RIO : Model, Language and Tools for Agent-Oriented Software Engineering

BAALA Oumaya BAKHOUYA Mohamed BERDAI Abdelhamid CAMINADA Alexandre CREPUT Jean-Charles GABER Jaafar GALLAND Stéphane GARROUTY Gilles GRUER Pablo HAJJAM-EL-HASSANI Amir HARITI Mohamed HAYARI Noureddine HILAIRE Vincent KOUKAM Abderrafiaa LAMOTTE Olivier LAMROUS Sid Ahmed LISSAJOUX Thomas MABED Hakim RODRIGUEZ Sebastian RUICHEK Yassine SIMONIN Olivier

UTBM
Belfort Technopôle 90000 Belfort - France

Agent Link III TFG-AOSE

Outline

Introduction

The RIO meta-model

The OZS notation

Tools : prototyping and verification

Conclusion

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Statements

- Many models and architectures for agent and multiagent systems
- Heterogeneous engineering approaches
- Understanding model is difficult
- Comparison and reuse are difficults

Comparison critera

Model

- Concepts underlying the model
- Architecture dependant

Language

- Formal
- Semi-Formal

Tools

- Validation
- Verification
- Code generation

Model

- Organizational
  [Wooldridge et al., 1999, Ferber and Gutknecht, 1998, MESSAGE, 2000, Burrafato and Cossentino, 2002]
- Componential [Brazier et al., 1997]
- Architecture dependant
- Application range

Language

Semi-Formal

- Mainly extensions of Object-Oriented notation : AUML [Bergenti and Poggi, 2000], MASE [DeLoach, 1999], ADELFE [Bernon et al., 2002]

Formal

- Formal Method [Luck and D'Inverno, 1995],
- Modal and Temporal Logic GAIA [Wooldridge et al., 1999]
- Knowledge Representation DESIRE [Herlea et al., 1999]

Advantages of formal approach

- Non ambiguous semantics.
- Precise specifications.
- Proof, simulation, prototyping.

Drawbacks of formal approach

- Difficult to produce an implementation.
- Limited expressive power (reactive aspects, transformational aspects, ...).

Tools

- Model checking [Herlea et al., 1999, Gruer et al., 2000]
- Proofs
- Prototyping [Hilaire et al., 2000a, Hilaire et al., 2000b]

Needed for a methodology

Objectives

- Concepts suited for description of a wide range of MAS.
- Covering phases from formal specification to implementation.
- Validation and Verification.

