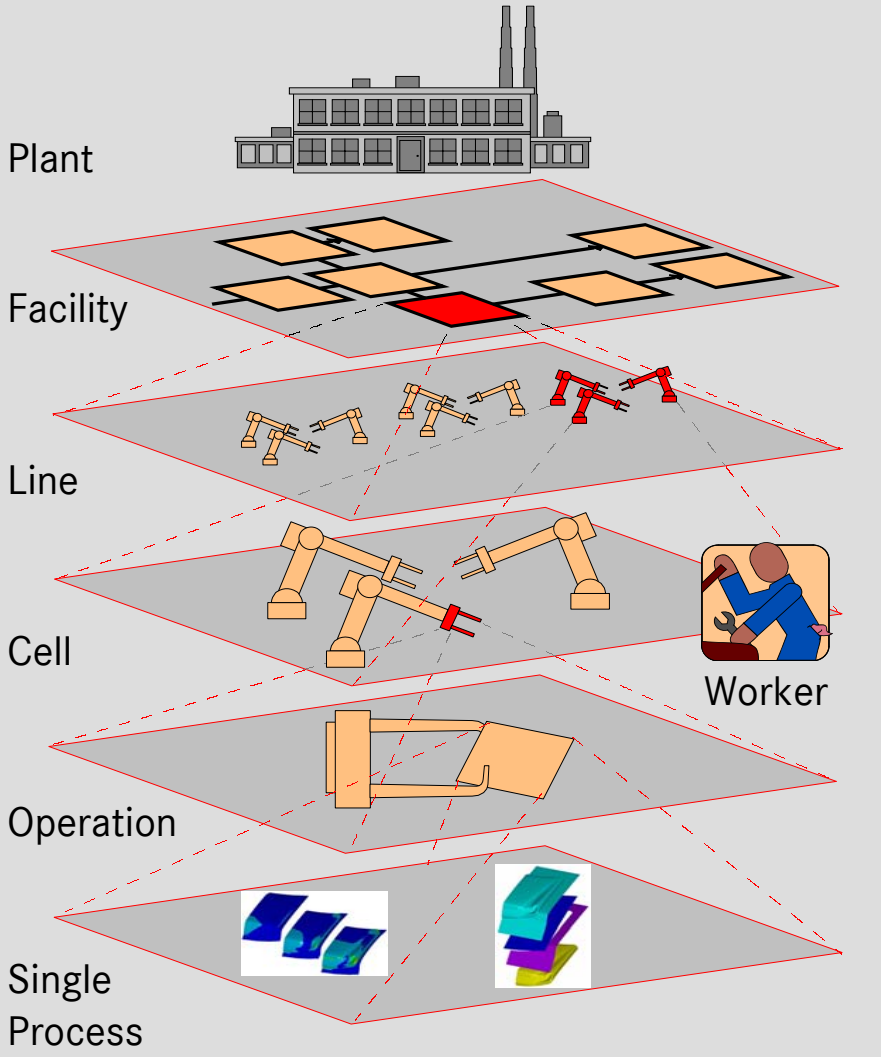
- ⇨ **planned**
- ⇨ **constructed**
- ⇨ **and operated**

⇨ **without complete digital verification**

With respect to :

- **Technological Processes**
- **Factory Components**
- **Quality**
- **Costs**
- **Capacity**

Source: GFP Vision 2005



Motivation / Current Situation (3)

	Digital Mock Up (DMU)	Digital Factory
Use	product development	process development, production, supply chain and customer order execution
Goal	100% digital car	100% digital processes
Optimisation	product properties	time, costs
Reference	3D CAD- model	(3D) simulation model
System world	clear, CATIA- pipelines	very heterogeneous
Possibility of data transition	high	low
Current Demand	high	Low (but increasing)

Motivation / Key Aspects for Distributed Simulation (4)

- Complexity increases
  (Product, Process, Production program, Customer structure, IT-Structure etc.)
- Cross-linking / Interconnections and dynamics of systems increases
- Stronger stochastic behavior
- Global optimization of all processes and operations required

Consequence: Continuous Digital / Virtual Optimization is necessary

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HLA – the State-of-the-Art for Simulation Interoperability (1)

- High Level Architecture for Modeling and Simulation (HLA):

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

- U.S. Department of Defense provides
  - HLA Standard
  - Infrastructure Software (Runtime Infrastructure, RTI)
  - Support Tools
- Architecture to support *Interoperability* and *Reusability* of different kinds of geographically distributed programs

