



# Semantic Web Applications for the Petroleum Industry

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## Introduction to IFP

A brief history of semantics in our industry

COGents and EpiSEM ACTION

Needs for ontologies

Conclusion



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# INSTITUT FRANÇAIS DU PÉTROLE

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## *Missions and areas of activity*

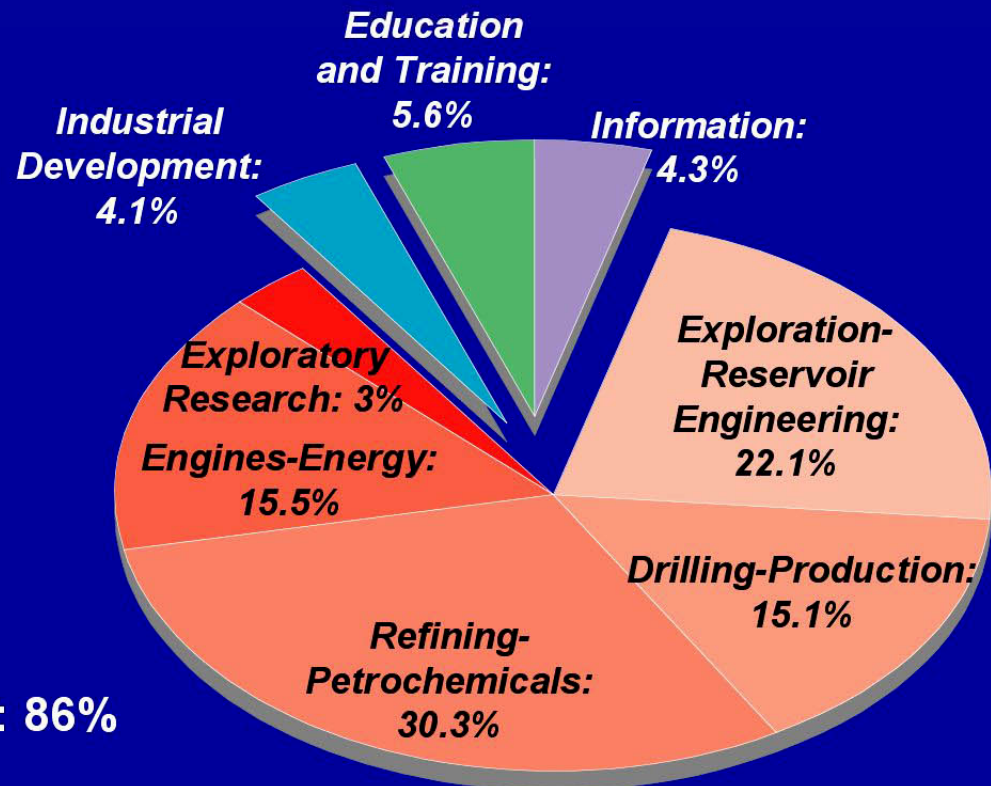
- Industrial research and development center
- Training center
- Information services center

In fields including the production, conversion, and use of oil, natural gas and their substitutes

## Staff and Budget

**IFP 2004 total budget: 291.5 M€**

*Including Technology Business Units and Exploratory Research: 273 M€*



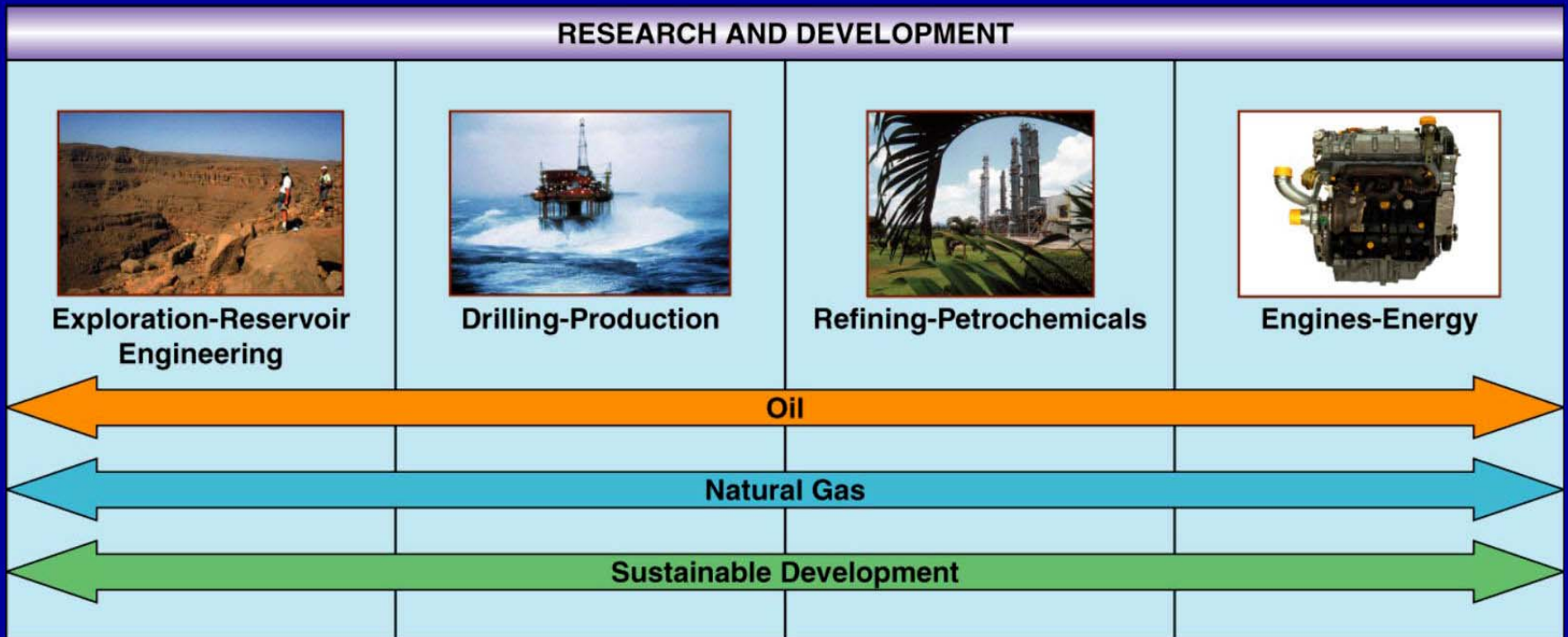
1,800 people,  
80% of them in R&D,  
plus 229 doctoral and  
post-doctoral researchers

**Research and Development: 86%**



# RESEARCH AND DEVELOPMENT

*Areas of activity*





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[semantics in our industry](#)

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# a brief history of semantics in the oil and gas industry

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- early 80s
  - expert systems, knowledge-based systems, OO programming
  - Drilling Advisor, Regent, Picon/G2, ..
- 90s
  - shared data models, some ontologies, software interoperability
  - POSC, pdXi, CLIP, OPC, CAPE-OPEN, OpenSpirit...
- 2000s
  - Data models in XML, more ontologies, first semweb approaches
    - POSC becomes ‘[energy eStandards, the place for petrotechnical XML standards](#)’ (WITSML, WellLogML, ...)
    - CLIP becomes OntoCAPE ‘[an Ontology of Computer Aided Process Engineering](#)’, several ontologies for process modelling, design, operation...