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Definitions

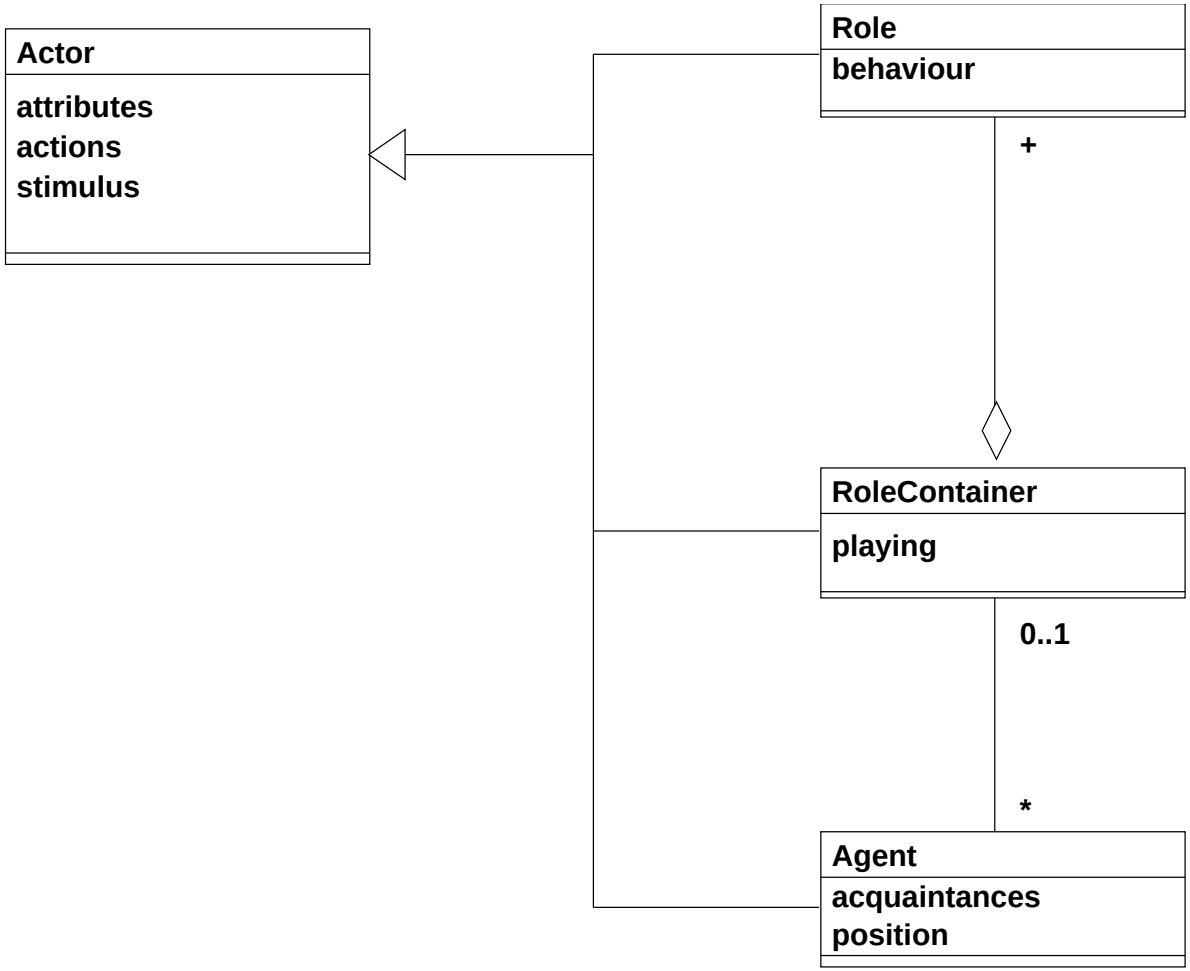
Definition

A role is an abstraction of a behaviour or a status in an organisation.

Definition

An organization is a set of roles such as every role interacts with at least one role in the organization.

