DynaCROM

An approach to implement regulative norms in normative multiagent systems

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ConText

- Multiagent systems
  - Heterogeneous agents
  - Autonomous agents
- Use of norms
  - Prevention of malicious actions
  - Maintain trust between the agents
  - Define desired or dreaded behaviors
    - Permission – Obligation – Probihition
- Normative multiagent systems
  - Submitted to norms during the execution
  - Decision by considering the norms
  - Acceptation of the norms
  - Violation of the norms and sanctions

Goal

Implementation guidelines to operationalize regulative norms in a normative multiagent system.

OutLine

- The DynaCROM methodology
  - Contextual Norm Classification
  - Contextual Norm Representation
  - Contextual Norm Composition
- The SCAAR framework
  - Self-controlled agents
  - Automatic generation process
- The DynaCROM – SCAAR combination
- Conclusion

THE DYNACROM METHODOLOGY

Specificites of DynaCROM

- An information mechanism
  - Provides the agents with *contextual norms*
- A methodology for norm management
  - Design – Implementation - Integration
- Related work
  - OMNI (Organization Model For Normative Institutions) [Vasquez-Salceda et al., MST'04]
  - Electronic Agent-Based Institutions [Esteva,AAMAS'02]

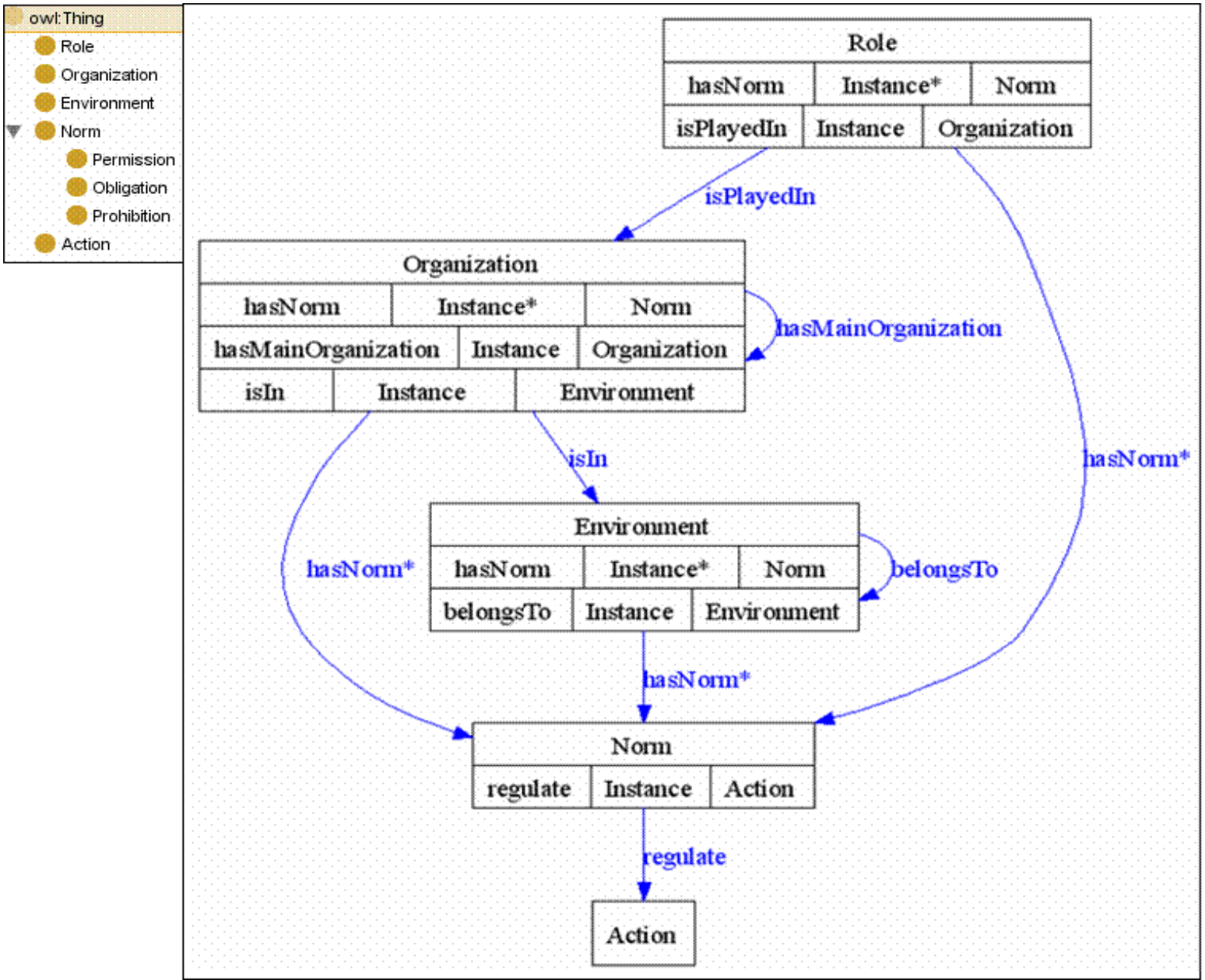
Contextual norm classification

- Multiagent System composition
  - Environments
  - Organizations
  - Agents playing Roles
  - Agents Interacting

- Norm informations contexts in DynaCROM
  - Set of basic concepts with top-down architecture
    - Environment
    - Organization
    - Role
    - Action
  - Addition of domain-dependent contexts
    - To represent application specific norms

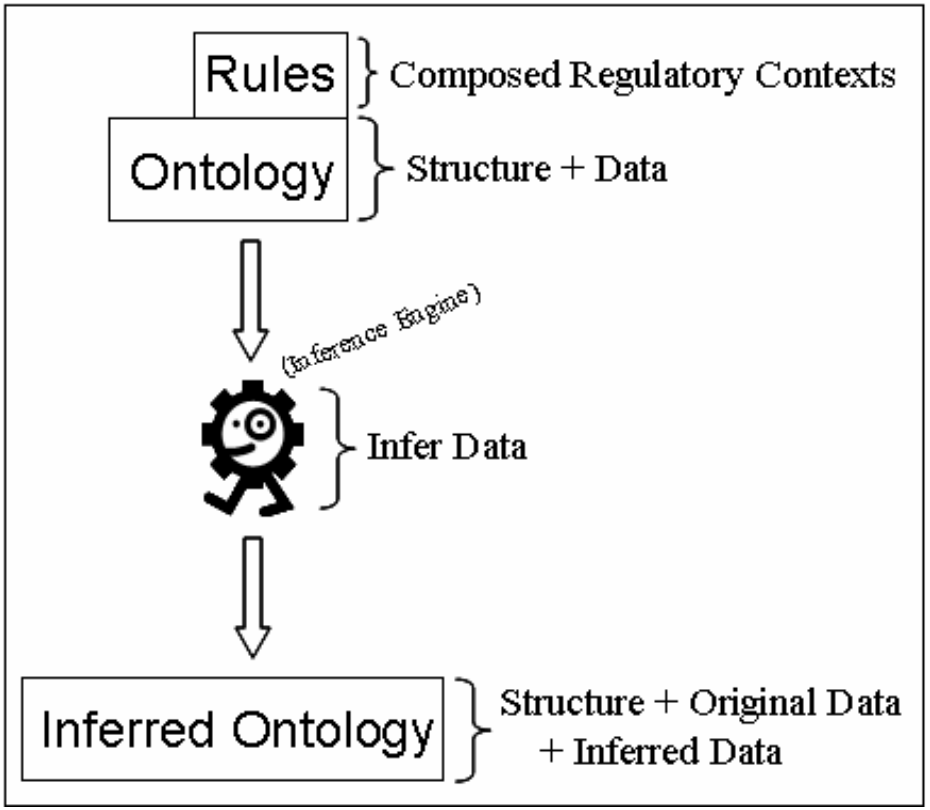
Contextual norm representation

Contextual Normative Ontology



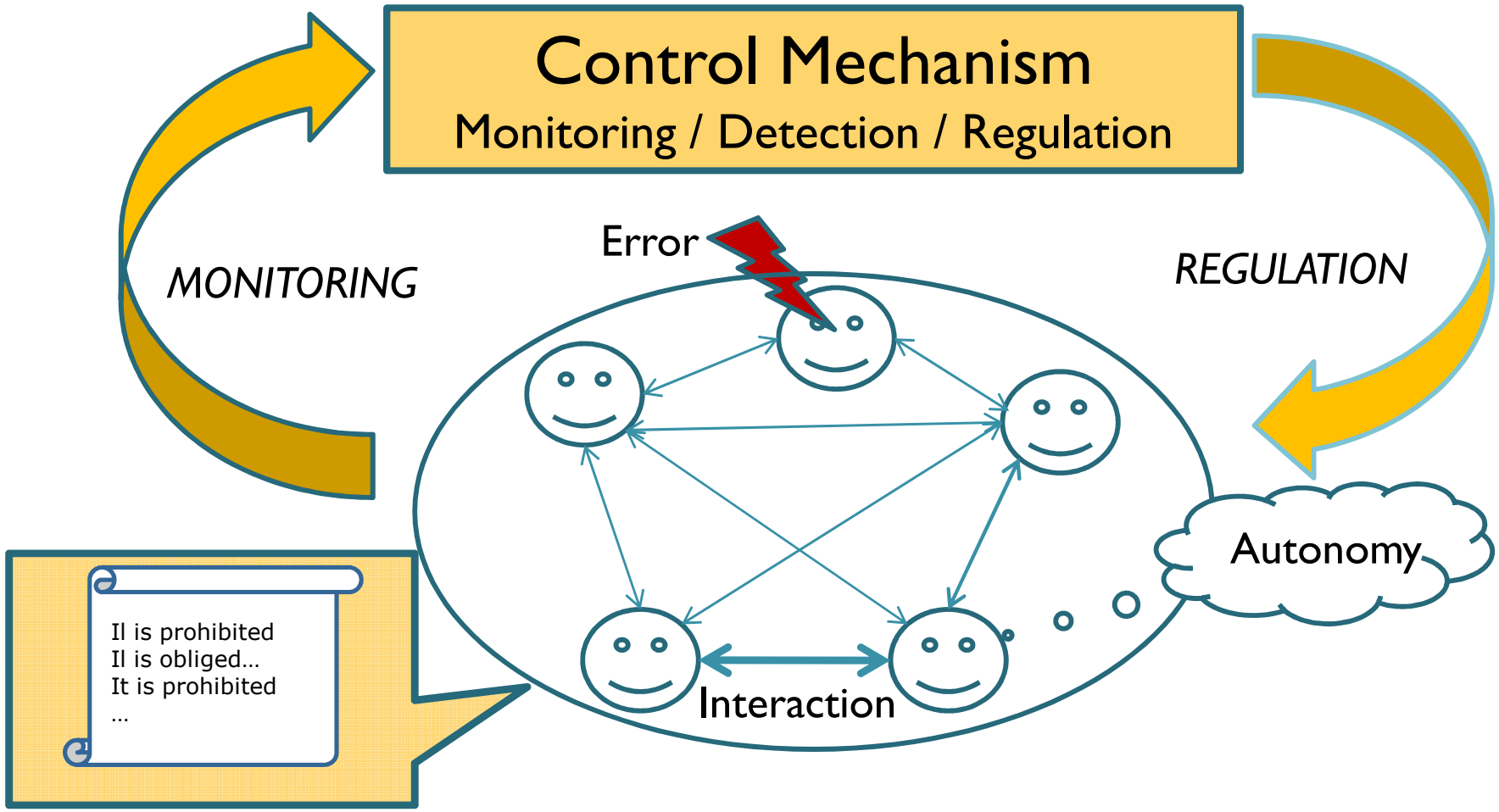
Contextual norm composition

- Dynamic composition during the execution
  - Ontology-driven rule written by the system developers
  - Instanciation of the ontology
  - Information of the agents about contextual norms

