Risk management in dynamic logistic systems by agent based autonomous objects

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Agenda

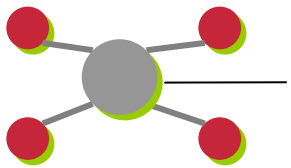
- Motivation: Effects of Autonomy
- Problem: Risk in and through Autonomy
- Approach: Risk Management
- Architecture of Application
- Concluding Remarks

Effects of Autonomy

Autonomy leads to...

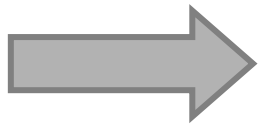
...a transfer of responsibility and competencies of decisions from a central instance to the autonomous objects

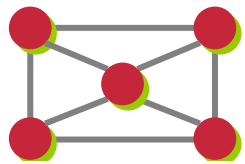
...different ways of communication and exchange of information



Central instance for planning

Central Control





Intelligent logistic object

Autonomy

To realize autonomy in logistic processes…

Factory Agent

Transport Agent

will be represented by:

Storage Agent

Package Agent

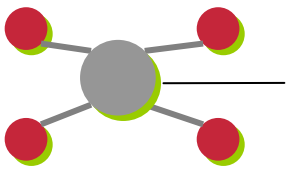
Central Intelligence

will be distributed:

Management in dynamic logistic systems

- Complex and dynamic environment

- Local decision making reduces local complexity (for the individuum)
- BUT: Introducing local decisionmakers (i.e., autonomy) introduces more complexity



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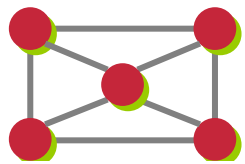


Intelligent logistic object

Autonomy

- Even harder decision making problem
- New mechanisms for decision making are needed

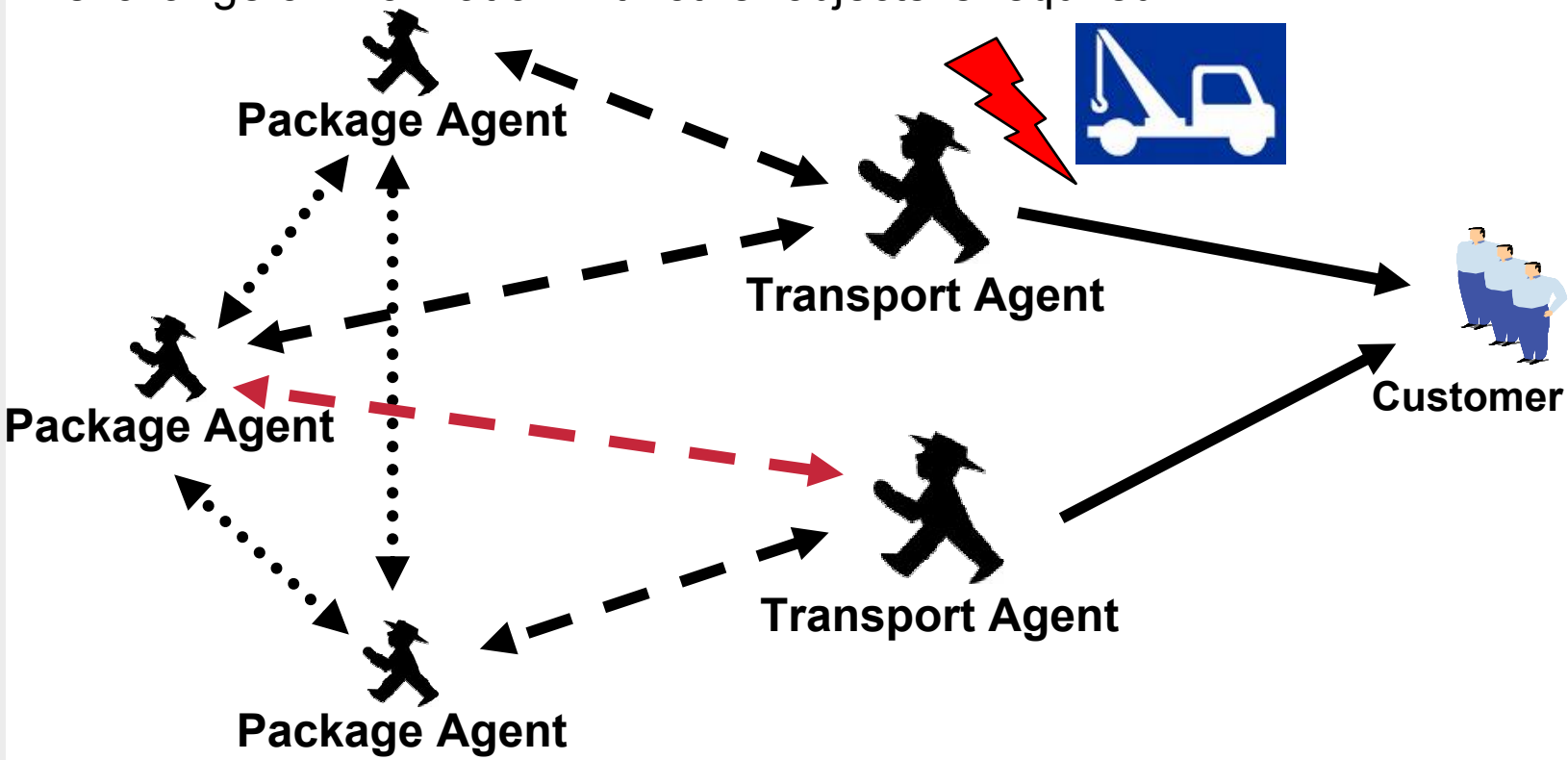
Risk Management:

The risk management with its containing parts risk identification, risk evaluation & option generation should be able to identify existing and potential risk an by establishing a relationship between the information and the goals of the logistic objects (matching of risk patterns).

