

Towards a Single Information Space for Environmental Management through Self-Configuration of Distributed Information Processing Systems



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DIADEM (FP7/STREP)

Distributed Information Acquisition and Processing for Environmental Management

-  Call: FP7-ICT-2007-2, ICT for Environmental Management and Energy
-  Duration 3 years, start September 1, 2008
-  **www.ist-diadem.eu**




Consortium

-  Thales-NL (Coordinator)
-  **DCMR Milieudienst Rijnmond (NL)**
-  **Danish Emergency Management Agency (DK)**
-  University of Karlsruhe (D)
-  University of Orebro (S)
-  University of Amsterdam (NL)
-  University of Craiova (RO)
-  Prolog Development Center (DK)
-  Space Applications & Systems (B)

The prime objective

-  An ICT system for **collaborative** decision making that effectively supports protection of the population and the environment against chemical hazards in industrial areas.

DIADEM Process Integration Framework

-  Facilitate collaborative problem solving in complex environmental management processes.
-  Hybrid information processing carried out by automated services and experts from multiple, geographically distributed organizations.
-  Simple implementation/evolutionary approach to automation.




Environmental Management: Example

- 🛡️ A chemical incident in Rotterdam: 1.2 million residents, high density of petrochemical and waste management industry
- 🛡️ Decision making: evacuation/shelter/stay indoors



Environmental Management: Challenges


Inherently complex information processing

-  Situation assessment.
-  Prediction.
-  Evaluate impact of different options.

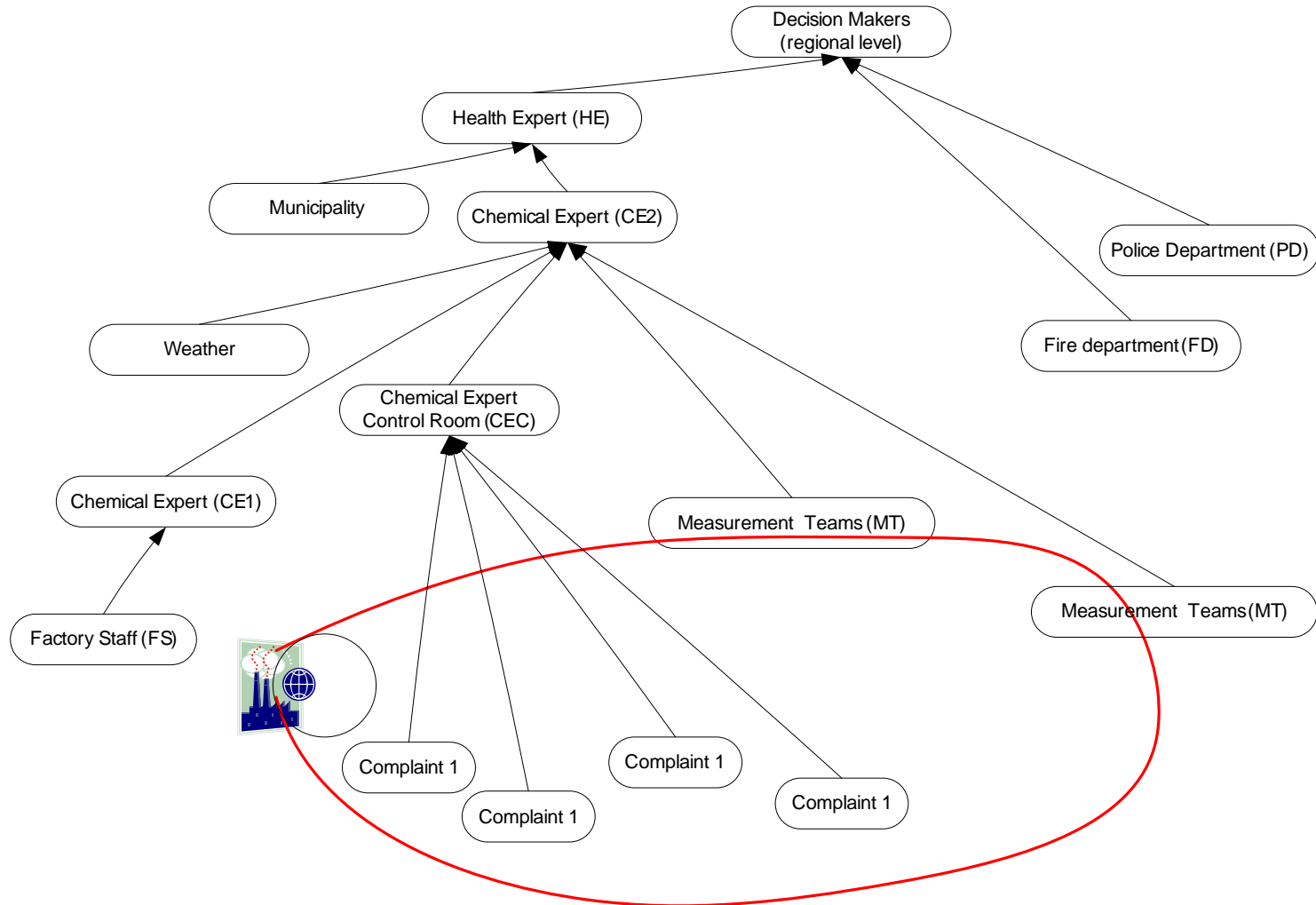
Acquire and process large quantities of information.