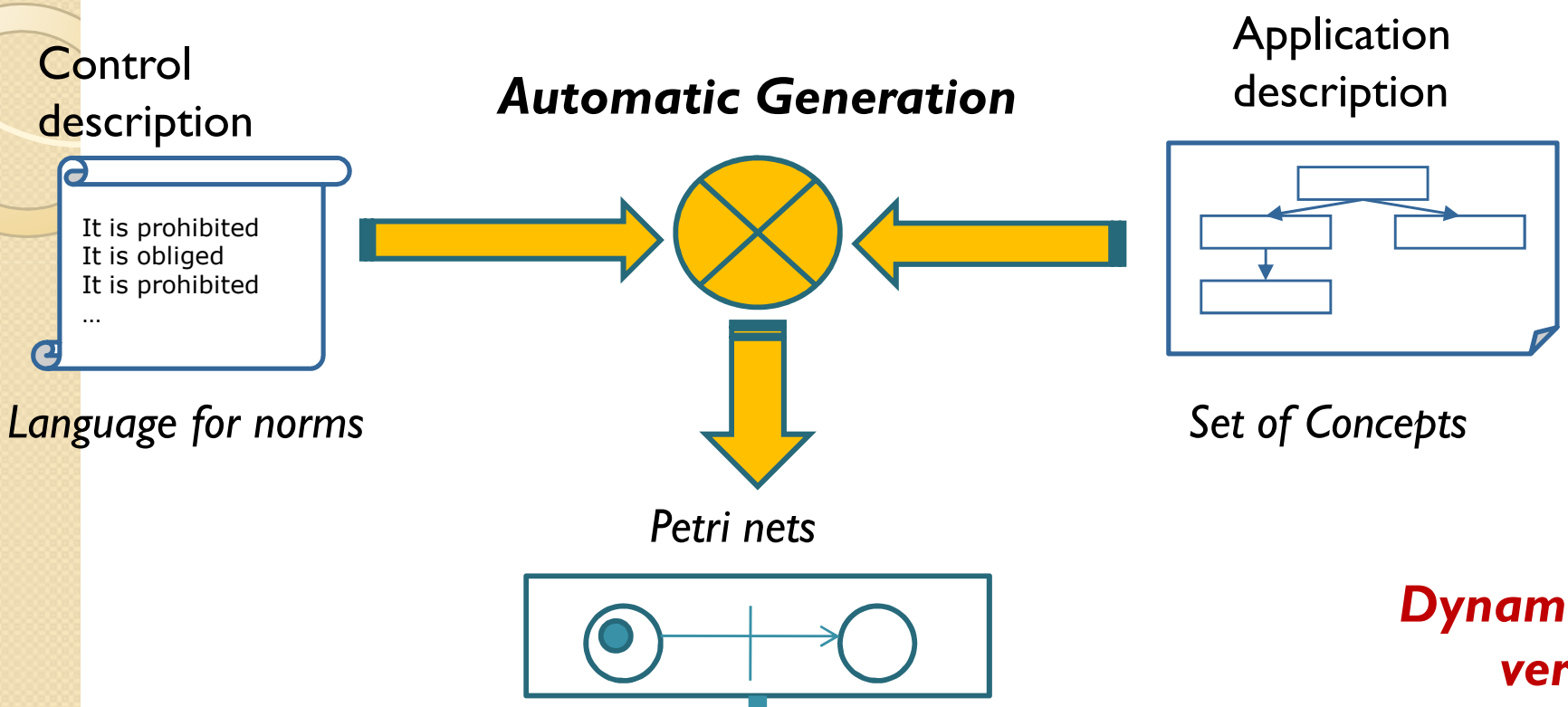


THE SCAAR FRAMEWORK

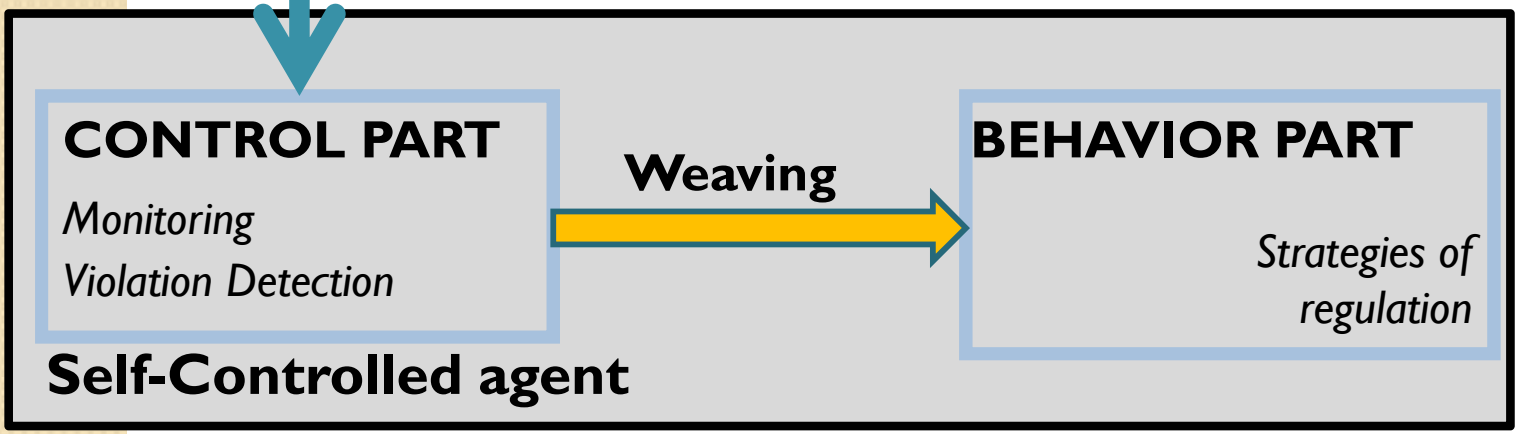
Prevention of undesirable behaviors



The generation of self-controlled agents

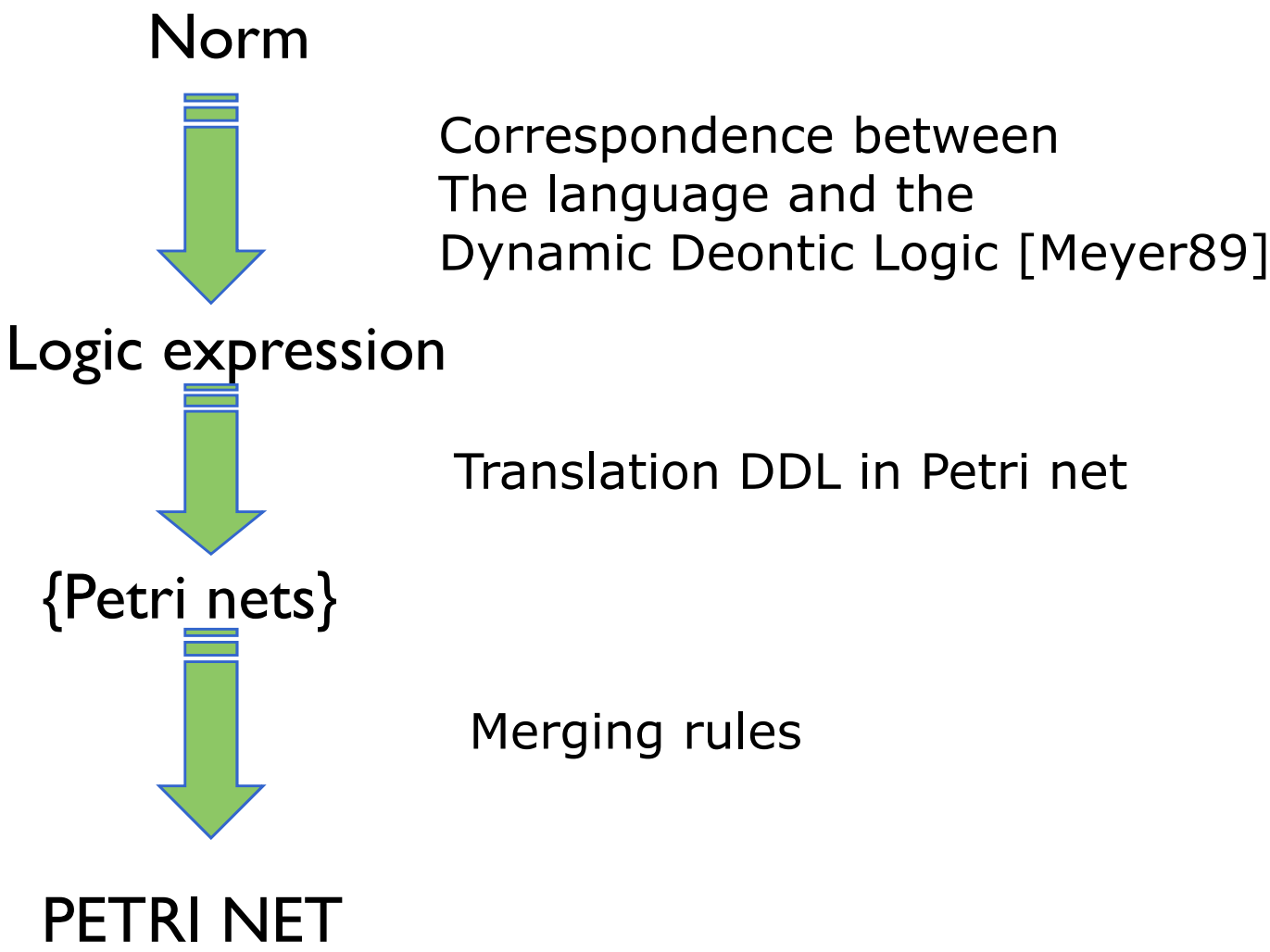


Dynamic norms verification



Introspective architecture

Petri net generation



The language for norms

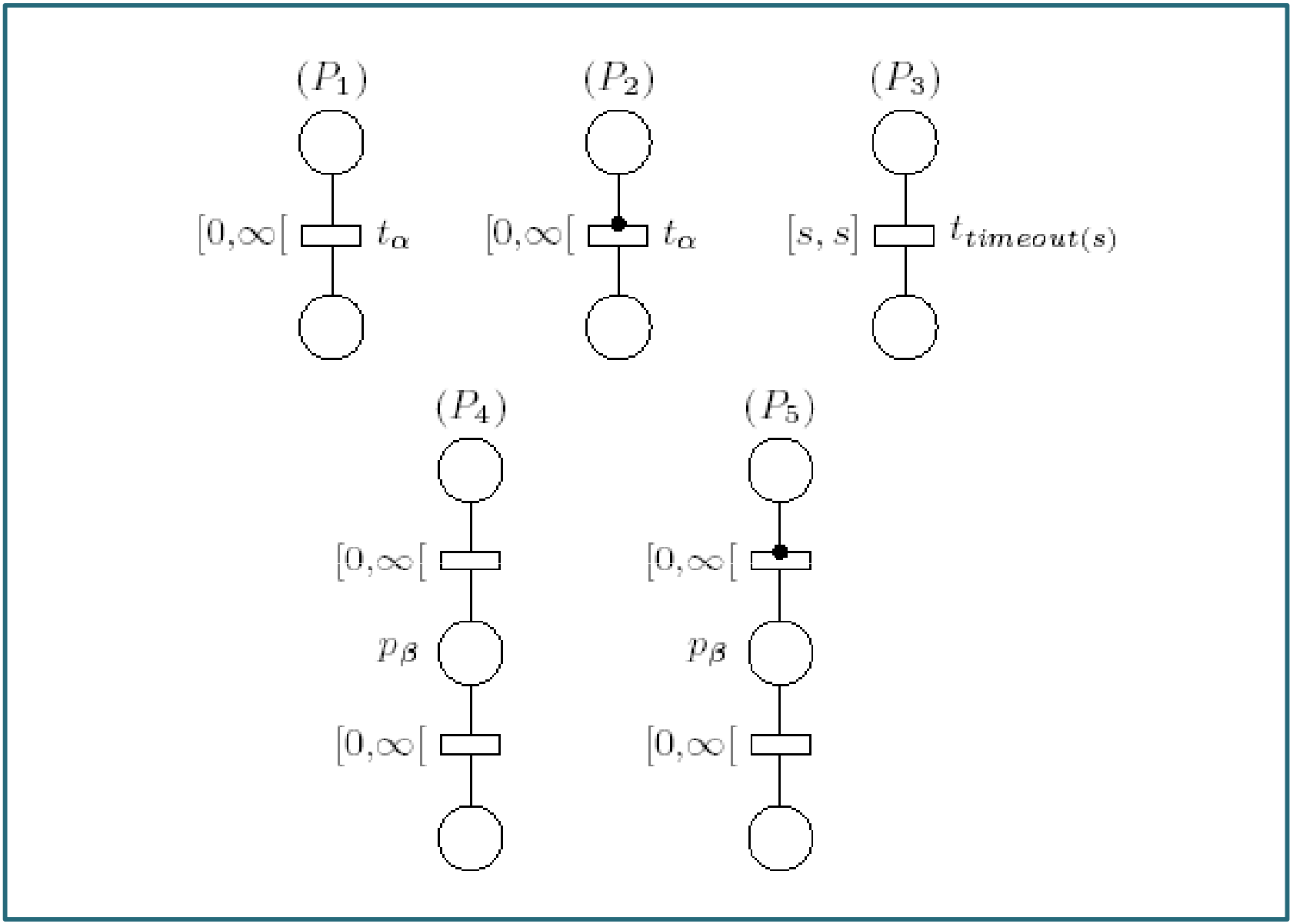
LAW	::=	{AGENTS} DEON | {AGENTS} CONTEXT
AGENTS	::=	agt_id: AGENT [suchThat PROP]
DEON	::=	FORBIDDEN EXP [BEFORE DEADLINE]|
		OBLIGED EXP BEFORE DEADLINE |
DEADLINE	::=	EXP | COMPACT+sec
CONTEXT	::=	DEON AFTER COMPACT [+sec] |
		DEON IF STATE
EXP	::=	STATE | COMPACT
COMPACT	::=	ACTION | CompAct THEN ACTION |
		COMPACT AND ACTION
STATE	:: =	agt_id be SMST [suchThat PROP]
ACTION	::=	agt_id do SMTH [suchThat PROP] |
