KES: Knowledge Enabled Services for better EO Information Use

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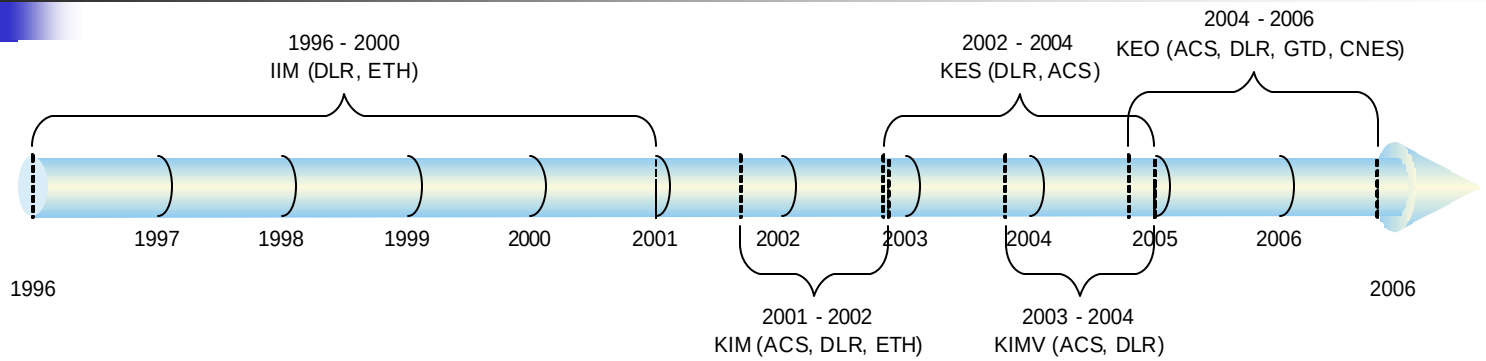
The problem

- During the last decades, the satellite image catalogues have stored huge quantity of data
- State of the art catalogues permit only to specify location, time of interest, metadata like platform, sensor, acquisition mode...

The interpretation task

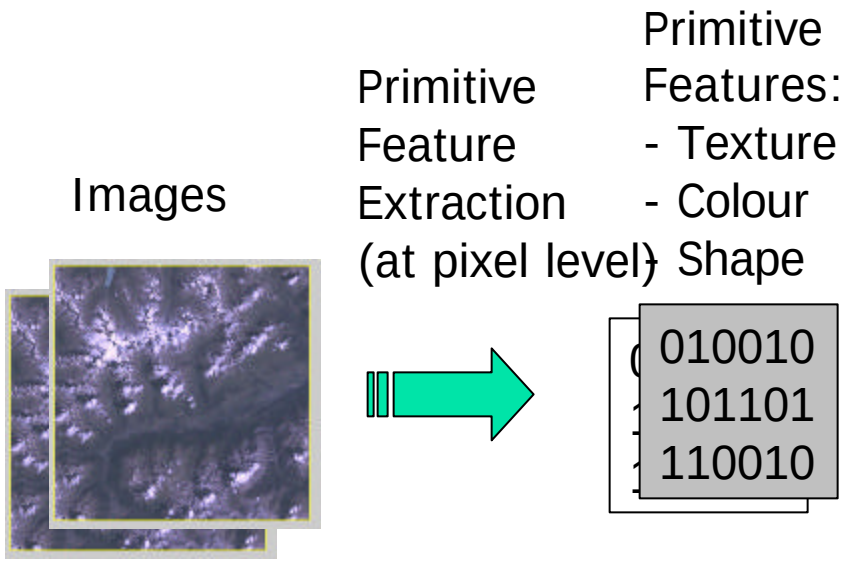
- The interpretation of EO images requires
  - Fusion of data/information for better understanding of structures
  - Aggregation with existing knowledge specific to the application fields (at higher level)

A little bit of history..