- Exploration & Production track
  - (90s-00s)POSC: E & P data model
  - (90s) OMEGA\*: OO geomodelling
  - (90s-00s)OpenSpirit : E&P interoperability platform
  - (00s) EpiSEM ACTION\*: E&P meta-modelling
  - (00s) AKSIO: Knowledge management for Integrated Operations
- Refining track
  - (90s-00s) CAPE-OPEN\*: process modelling software interoperability
  - (00s) CHEM\*: process supervision architecture & data model
  - (00s) hTechSight: knowledge management platform for the process industries
  - (00s) COGents\*: process model configuration with agents





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the CAPE-OPEN vision



**CAPE-OPEN  
COMPLIANT SOFTWARE**

**UNITS'Я'US®**  
alpha-olefins reactor v12.3

B2B ready

**Tested**

**As seen on the Web!**

**PLUGS  
INTO ANY  
COSE**

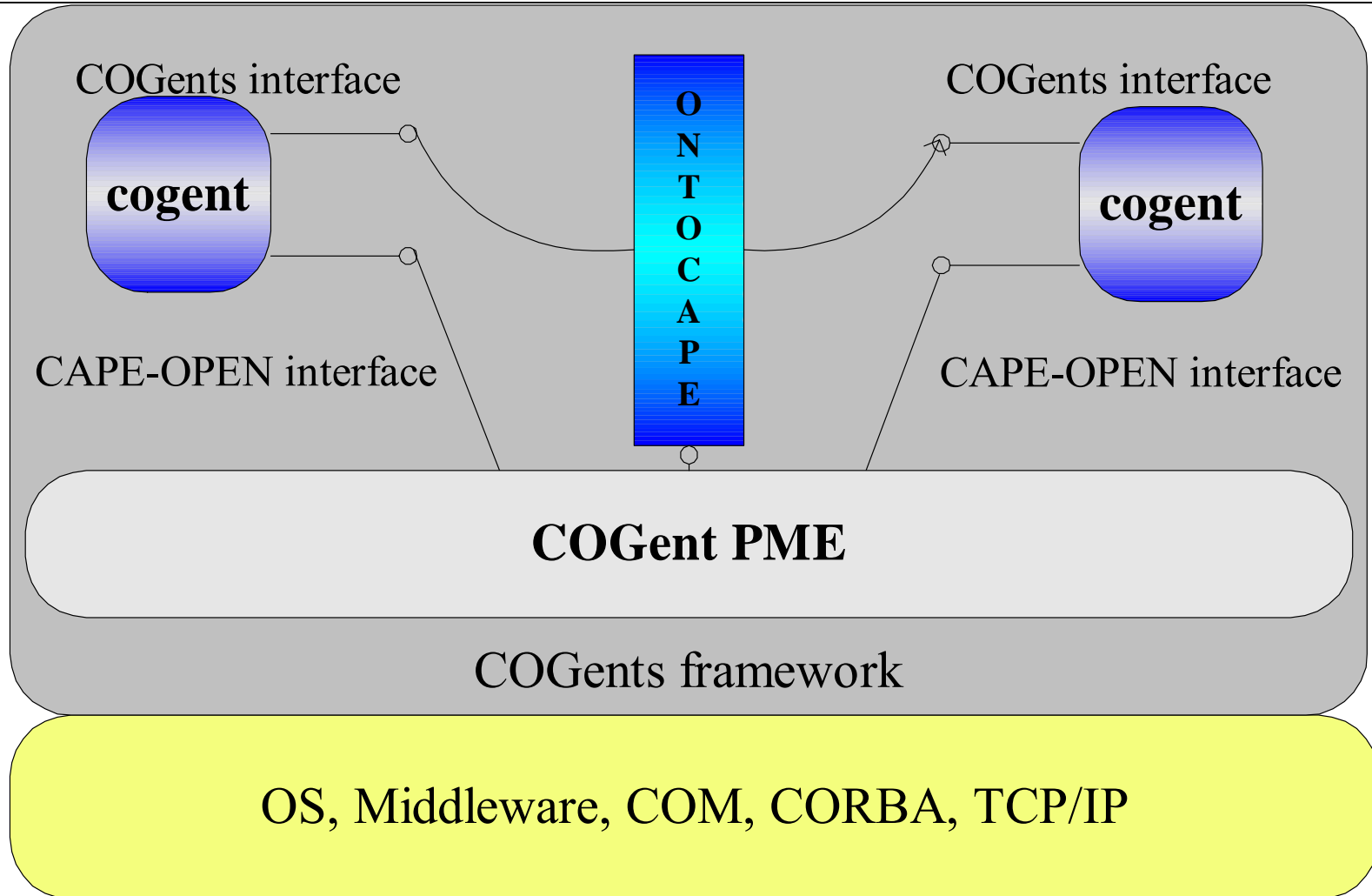
Peter Banks son... (52) ...  
055)October 1998... (FANT, Message-Suite is not com...  
a version of EasyFax... Series 5you must remove this BEFC...  
"What to do if you have... for instructions.The Message S...  
to the Series 5Control Panel (re... ns). You must change setting... in the... man...  
program before you can use the M... grams. See the Message Suite U...  
have a previous version of Message...  
It is best to install the new release without... previousversion so that your settings (e.g. email messages,  
setup and serviceprovider information) are p... these settings will be removed ifyou remove your existing  
version before upgrading.Note that it is recomm... that you back-up your Series 5 beforeinstalling additional

	<p>IFP RSI</p>		<p>Co-ordinator end user</p>
	<p>Aspentech Barcelona</p>		<p>Software Provider</p>
	<p>RWTH Lehrstuhl für Prozesstechnik</p>		<p>Research in CAPE</p>
	<p>University College London</p>		<p>Research in CAPE</p>
	<p>Lab. Info. Paris 6 OASIS</p>		<p>Agent tech. Provider</p>

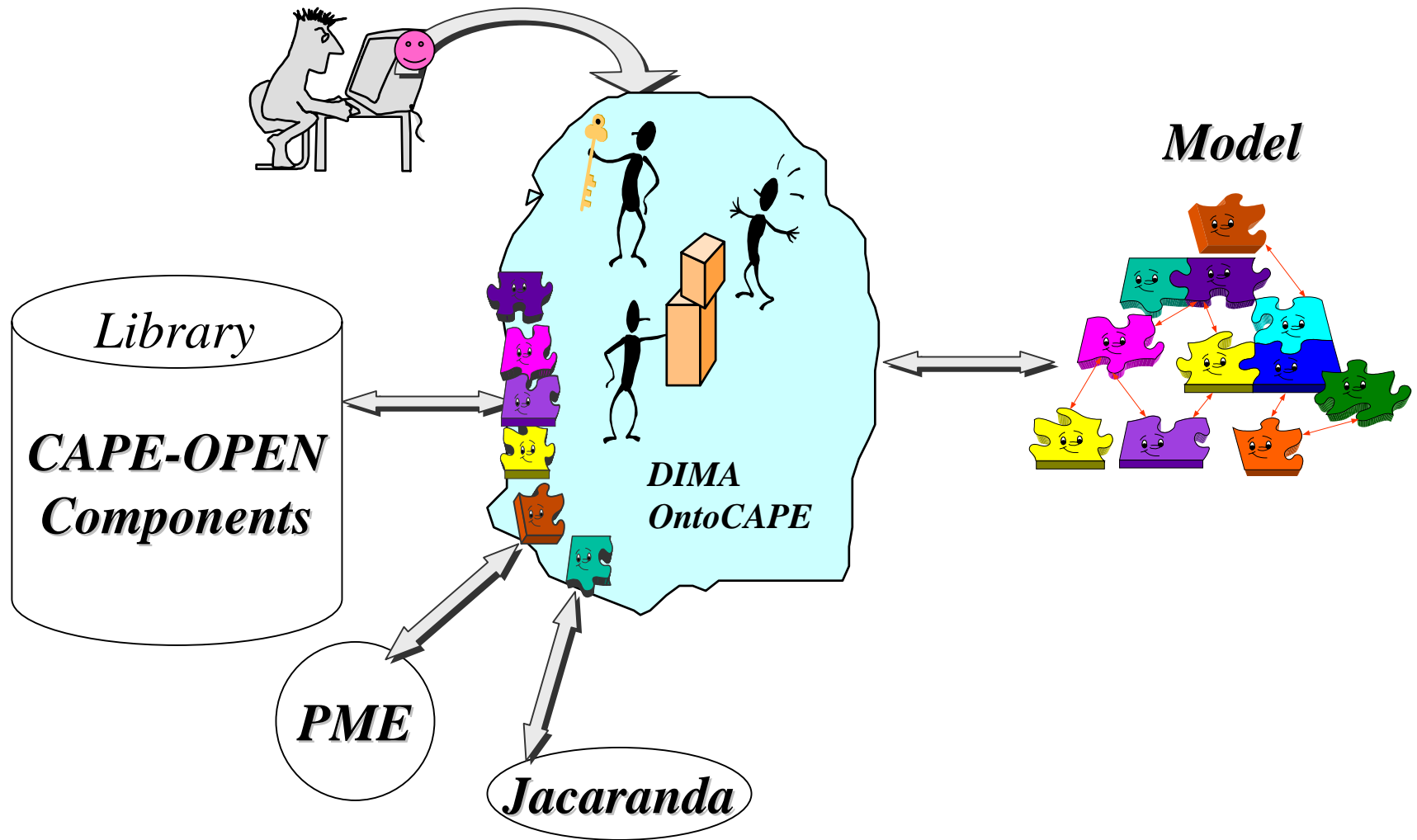
- New distribution mechanisms for process simulation software
  - define a framework allowing simulation components to be distributed and referenced on the internet and intranets, facilitating provision of application services in process modelling;
  - demonstrate it with Process Modelling Environments and Process Modelling Components
- Knowledge-based dynamic configuration of simulations
  - define representations of requirements and services in form of an ontology of process modelling, that supports opportunistic configuration of simulators from internet components
  - design new facilities for supporting the dynamic matchmaking of modelling components
- Further development of the CAPE-OPEN standards
  - develop the CAPE-OPEN standards in the semantic and knowledge-based dimension