AGENT	::=	an AGENT sub-concept
SMTH	::=	an ACTION sub-concept
SMST	:=	a FEATURE sub-concept
PROP	::=	properties on the concept attributes

The language to Dynamic Deontic Logic

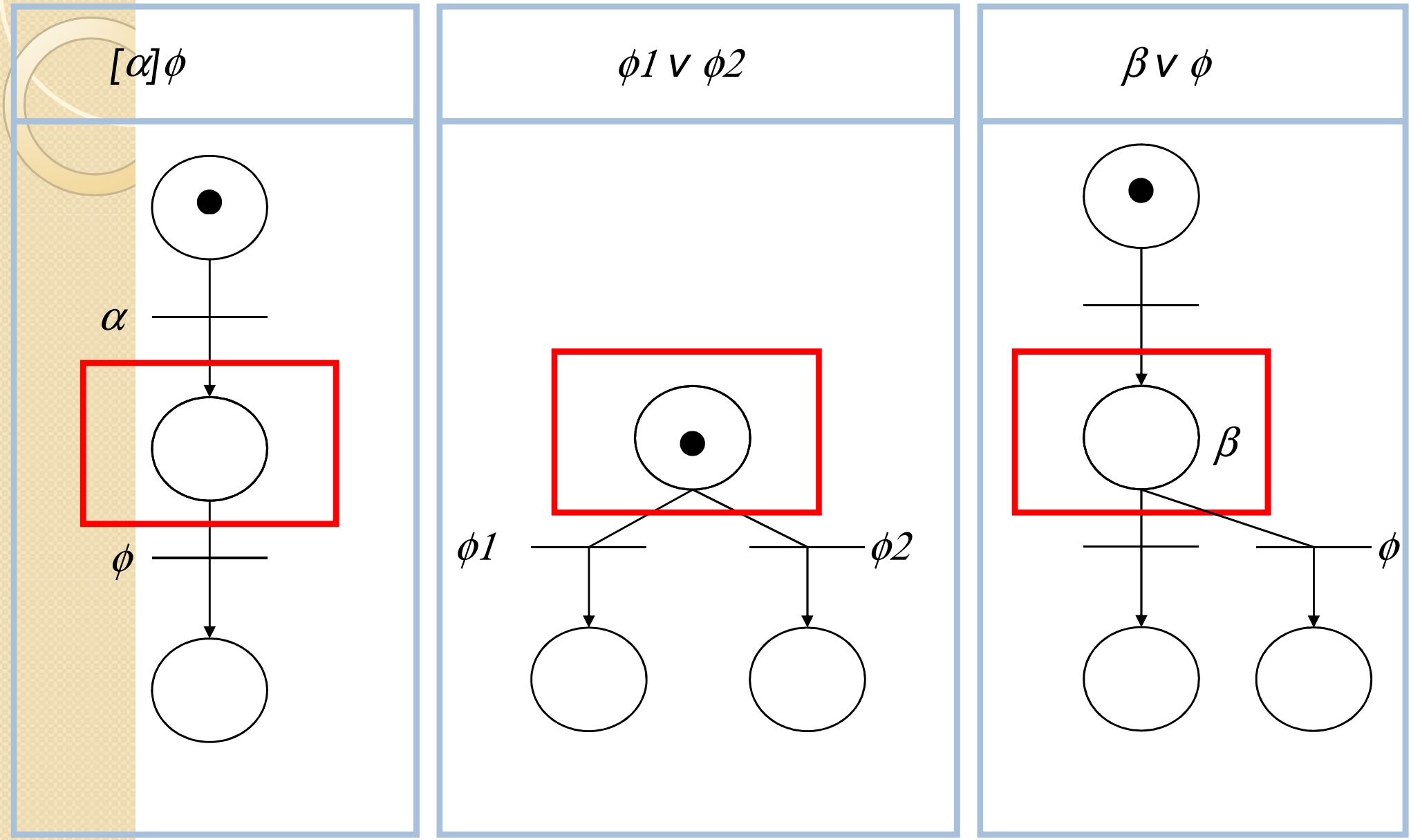
Correspondence between the language and the DDL Dynamic Deontic Logic [Meyer88]

FORBIDDEN α	F α
FORBIDDEN $\alpha 1$ BEFORE $\alpha 2$	F $\alpha 1$ v DONE($\alpha 2$)
OBLIGED $\alpha 1$ BEFORE $\alpha 2$	O $\alpha 1$ v ¬ DONE($\alpha 2$)
ϕ AFTER γ	[γ] ϕ
ϕ IF β	β –> ϕ
γ THEN α	γ ; α
γ AND α	(γ ; α) U (α ; γ)
ϕ + *sec*	γ v done(time(sec))

The basic Petri nets

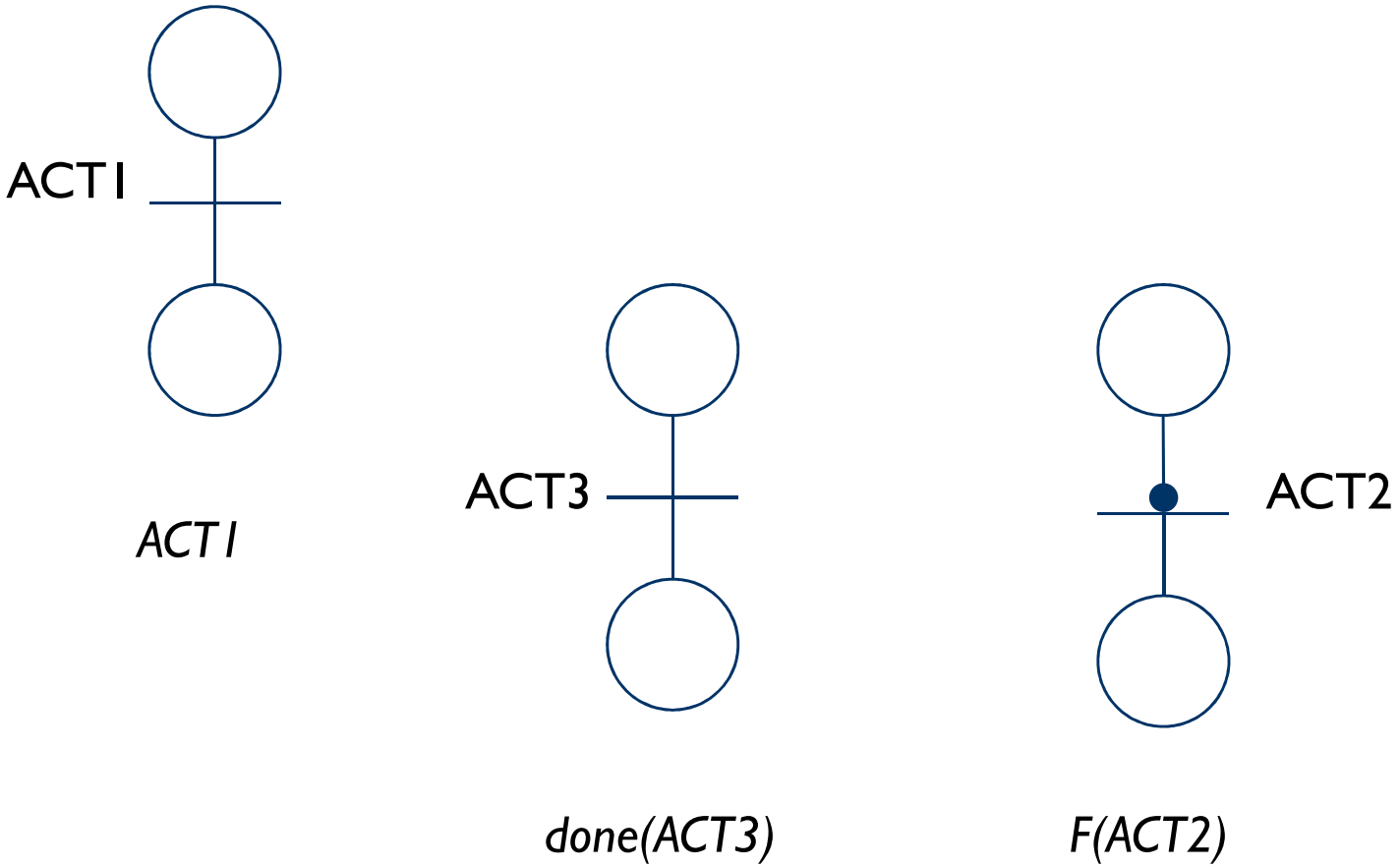


The rules of merging



An example of generation

- FORBIDDEN (ACT2) AFTER (ACT1) BEFORE (ACT3)
  - [ACT1](done(ACT3) v F(ACT2))