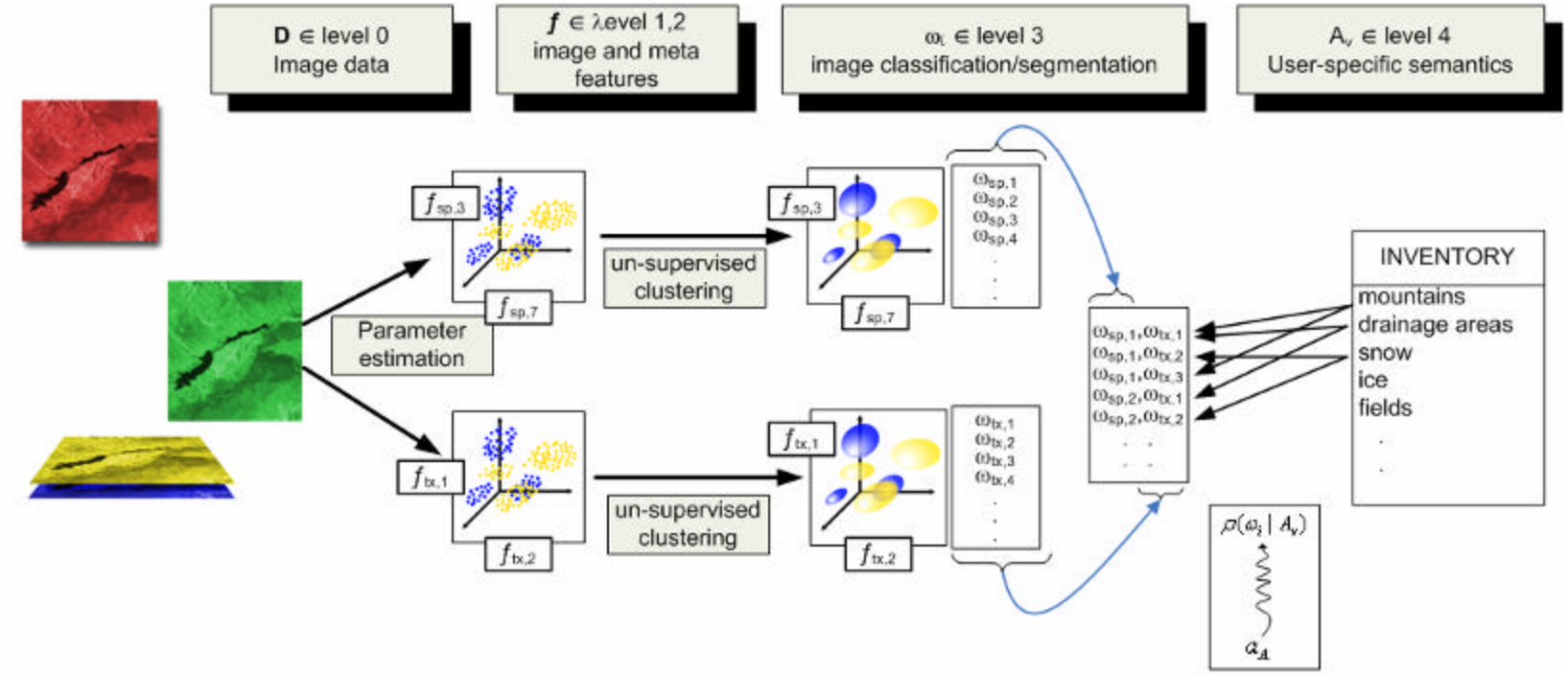


- 1996-2000 IIM (Image Information Mining) (http://isis.dlr.de/mining)
- 2001: KIM (Knowledge Information Mining) (http://www.acsys.it:8080/kim)
- 2002: KES (Knowledge Enabled Services)
- 2003: KIMV (KIM Validation)
- 2004: KEO (Knowledge-centred Earth Observation)

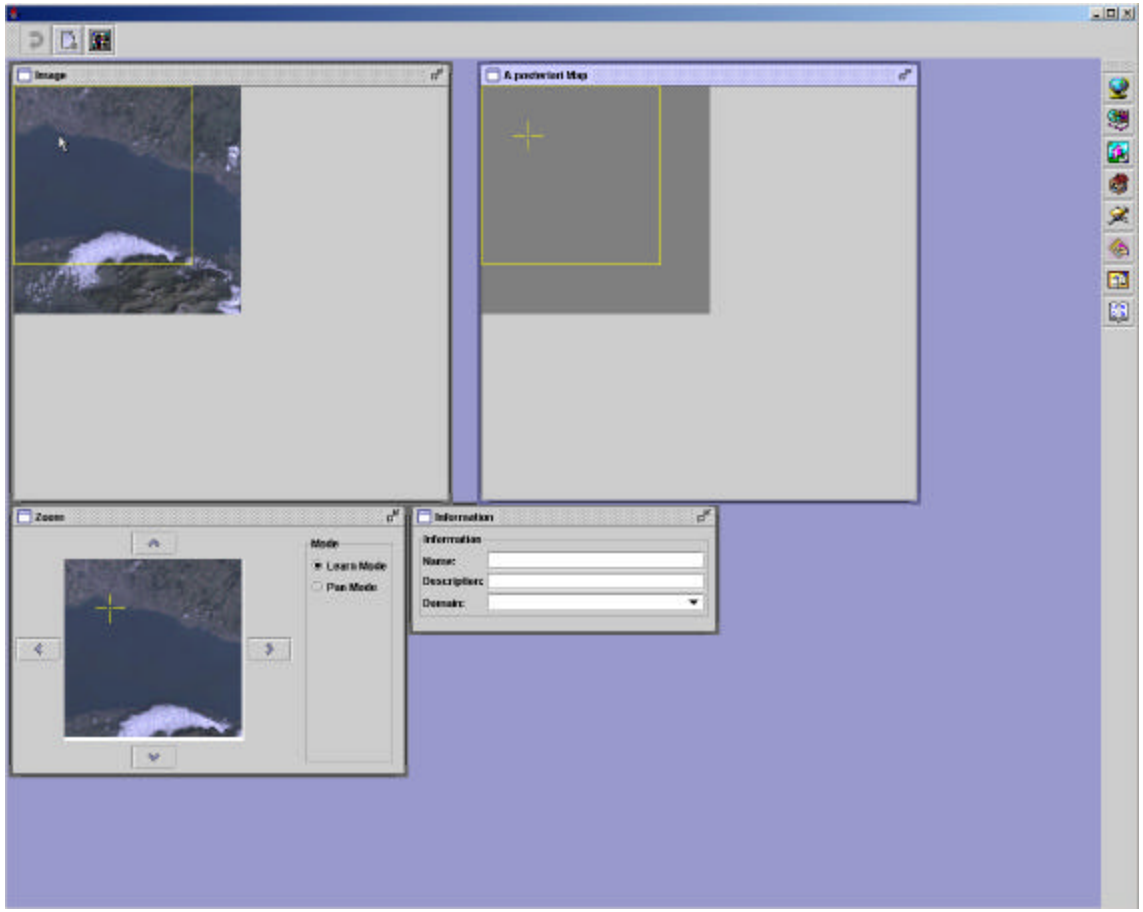
KIM: Knowledge Driven Information Mining



