Simulation Modeling of UML Software Architectures

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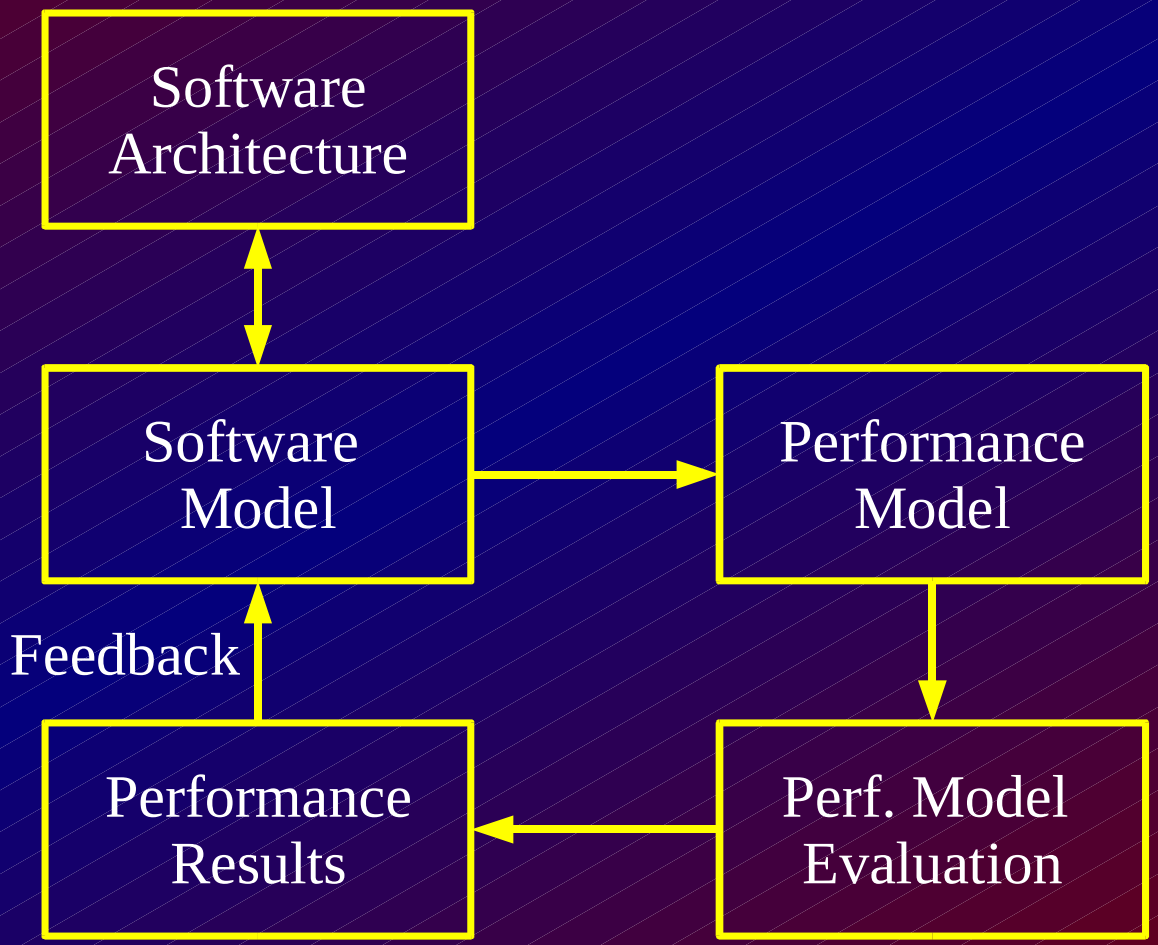
Performance Evaluation of SA

- Early identification of performance problems in Software Architectures is very useful
  - Costs of changing the design increases as the software development process proceeds
- Performances of SA can be evaluated with
  - Measurement-based approach (requires a running system)
  - Model-based approach (can be done at early stages of the software development process)

Model-based approach/1

- Develop a model of the system
- Translate the model into a *performance* model
- Evaluate the performance model
- Report feedback into the original system.