⇨ Distributed Simulation based on HLA can be a solution for simulating continuos process chains

⇨ Combination of different submodels developed with different simulation tools to form a overall simulation of the production facility

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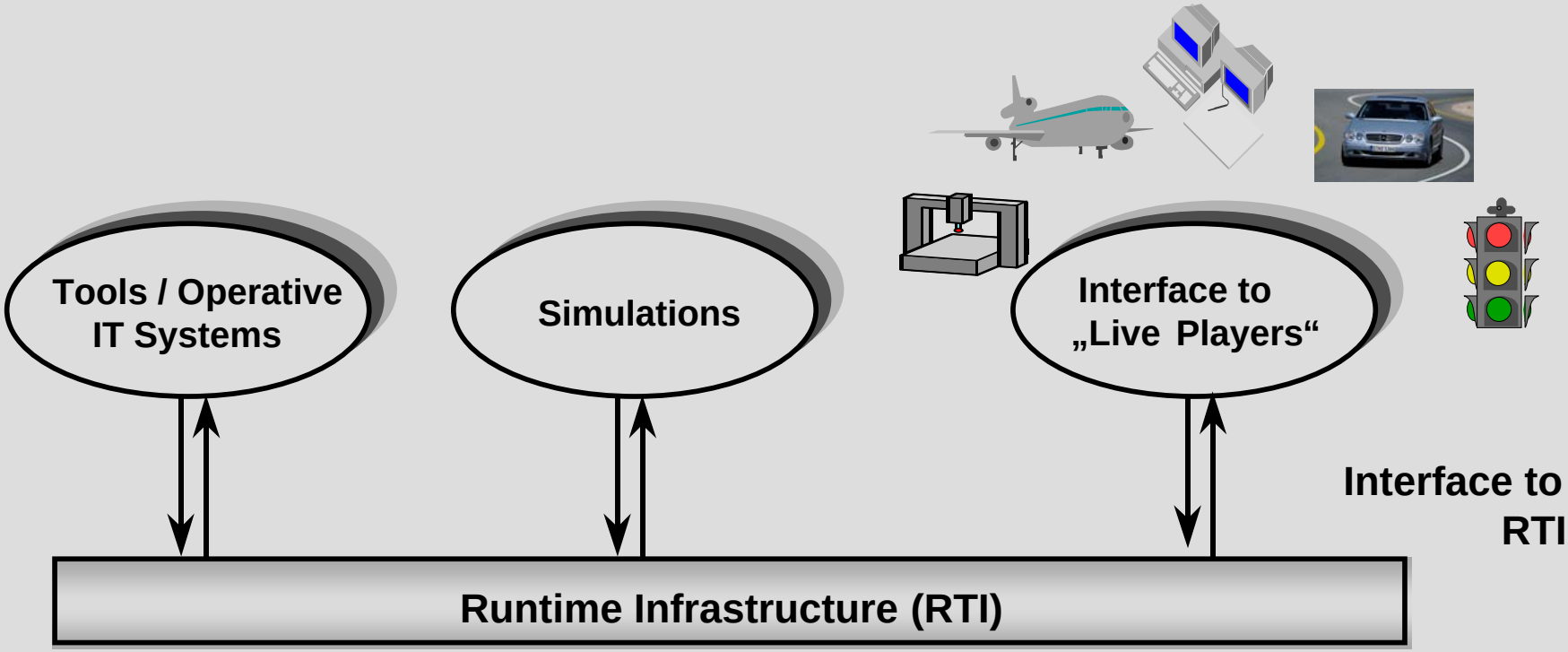
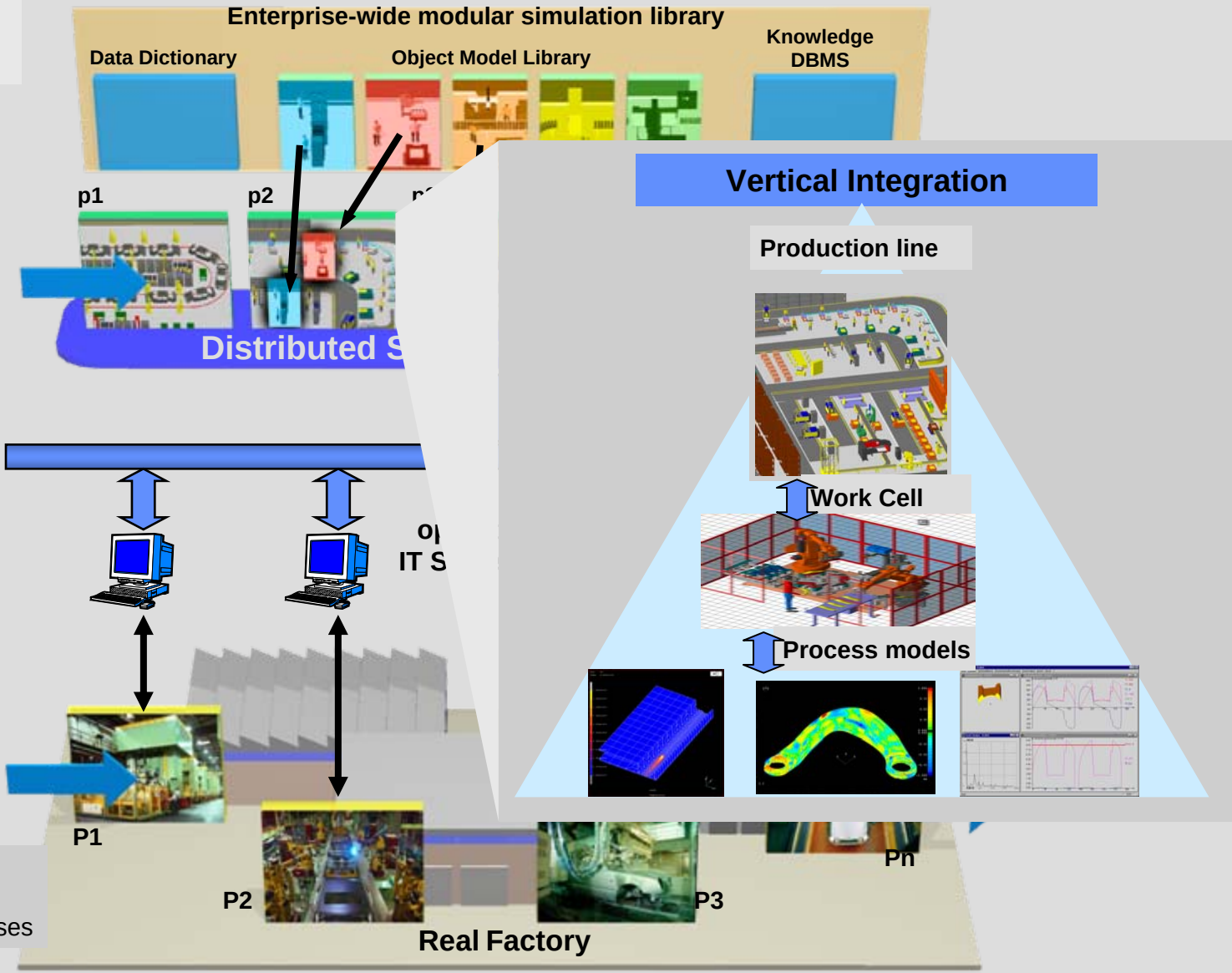
HLA – Functional Overview