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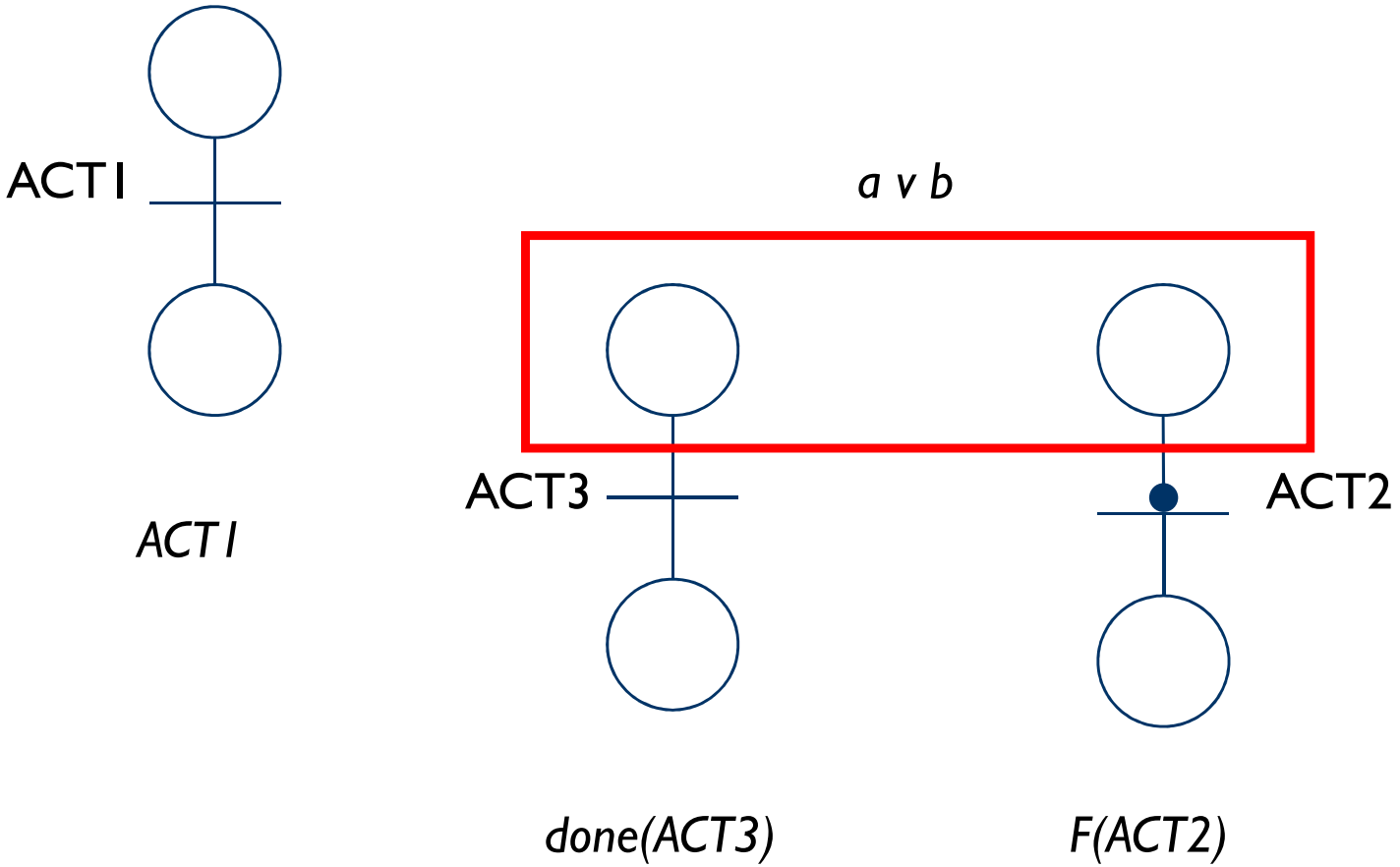

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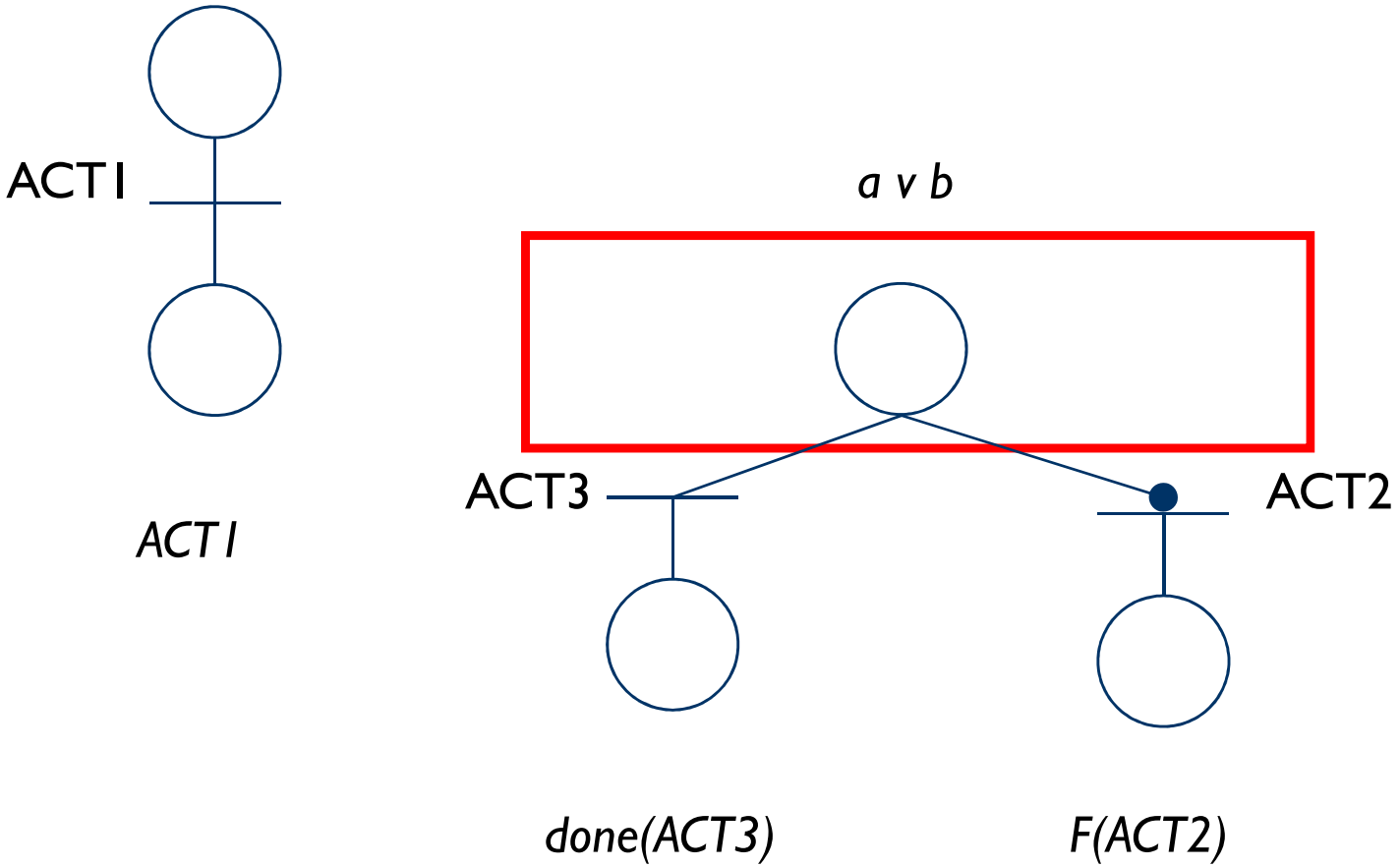

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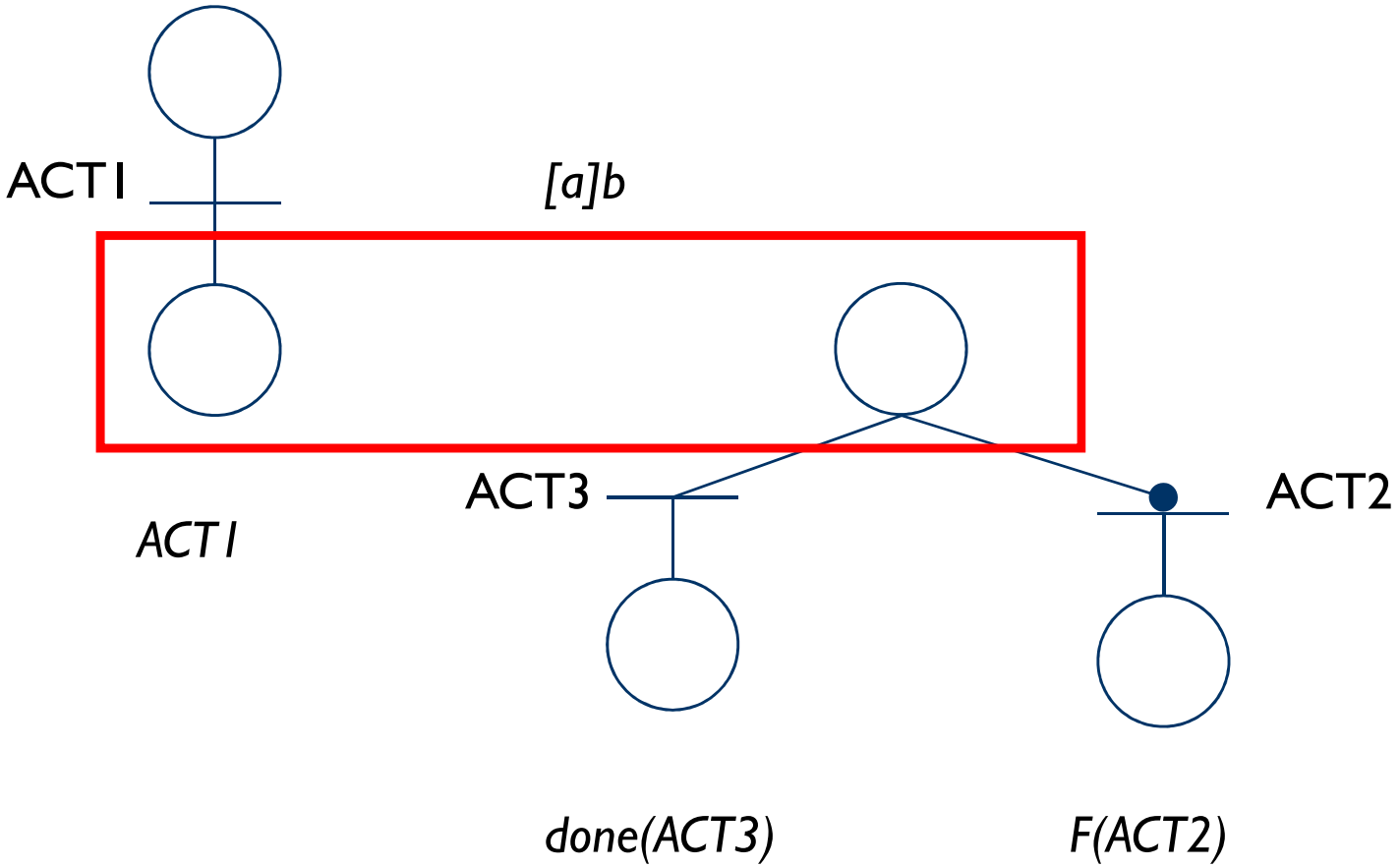