-  Cognitive capabilities of a single expert are exceeded.
-  Full automation of decision making is not feasible/acceptable.

Crisis management

-  Systems of systems
-  Ad-hoc organization of organizations

Environmental Management: Collaboration



State of the art




- 🛡️ A lot of useful information and expertise is not exploited
 - 🛡️ Often it is not known who has the relevant expertise or the person cannot be reached in a given situation.
 - 🛡️ The experts are exposed to irrelevant information.
- 🛡️ All relevant information cannot be used due to cognitive limitations and time pressure. **Information flood!**
- 🛡️ A great variety of data formats, communication protocols, processing methods, etc. **Information inaccessibility!**

A Uniform Information Space

Standardized formats/protocols

-  Facilitate data/information exchange

Information processing services



-  Transform heterogeneous data/info to more abstract information types.
-  Deliver the interpretation results to the experts that can use them.
-  Draw attention of experts in case of relevant data/information => rapid response via direction of attention.

Hybrid collaborative processing



Multiple experts

-  Contribute specific expertise and processing capabilities

Automated reasoning processes

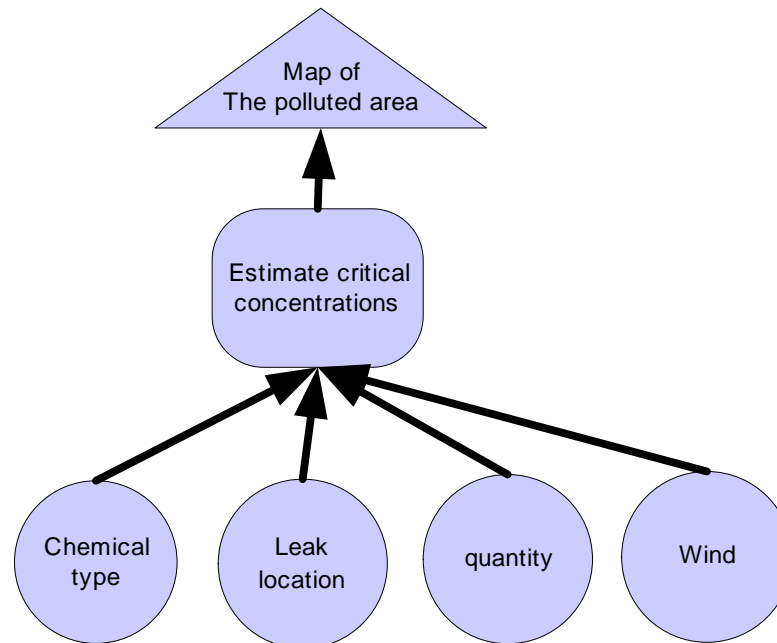
-  Implemented by software agents
-  Speed up certain types of information processing

Humans and agents are processing nodes

-  Note: humans are NOT mere users of a system.
-  Humans and agents contribute processing services needed for solving a particular problem.