Model-based approach/2



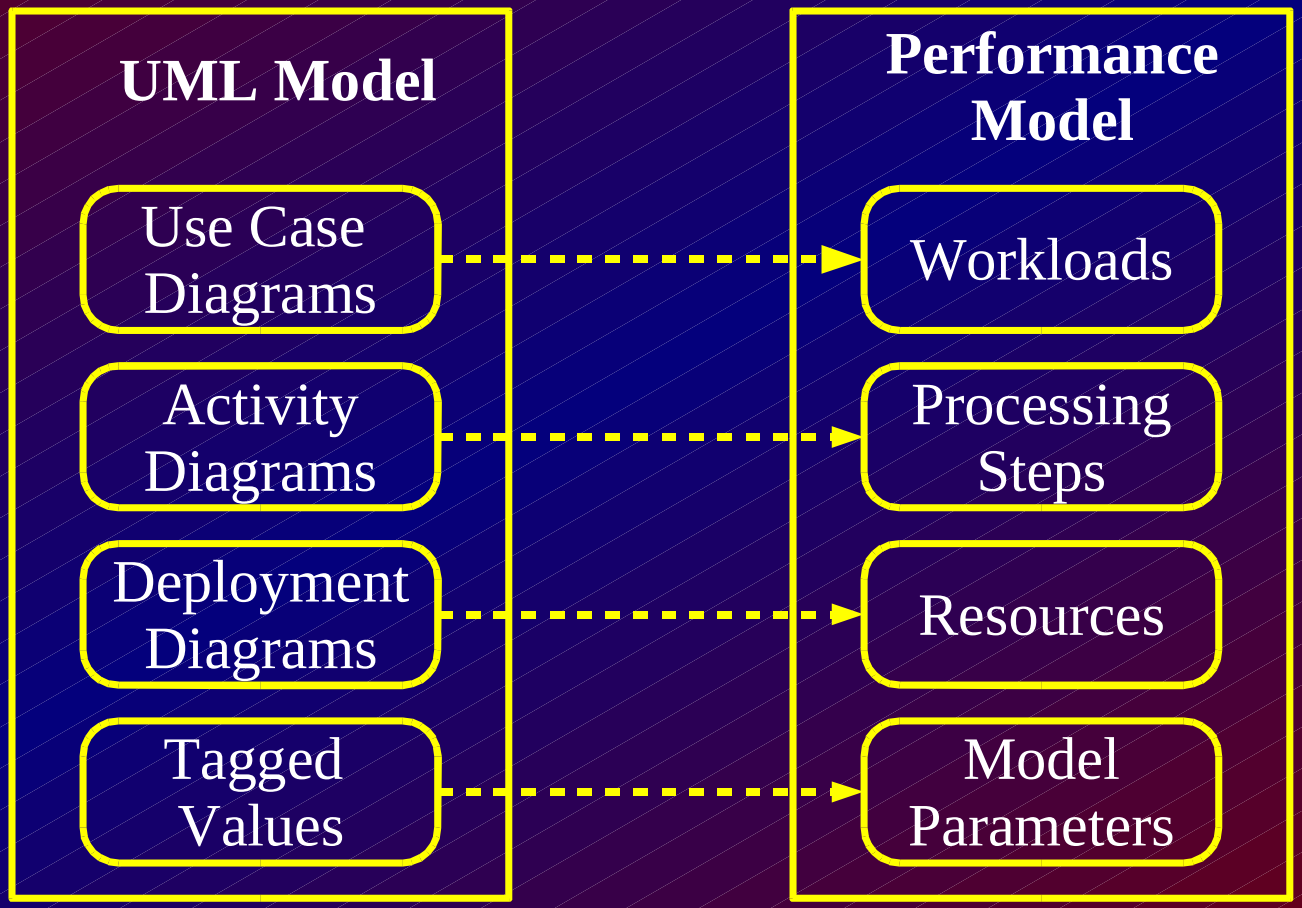
Simulation for Software Performance Evaluation

- Simulation not considered a solution technique for other performance models, but a performance model itself
- Advantages
  - Mapping between Software Model and Performance Model should be immediate
  - No constraints on the Software Model
  - Easy to report feedback into the Software Model