Risk in and through Autonomy

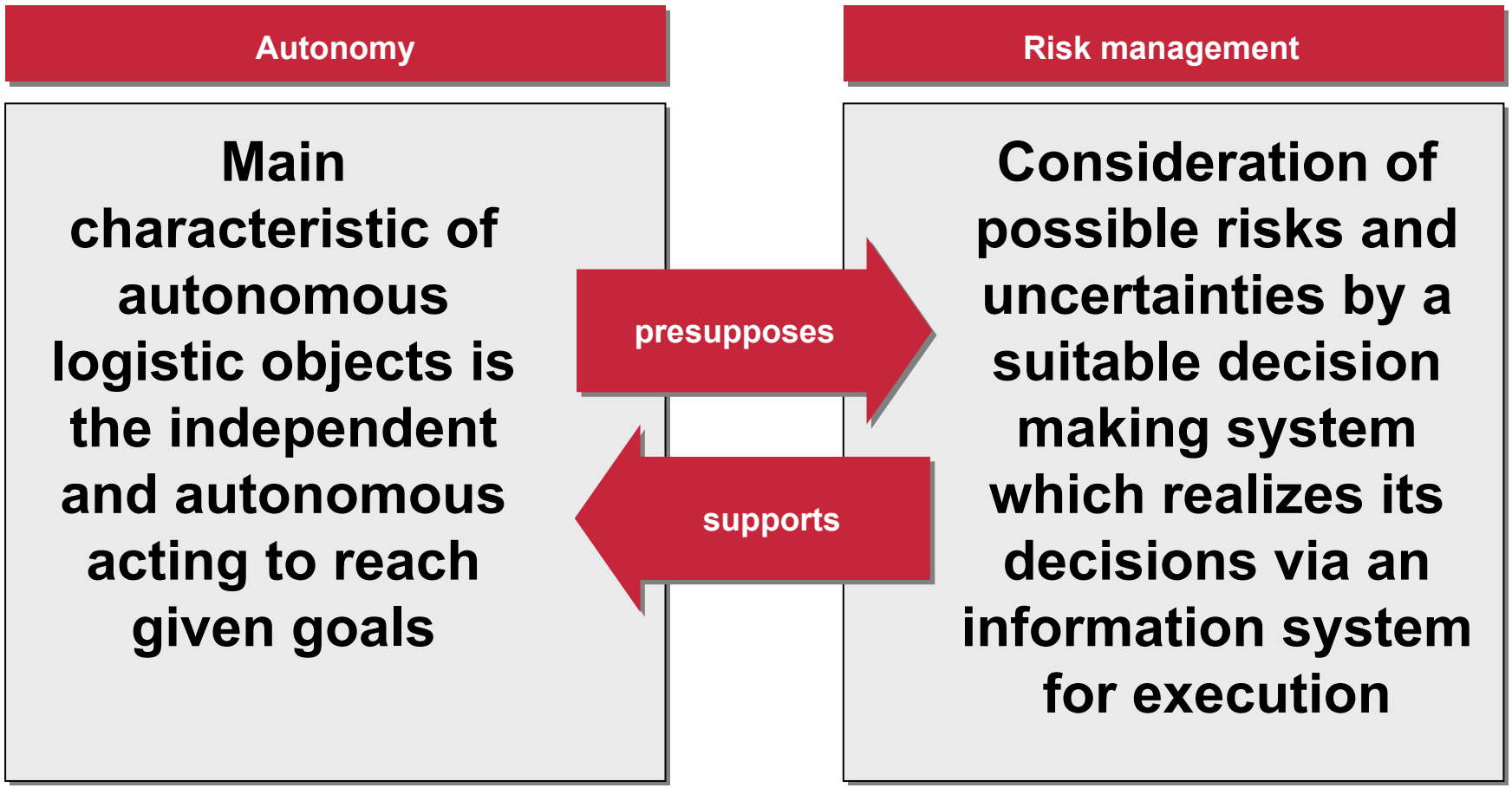
New opportunities result from autonomy:

...local changes of situations or information can be considered online, because no exchange of information with other objects is required.



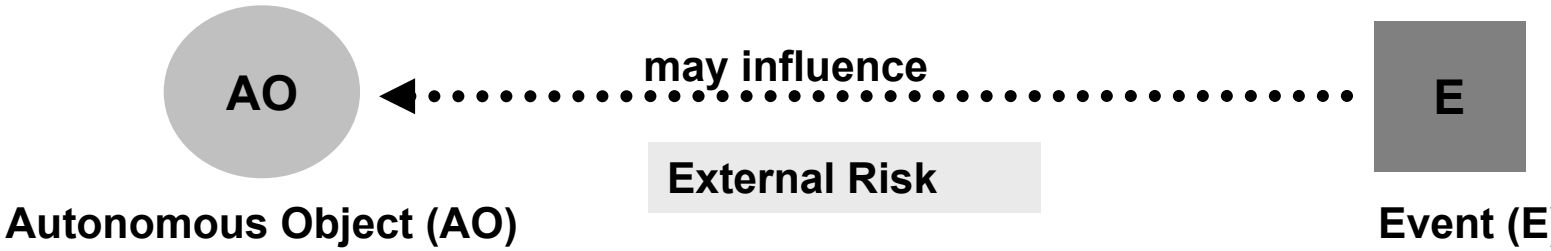
The logistic objects can faster act and react but they have to consider possible risk which may influence the success of logistic processes.