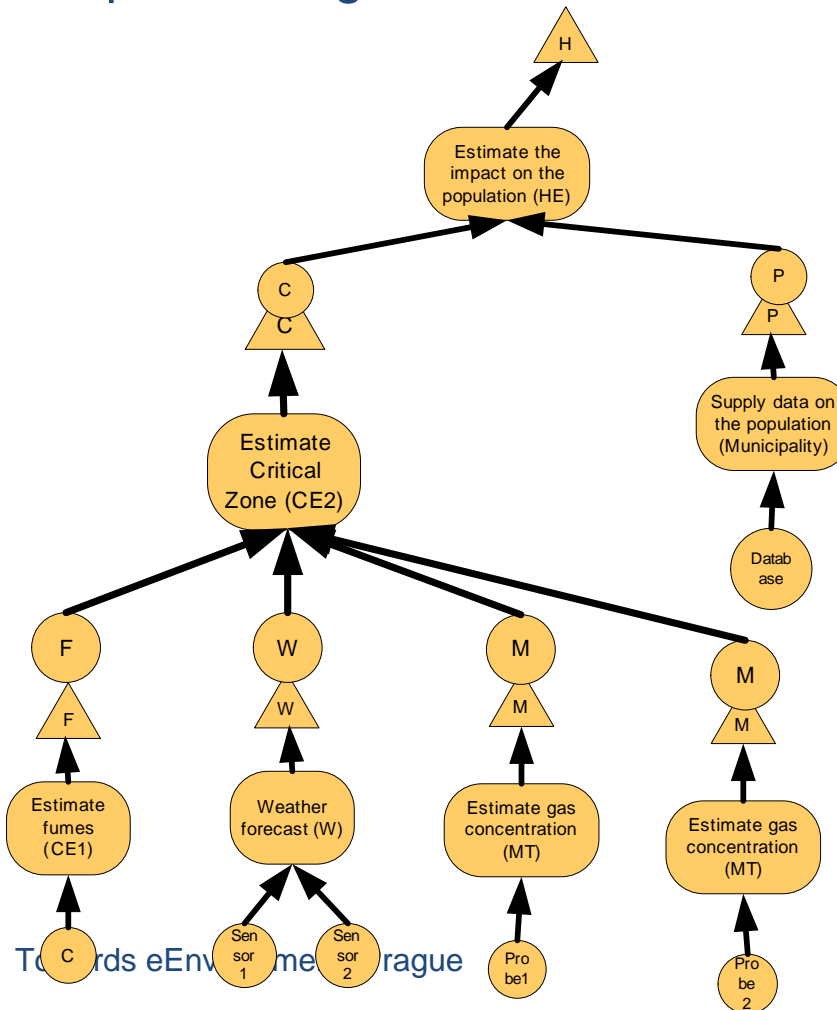
Processes

- Each expert/agent provides a particular service for certain inputs.
 - Implement a particular transformation process.
- Decentralized description of provided services and inputs
 - Each expert/organization or designer defines a local ontology.
 - OntoWizzard tool supports decentralized creation of coherent service descriptions.