Proposed approach/1

- Annotated UML Use Case, Activity and Deployment diagrams as SA description model
- Performance model based on UML Profile for Schedulability, Performance and Time Specification
- Process-oriented simulation model
  - Model is implemented as a C++ simulation program, using home-made simulation library

Proposed approach/2



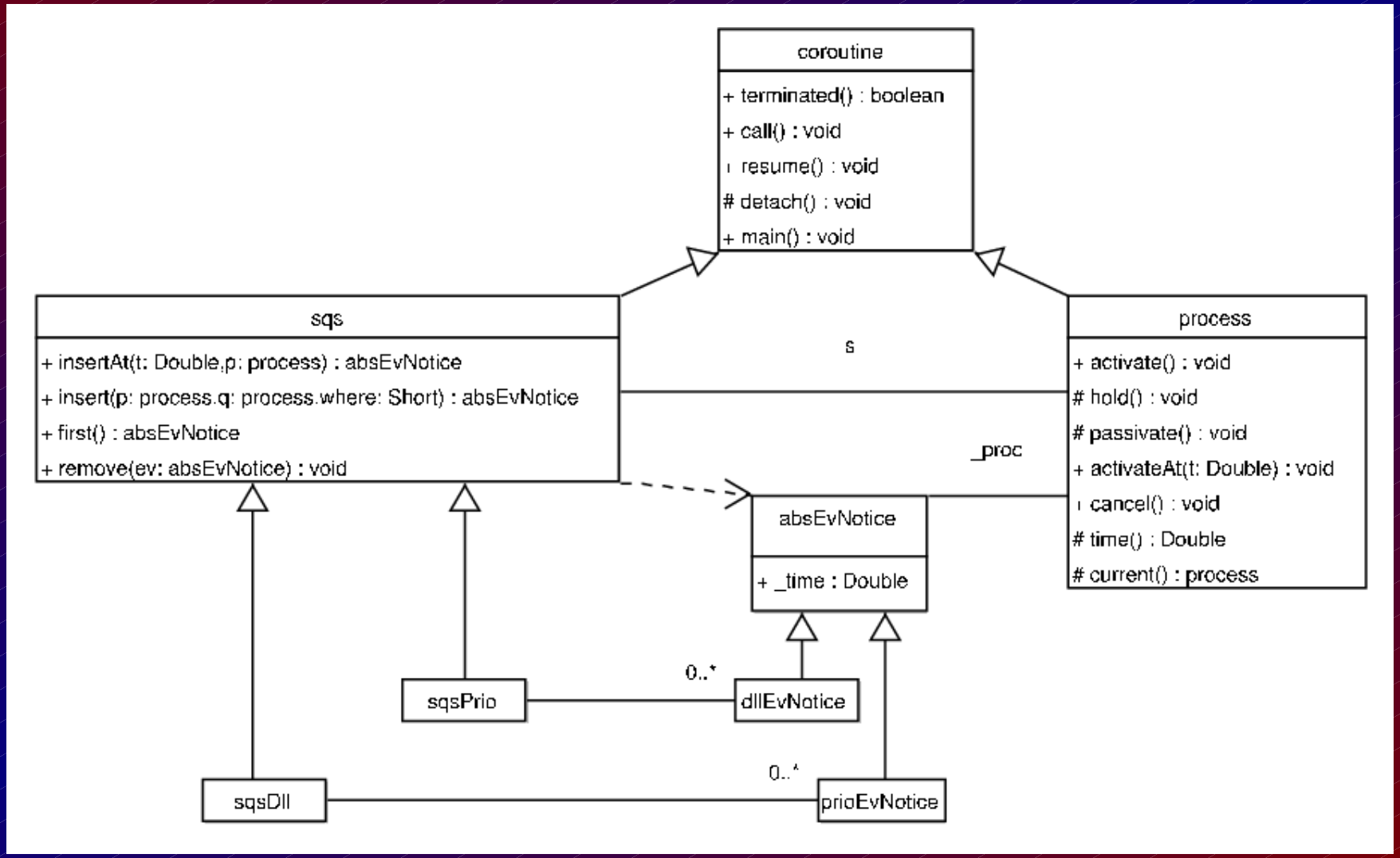
Proposed approach/3

- User annotates the UML diagrams according to (a subset of) the UML Performance Profile
- UML model is exported in XMI format
- We built a tool which parses the XMI file and builds the simulation model
- Model is executed according to user-supplied parameters
- Simulation results are put back into the UML diagrams as tag values