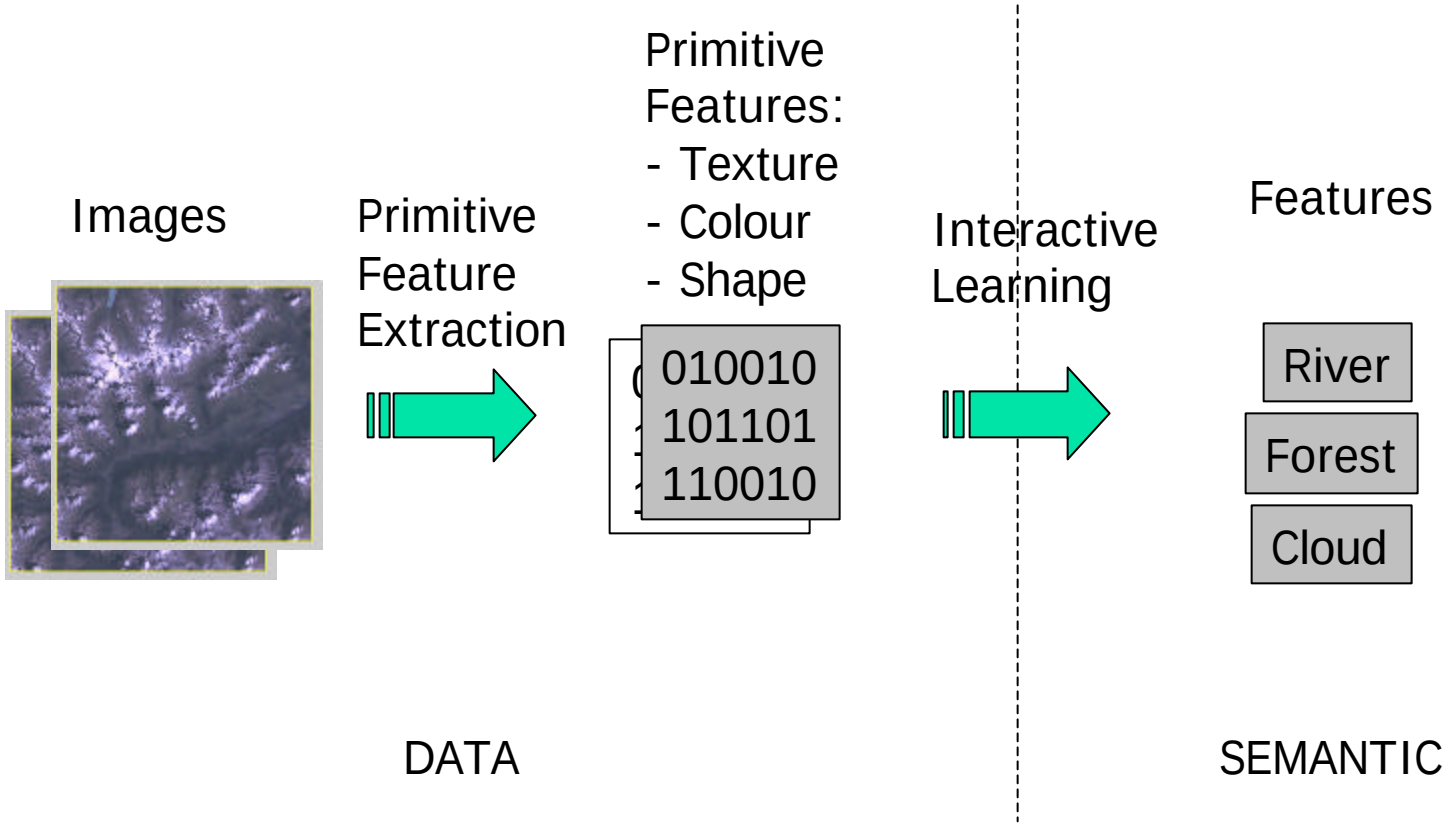
More in detail



KIM Interactive learning



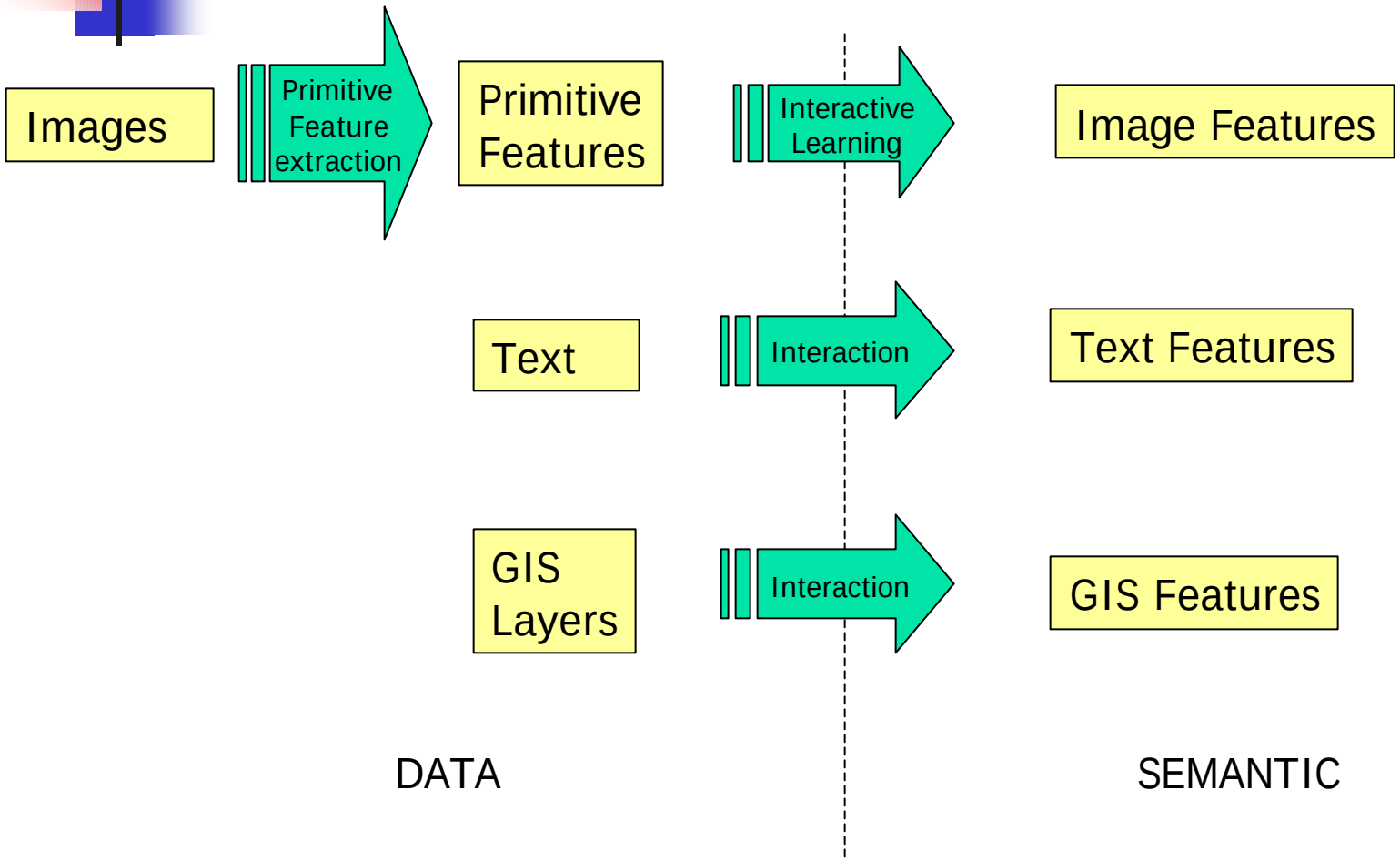
From data to semantic



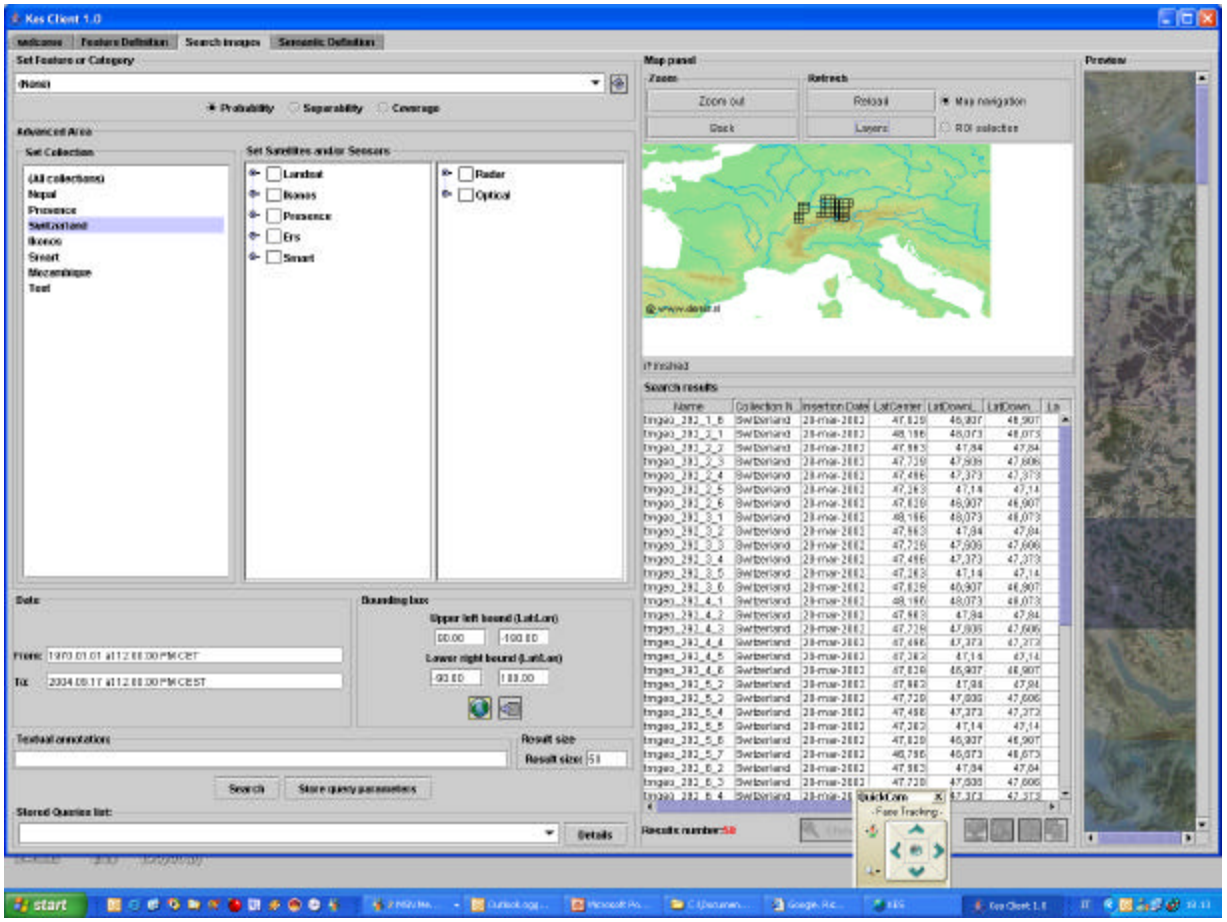
From KIM to KES (Knowledge Enabled Services)

- Image interpretation is not a simple task. Each user needs a set of accessory data, as for example GIS layers or texts obtained through Internet.
- Yet, the amount of available information makes searches a demanding and expensive task.
- An environment where images are at the focal point, and where each user can navigate through a taxonomically structured knowledge, could be of extreme value.