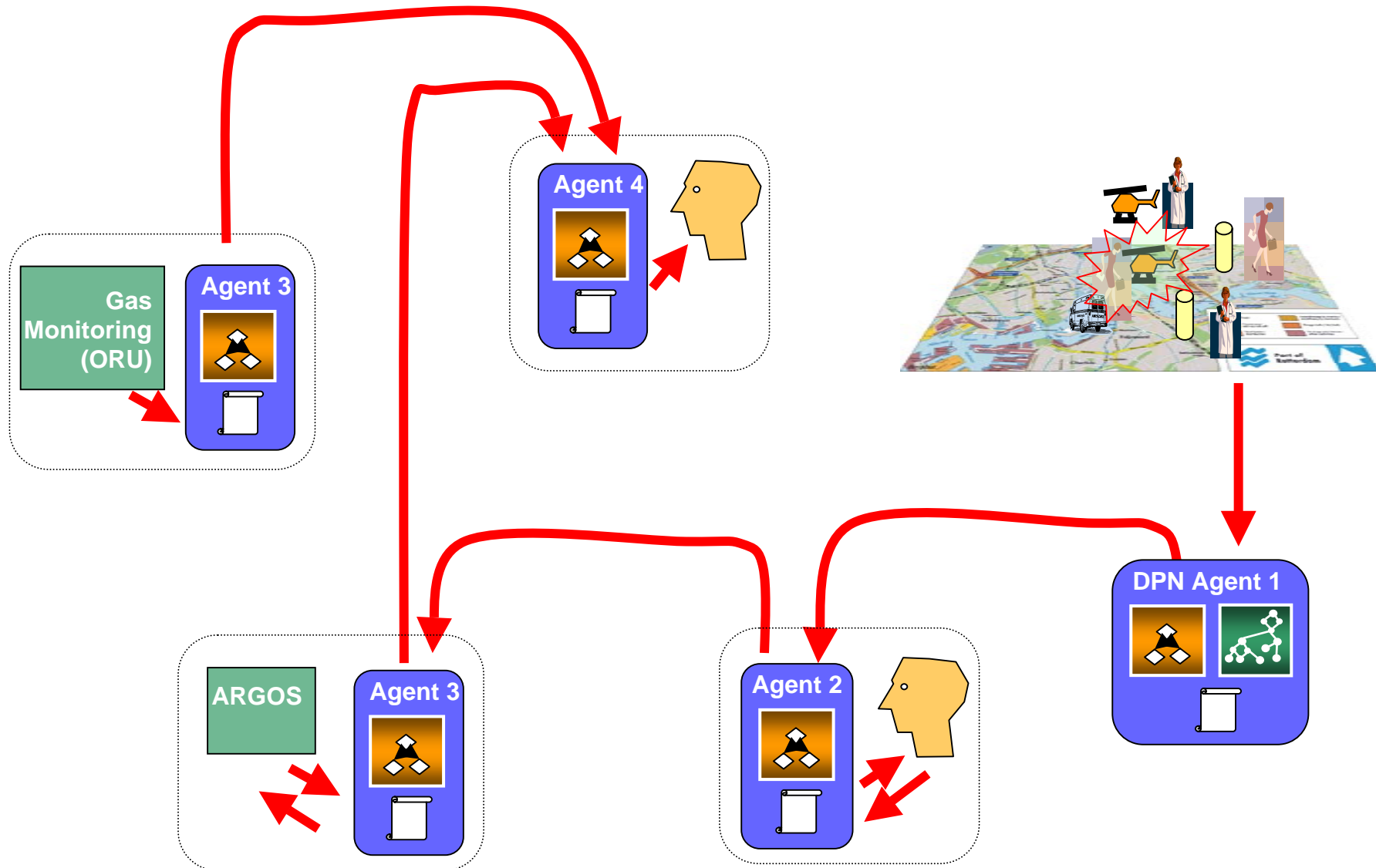


Processing in workflows

- Locally defined services are registered (e.g. yellow pages)
- Through service discovery configure workflows between experts and machines supporting hybrid processing.