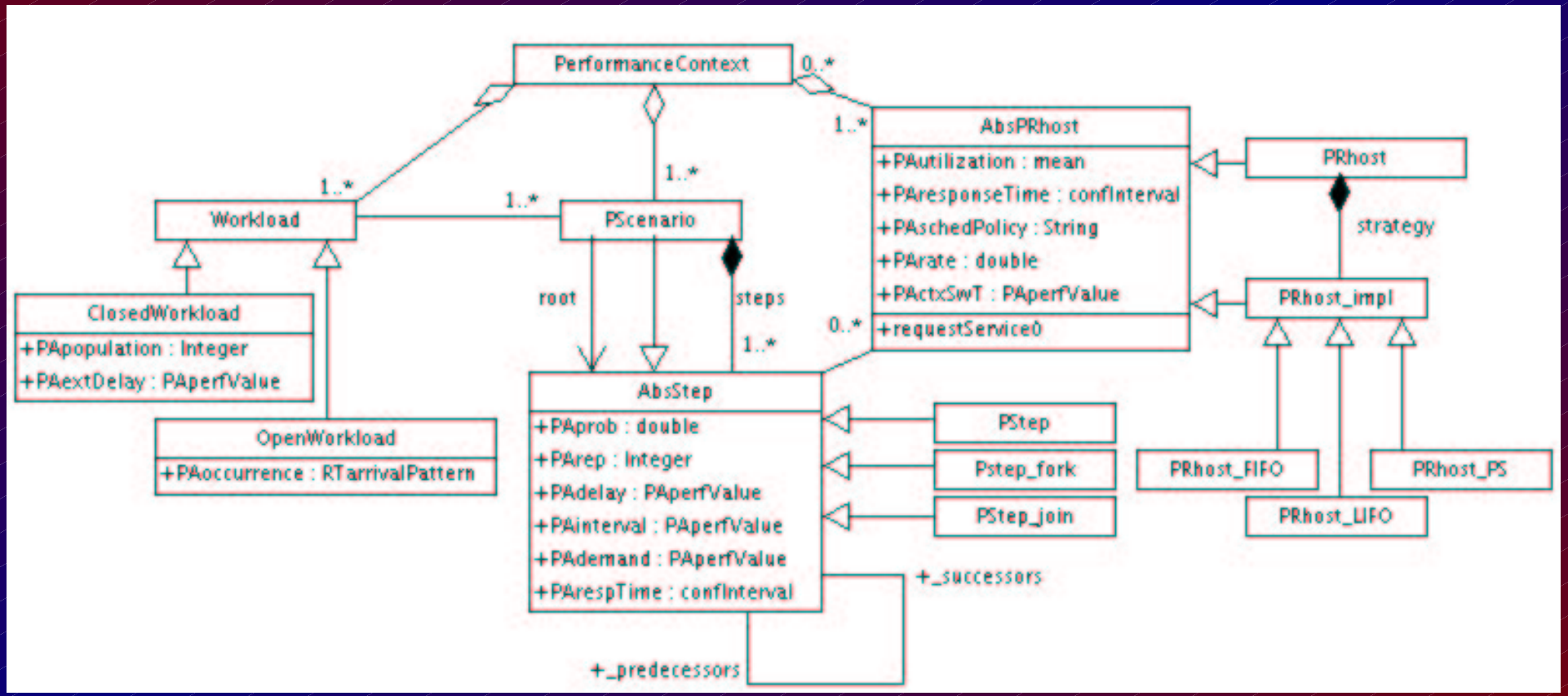
The Simulation Library/1

- Layered structure (classes):
  - Layer 0: Coroutines
  - Layer 1: Simulation Processes, Simula-like SQS
  - Layer 2: Random Variate Generators, Basic Statistics