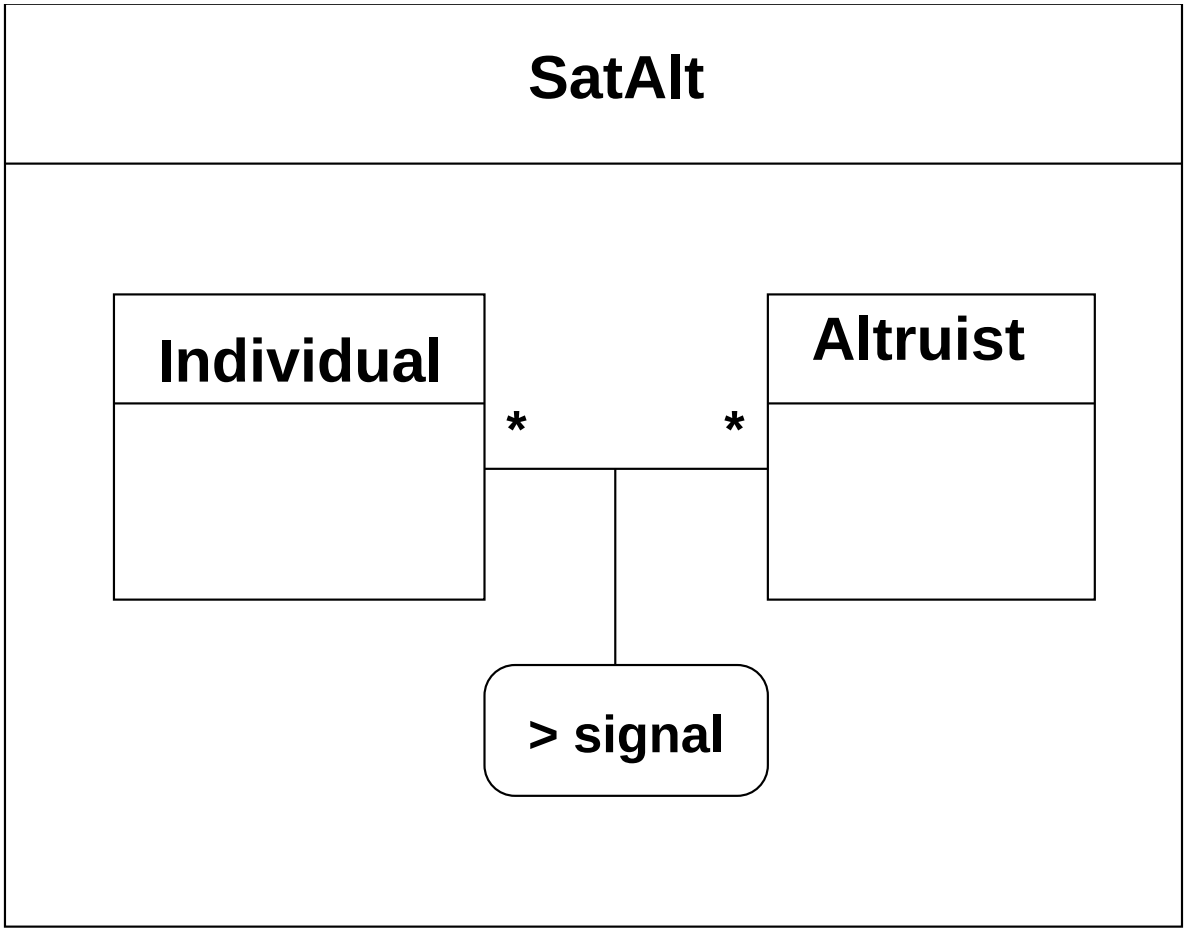
Meta-model overview



Organizational meta-model

- The meta-model uses concepts such as organization and role as first class citizen.
- Each concept (role, interaction, organization) is specified by a class with he OZS notation.
- Specification consists in specialization of framework classes.

Organization example



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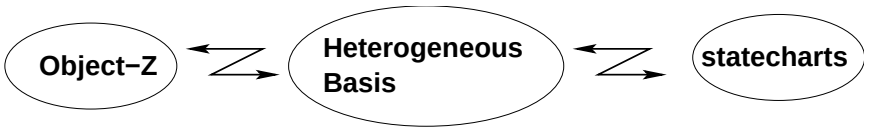
Multiformalisms notation

We have chosen two formalisms : Object-Z [Duke et al., 1991] and statecharts [Harel, 1987].

- Great expressive power.
- Specification simplified.
- Operational semantics.

Integration principles

[Gruer et al., 2004]

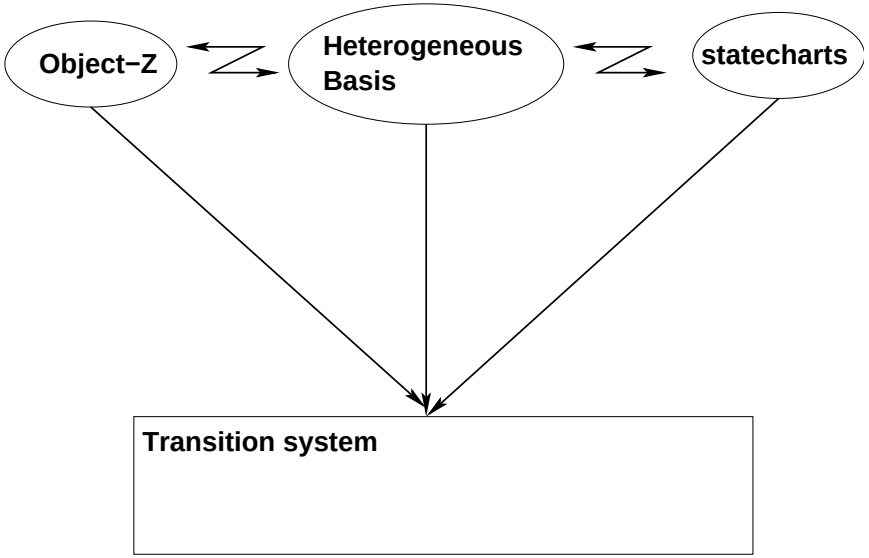


Syntaxic integration

Object-Z classes integrates a statechart which specifies their behaviours

Integration principles

[Gruer et al., 2004]



Semantic integration

Object-Z classes with a state-chart are given an operational semantics with transition systems.