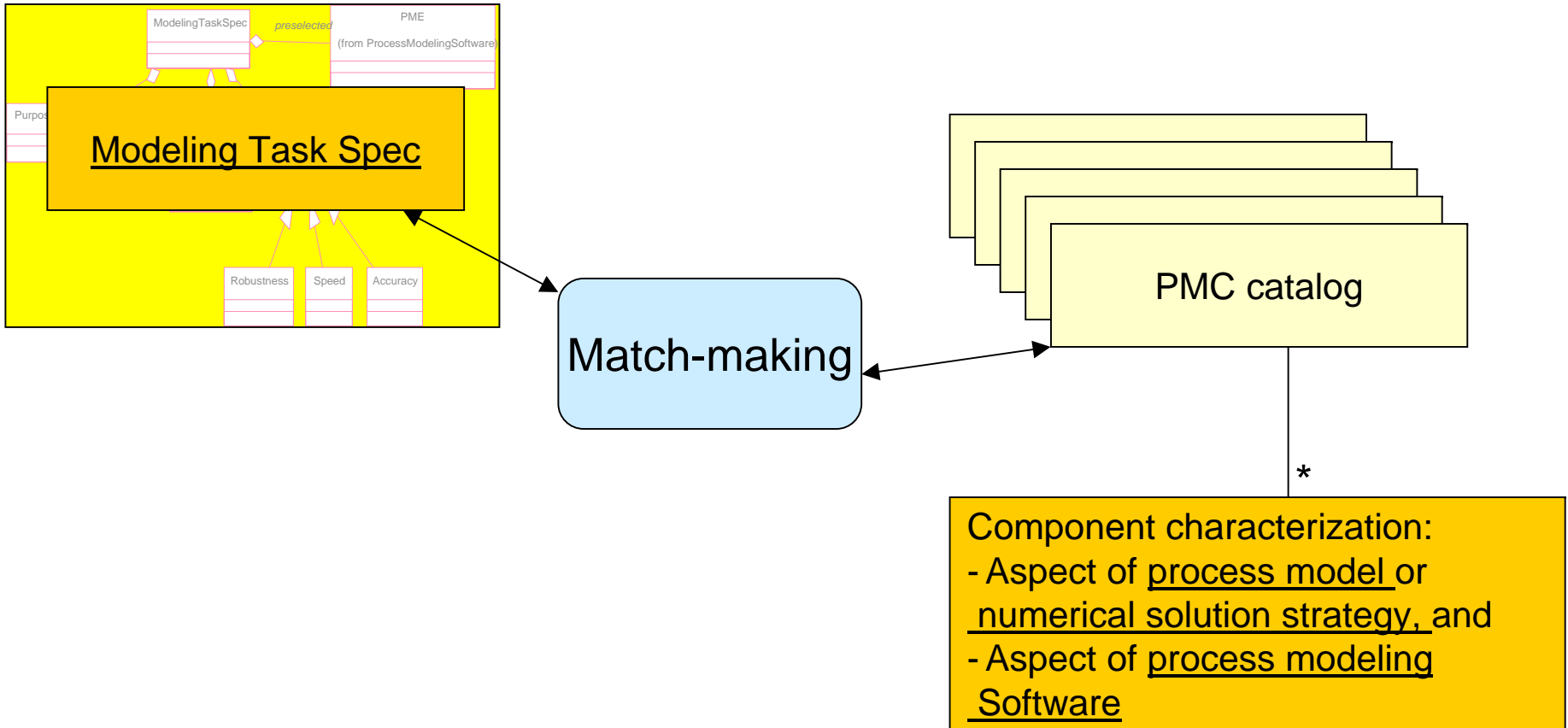


# COGents = CAPE-OPEN + Ontology + Agents

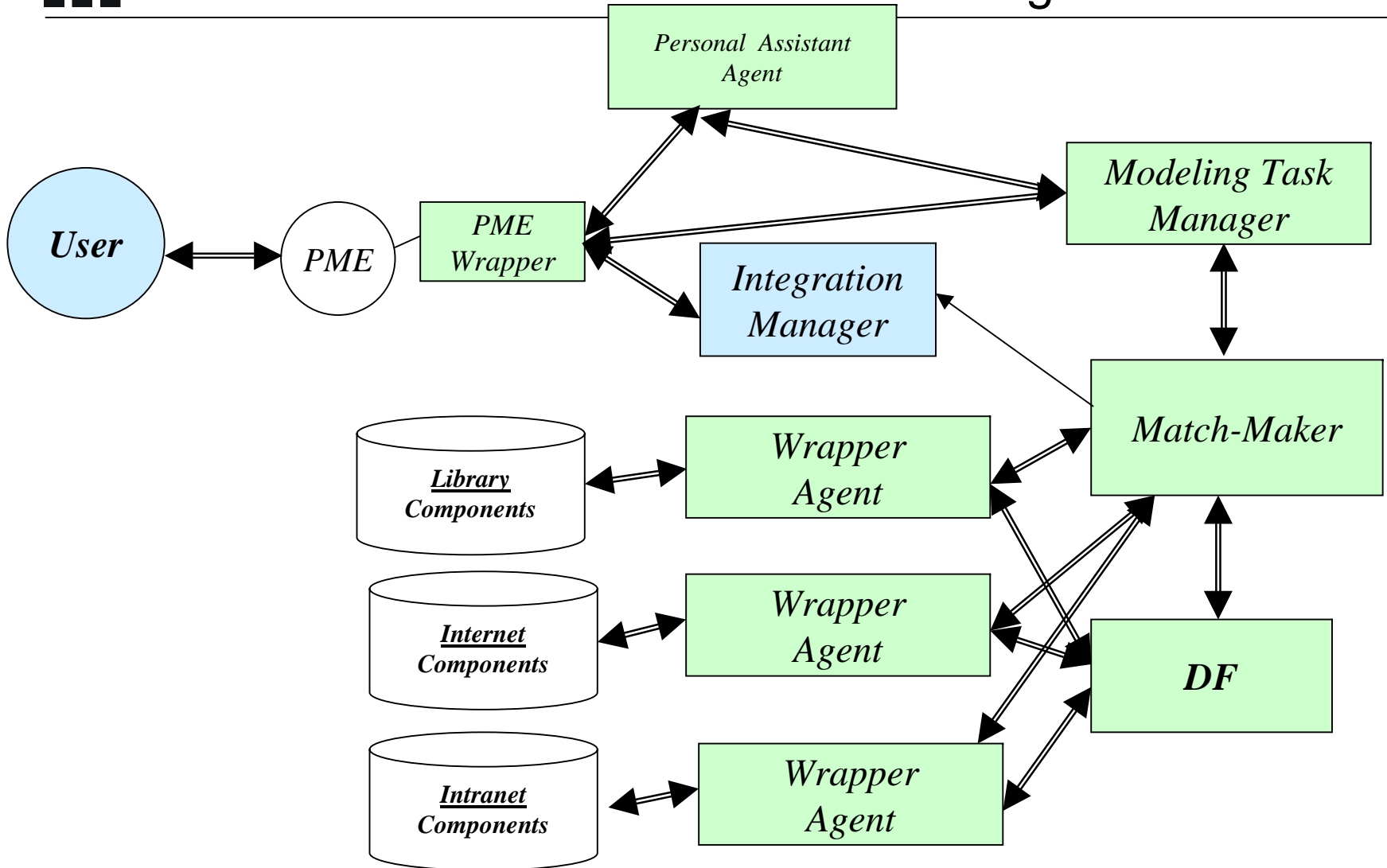


## Personal Assistant

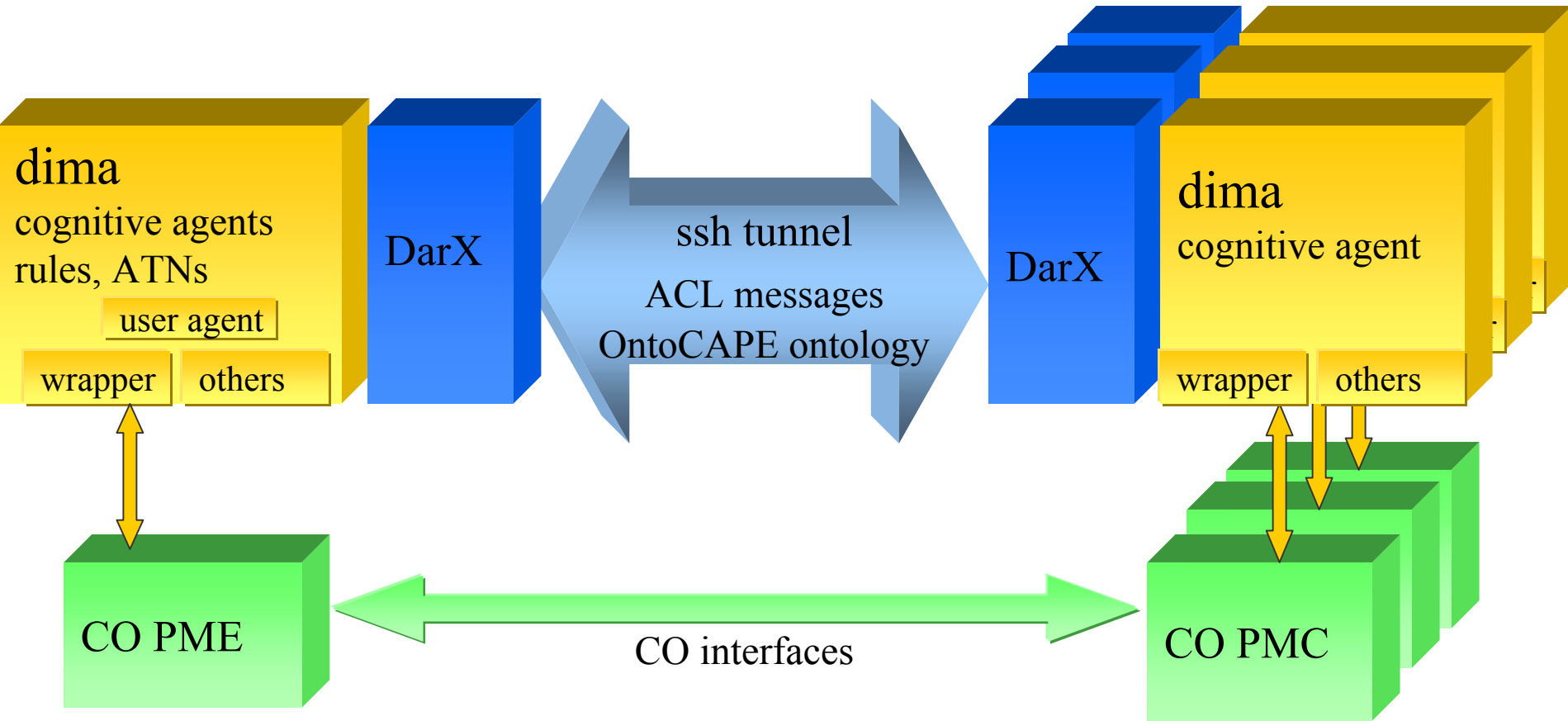


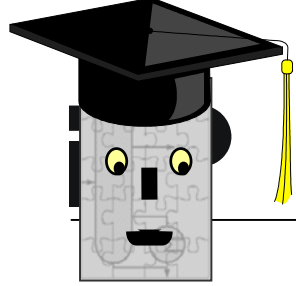


# COGents' multi-agent architecture

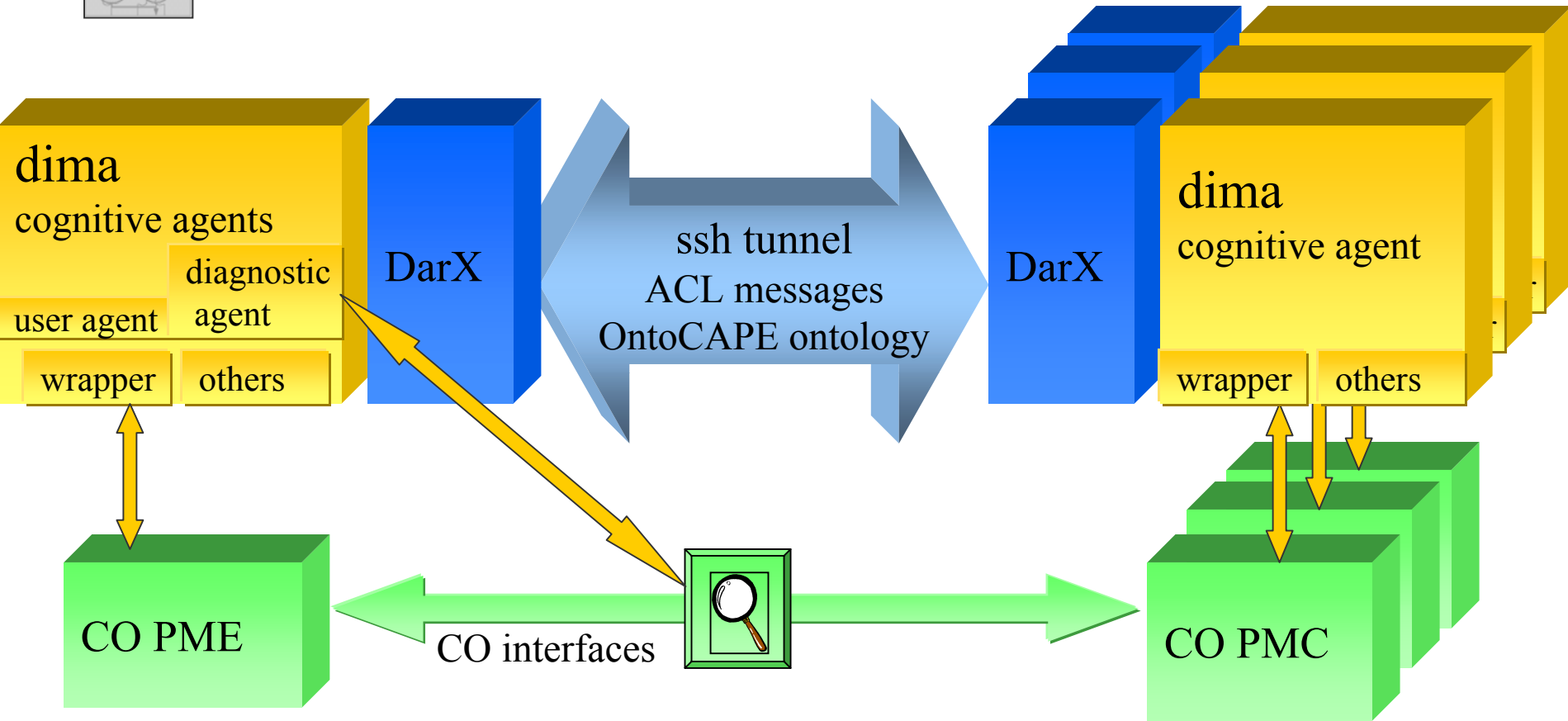




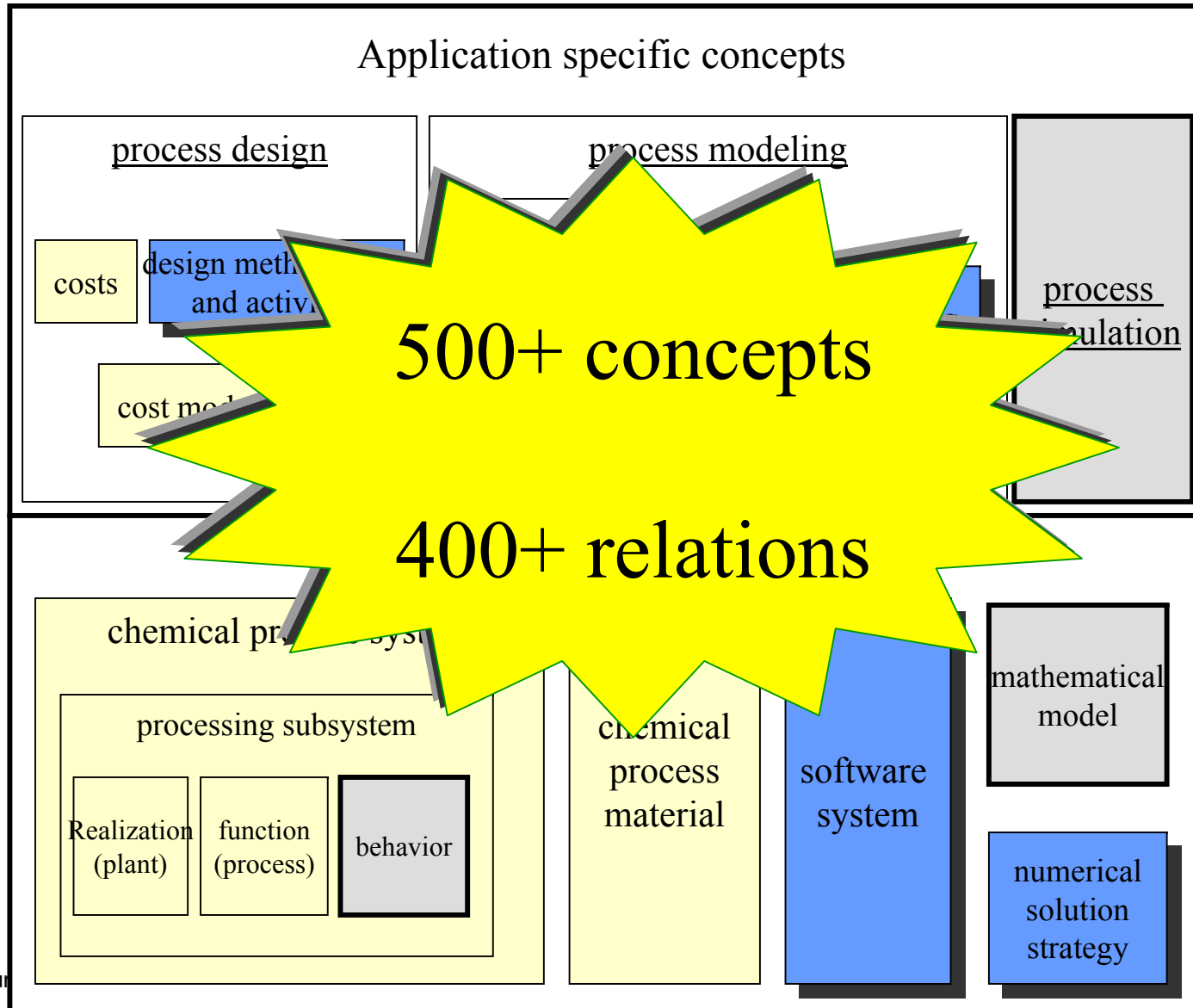


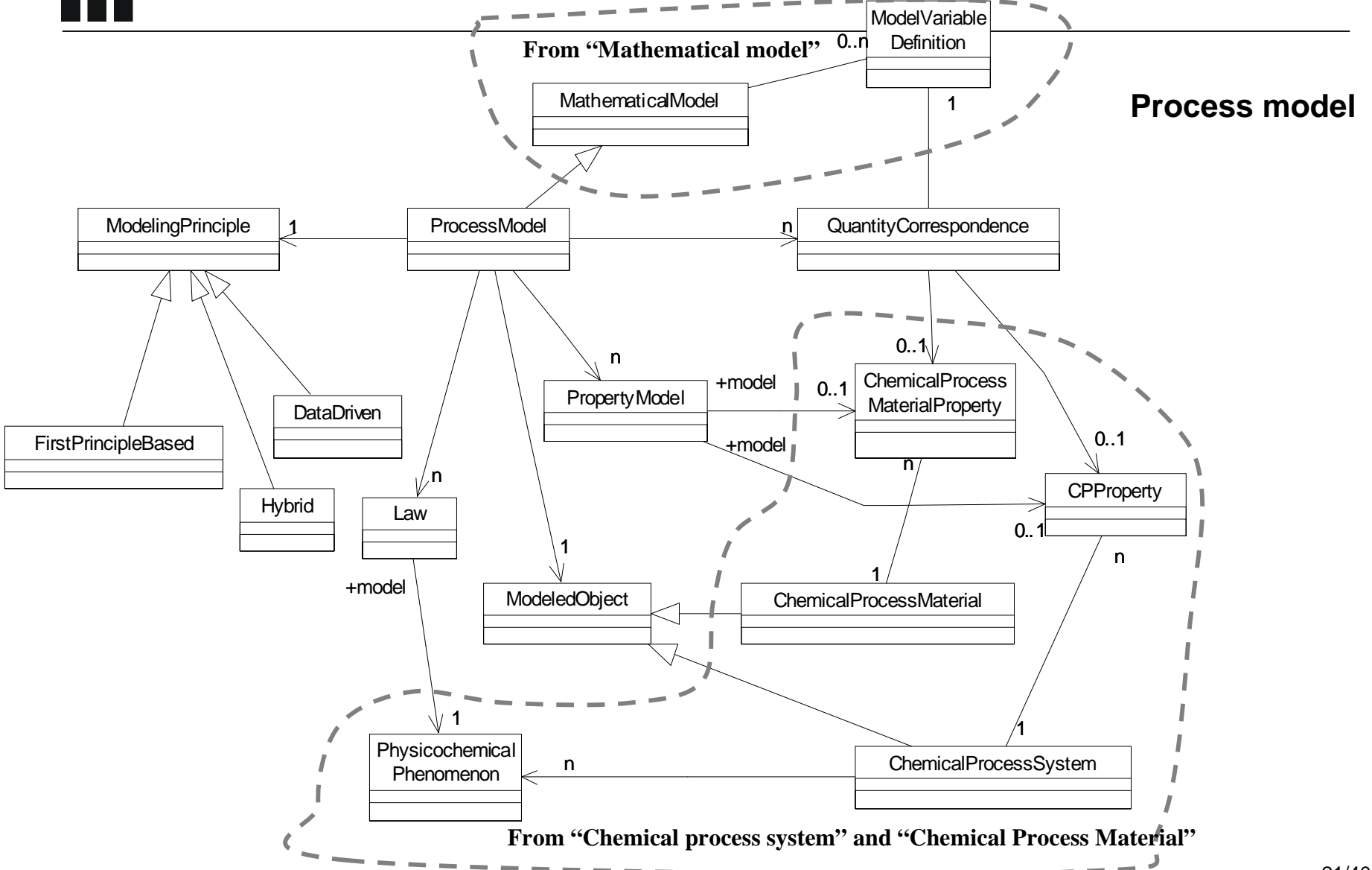


# COGents Technology (runtime mode)



- To provide explicit specification of concepts for software agents to perform automatic selection and use of process modelling components