Other semantic



KES: New interface



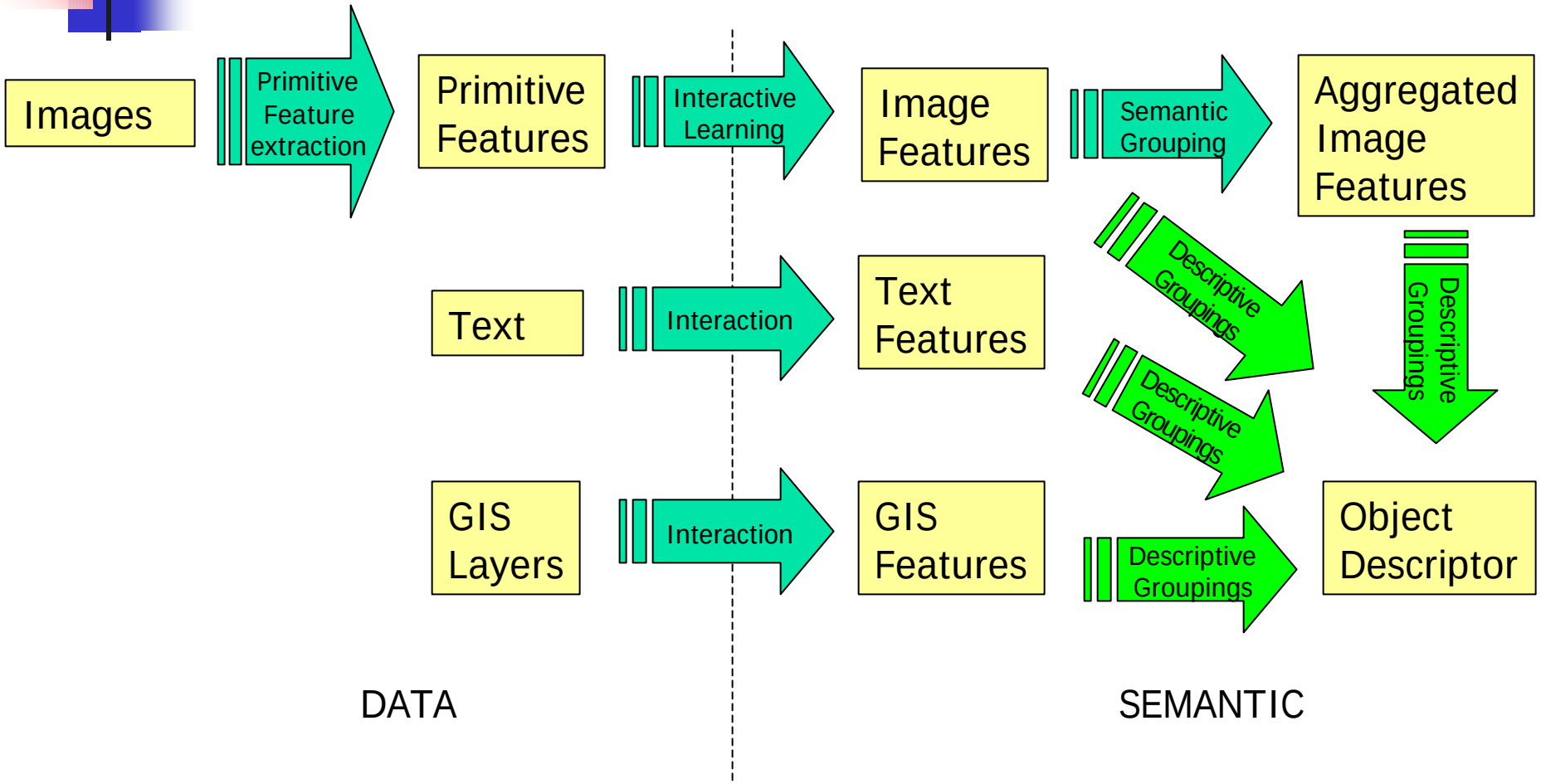
Semantic Grouping

- In KIM it is simple to define a feature by identifying a river through positive and negative examples.
- However, the “river" might become part of a wider concept (e.g.: water). This should be implemented without retraining the system for all possible water types.

Aggregated Features

- In KES a new kind of grouping, called “aggregated features”, has been introduced.
- In a similar way as in defining positive and negative examples on the image, it will be possible to define the concept “water” as:
- Positive examples:
  - sea + river + lake + water reservoir
- Negative examples:
  - streets + houses + mountains