Simulation Library Core



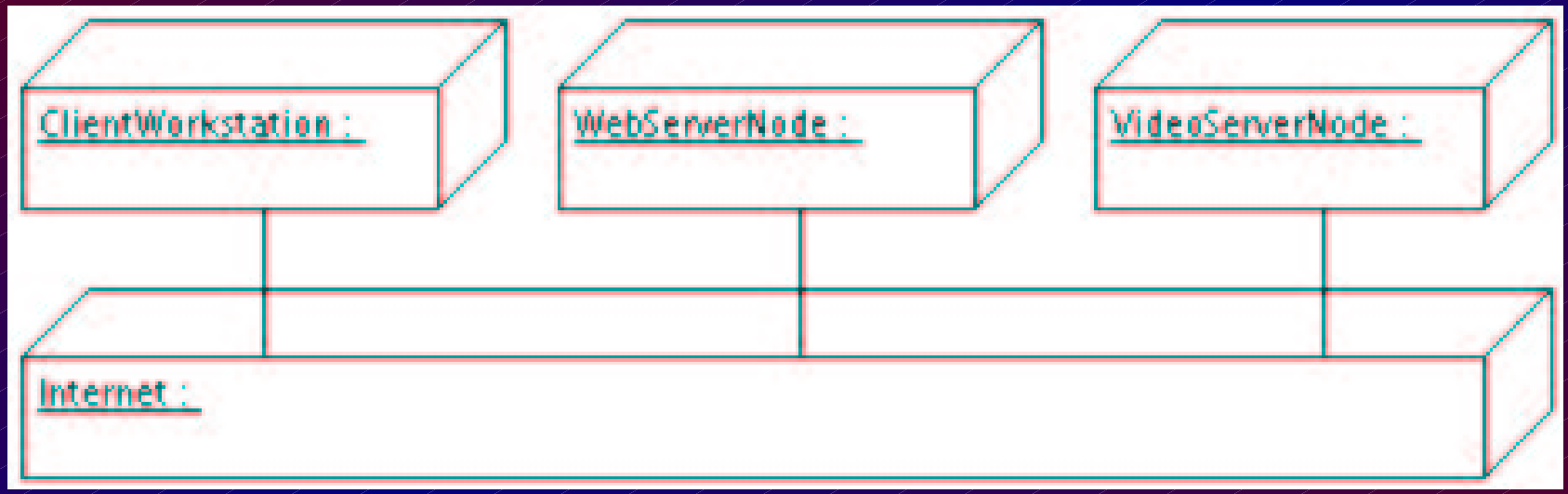
The Performance Model



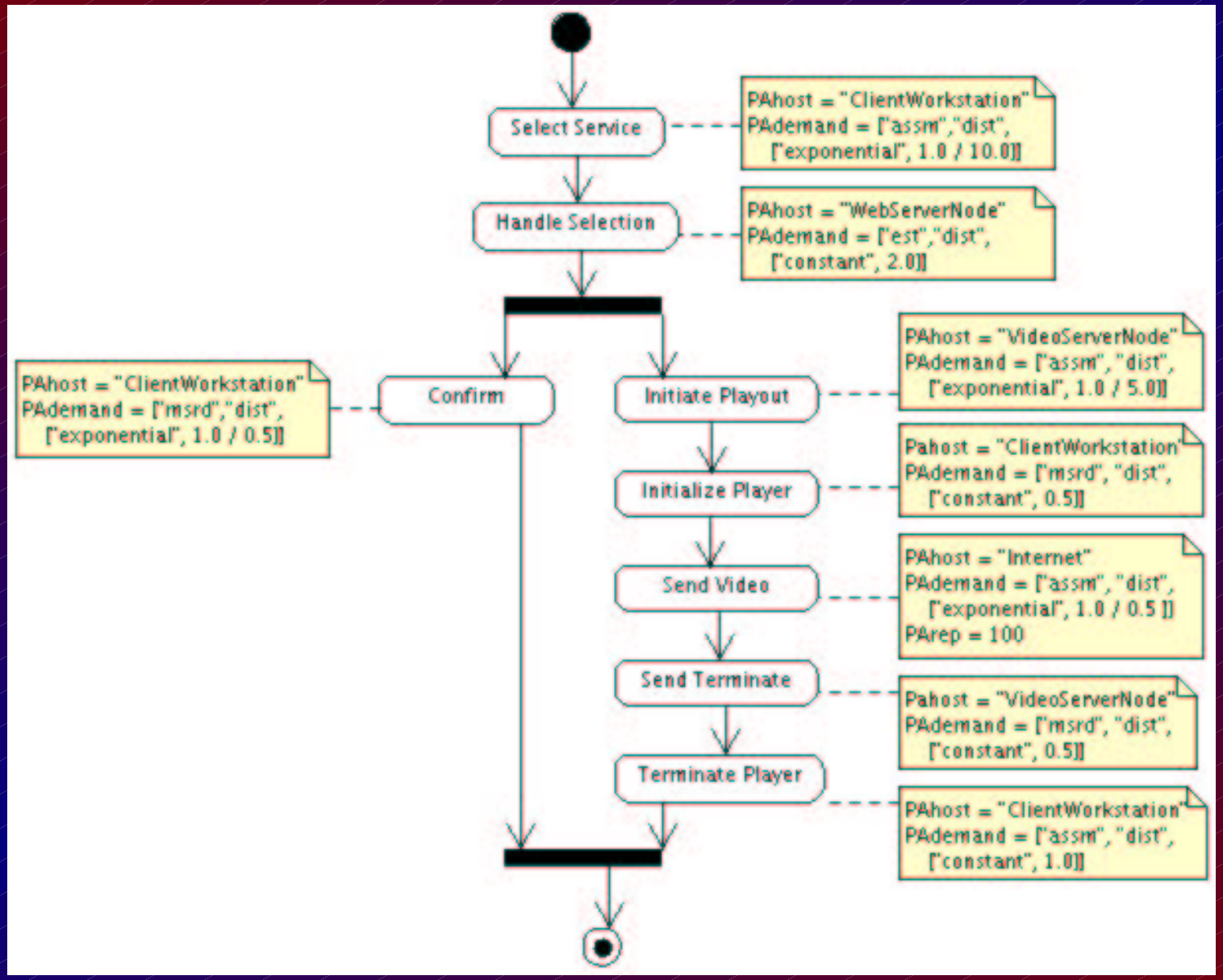
Example: Web Video Application

- User accesses with a browser the Web Server and requests a video
- The Web Server initializes the Video Server
- Video Server sends the frames through the Internet
- Video Server sends termination frame
- User workstation terminates the video player

Example/1


ClientWorkstation :
WebServerNode :
VideoServerNode :
Internet :