- Covers the needs of the COGents case-studies
- Extensible to support applications beyond the case studies.





- Modelling the leacher unit in a polyamide6 process
  - looking for a model and a solver
- Automated Design for HDA Process
  - based on UCL's Jacaranda synthesis tool
- Out-of-bounds monitoring in an HDA simulation
  - Using Aspentech's HYSYS in steady state mode
  - Using RSI's INDISS in dynamic mode
- Video files/flash animations on [www.cogents.org](http://www.cogents.org)

- Questions about the appropriate size of an ontology
  - OntoCAPE *full* vs. OntoCAPE *light*
- matchmaking complex structures in reasonable CPU time and memory
- How to make a complex ontology easy to use???
- Significant amount of work needed to reach a concrete application level
- ... migration from DAML+OIL to OWL not so trivial!



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- A system to catalog and monitor on the web, meta information about Share Earth Model Entities & Activities while a complete lifecycle
- These catalogs contain information about « meta data » on activities and entities of the share earth model

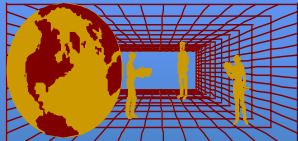
## EpiSEM Shared Earth Model Project

[www.posc.org/workpgrm/sem.shtml](http://www.posc.org/workpgrm/sem.shtml)

### EpiSEM Partners

- Agip
- Chevron
- IFP
- Landmark
- Mobil

Design team members



### EpiSEM Reference Implementaton Team

- IFP
- PDS
- POSC
- Shell / Geoquest

nation view

CEPM 29/10/2001

discipline instead of a common Earth model



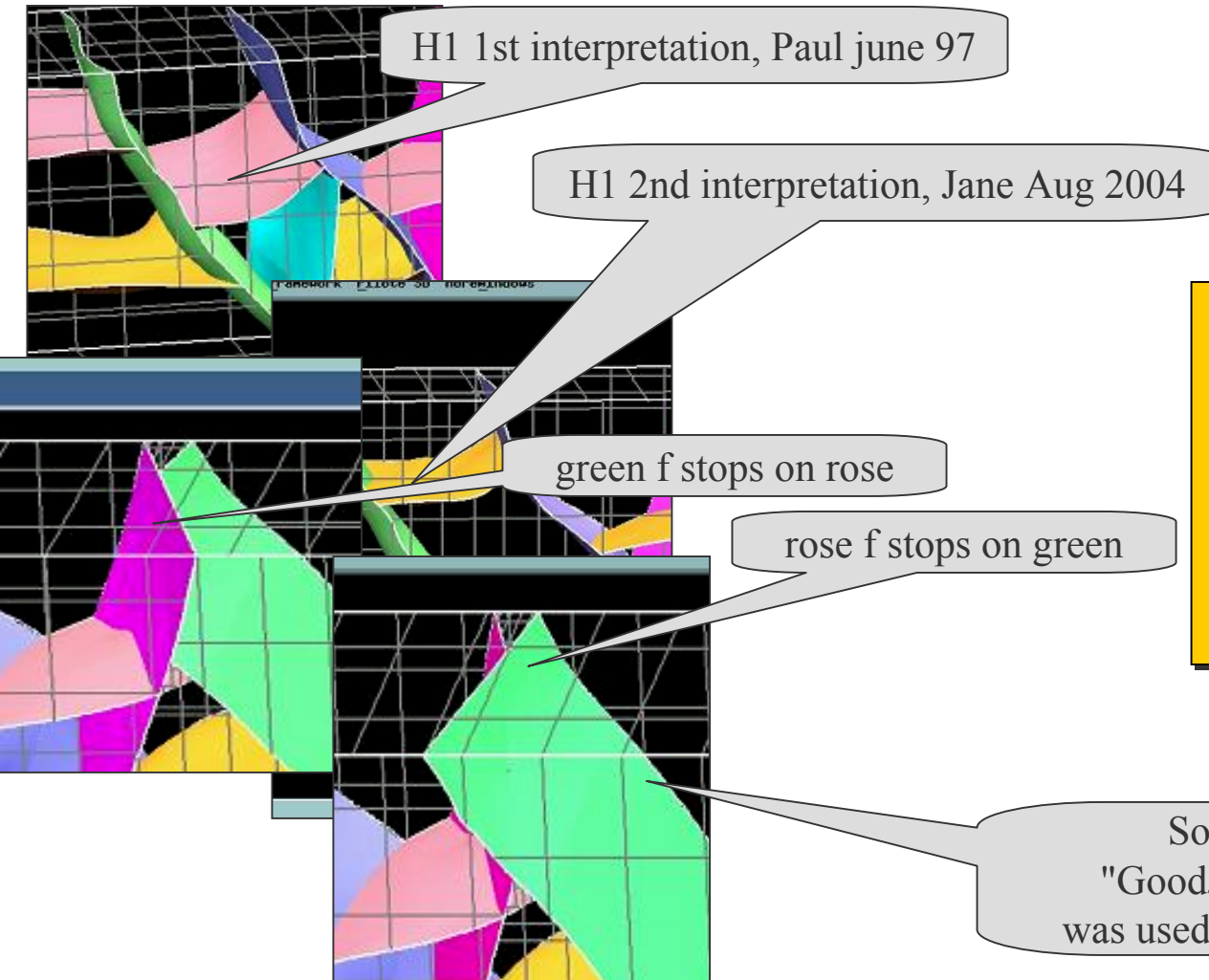
## EpiSEM ACTION Overall Project Objectives

