

# Using UML 2.0 in Real-Time Development

Kirsten Berkenkötter

University of Bremen

- } Introduction
- } Weaknesses of UML 1.4
- } New Features of UML 2.0
- } Weaknesses Reviewed
- } Conclusion

# Introduction

- } UML 1.4
  - common standard
  - basics are easy to learn
  - useful for communication, specification, documentation
  
- } structural modeling
  - class diagrams
  - object diagrams
  - component diagrams
  - deployment diagrams

# Introduction

- } behavioral modeling
  - use case diagrams
  - collaboration diagrams and sequence diagrams
  - statechart diagrams
  - activity diagrams
  
- } real-time development
  - hardware-software mutual dependencies
  - high reliability
  - often safety-critical background
  - ↳ high demands on a modeling language

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# General Weaknesses of UML 1.4

- } UML specification
  - informal
  - sometimes ambiguous
  
- } metamodel
  - 4-layer metamodeling approach not followed
  
- } usability
  - overwhelming number of diagrams and elements

# General Weaknesses of UML 1.4

- } diagrams and views
  - inconsistent
  - no mapping between different diagrams in a model
  
- } composition of models
  - no hierarchy
  - insufficient for large models

# Real-Time Dependent Weaknesses of UML 1.4

- } hardware-software interdependencies
  - no sufficient support
  
- } timing constraints
  - no syntax and semantics for timing purposes
  
- } communication
  - no communication structures like ports, connectors, protocols



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# New Features of UML 2.0

## } general

- different specification documents
- division of language core and modeling elements
- 4-layer metamodeling approach realized

## } profiles

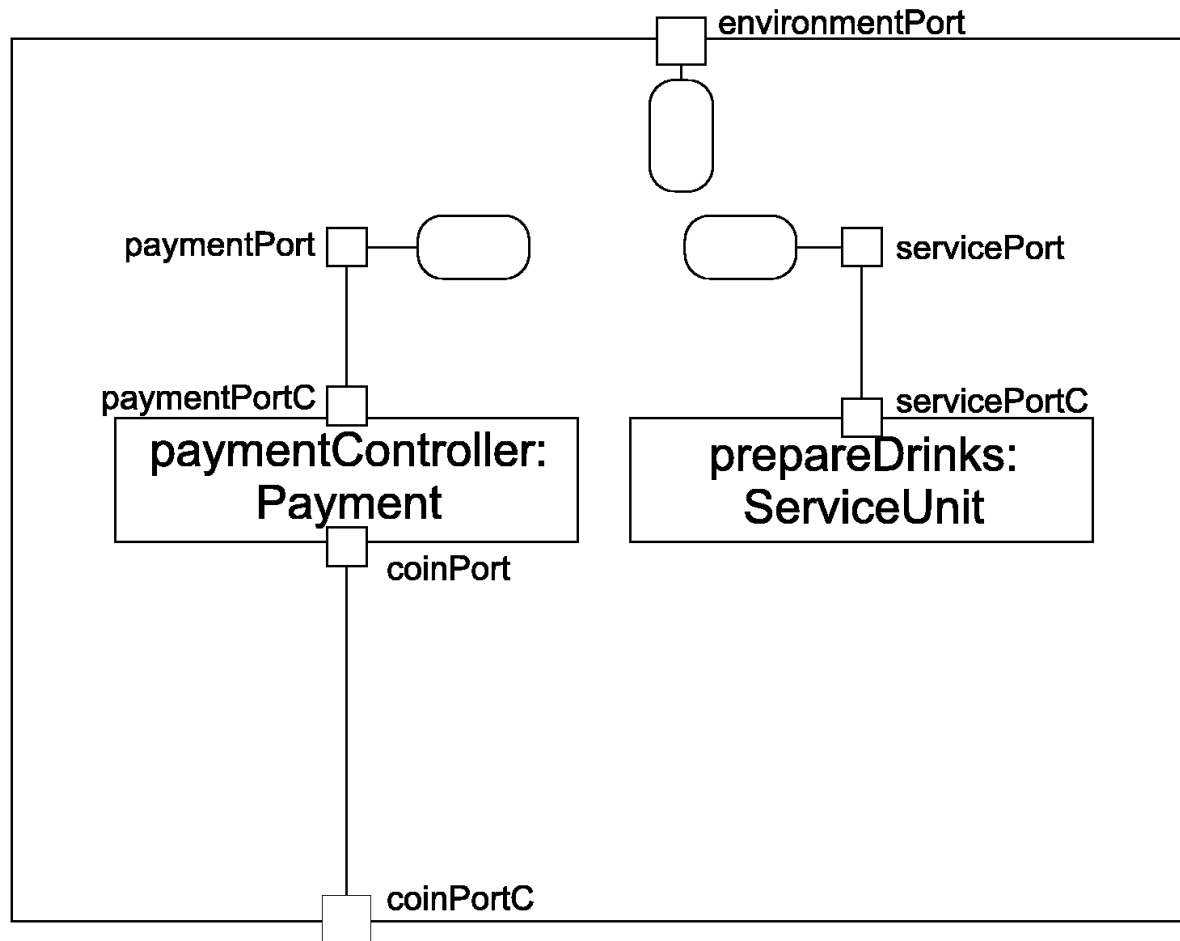
- deriving new elements from metamodel
- introducing new terminology, new syntax, new semantics and constraints, and further information like transformation rules