Individual

Role

$current : Action$

$initialWeight, weight : Action \rightarrow [0, 1]$

$progressionReward : Action \rightarrow BMValue$

$s : DiscreteSensor$

$satisfaction, I : [-P_{max}, P_{max}]$

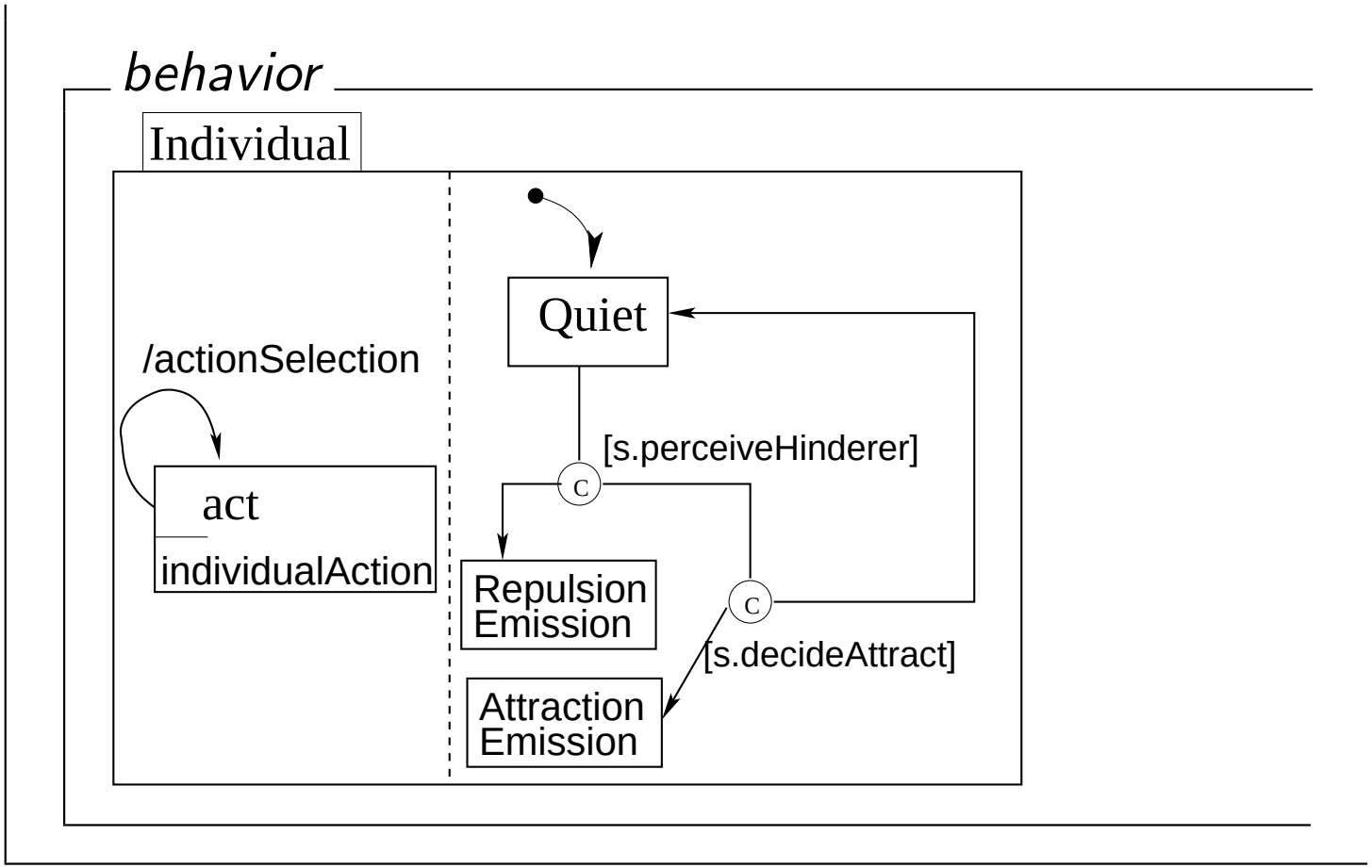
$\alpha : [0, 1]$

$current \subseteq actions$

$obtainCondition = \{|I_{ext}()| \leq P() \wedge |I_{ext}()| \leq I\}$

$leaveCondition = \{|I_{ext}()| \geq P() \wedge |I_{ext}()| \geq I\}$

$$\frac{ext! : \mathbb{R}}{ext! = s.getMax()}\ I_{ext}$$


behavior
Individual
Quiet
/actionSelection
[s.perceiveHinderer]
C
act
individualAction
Repulsion
Emission
C
[s.decideAttract]
Attraction
Emission