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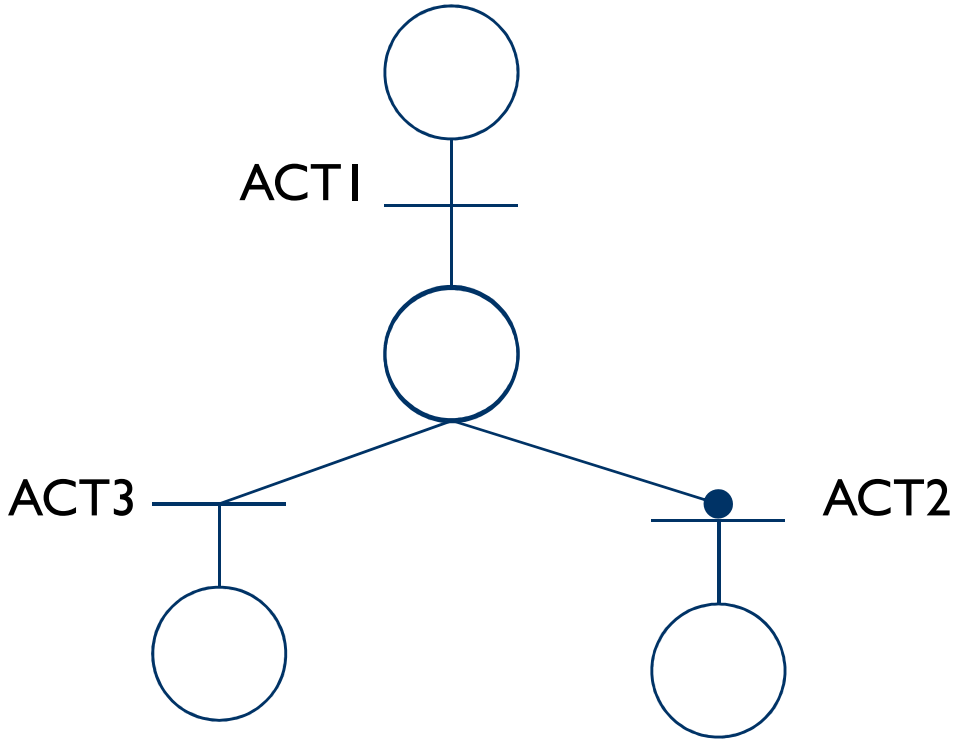
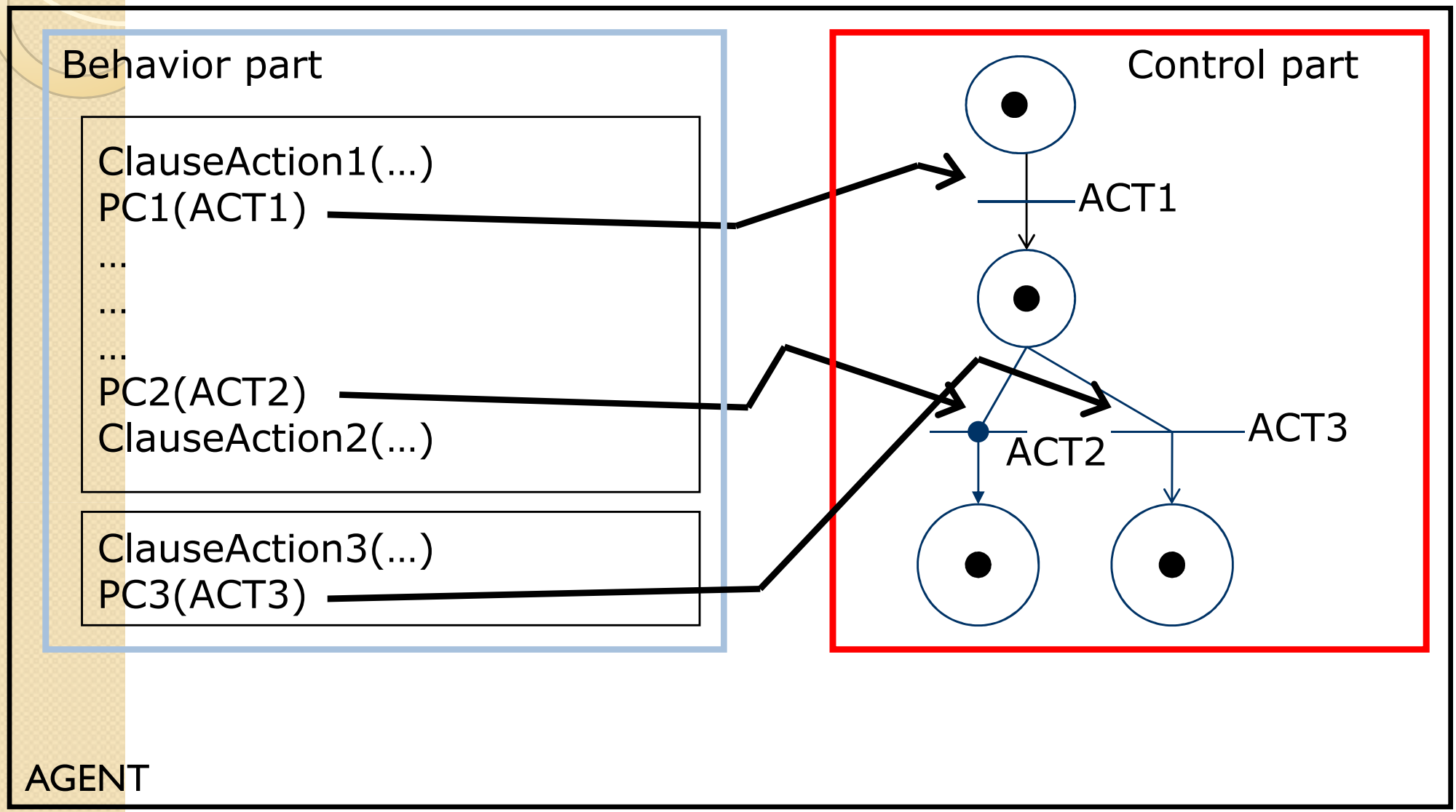


An example of violation detection

FORBIDDEN (ACT2) after (ACT3) before (ACT3).



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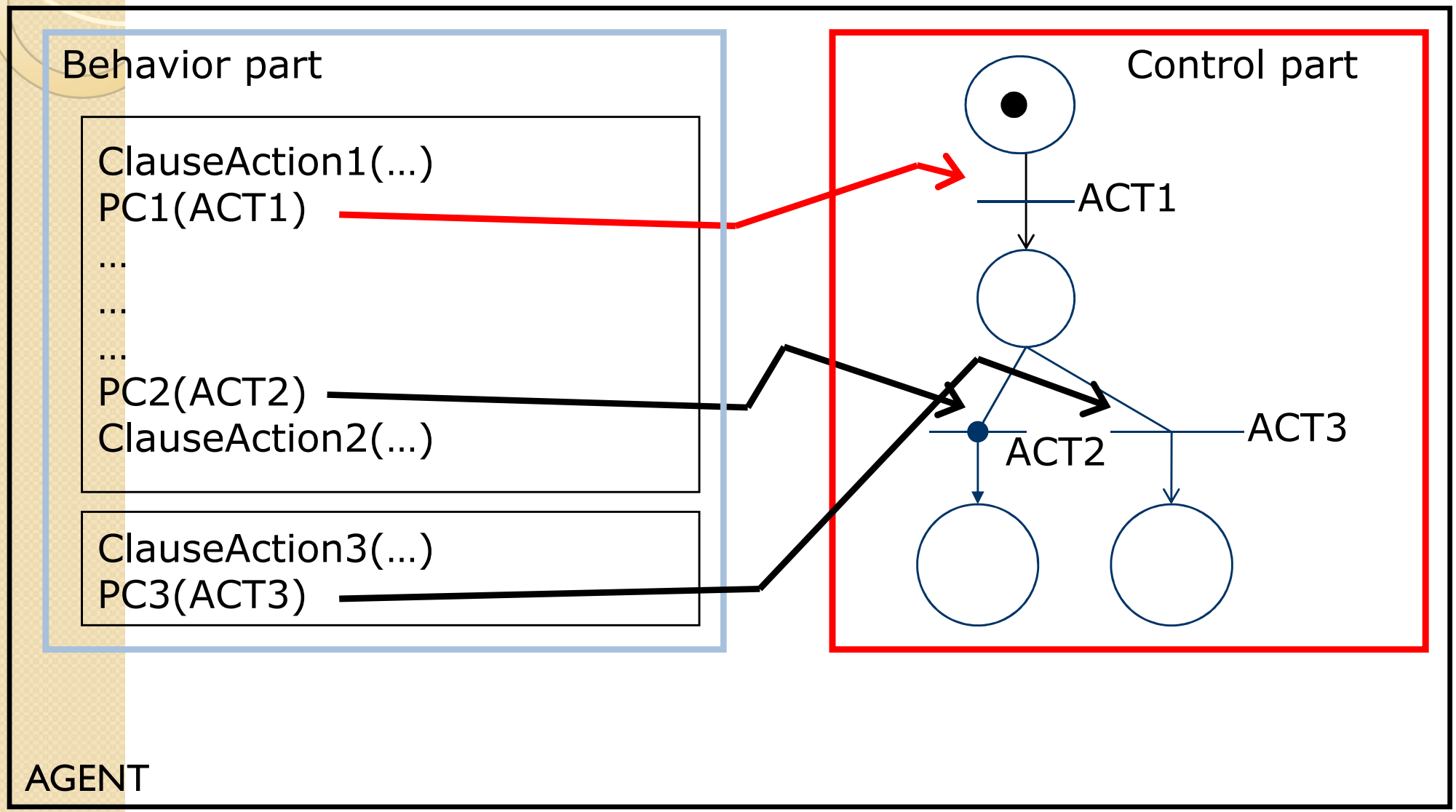