# New Features of UML 2.0

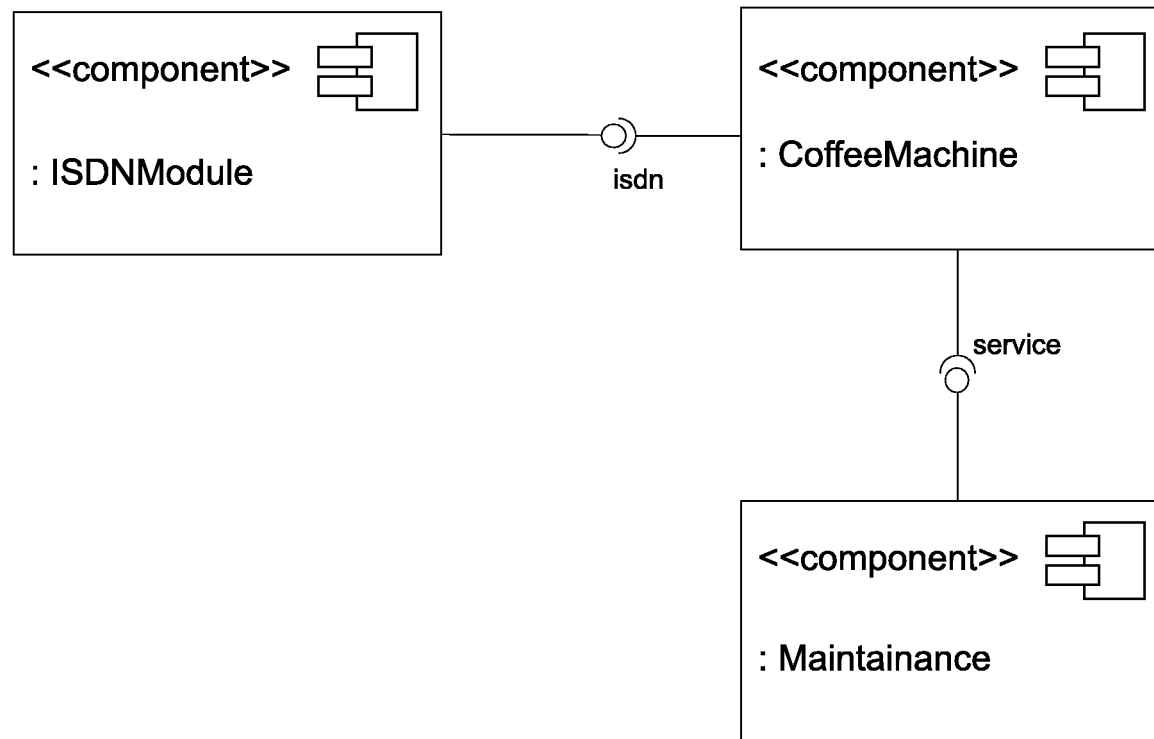
## } structural modeling

hierarchical modeling in composite structure diagrams  
communication structures with ports and connectors  
components as software components with internal structure  
and interfaces to the outside