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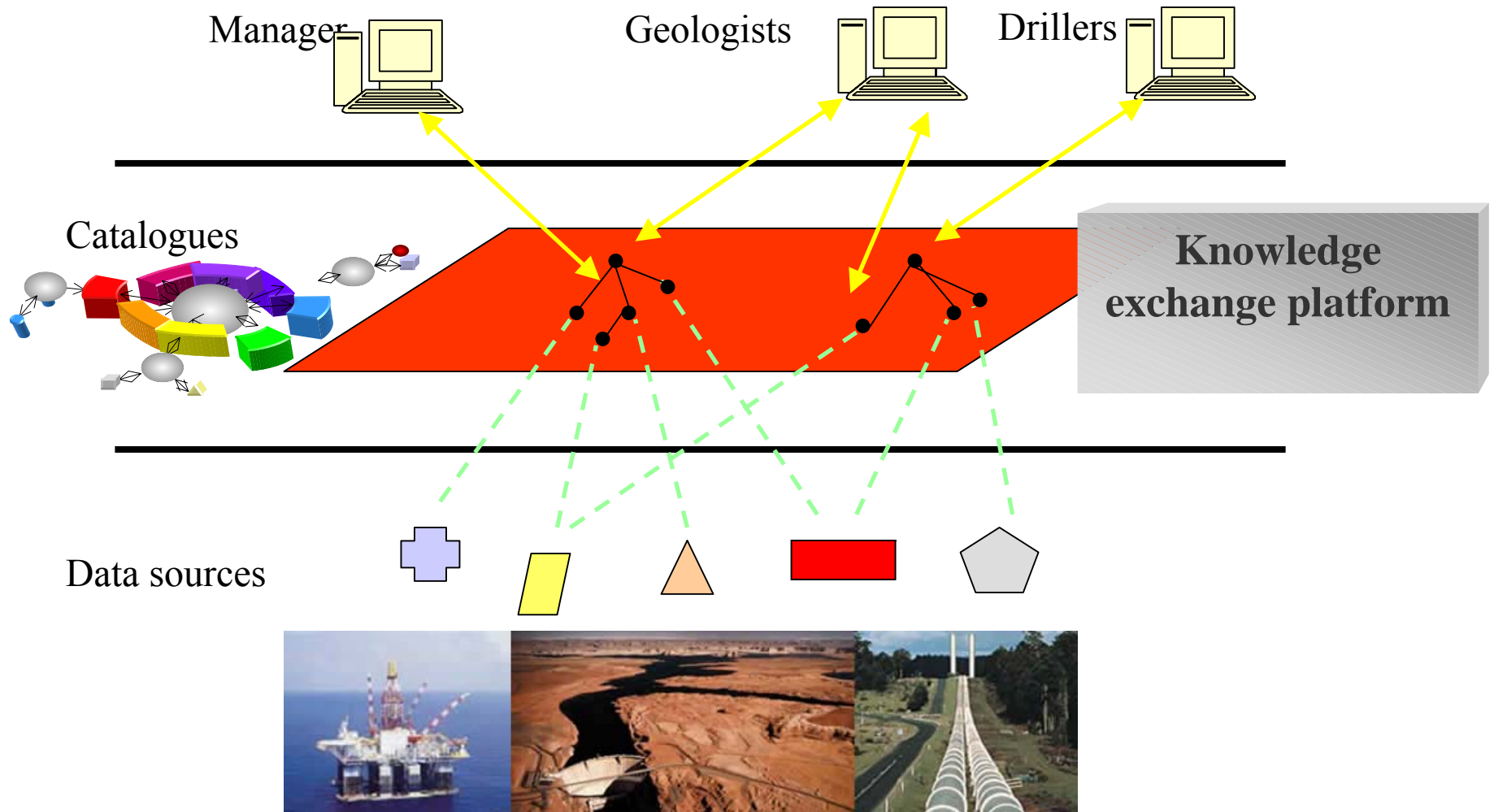
- Define and develop open standards based adaptive middleware components that support application collaboration and activity workflow management between scientific, technical and engineering specialists working in multi-disciplinary, geographically distributed teams.
- Prototype a framework that enables the production of middleware components and the semi-automatic generation of customised application work-flows.



# Basic Business needs : Remember important "things"

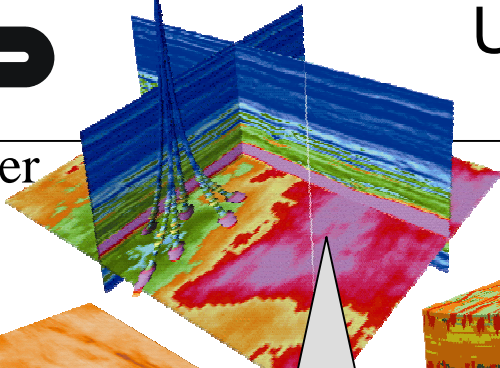


- Business Objects life
- Relations between Business Objects
- Process used to obtain models

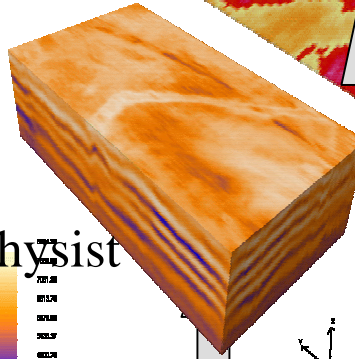
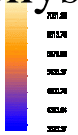




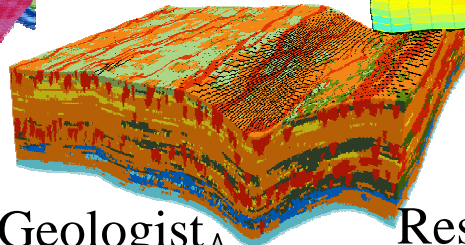
Driller view



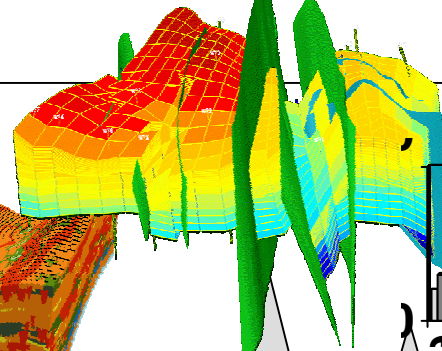
Geophysicist view



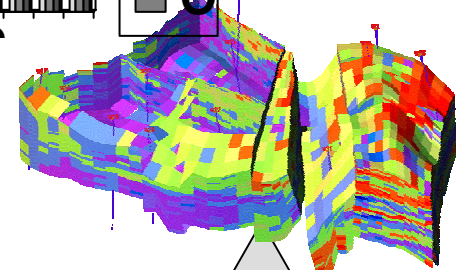
Geologist view



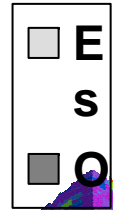
Reservoir engineer view (static)



Reservoir engineer view (dynamic)



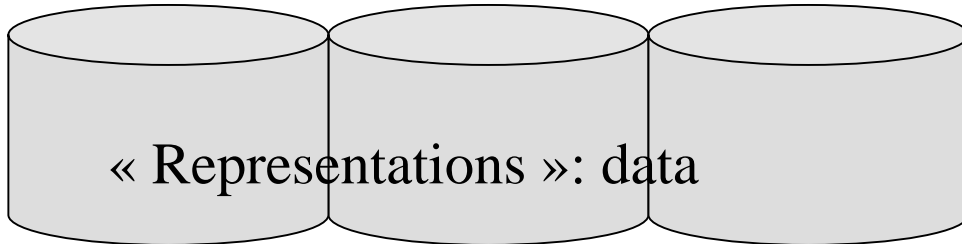
Economist view



# Update of the different view - a view by skill

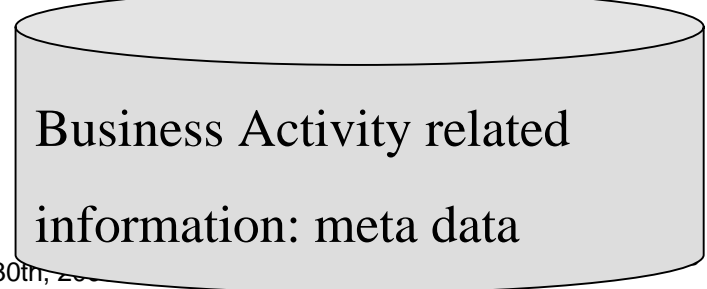
Information Distribution by network

Data exchange or sharing



« Representations »: data

Business Activity monitoring



Business Activity related information: meta data



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- Support software interoperability by semantic annotations:
  - automatically generated connectors for databases and software components
  - semantically enhanced software discovery
    - on our intranet
    - from the Web
  - support intelligent workflow management
  - support to users for external software
  
- Application domains: E&P, Refining, Environmental

- Current IFP Quality Assurance/Project Management practice:
  - “conventional” project memory
  - store key technical and project documents in a documents base
- Envisaged Future IFP QA/PM practice:
  - each document is “ontologised” (semi-automated semantic annotations) before it is stored in the project memory.
  - **Semi**-automated has to be in fact **95%** automated for real-world use!