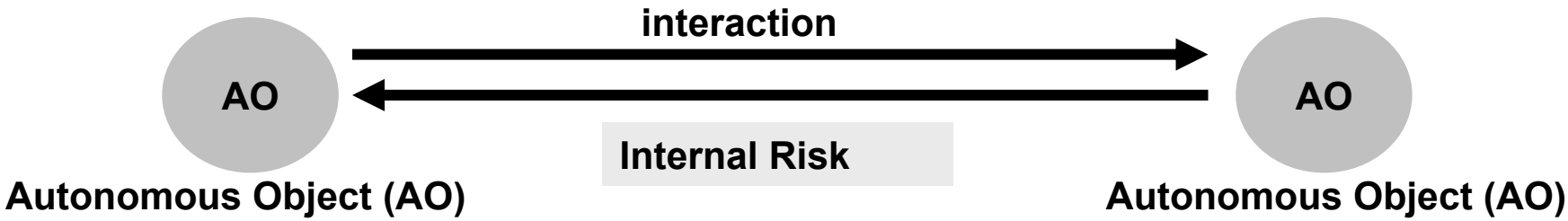
Autonomous Acting and Risk

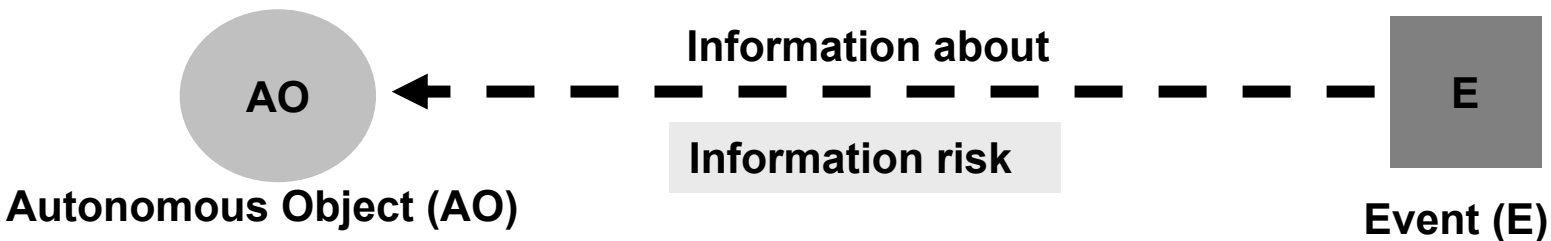


Parameters of Risk

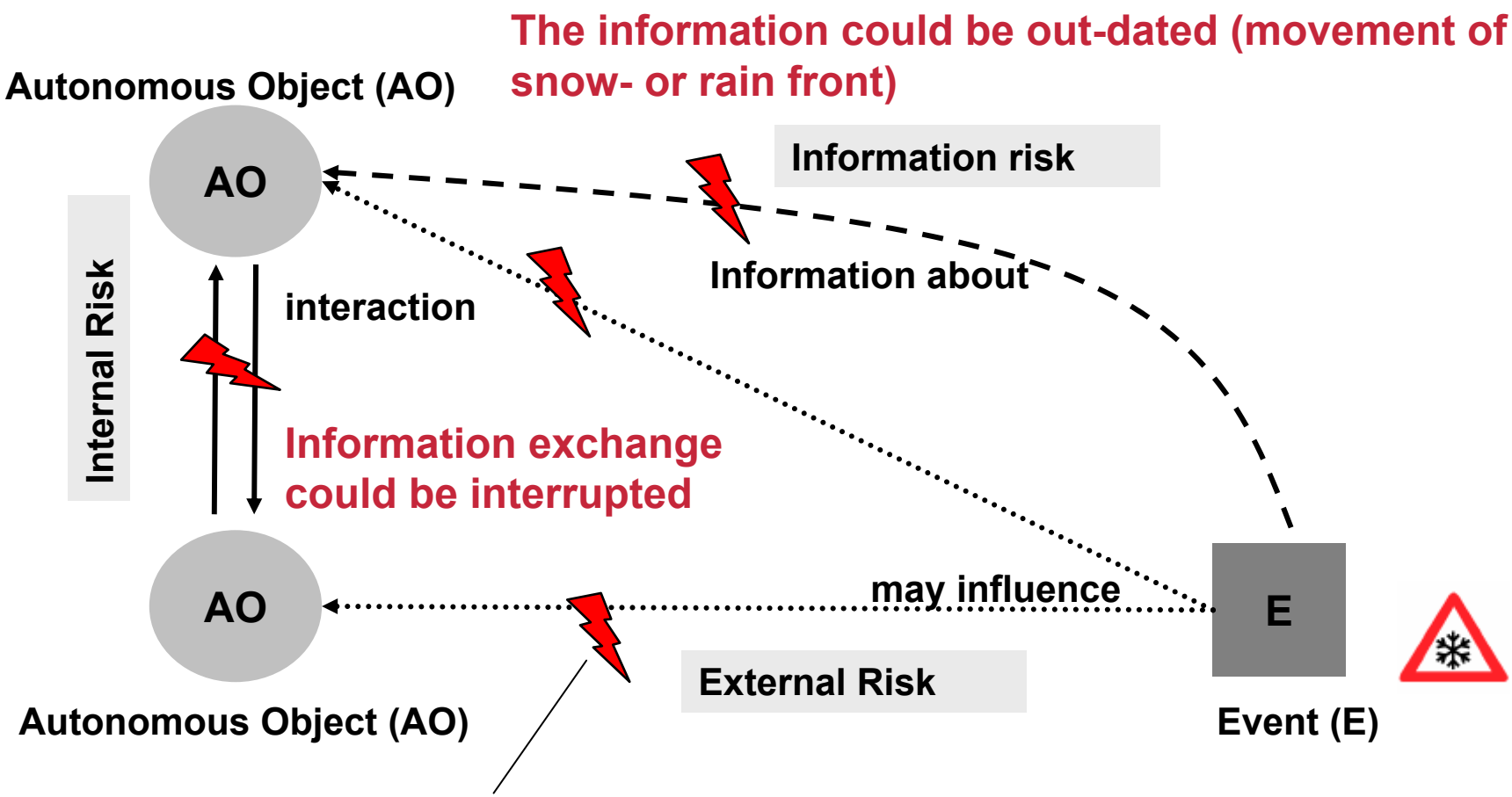
Parameters of risk which can appear in autonomous logistic processes and for autonomous objects:





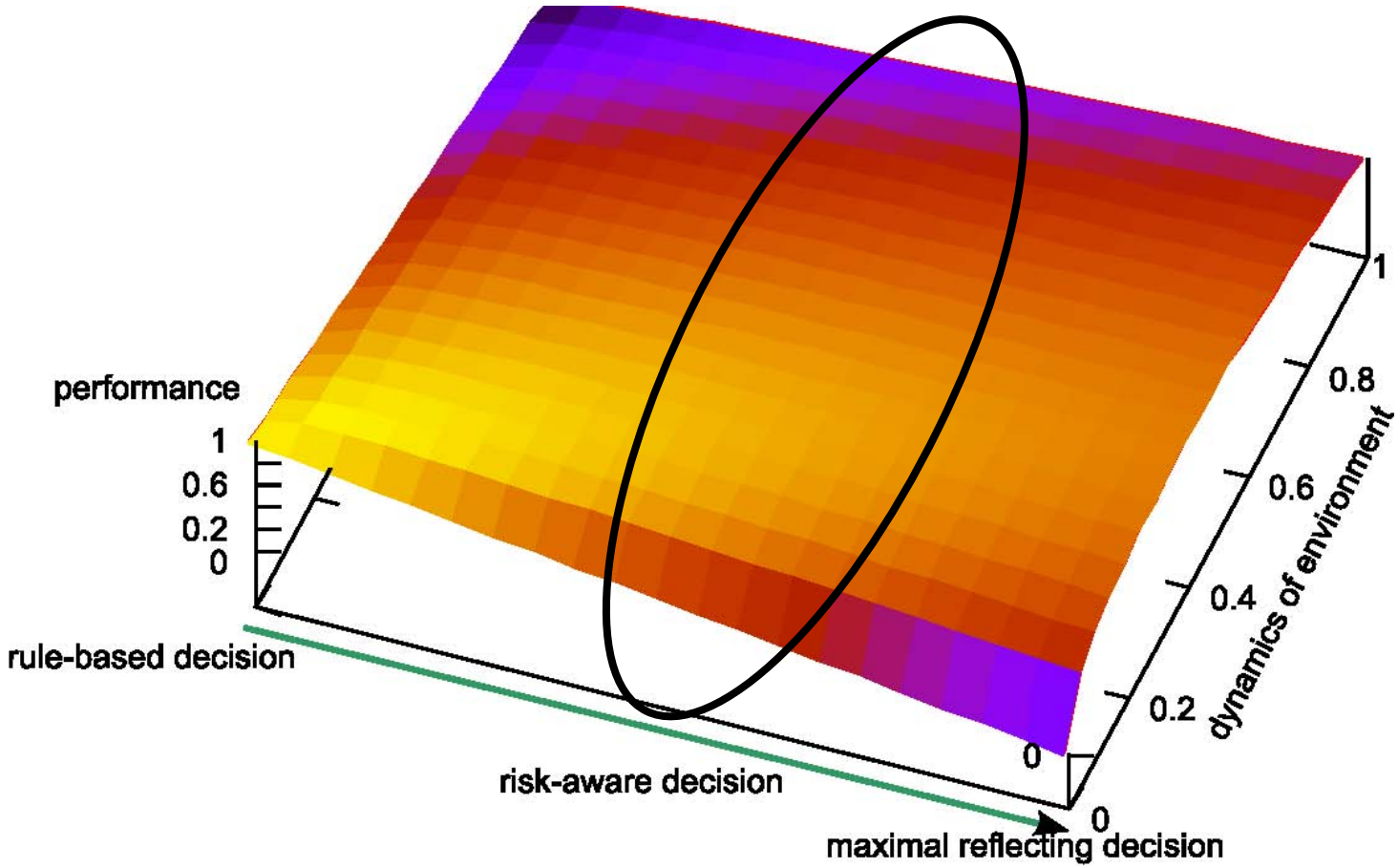


Combined Parameters of Risk

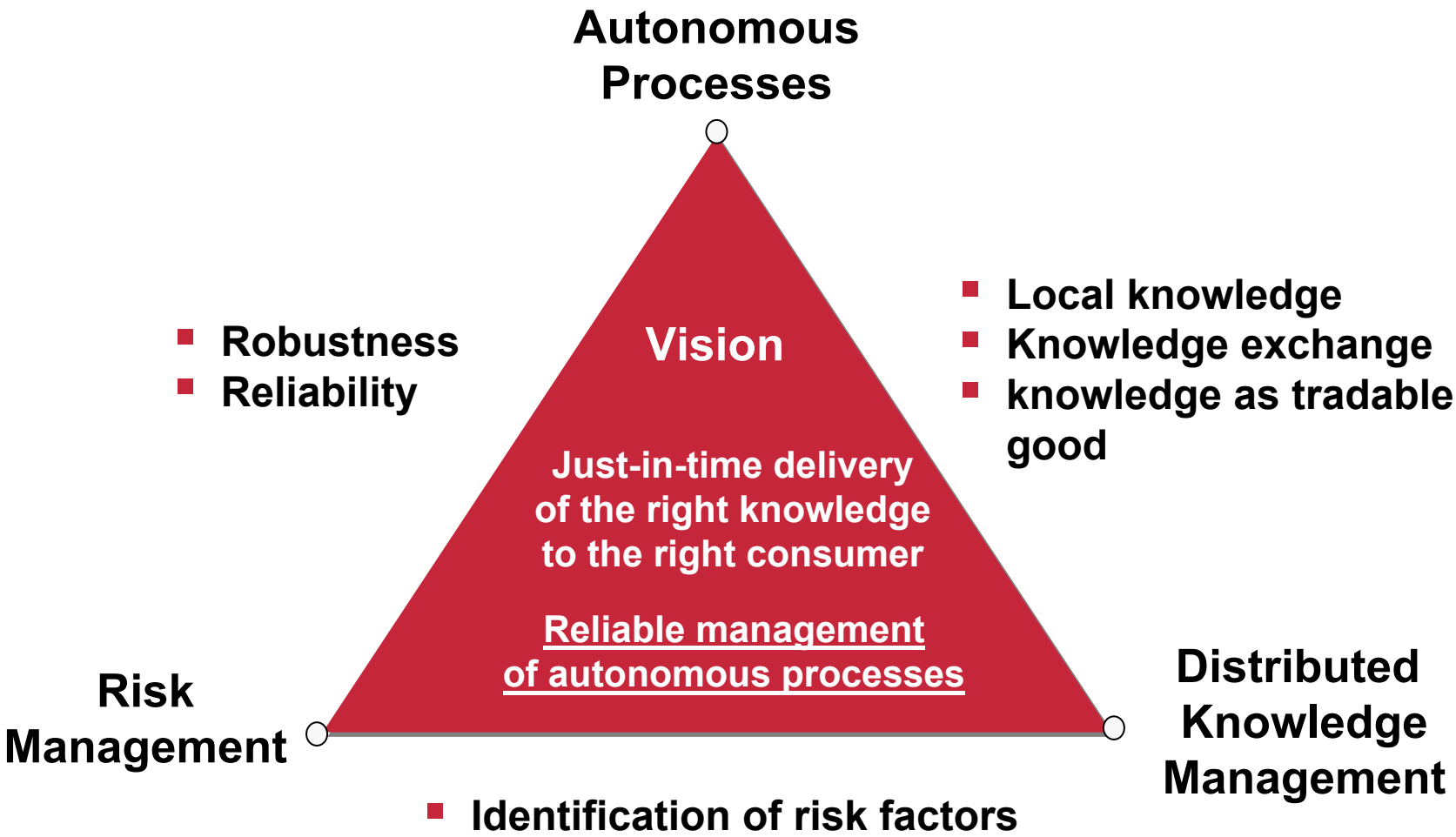


Estimated influence by risk management