Example/2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["exponential", 1.0 / 10.0]]
Handle Selection
PAhost = "WebServerNode"
PAdemand = ["est","dist",
["constant", 2.0]]
Confirm
PAhost = "ClientWorkstation"
PAdemand = ["msrd","dist",
["exponential", 1.0 / 0.5]]
Initiate Playout
PAhost = "VideoServerNode"
PAdemand = ["assm", "dist",
["exponential", 1.0 / 5.0]]
Initialize Player
Pahost = "ClientWorkstation"
PAdemand = ["msrd", "dist",
["constant", 0.5]]
Send Video
PAhost = "Internet"
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["exponential", 1.0 / 0.5]]
PArep = 100
Send Terminate
Pahost = "VideoServerNode"
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["constant", 0.5]]
Terminate Player
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PAdemand = ["assm", "dist",
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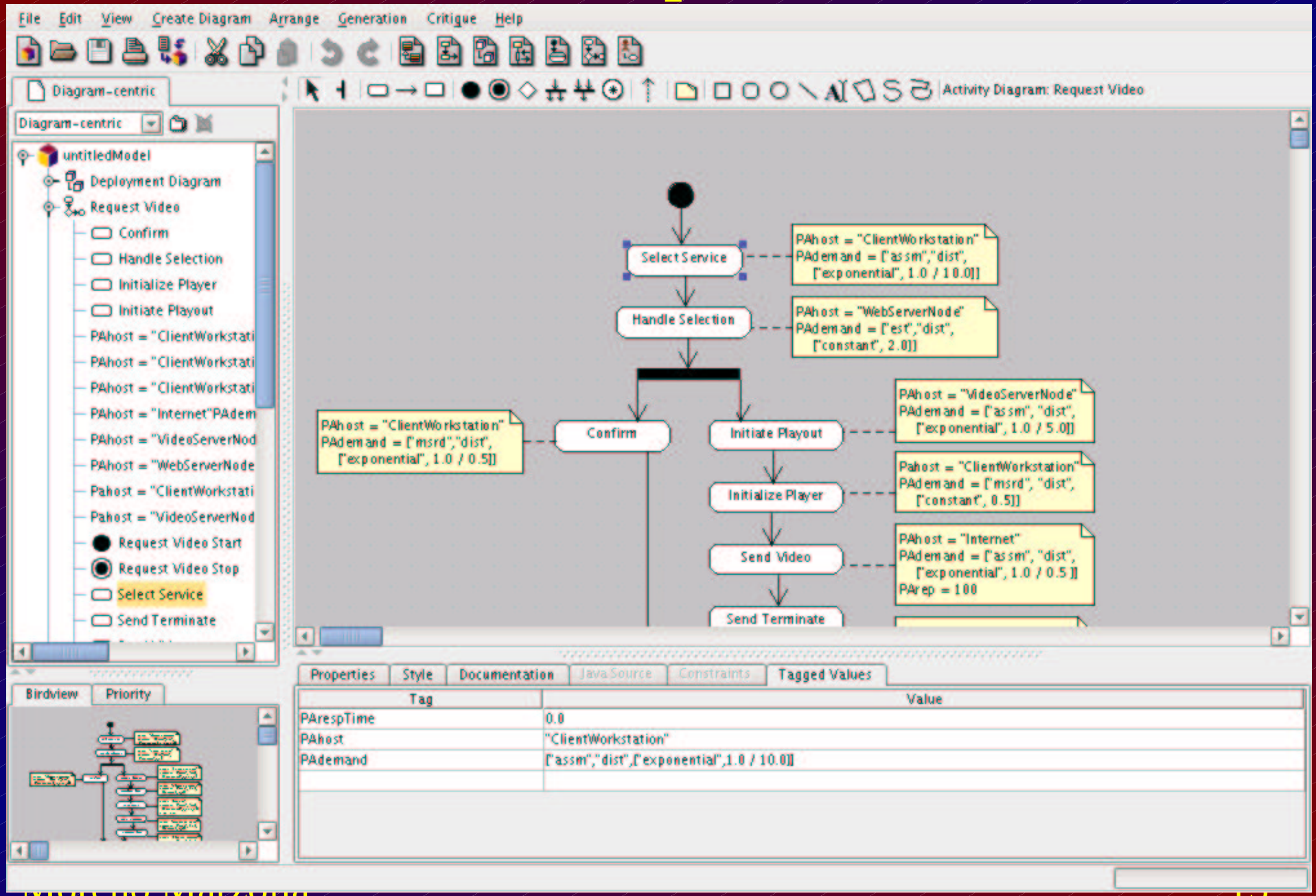
Example/3