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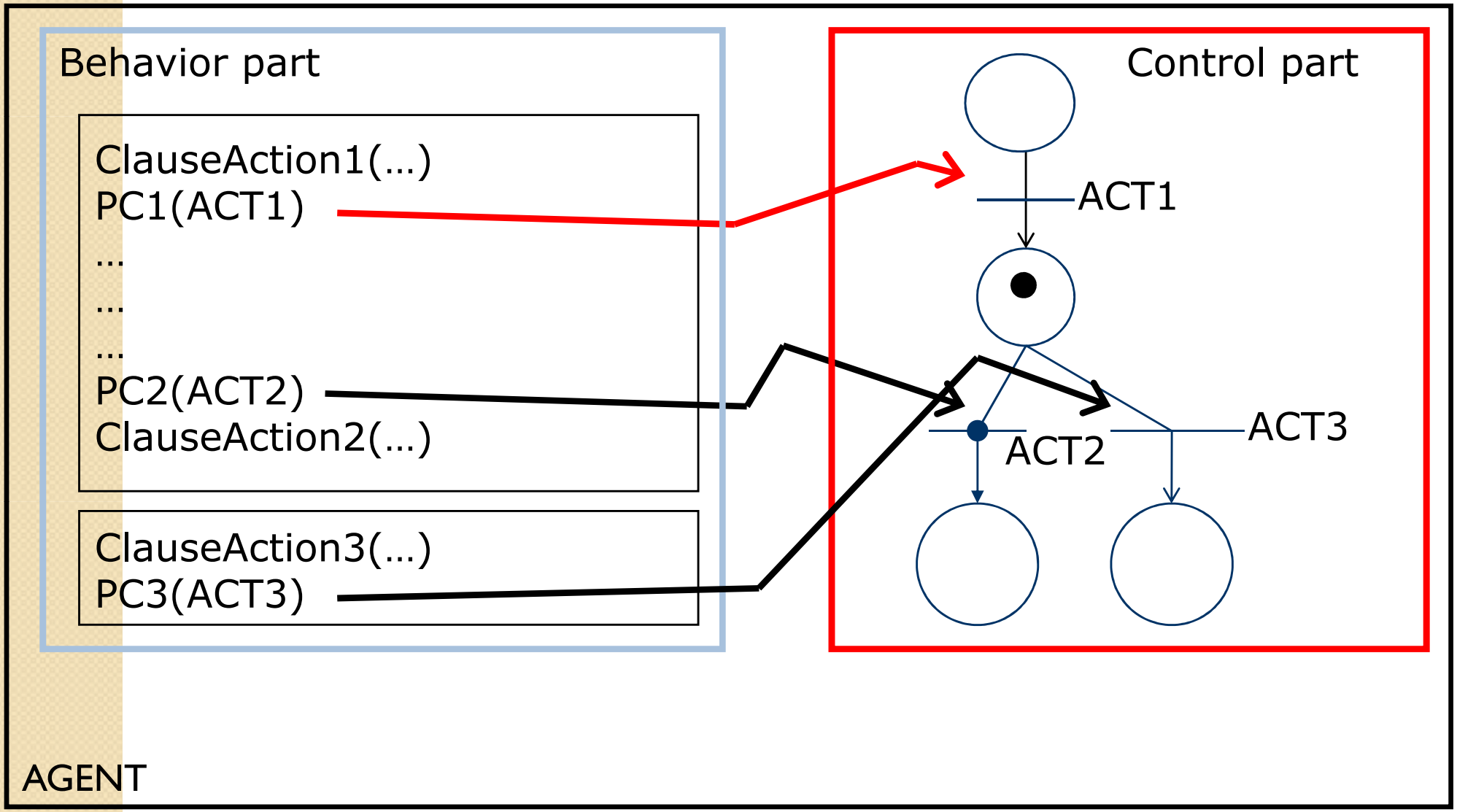

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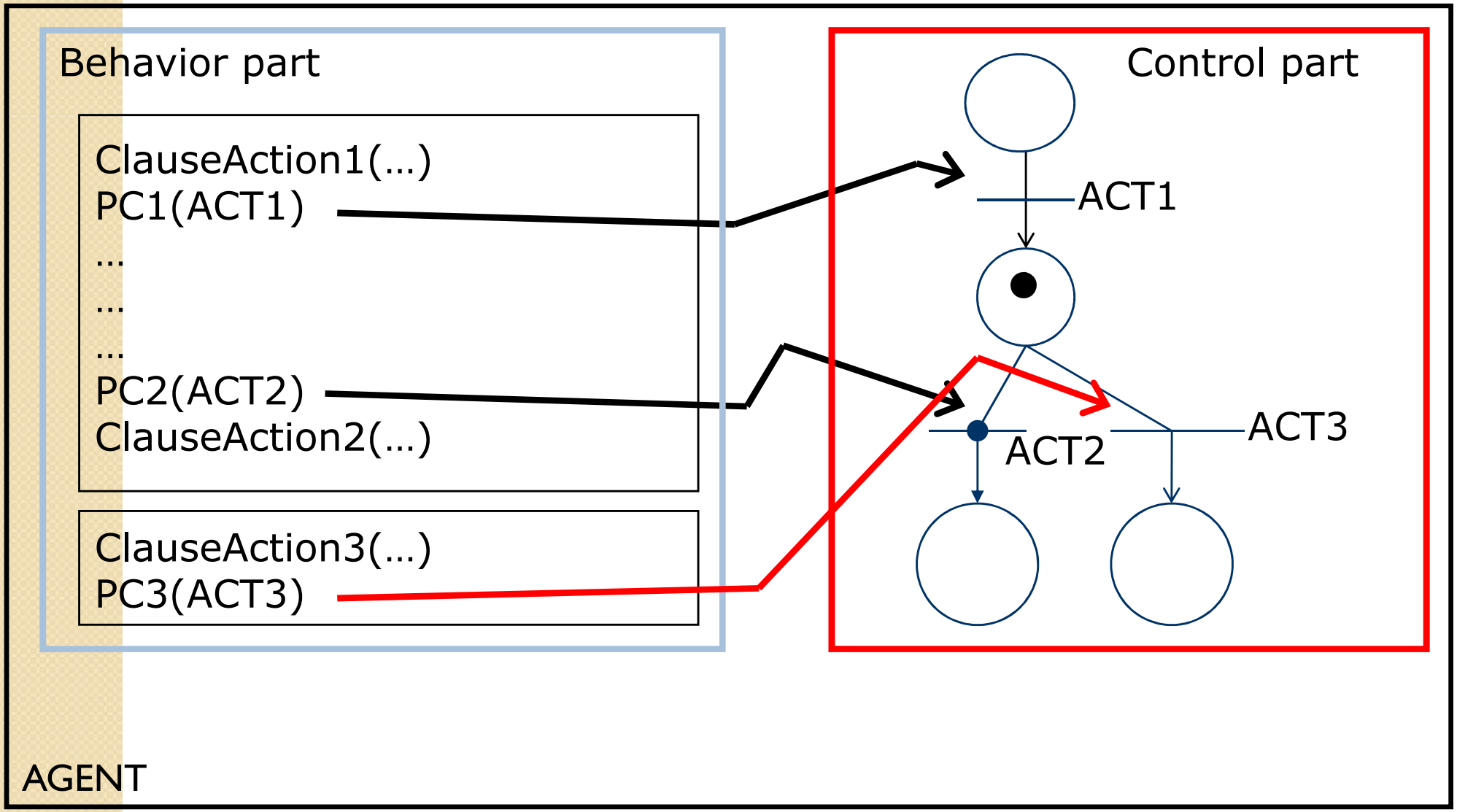

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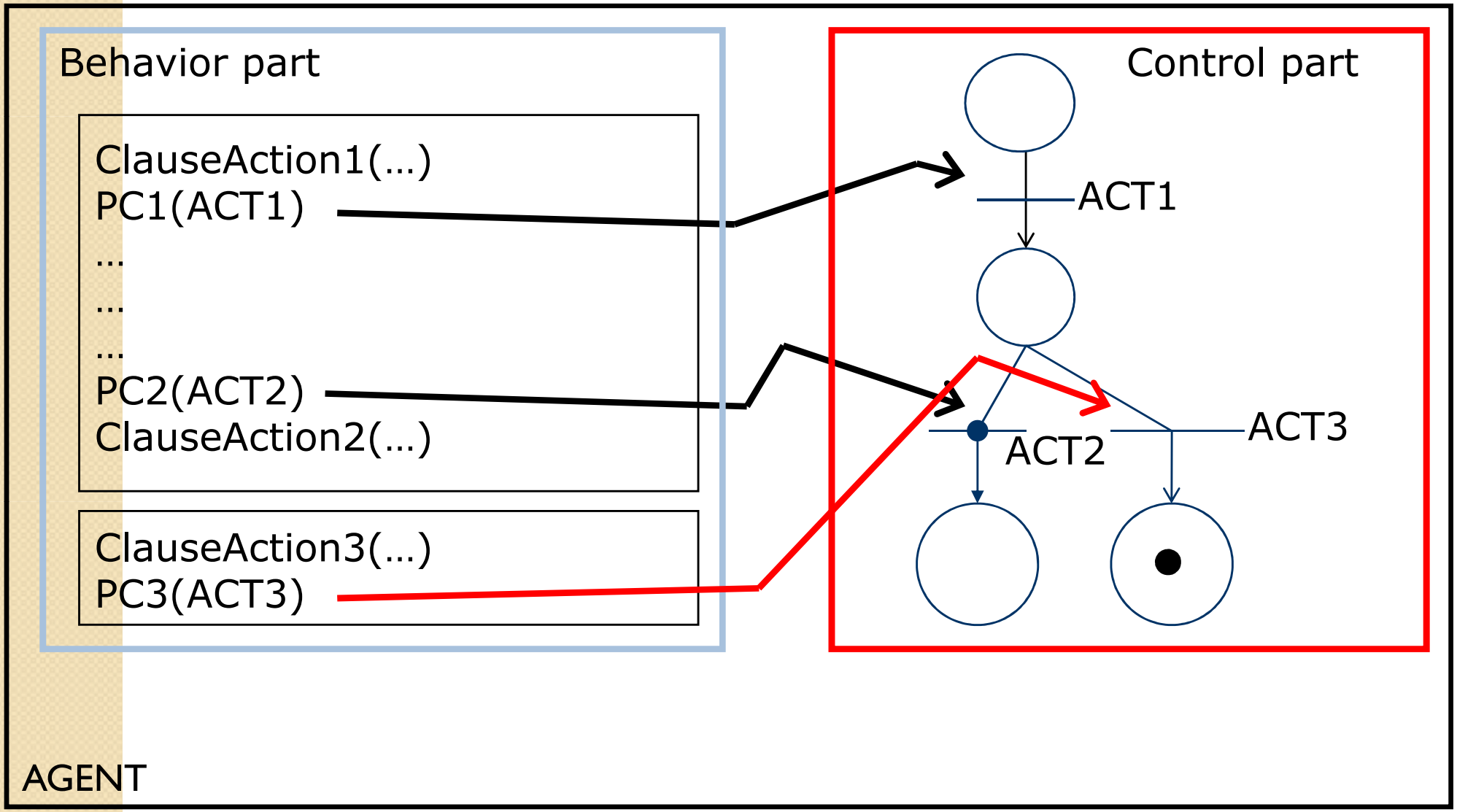