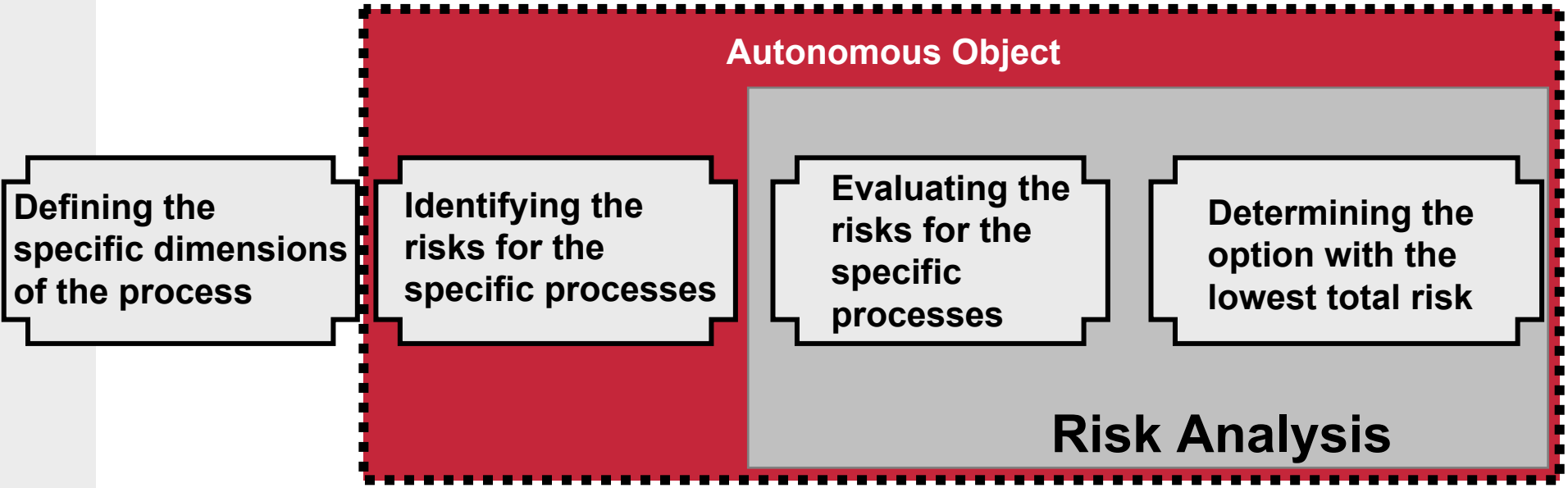
- Enabling autonomous objects to risk-aware decision making
- Managing risk in a dynamic environment