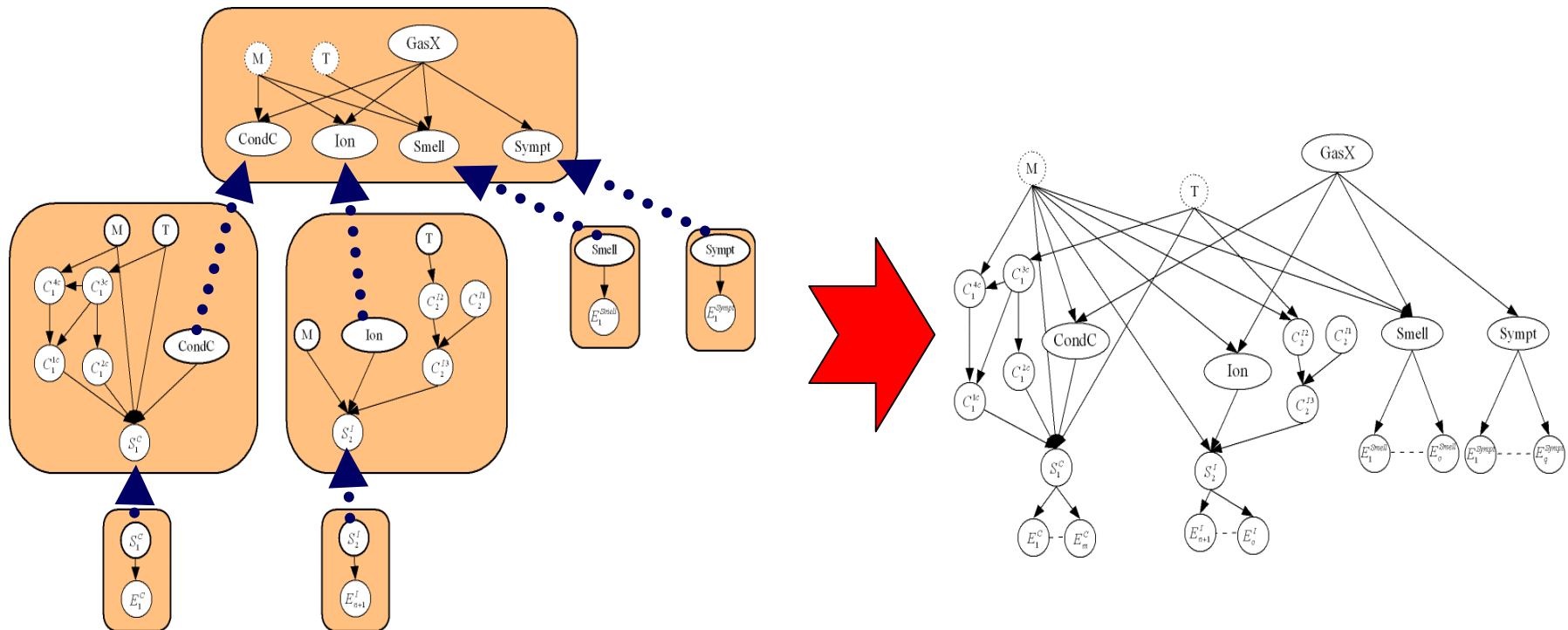


Agents: Basic Building Blocks



Distributed Bayesian Inference

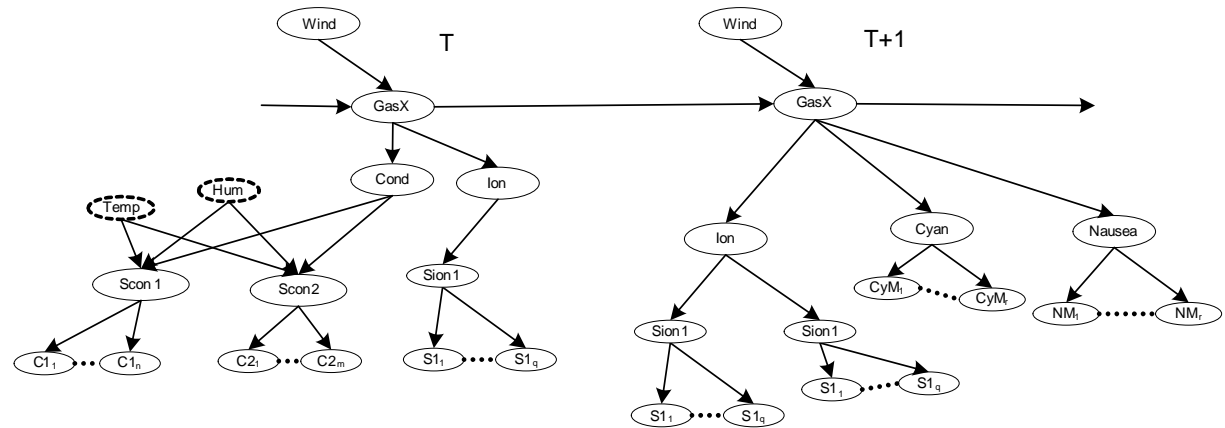
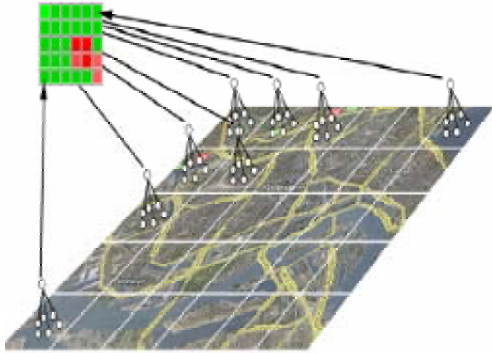
- Agents support Bayesian information fusion.
- Complex fusion systems obtained by combining local Bayesian models; decentralized, globally coherent inference
(de Oude&Pavlin, Fusion 2007; Pavlin et. Al, Information Fusion Journal 2008).