Data Collectors/ Environmental Information Systems
Passive Viewers
Command & Control Systems
...



Vision



Legend:
P1-PN: real processes
p1-pn: simulated processes

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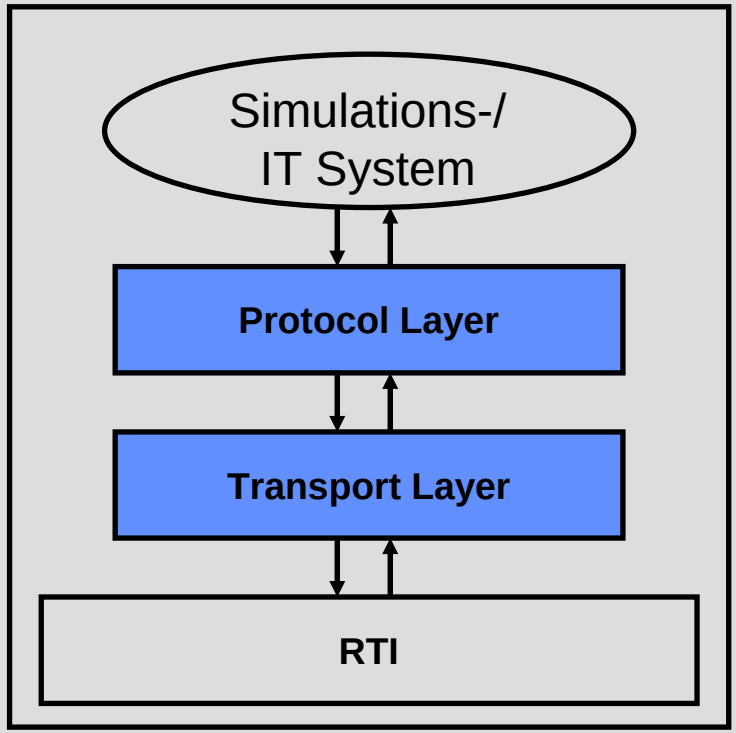
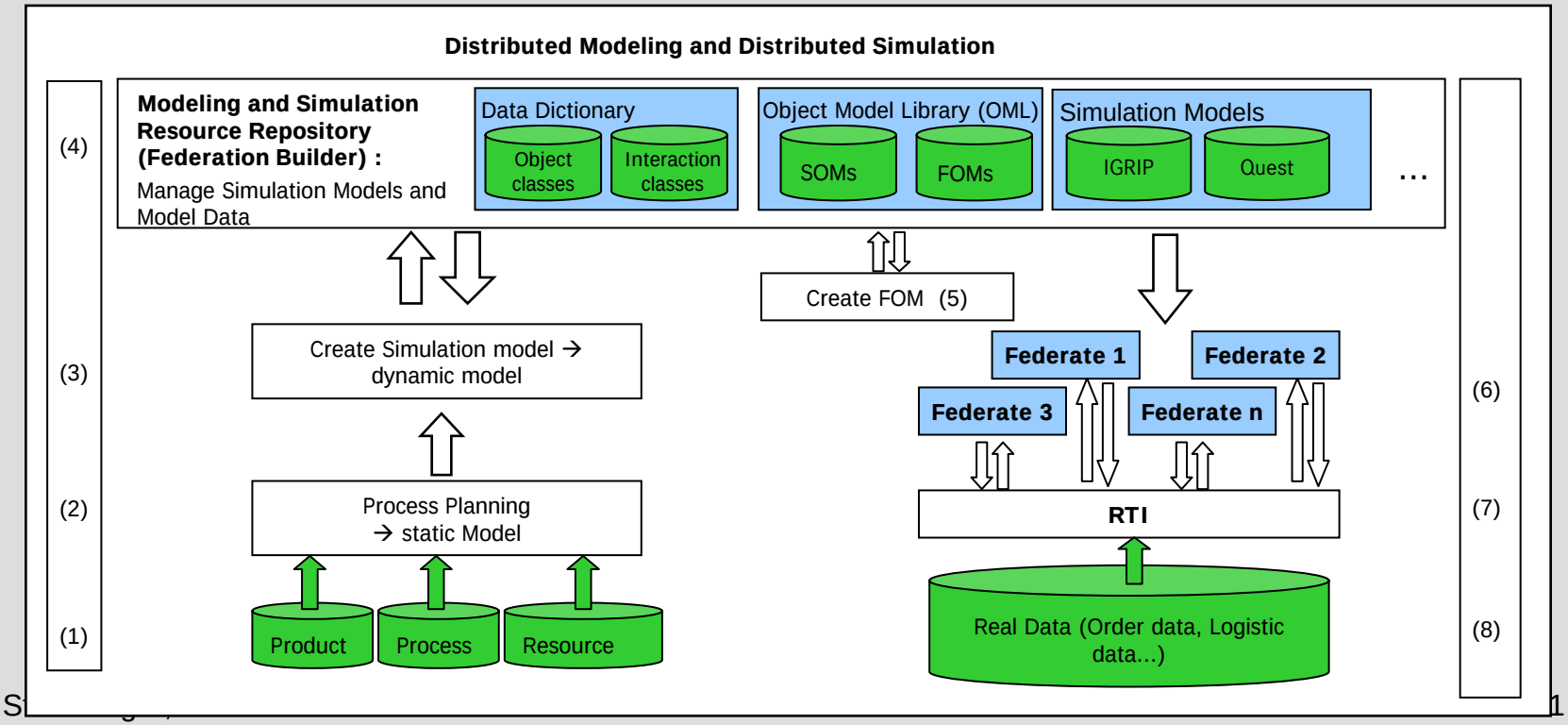
Universal Interface Concept