Role of Risk Management

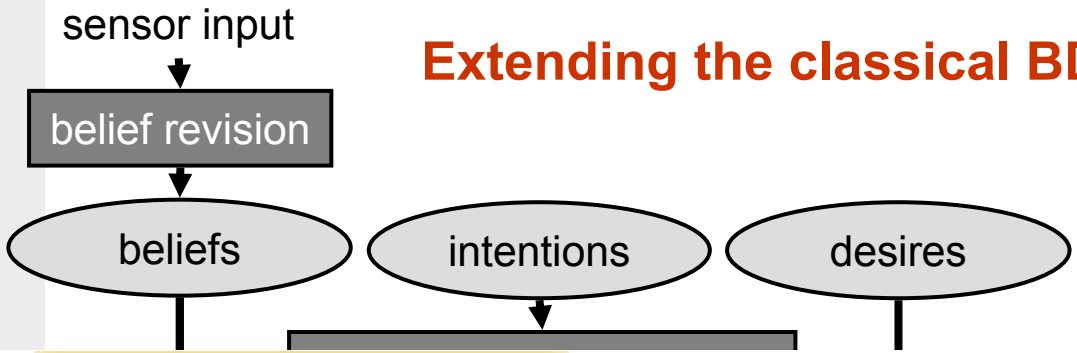


Risk Management Process



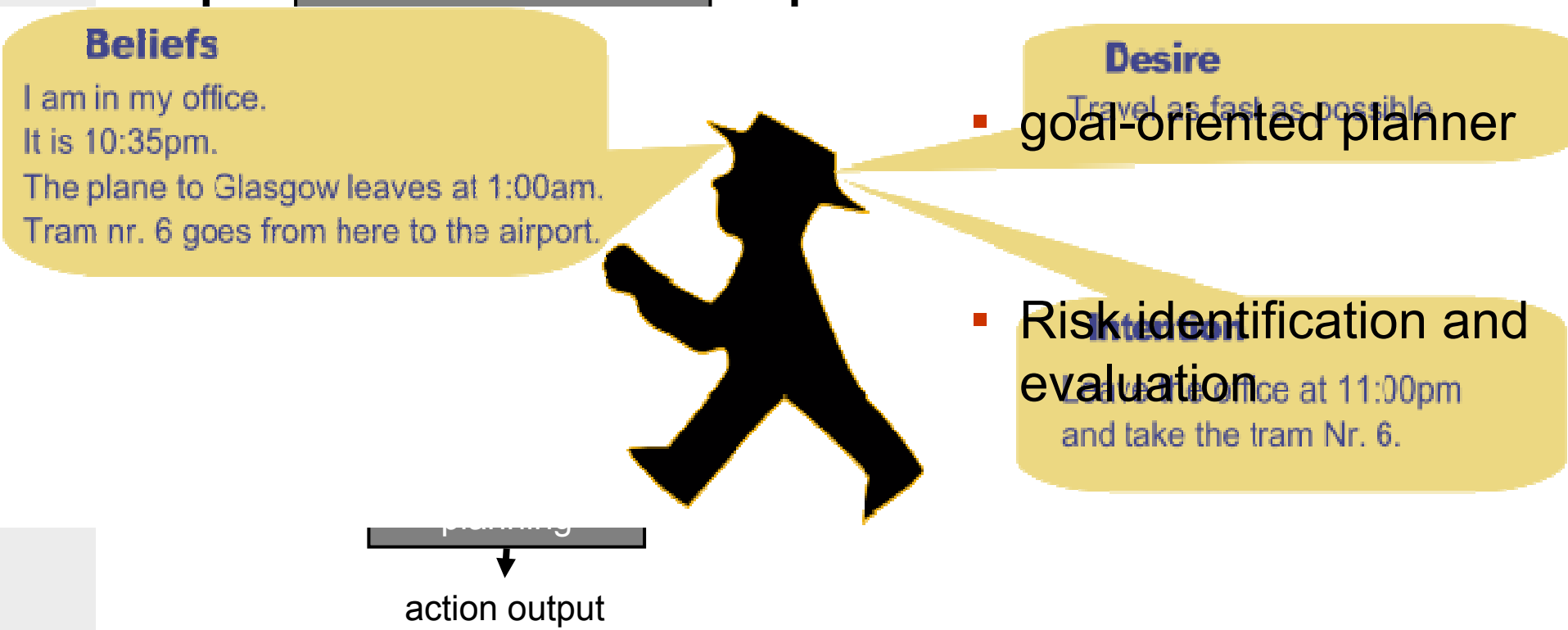
Process Goal	Risk identification	Risk evaluation	Option generation
• Delivery reliability • State of goods • Profit maximization	• Delay • Perished/ damaged goods • Hidden costs	• Risk of delay in delivery • Possible cost overrun • Damaged goods	• Alternative routes • Other production possibilities • Alternative transportation types

Architecture of planned Application



Extending the classical BDI approach

- probabilistic knowledgebase
- goal-oriented planner
- Risk identification and evaluation



Risk Identification in Possible Worlds

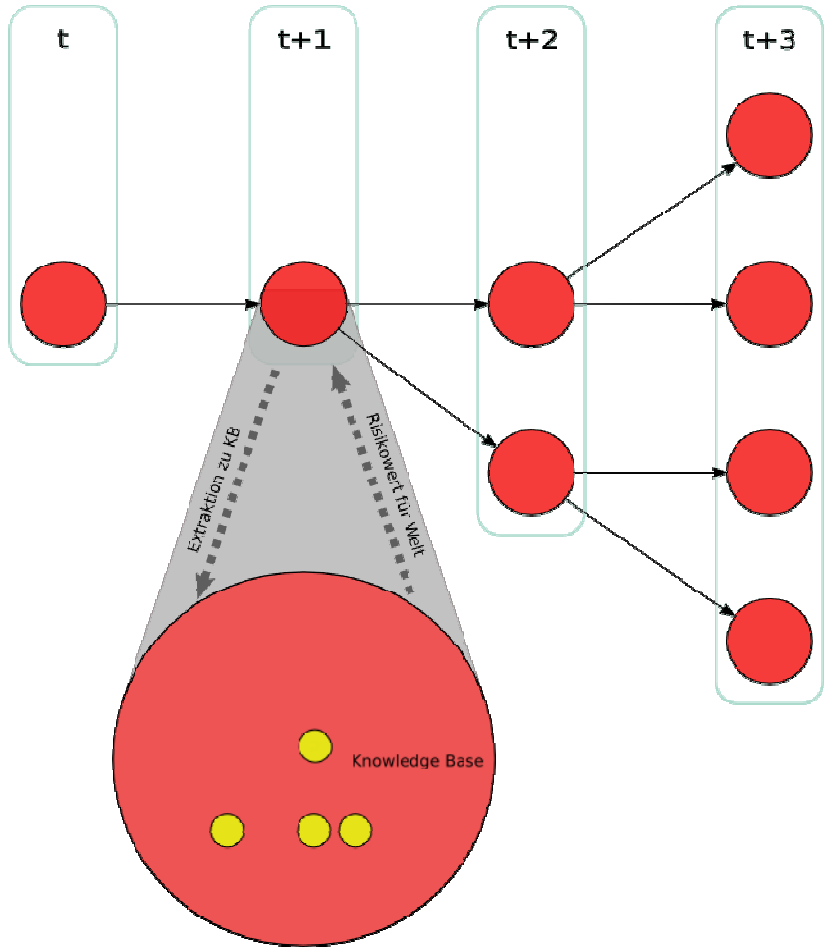
Spanning possible worlds

- t ➔ t+1 action:
  pick up a paper roll
- t+1 ➔ t+2 action:
  pull out or stay put
- t+2 ➔ t+3 event:
  rain starts falling