File Edit View Create Diagram Arrange Generation Critique Help
Diagram-centric
Activity Diagram: Request Video
untitledModel
Deployment Diagram
Request Video
Confirm
Handle Selection
Initialize Player
Initiate Playout
Request Video Start
Request Video Stop
Select Service
Send Terminate
Select Service
Handle Selection
Confirm
Initiate Playout
Initialize Player
Send Video
Send Terminate
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Birdview
Priority
Properties
Style
Documentation
JavaSource
Constraints
Tagged Values
Tag
Value
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"ClientWorkstation"
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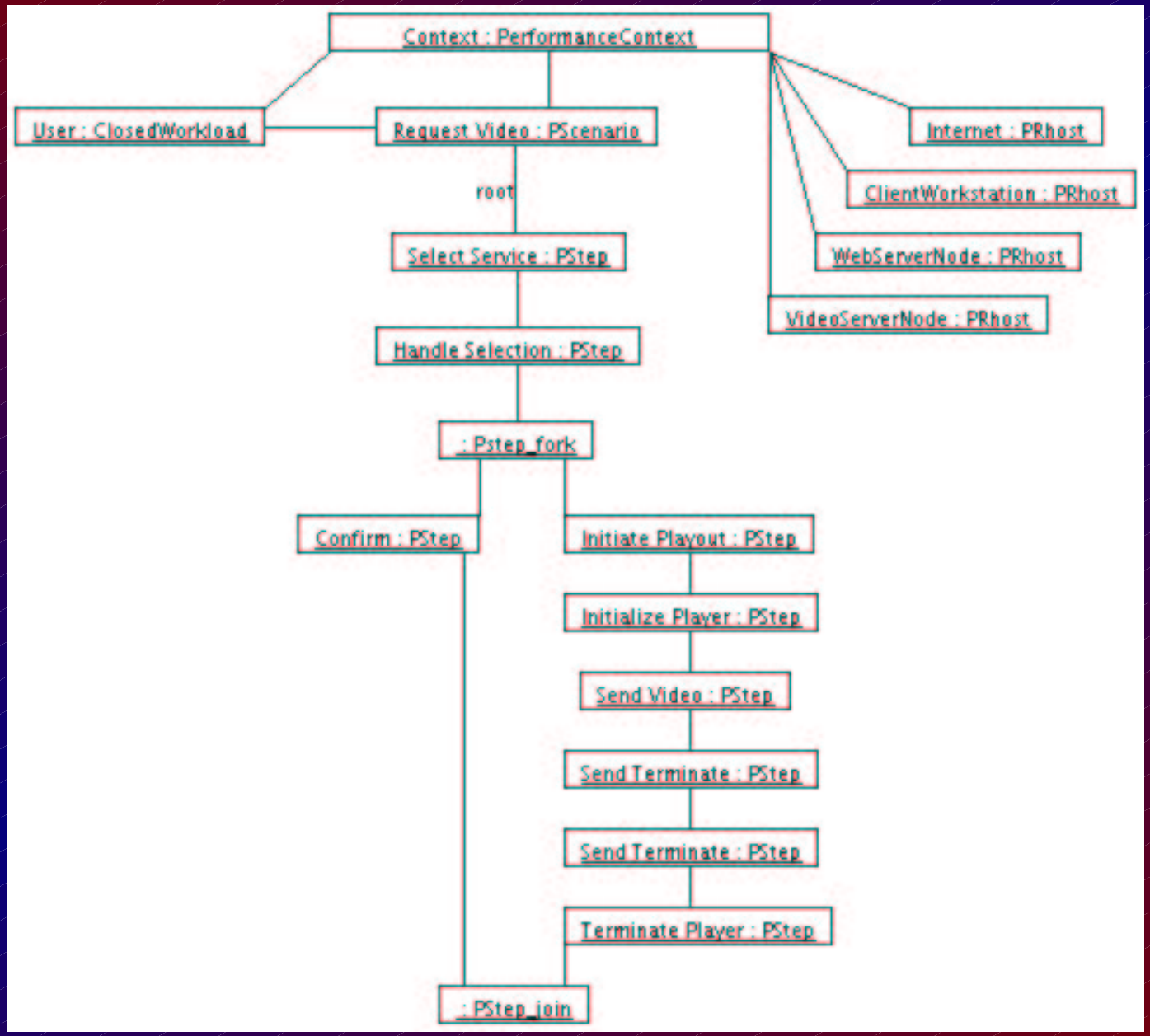
Example/4


Context : PerformanceContext
User : ClosedWorkload
Request Video : PScenario
Internet : PRhost
ClientWorkstation : PRhost
WebServerNode : PRhost
VideoServerNode : PRhost
root
Select Service : PStep
Handle Selection : PStep
: Pstep_fork
Confirm : PStep
Initiate Playout : PStep
Initialize Player : PStep
Send Video : PStep
Send Terminate : PStep
Send Terminate : PStep
Terminate Player : PStep
: PStep_join

Work in progress

- Extend the performance model to include passive resources
- Compute more performance measures
- Validate the methodology
- Apply the methodology to a real-life case study
  - Including mobility?
- Integrate the methodology into a more general framework