- Concept for a Universal Federate Adapter (UFA) which simplifies the usage of the HLA IF Spec
- Fast Connection of IT systems
  - Simulation - Simulation
  - Simulation - Non-simulation
  - Non-simulation - Non-simulation
- Dynamic Communication between IT systems at runtime
- Usage of Publish-/Subscribe Mechanisms for communication of attribute changes

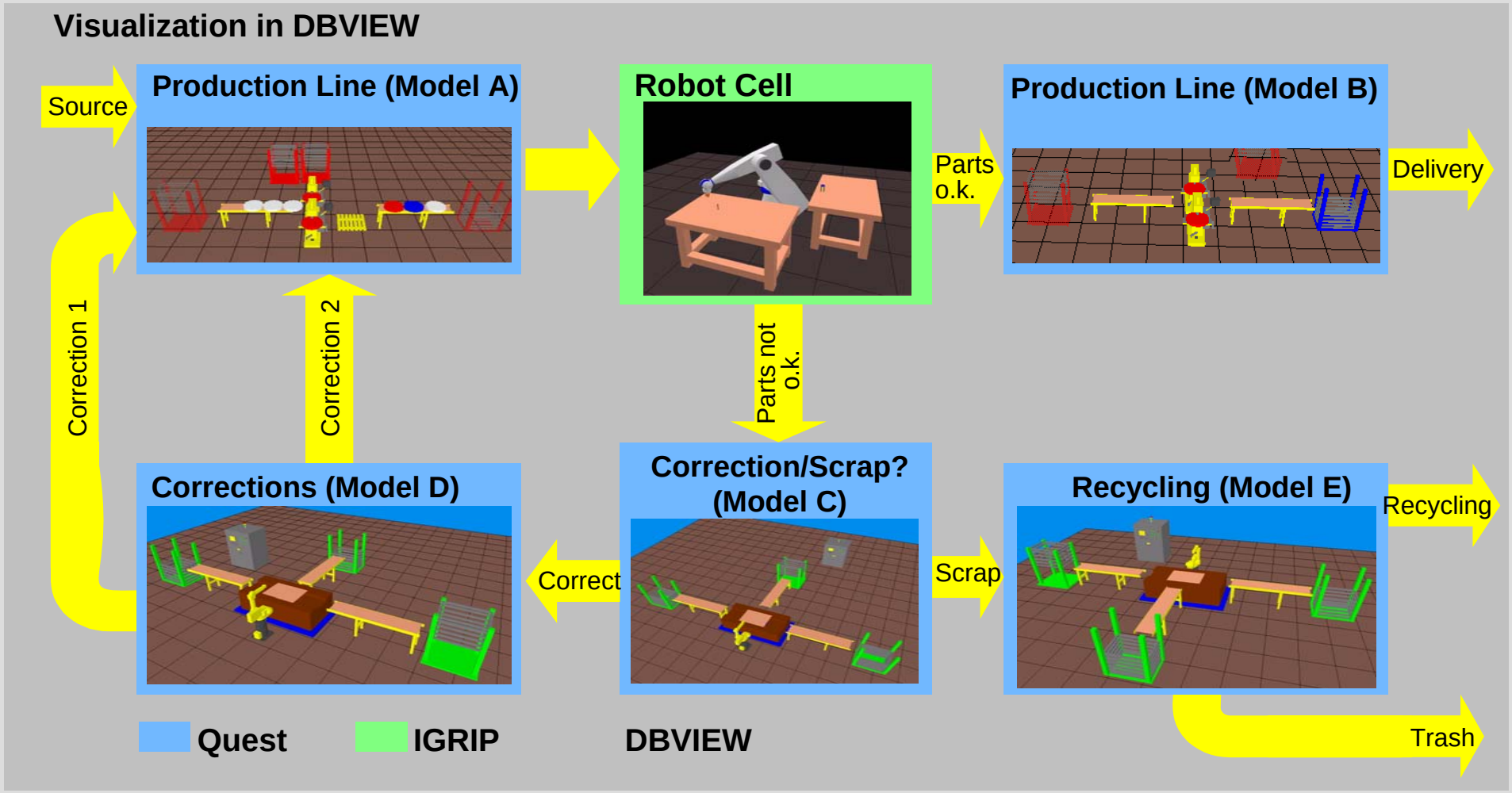


Distributed Simulation in the Global Context: Enterprise wide process for Distributed Modeling and Simulation is required