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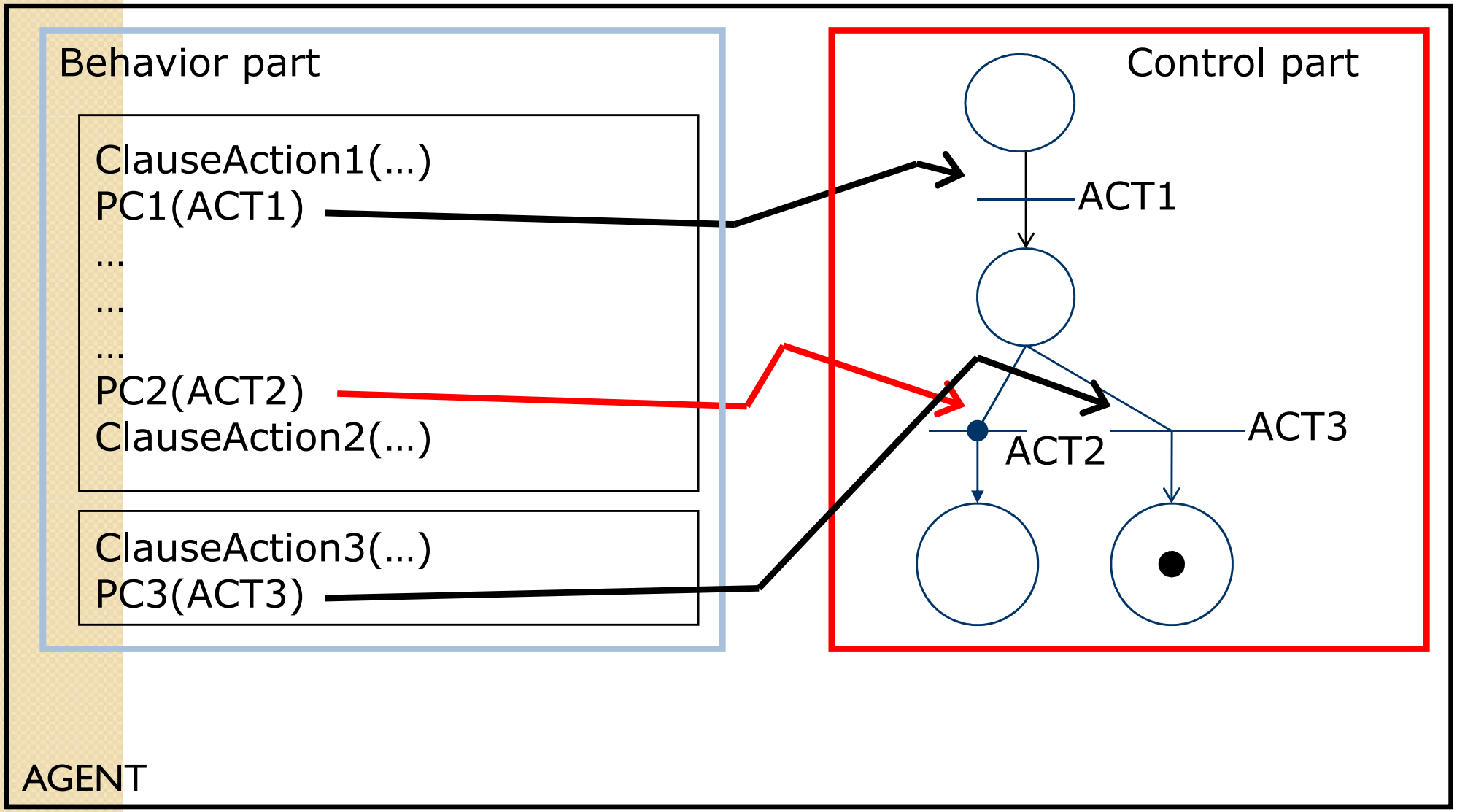

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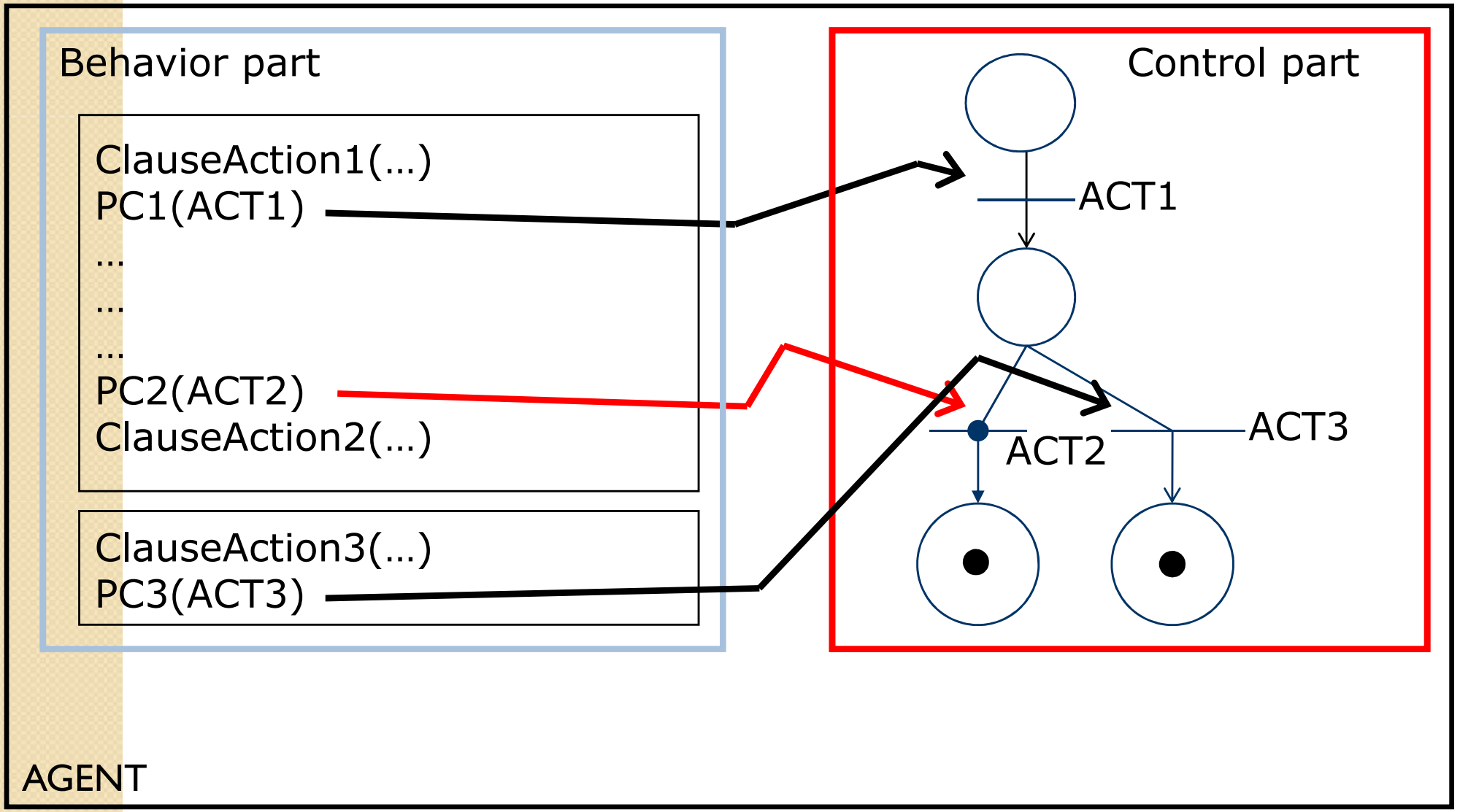

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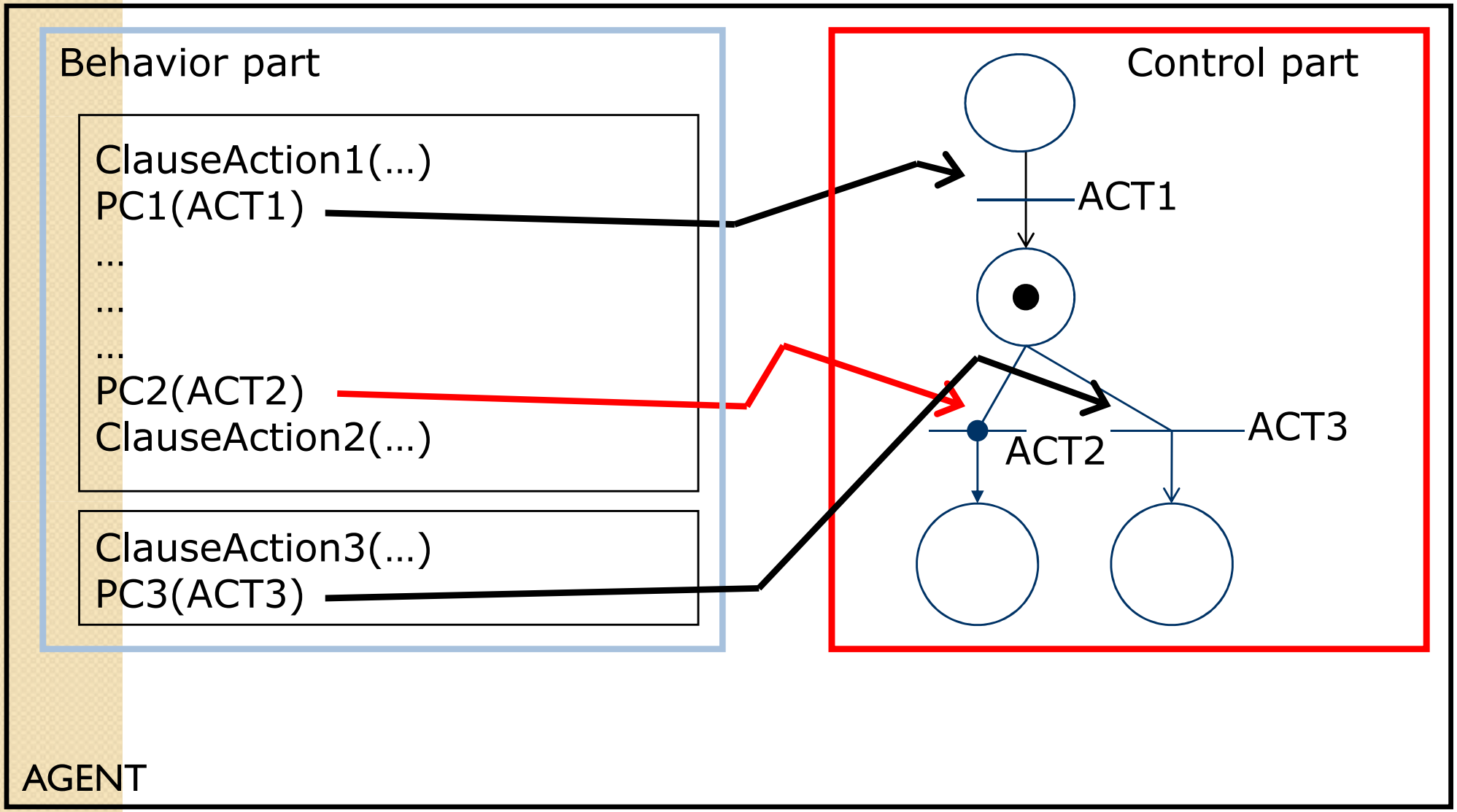