Gas Detection/Source Estimation



Complex sensor models



Integrate humans as “sensors”

- Generate queries answered with yes/no: “Do you observe a yellow haze?”
- Use the existing infrastructure: **GSM and Internet**.



Integrate mobile sensor platforms on the fly

Streamlining Human Based Processing

Multi-criteria decision making

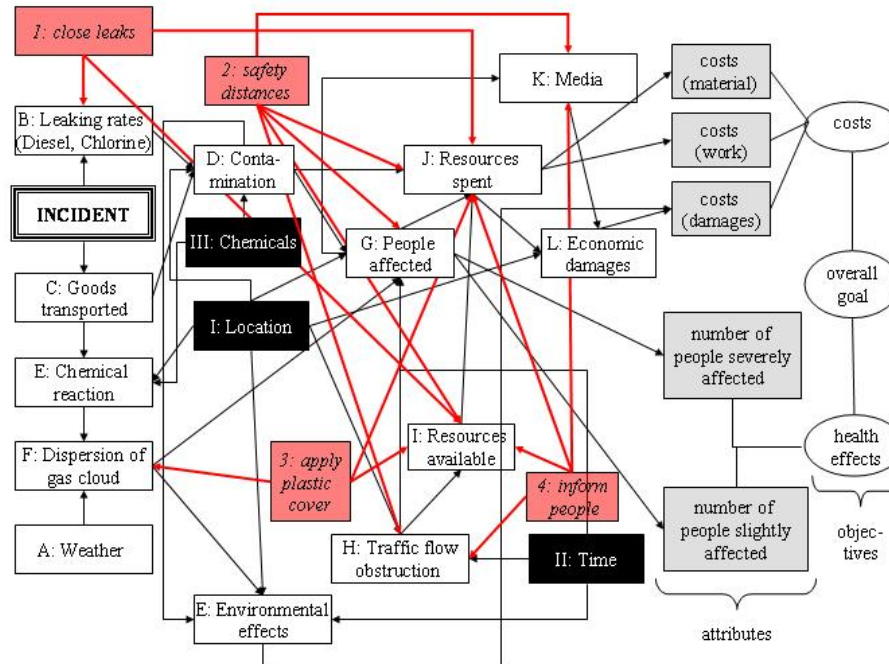
- Transparent resolution of complex decision problems with conflicting objectives