Risk Identification in Possible Worlds

Extraction of state-variables

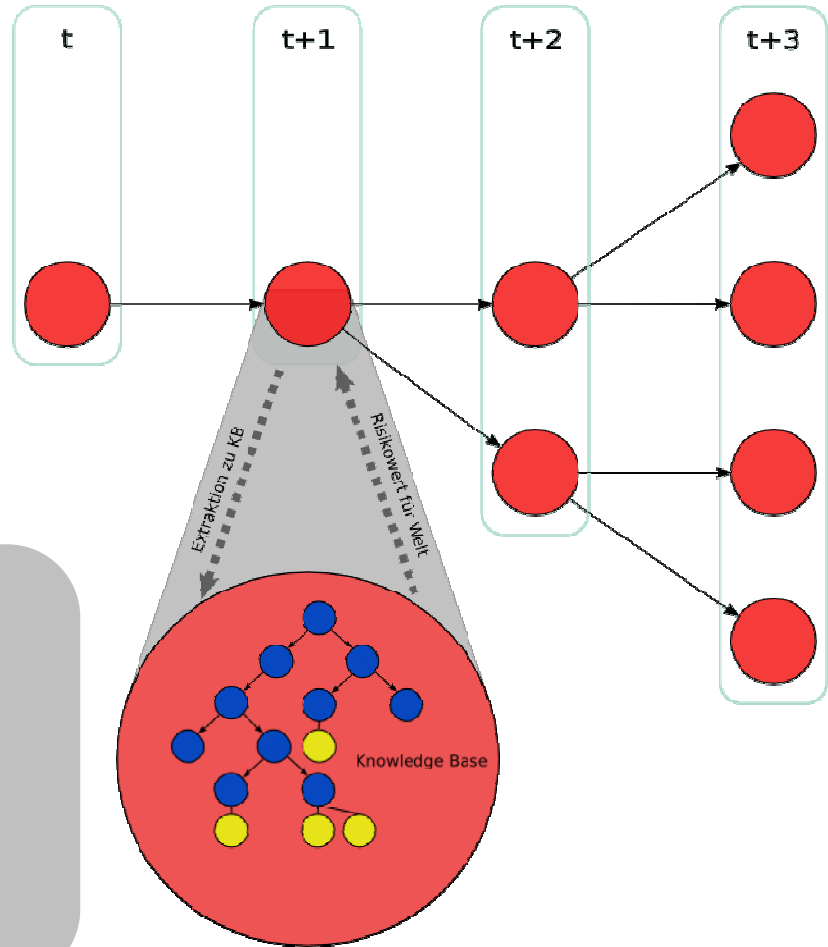
- load:
  paper-roll
- environment:
  pier 14, ramp C
- humidity:
  high
- floor condition:
  wet



Risk Identification in Possible Worlds

Identification of risk

- state extraction of possible world
- application of risk patterns



<O,R,ρ,F>

O=paper

R=openField ∧ water_from_above

ρ=0.75

F=total_loss

Risk Identification in Possible Worlds

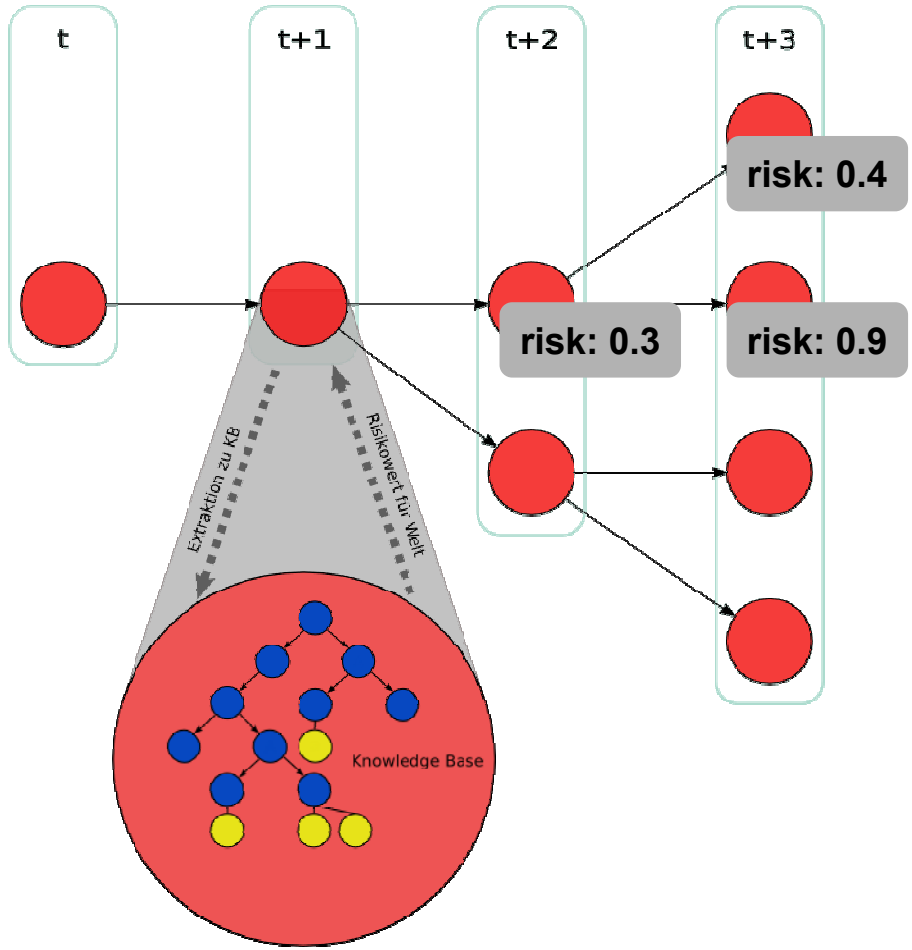
Annotation of a plan

- risk-values
  - probability of this world
  - risk factor of this world
- grade of goal fulfillment of final world