Altruist

Role

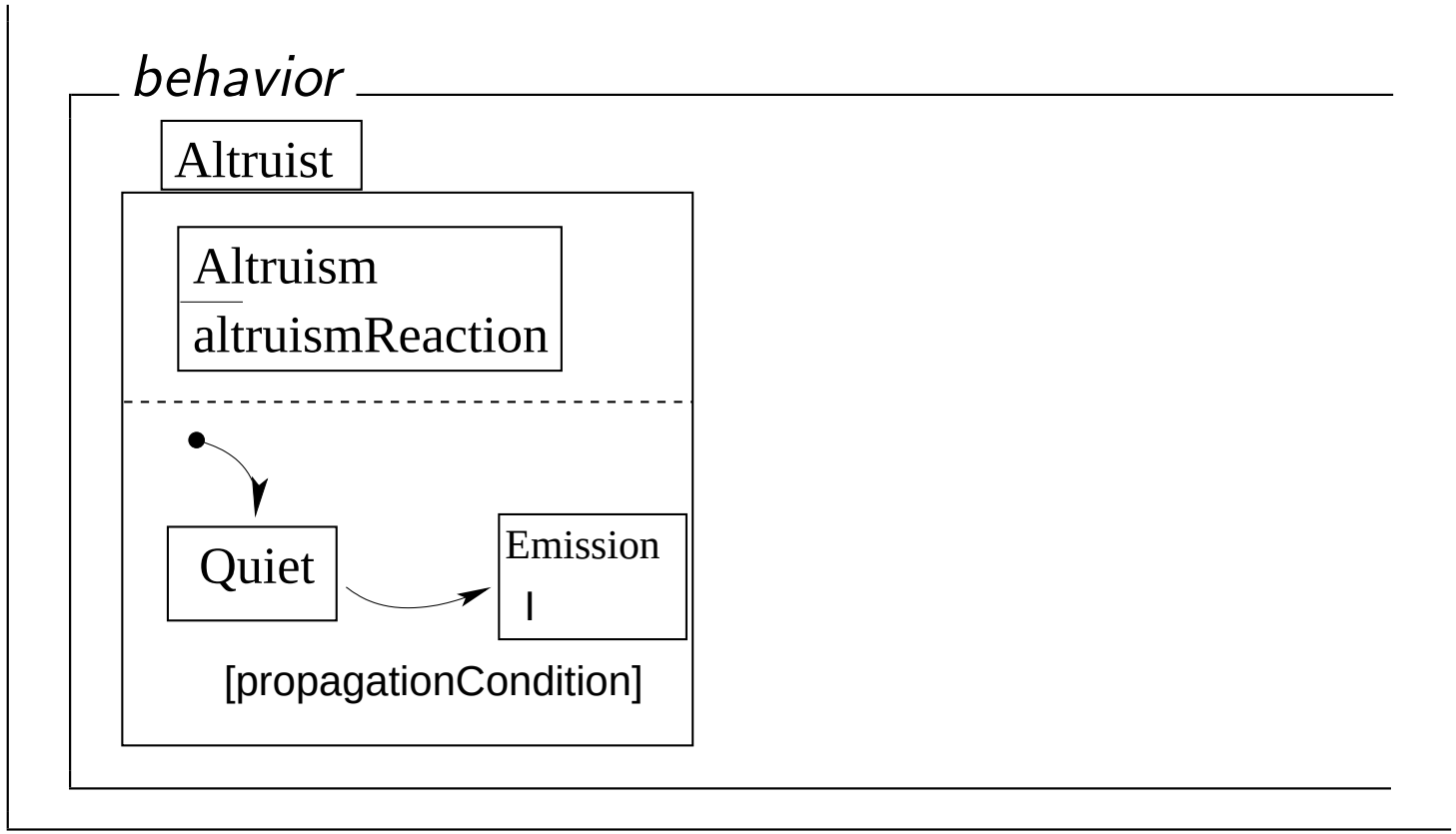
$$progressionReward : Action \rightarrow BMValue$$
$$s : DiscreteSensor$$
$$satisfaction, I : [-P_{max}, P_{max}]$$

$$current \subseteq actions$$
$$obtainCondition = \{|I_{ext}()| \geq P() \wedge |I_{ext}()| \geq I\}$$
$$leaveCondition = \{|I_{ext}()| \leq P() \wedge |I_{ext}()| \leq I\}$$

I_{ext}

$$ext! : \mathbb{R}$$

$$ext! = s.getMax()$$


behavior
Altruist
Altruism
altruismReaction
Quiet
Emission
I
[propagationCondition]