Scenario-based reasoning

- Plausible future developments

Integration

- decision making in dynamic environments



Conclusions

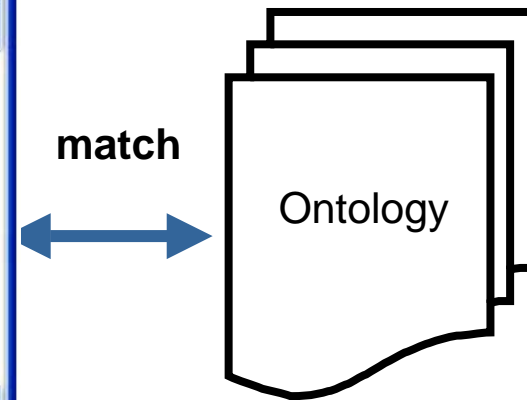
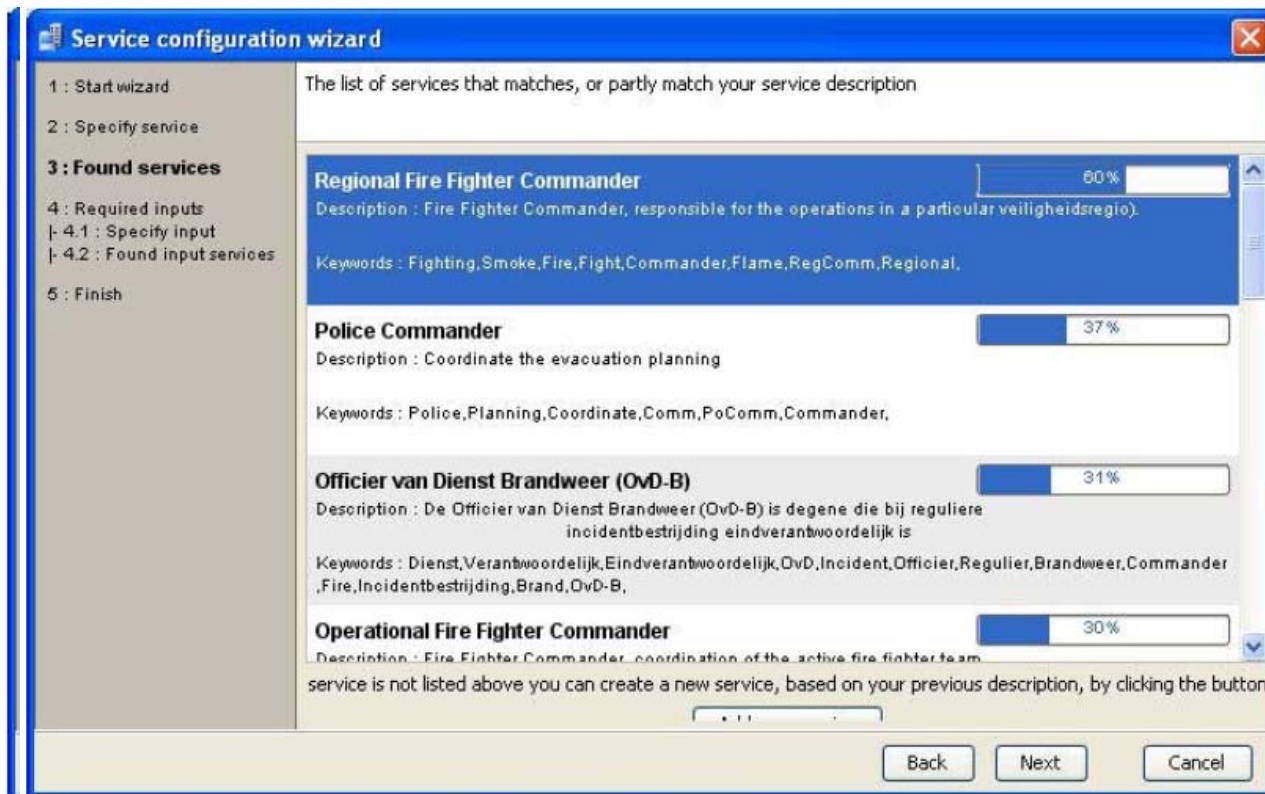
- 🛡️ A service oriented framework facilitating collaborative problem solving.
 - 🛡️ Seamlessly combine experts, citizens and automated services into collaborative processing systems.
 - 🛡️ Acquire relevant information and harness the expertise.
 - 🛡️ Expertise-driven information dissemination.
 - 🛡️ Initial implementation **DIADEM Process Integration** framework.

- 🛡️ Hybrid information processing integrating
 - 🛡️ Arbitrary automated reasoning processes.
 - 🛡️ Advanced methods for human based reasoning.

- 🛡️ Methods and tools facilitating implementation
 - 🛡️ Development of modules which “wrap” heterogeneous services
 - 🛡️ OntoWizzard Tool for decentralized and coherent definition of services.




OntoWizzard

- 🛡️ A tool for collaborative definition of services.
- 🛡️ The system assists a user with the specification of services such that other modules can understand them.



Environmental Management (2)

Unpredictable domains

-  Each incident is a unique combination of events/phenomena of *known* types.
-  General knowledge about event/phenomena types is available.
-  Mapping between experts and event types can be made a priori.

Professional bureaucracy

-  Division of labor between experts: experts are “processing nodes”.
-  Each expert implements a particular transformation between different types of information.