➔ decide for a plan

or

➔ variation / change of the goal



Knowledge about the World

Forecast of possible worlds and its probability requires knowledge

Acquisition of knowledge

- own sensors
- communication
- inference

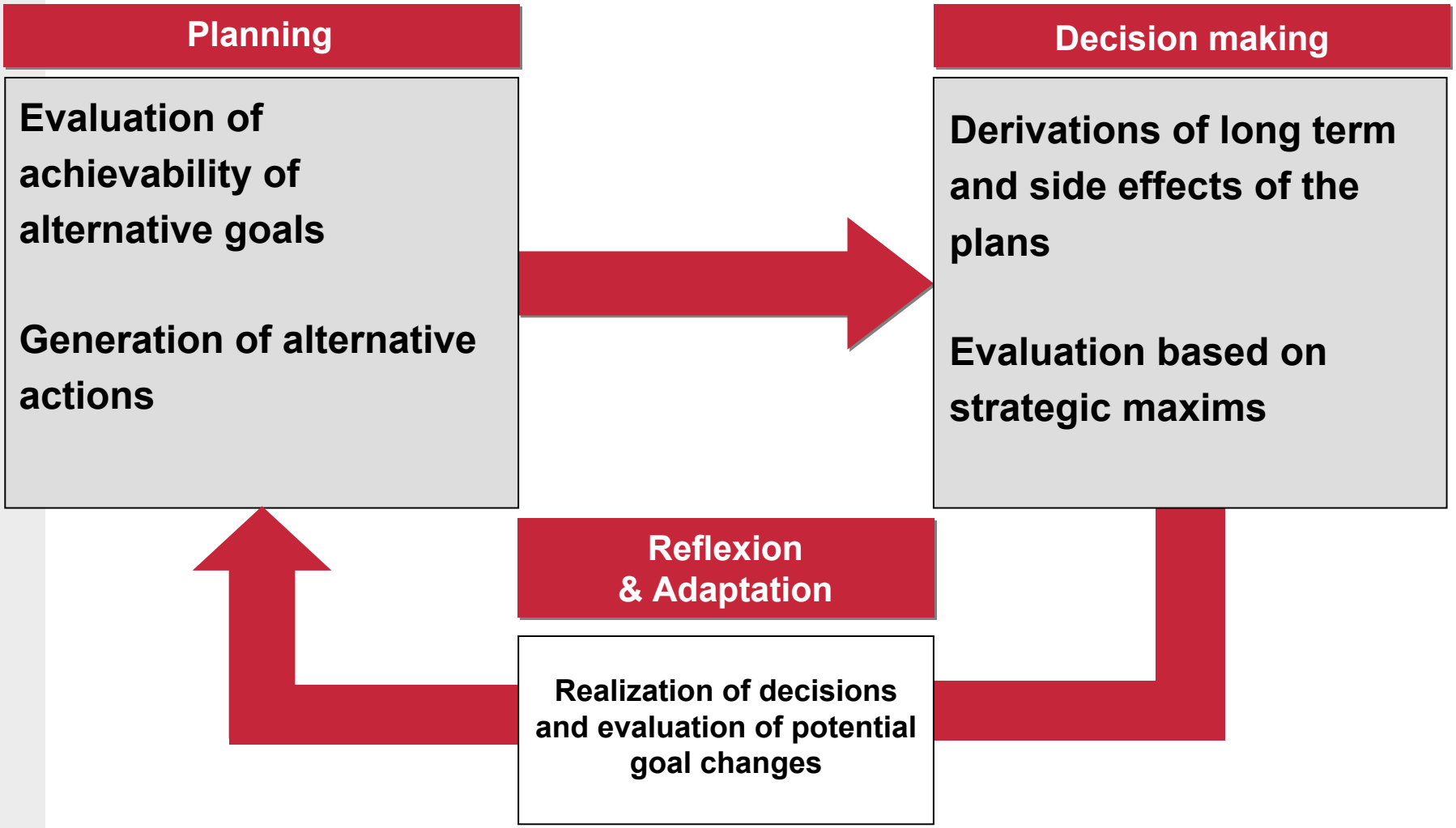
Knowledge is inherently uncertain

- depending on source and
- channel

Interface with knowledge management component

- evaluation of information need and
- quality of present knowledge

Next Step in Development: Reflecting Agent



Concluding Remarks

Risk parameters for an autonomous object

- Impact of an event (external risk)
- Information about an event (information risk)
- Interaction of autonomous objects (internal risk)

Autonomous identification and analysis of risk

- Goal oriented
- Constitutive on planning
- Combined with knowledge management (knowledge base)

Enhancement of autonomy by reflexion

- Identification of risk due to long range effects and side effects
- Evaluation of alternative goals
- Higher level of abstraction for the objectives

Thank you

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Backup

Evaluation without Occurrence Probability

Ignorance

h_i: hypothesis	P(„it‘s raining”)
$Pl(h_i)$: plausibility	P(„it is possible that rain falls”)
$Supp(h_i)$: support	P(„rain necessarily falls“)

$\varphi_i = Pl(h_i) - Supp(h_i)$

The narrower the interval [Supp;Pl] the more the agent knows about h_i – the surer he is that h_i is true.

A hypothesis with importance for the decision process and high φ_i needs more evidence…