Semantic Grouping



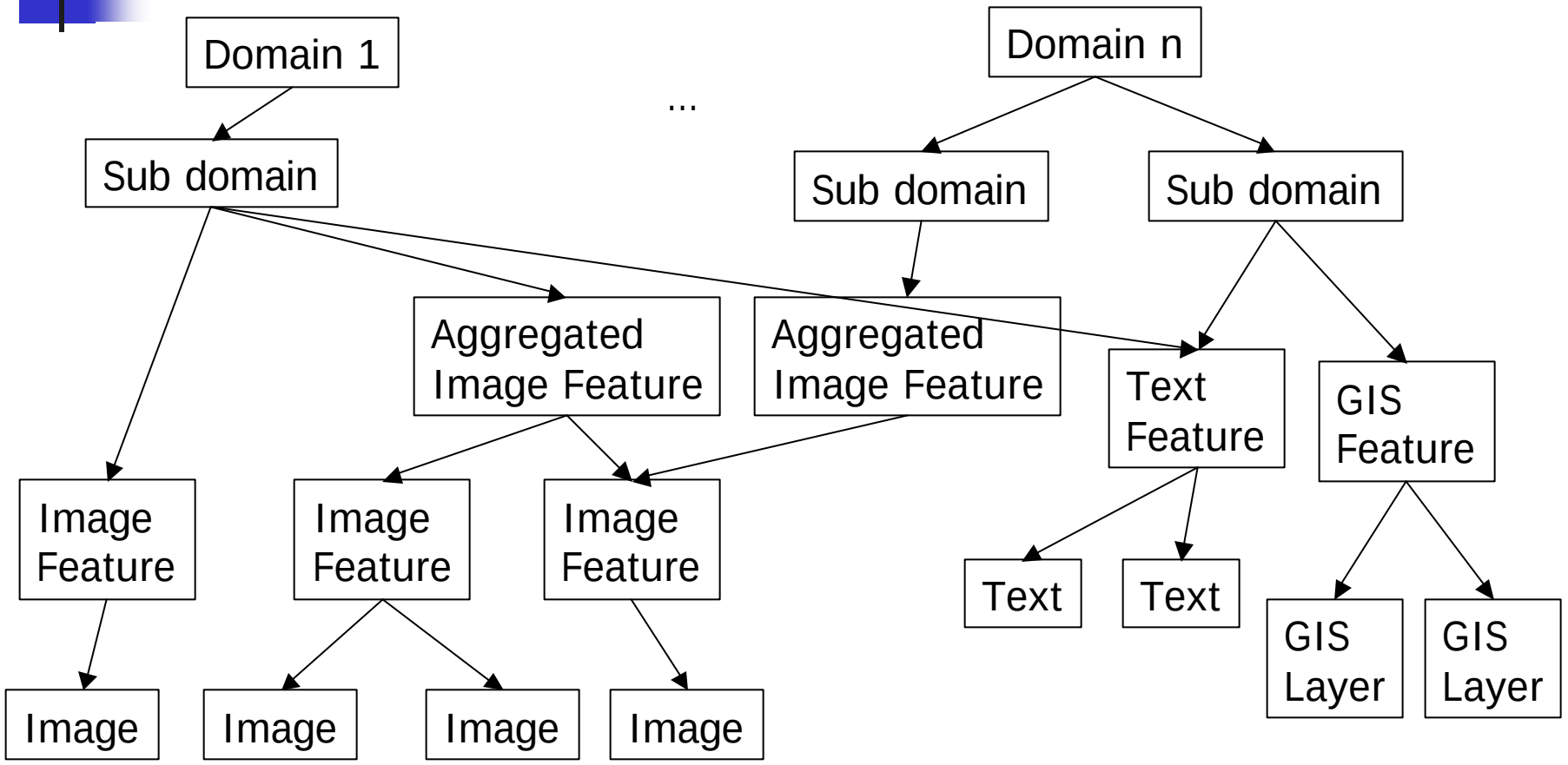
Ontology

- Ontology is the specification of a conceptualisation. It can be related to a system (System Ontology, which can be domain independent and reused for different domains) or to a domain (Domain Ontology, specific for that domain).

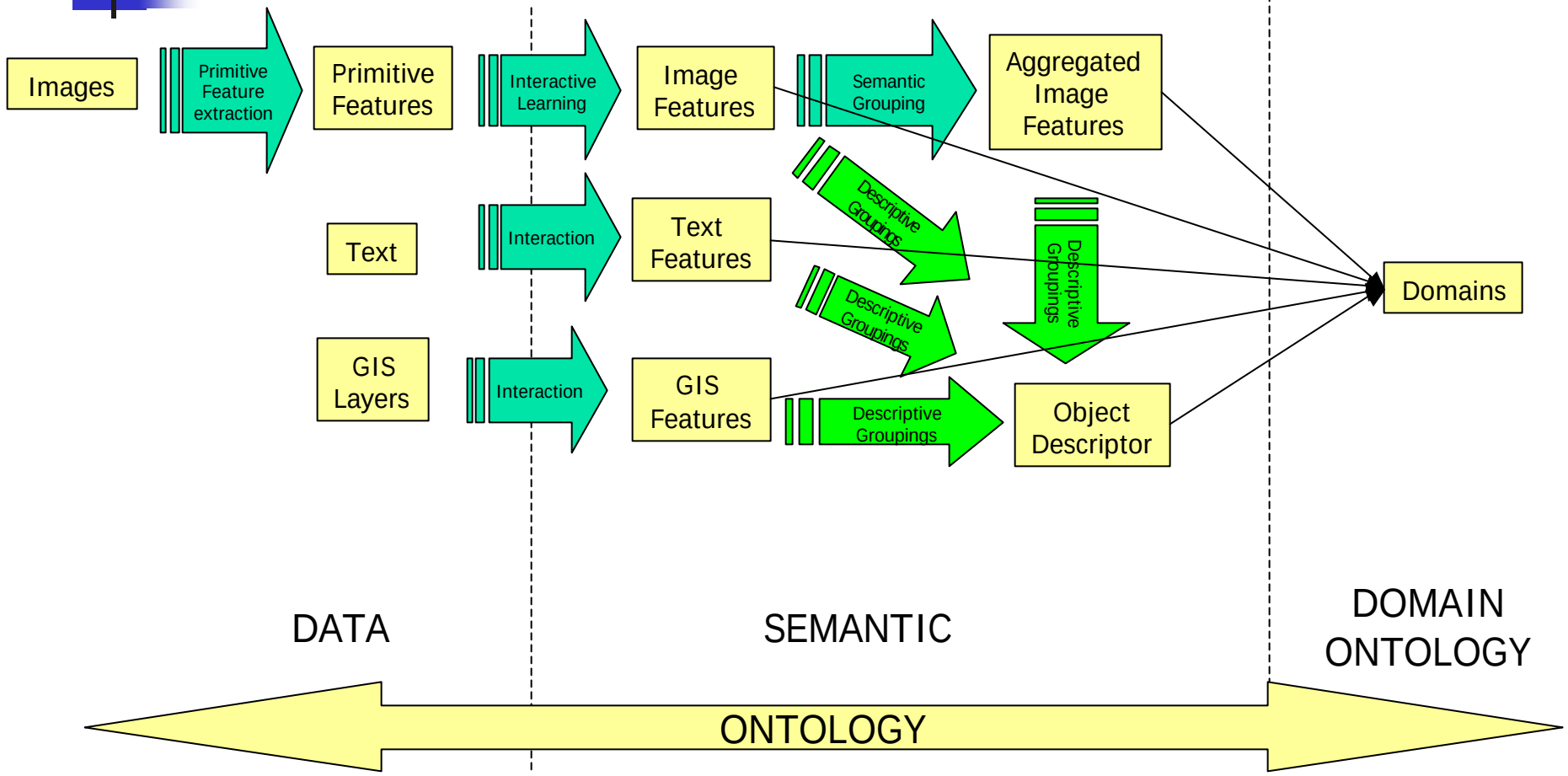
Domain Ontology

- Domain ontology is the set of definitions and concepts pertaining and belonging to a specific domain (and shared by concerned people).
- Different domains have generally different ontologies. As an example, a climatology expert could have a different vision of (and terms to describe) water compared to that of an oceanography expert.