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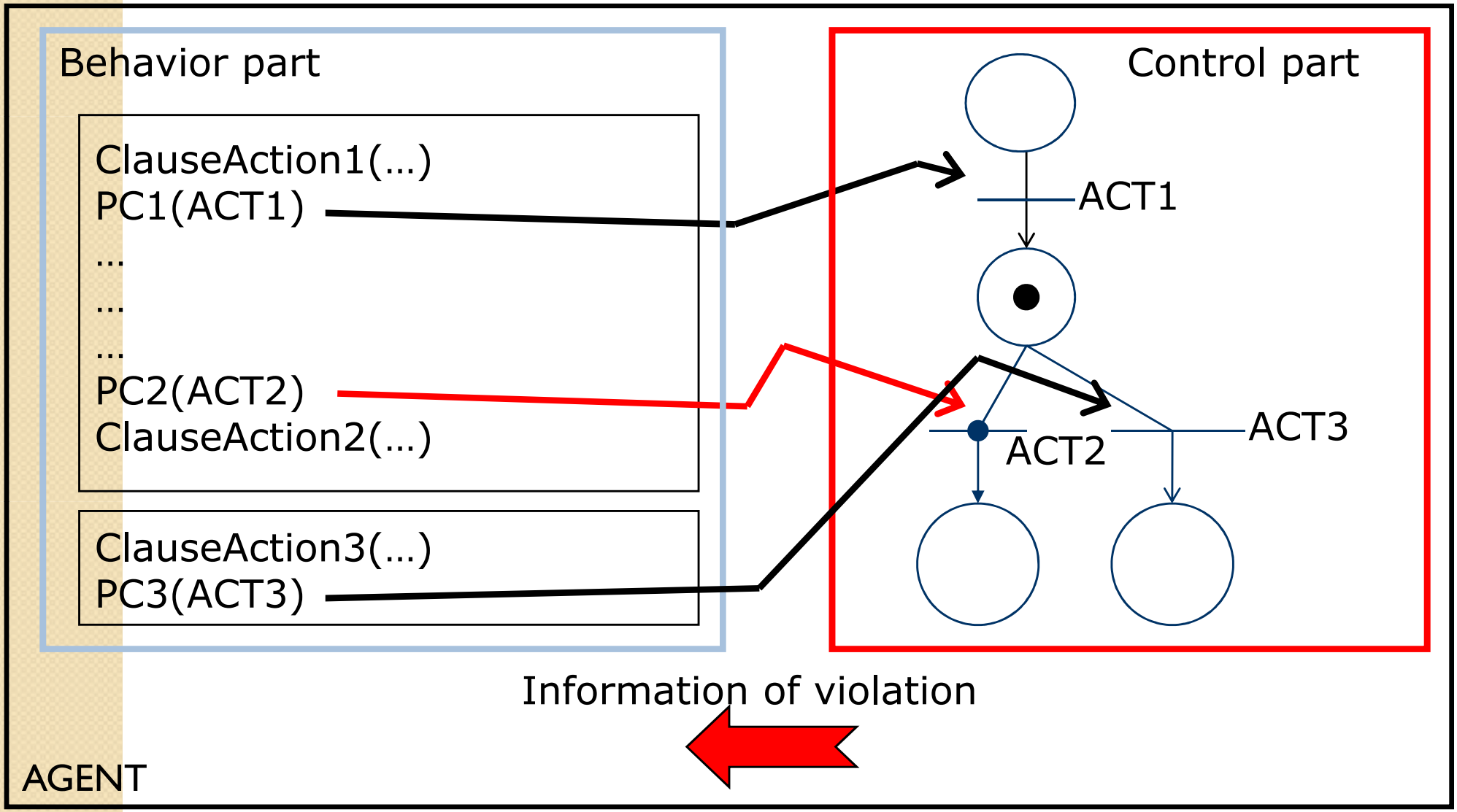
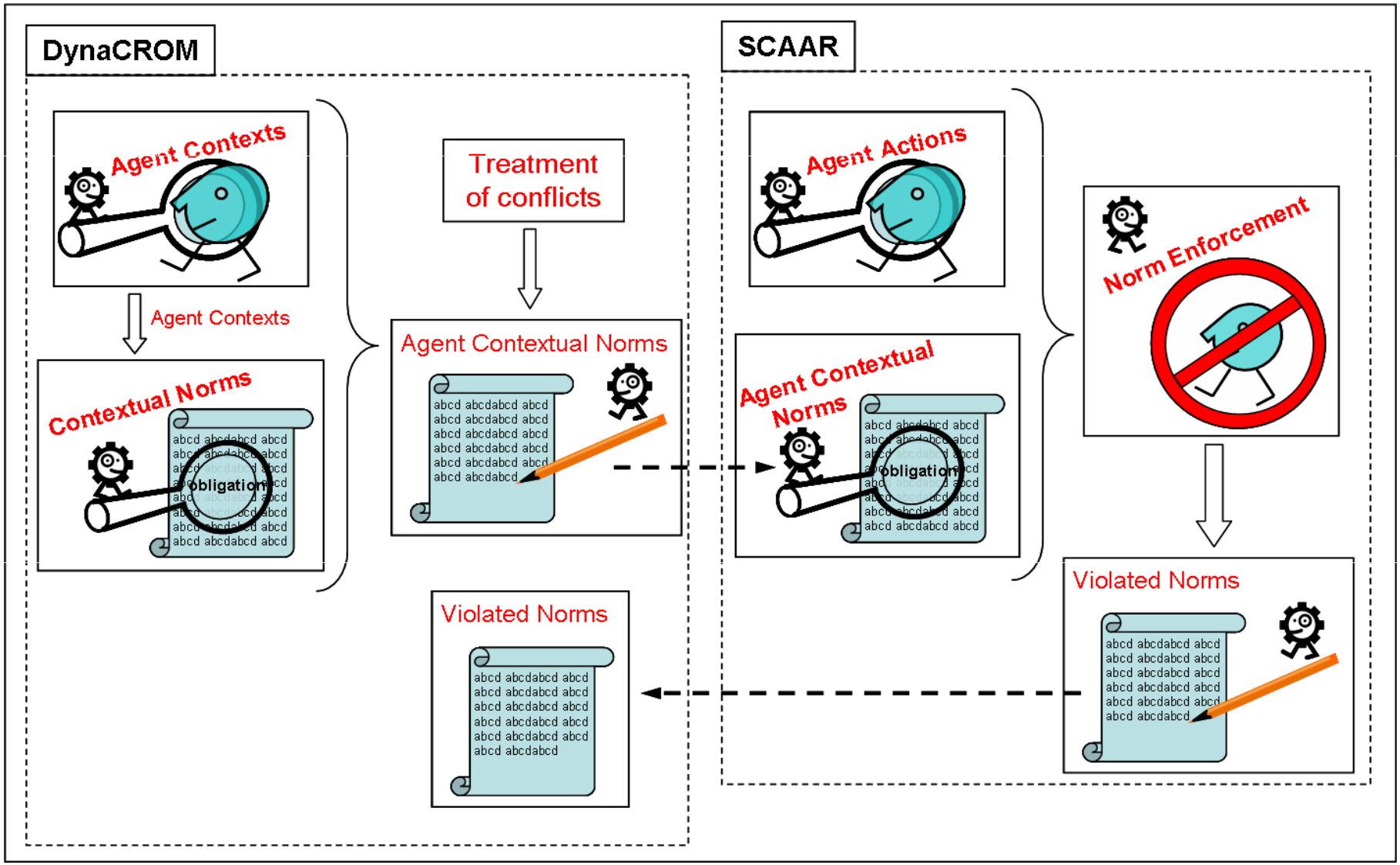


DYNACROM AND SCAAR COMBINATION

Working together



An example (1) - Context

An American manufacturer wants to build a computer

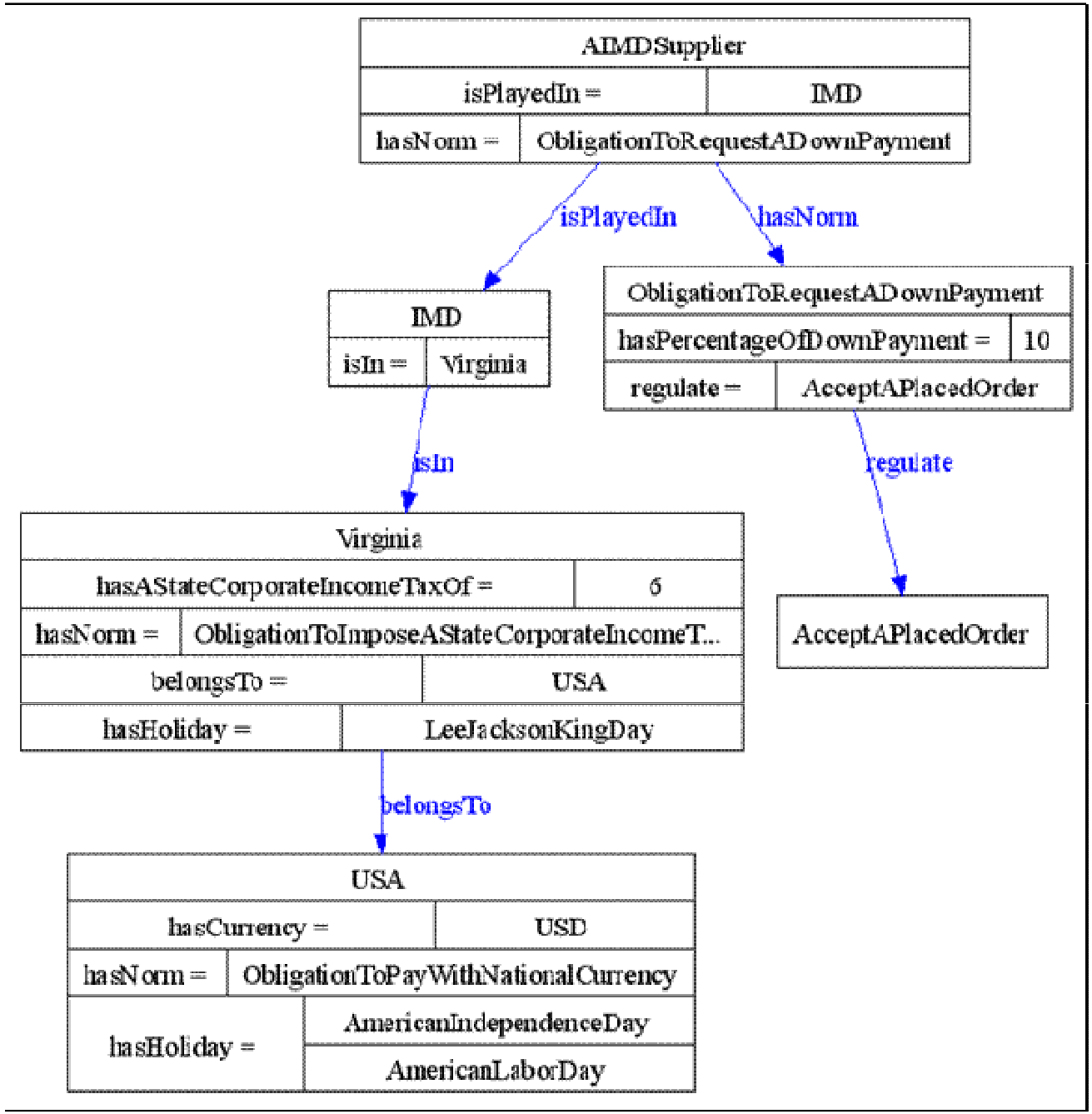
Computer components' information

Description	Base price (USD)	Supplier
Pintel CPU	750	Pintel
IMD CPU	650	IMD
Pintel Motherboard	350	Macrostar
IMD Motherboard	300	Basus
Memory 2 GB	150	Macrostar
Memory 2 GB	100	Basus
Hard disk 500 GB	200	Macrostar
Hard disk 500 GB	150	Basus

Multinational supplier organizations

Organization	Country	State
Pintel	USA	Missouri
IMD	USA	Virginia
Basus	Japan	Osaka
BasusUSA	USA	California
Macrostar	China	Shanghai
MacrostarJapan	Japan	Hiroshima

An example (2) – DynaCROM norms



An example (3) – SCAAR norms

(1) SCAARNorm1- [(agt: aGenericAgent)
(2) OBLIGED(agt DO PayWithNationalCurrency
(3) WITH environment.hasCurrency = agtInformedCurrency)
(*USA*).hasCurrency = *USD*)
USD = *USD*
(4) IF (agt BE in Environment WITH
(5) ((environment = agtInformedEnvironment) OR
(6) (environment.belongsTo = agtInformedEnvironment))]
USA = *USA*

(1) Rule1- [ruleForEnvWithOEnvNorms:
(2) hasNorm(?Env,?OEnvNorms)
hasNorm(*Virginia*, *ObligationToPayWithNationalCurrency*)
(3) <- hasNorm(?OEnv,?OEnvNorms),
hasNorm(*USA*,*ObligationToPayWithNationalCurrency*)
(4) belongsTo(?Env,?OEnv)]
belongsTo(*Virginia*,*USA*)

Conclusion

- Decrease the complexity of norms management in MAS
  - Decoupling information in Contexts
- The DynaCROM solution
  - Application of contextual norms
  - Management regulation in MAS
- Main Contributions
  - Top-down classification for contextual norms
  - Contextual normative ontology
  - Norm composition process
- Enforcement mechanism
  - Currently, the SCAAR framework
  - DynaCROM is not tightly coupled with a particular enforcement mechanism

Questions ?

THANKS FOR YOUR ATTENTION