- Excerpts from a Report
  - “... on the **Alwyn field** in block 19-A, british **North Sea** ... , an **oil** producing layer in **Dévonien Supérieur** shows higher than usual **permeabilities**”
- will generate a link to the existing 3D permeability map of the corresponding oil field
- ... or will generate detailed instructions for a 3DViz software for creating and displaying the map
- We need semantics of places (**North Sea**), objects of interest (**Alwyn, Dévonien**), properties (**permeability**), etc.



## Aztec (technical assistance for processes)

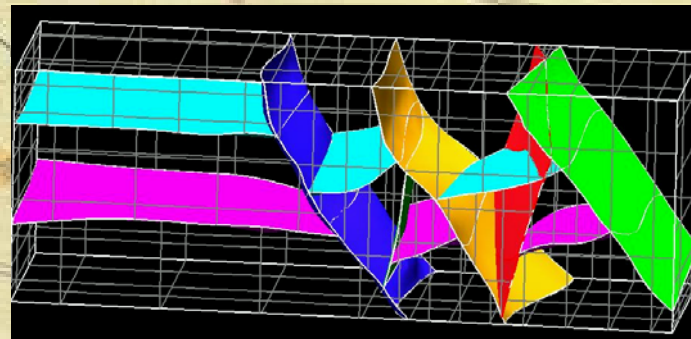
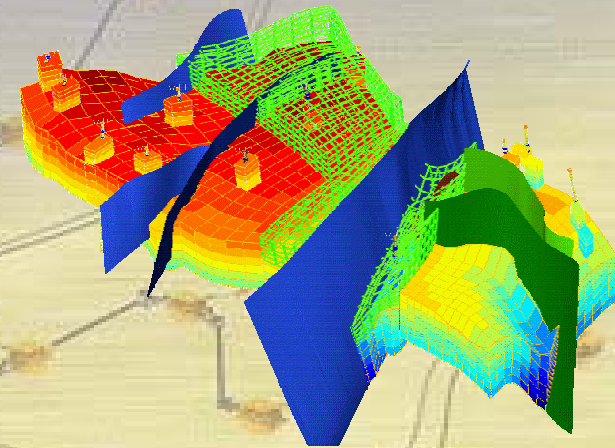
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- Axens's technical assistance department answers customer questions
  - fax, emails, small reports & technical notes
  - in the range of 1,000 per year
- Problem: consistency of answers to similar questions, to same customers...
- Need intelligent search in memory of previous answers
  - semantic representation of questions
  - semantic representation of answers
- Might need some kind of support for answering new questions



## Expected contents of “upstream” ontologies

- Places, geographical knowledge
- 3D Topology (faults, layers, horizons)
- Geological history (stratigraphic sequences)
- Materials (solids, liquids, gases)
- Thermodynamic behaviour, fluid flow
- Drilling equipment & processes
- Production (pipes, flows, topside facilities):  
see processes





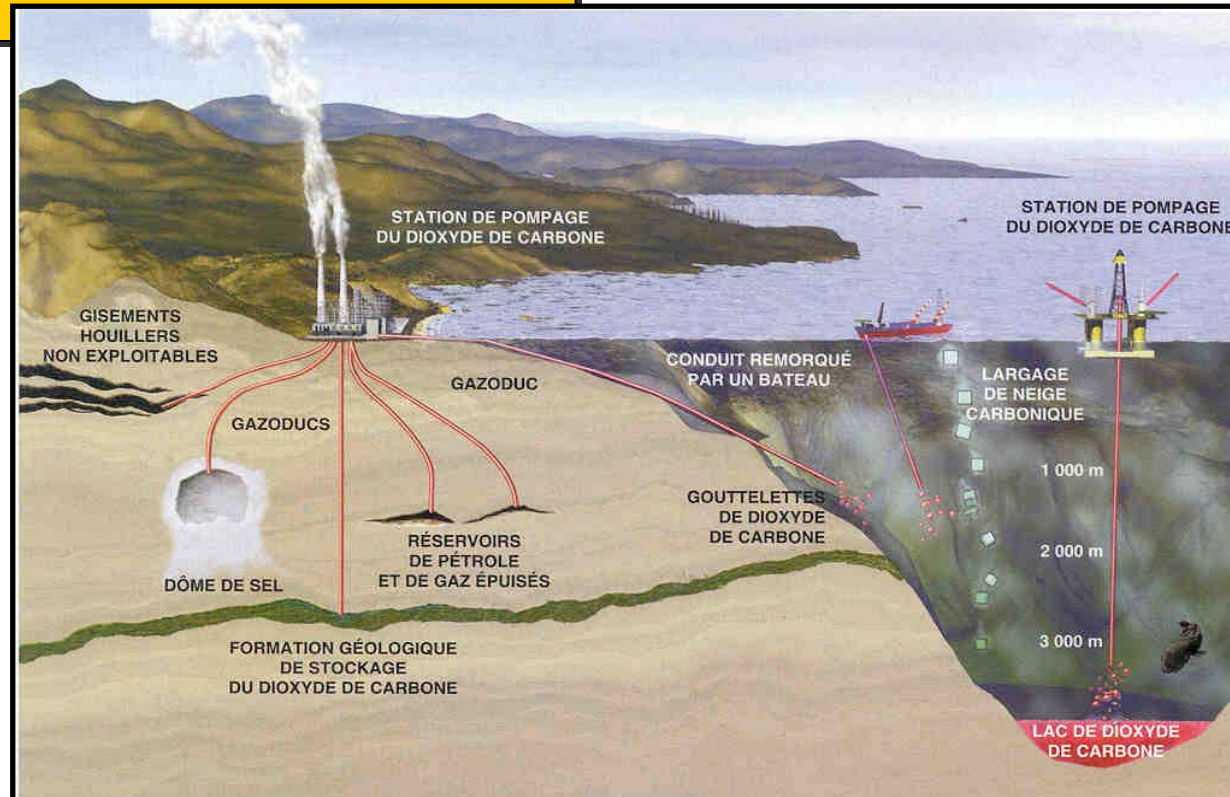
- More or less the same as OntoCAPE:
- Processes, flowsheets (unit operations, streams...)
- Chemistry & Physical phenomena
- Thermodynamic & physical properties of fluids
- Equipments (reactors, valves, columns, control systems,... everything that is found in a P&ID)
- Mathematical modelling of all this!

- *Work processes ontologies*
  - the basis for task-awareness software systems, such as task-related retrieval of information, or automated process workflow execution.
- *Document ontologies*
  - characterize the documents produced in the course of a project
- *Decision ontologies*: formal models of decision making procedures
  - inference engines can check if the decisions are consistent.
- *Organisation ontologies* : internal structures of the companies and institutions involved.
  - used to restrict access rights to information, to define user-specific views, to coordinate cross-institutional project teams



# CO2 mitigation is an appropriate application domain

- CO2 capture in industrial processes
- CO2 transportation
- CO2 storage in depleted oil fields





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- The Petroleum Industry is a potentially **rich domain** for Semantic Web technologies.
- **IFP wants to be involved** in developing the ontologies that are key to our activities:
  - earth sciences, processes, environment, CO<sub>2</sub>,...
- CO<sub>2</sub> mitigation is an adequate target application domain
- IFP will undertake new activities on this subject.





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