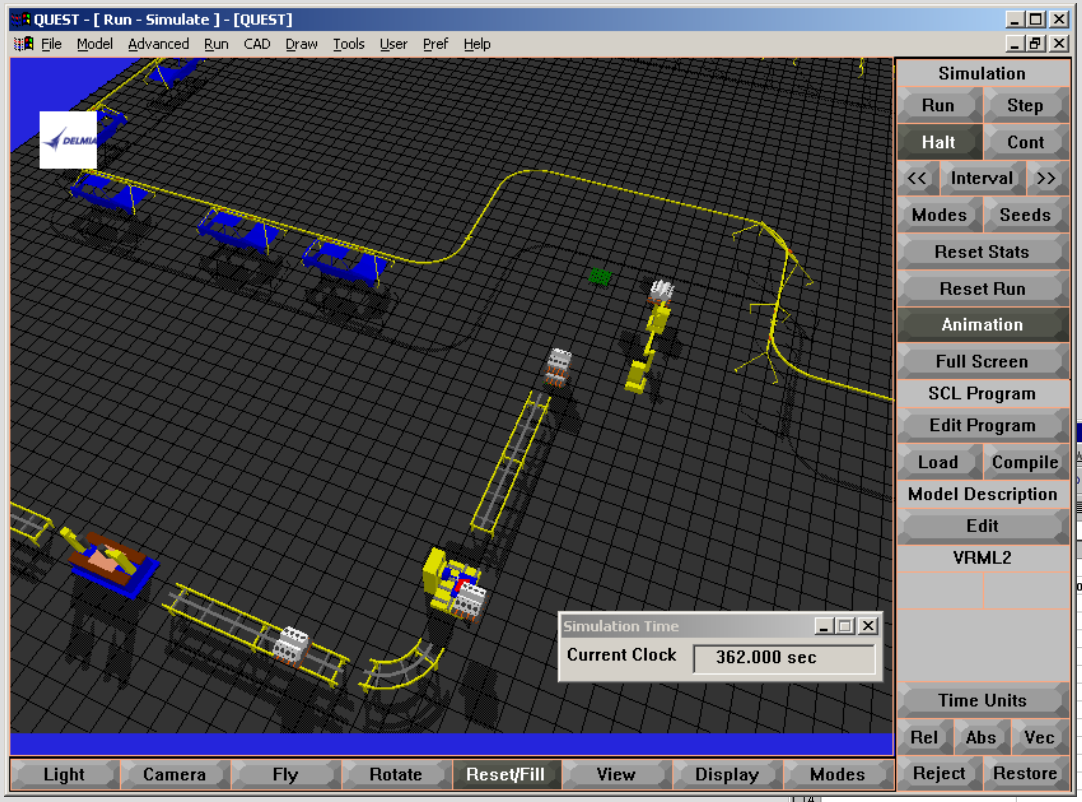
(1,2) Product-, Process-, and Resource Data /Creation of the static process model
(3) (semi-)automatic derivation of the dynamic process model
(4,5) Management of object and simulation models / Connection and mapping of the object models
(6,7) Interoperability at runtime, communication backbone
(8) Real data as input from existing IT systems



Application Scenario “Measurement Federation”