# New Features of UML 2.0



# New Features of UML 2.0



# New Features of UML 2.0

## } behavioral modeling

- fine-grained action model

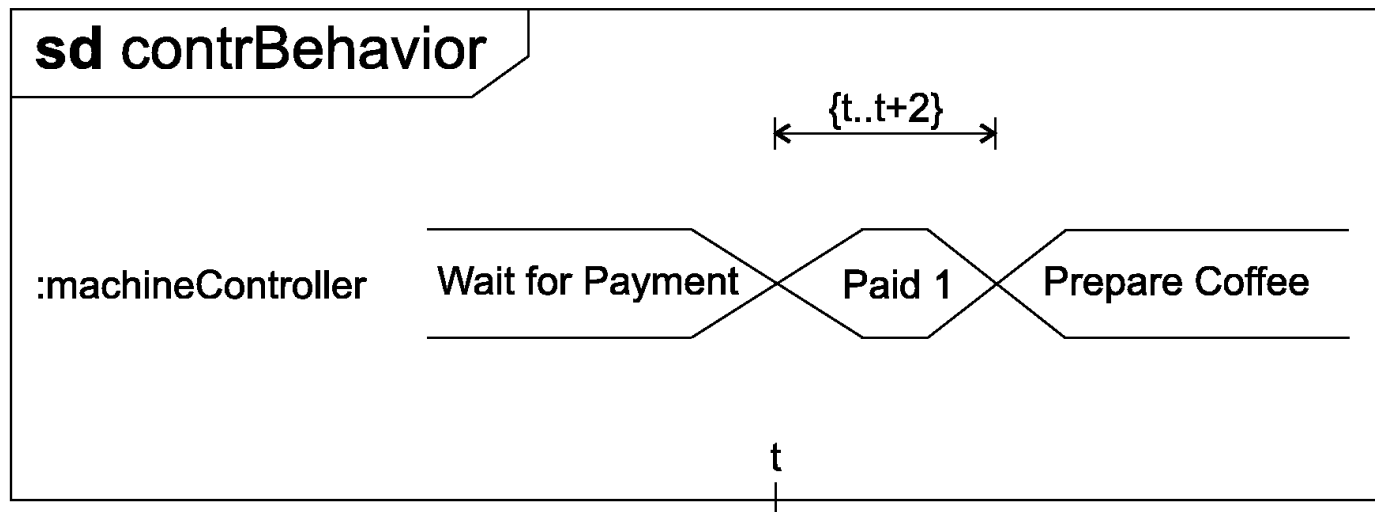
- independently defined activity diagrams with new features like interruptible regions and loops