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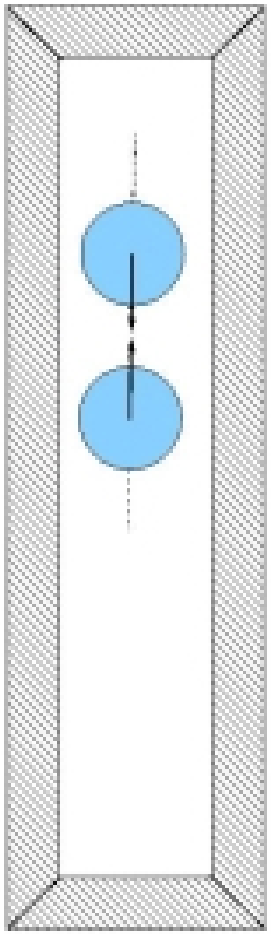
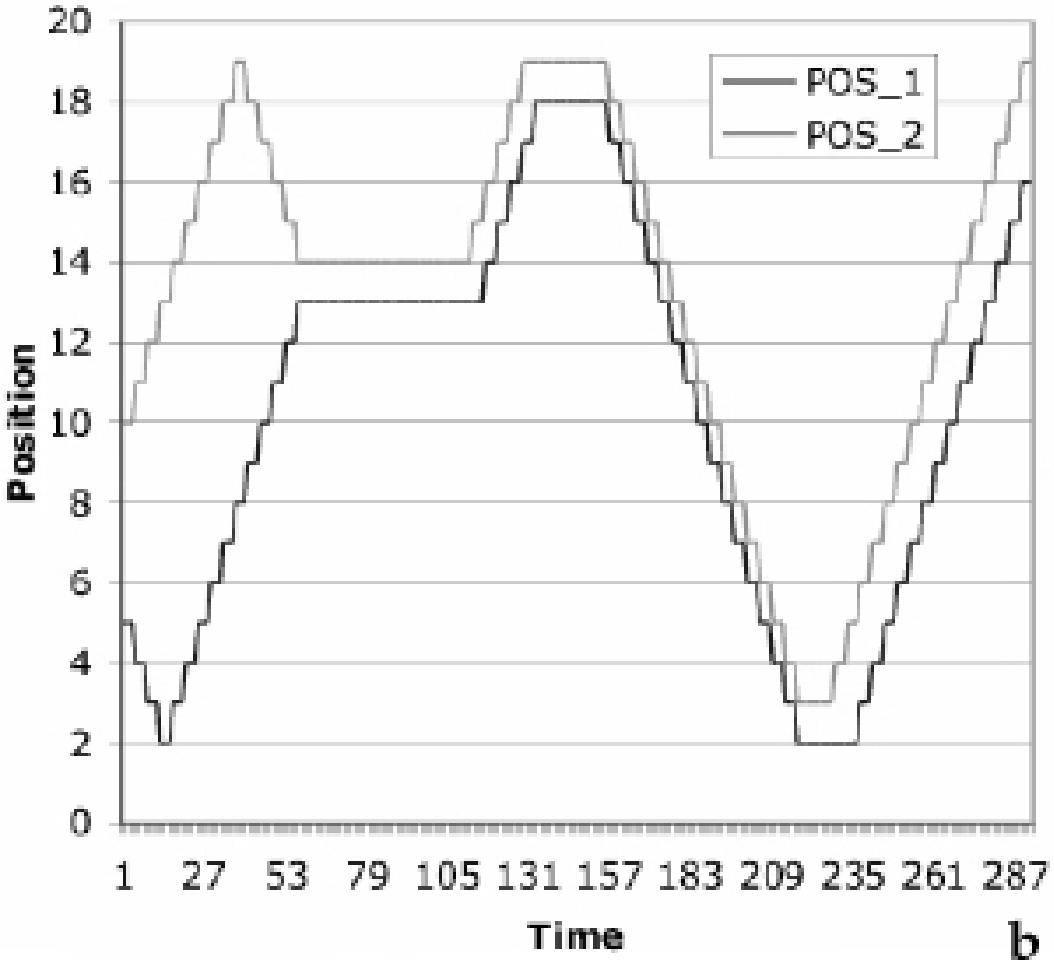
Prototyping



a



b

Verification

- Model-checking
- Verification

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- Formal specification linked to implementation.
- Modularity and abstraction,
- Simulation and animation.
- Proofs.

Perspectives

- CASE Tool currently in development.
- Compositional verification techniques.
- Refinement process.
- Integration with existing semi-formal notations.


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