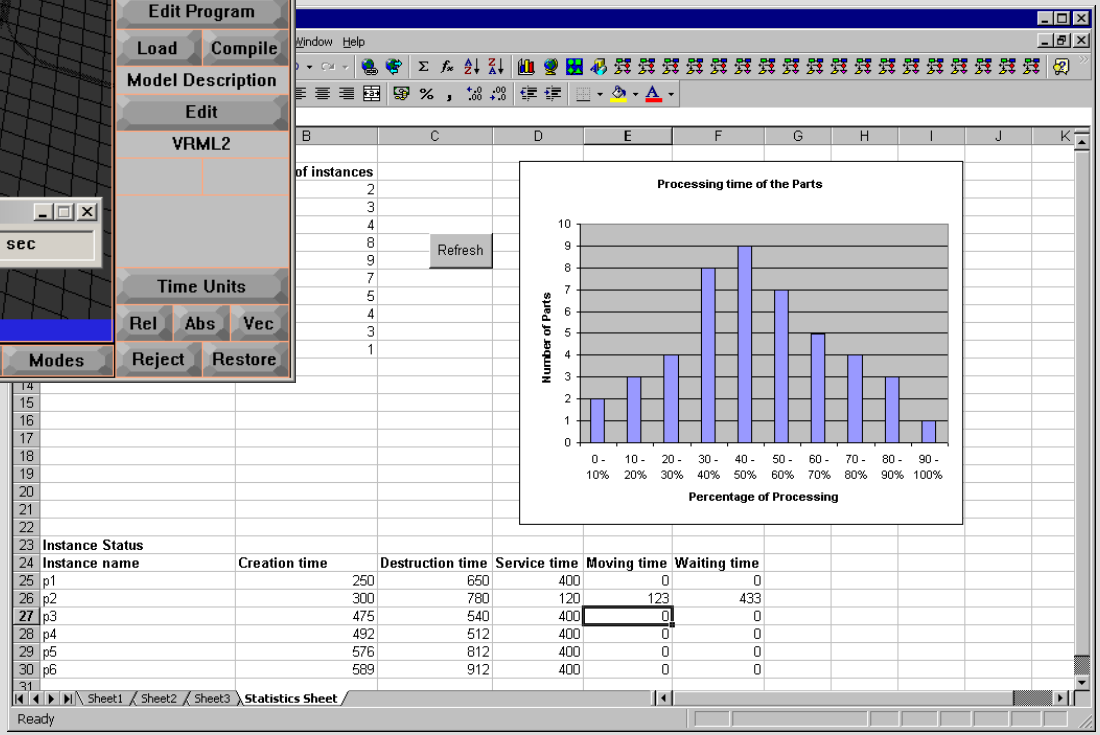


Scenario “Quest and Excel” (Material Flow Scenario)



Applications

- Online Statistics of current simulation data
- Provide and Generate Order data as simulation input
- Modification of Simulation Parameters

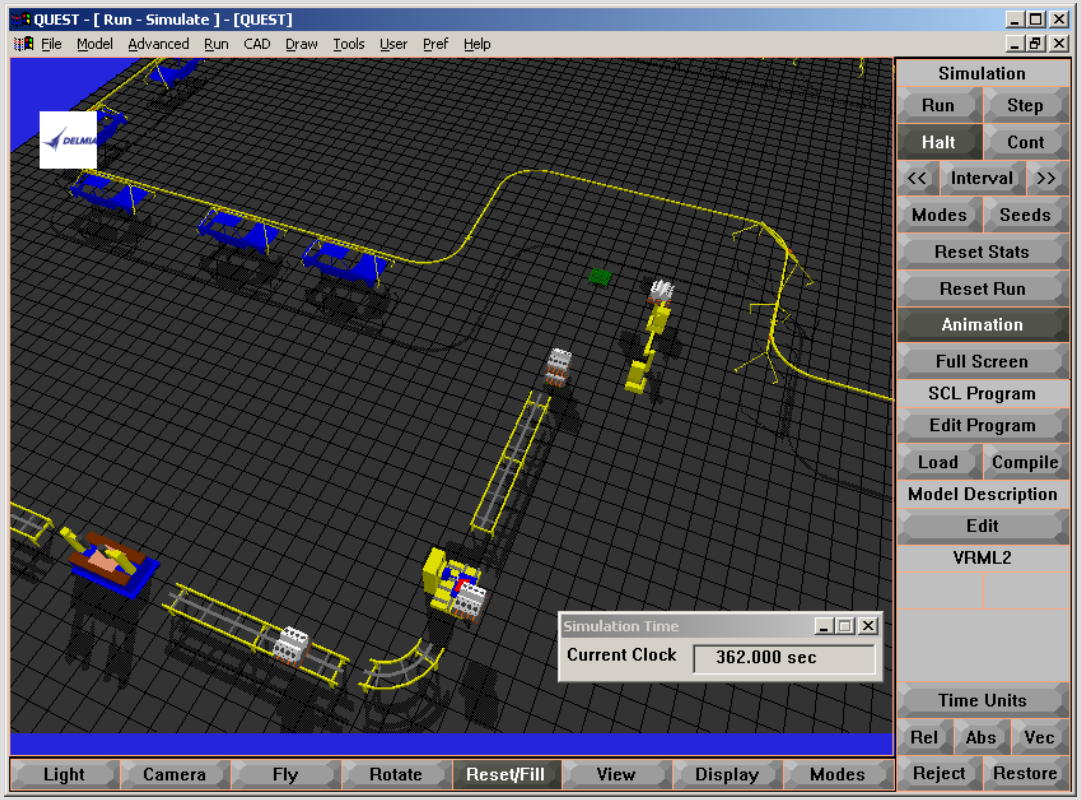


Further Couplings:

- QUEST-QUEST
- QUEST-IGRIP
- DBView-IGRIP+QUEST

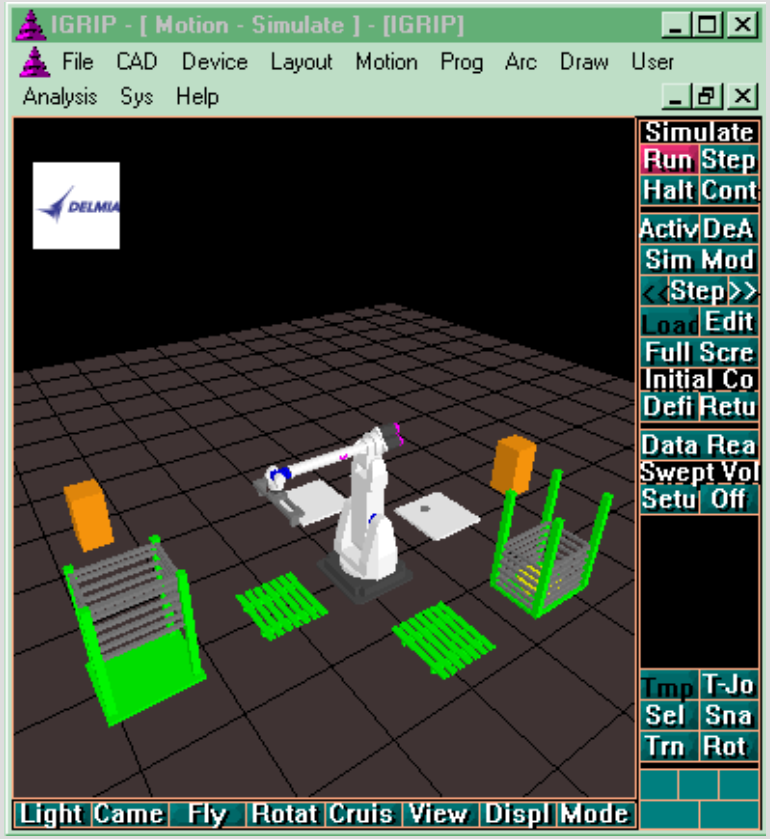
S. Straßburger, RIC/EP

Scenario „Quest & IGRIP“ (Material Flow and Robot Simulation)



Objectives and Scenario

- Example for vertical integration
- Integration of a robot simulation with a material flow simulation
- Simulation at different levels of detail



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User Education - Demonstration of the Advantages and Development of a clear Business Case

- What makes HLA/Distributed Simulation useful for civilian/ industrial applications ?

  - Business Case for military applications very clear
  - In comparison to military applications, the civilian sector uses simulation only very seldom and for isolated problems

- Where is the Killer Application which shows the benefit?

  - Only niche applications or the “usual suspects” have been demonstrated (traffic and harbor simulation, civilian training applications)

Software Vendors need to adopt HLA for their systems

- Simulation system vendors need to adopt HLA as interoperability standard and integrate HLA interfaces into their systems
- Reality: Often reluctant position, because of implementation and maintenance cost, and reluctance towards offering interoperability with a competitor's system

Avoid potential interoperability pitfalls

- Certain issues in the HLA IF Spec require proprietary protocols
  - Sample “Ownership Transfer”
    - No mechanism for a directed, time-stamped ownership transfer
    - Workaround are easily possible, but lead to incompatibilities
    - Standardization required !
- Standardized Object Models for Civilian Applications Needed
  - FOM “Manufacturing Simulation”
  - FOM “Digital Mockup”
  - ...

Performance and Usability

- Performance of distributed simulations
  - Slowdown vs. Speedup
  - Implications of lookahead to accuracy
  - Mechanisms for automatic lookahead determination from any given simulation model

- Usability needs to be simplified for mainstream application
  - Easy interfaces to (distributed) simulation
  - Excel is the most common planning tool in many companies (!)
  - Central run control/management components needed

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Summary

- HLA can be a basis for the digital factory and other civilian simulation applications
- Vision & Objective:
  - Obtain a continuos and overall representation of the virtual factories
  - Perform global optimizations by combining individual component and analyze interdependencies
  - Integrate HLA into existing IT infrastructure
- Remaining Challenges
  - User & Vendor acceptance
  - Standardization
  - Performance
  - Usability

A Grand Challenge (?)

- To reach true Plug-and-Play Interoperability of simulation applications and models in an application domain X, where
  - X = Automotive Industry
  - X = Semiconductor Production
  - X = Manufacturing Simulation
  - X = Air Traffic Simulation
  - ...