- simple time model and timing diagrams

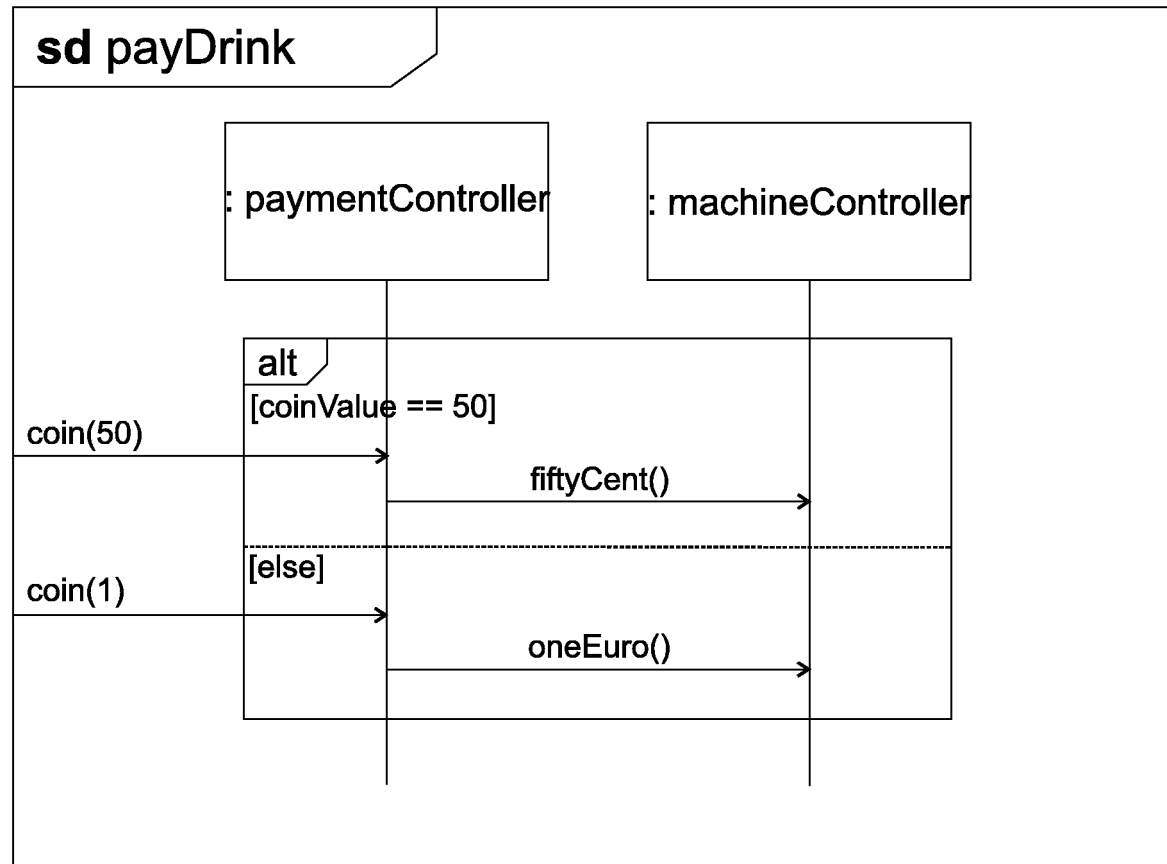
- interactions with new features like alternatives, options, breaks, loops, critical regions

- behavioral and protocol state machines

# New Features of UML 2.0



# New Features of UML 2.0





# New Features of UML 2.0

## } structural modeling

- class diagrams
- object diagrams
- package diagrams
- component diagrams
- composite structure diagrams
- deployment diagrams

## } behavioral modeling

- use case diagrams
- sequence diagrams
- communication diagrams
- activity diagrams
- interaction overview diagrams
- statechart diagrams
- timing diagrams

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# Review

## General Weaknesses

- } UML specification
  - more fine-grained
  - still informal
  
- } metamodel
  - 4-layer metamodeling approach realized
  - extension mechanism based on metamodel (profiles)

# Review

## } usability

even more diagrams and elements added

↪ even worse

## } diagrams and views

no change

## } composition of models

improved by hierarchical modeling with composite structure diagrams

# Review

## Real-Time Dependent Weaknesses

- } hardware-software interdependencies
  - deployment diagrams still insufficient
  - modeling of hardware as components with ports as access points possible

# Review

## } timing constraints

timing model lacks important features:

- no discrete and dense time
- no timing zones
- no system time
- no synchronization between clocks

## } communication

ports and connectors  
protocol state machines

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# Conclusion

## } improvements

- hierarchical modeling
- communication structures
- profiles

## } problems

- informal specification ↪ no formal reasoning
- usability

↪ profiles best solution for real-time development