Taxonomy


Domain 1
...
Domain n
Sub domain
Sub domain
Sub domain
Aggregated Image Feature
Aggregated Image Feature
Text Feature
GIS Feature
Image Feature
Image Feature
Image Feature
Text
Text
GIS Layer
GIS Layer
Image
Image
Image
Image

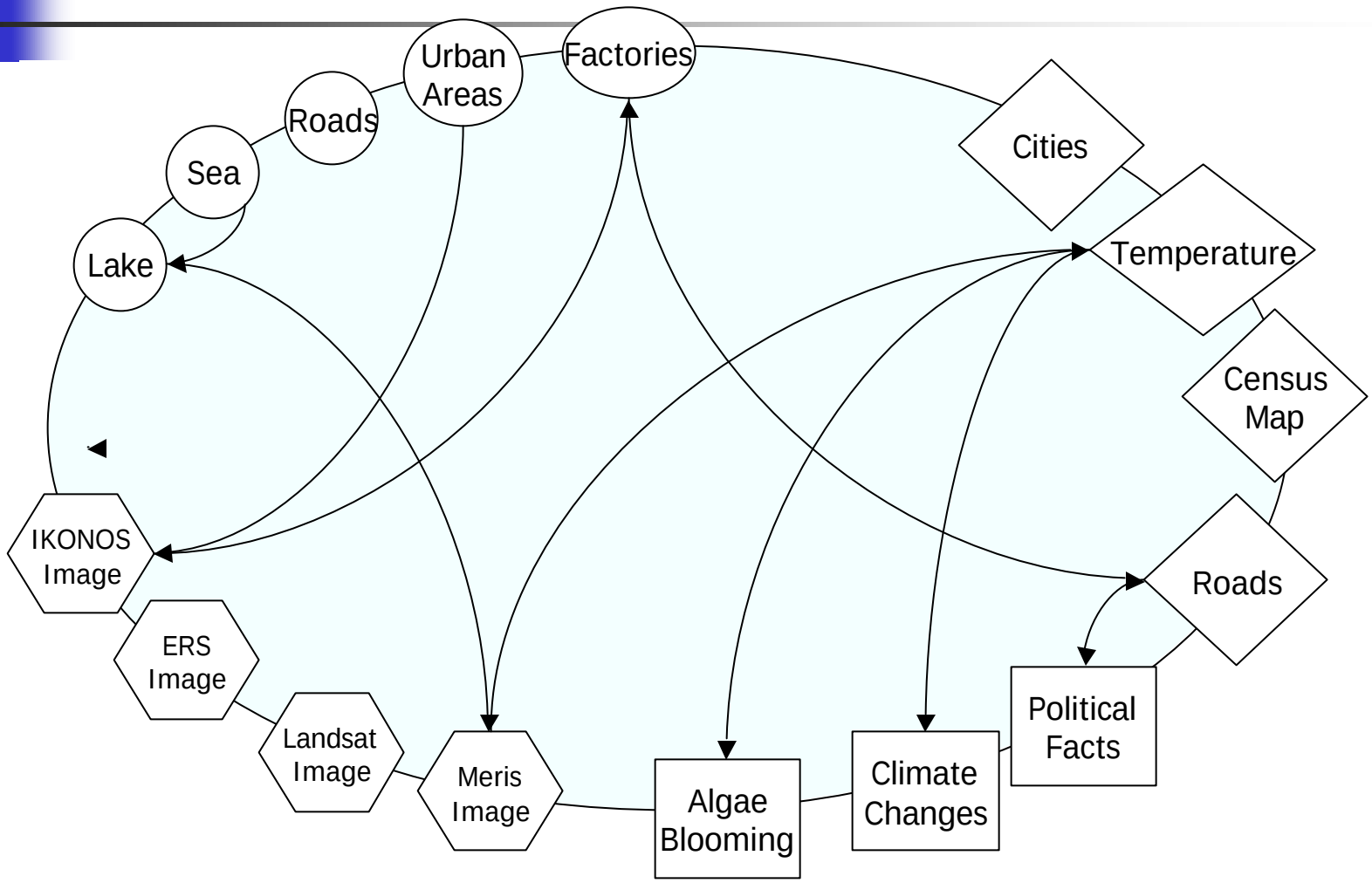
Data / Semantic / Ontology



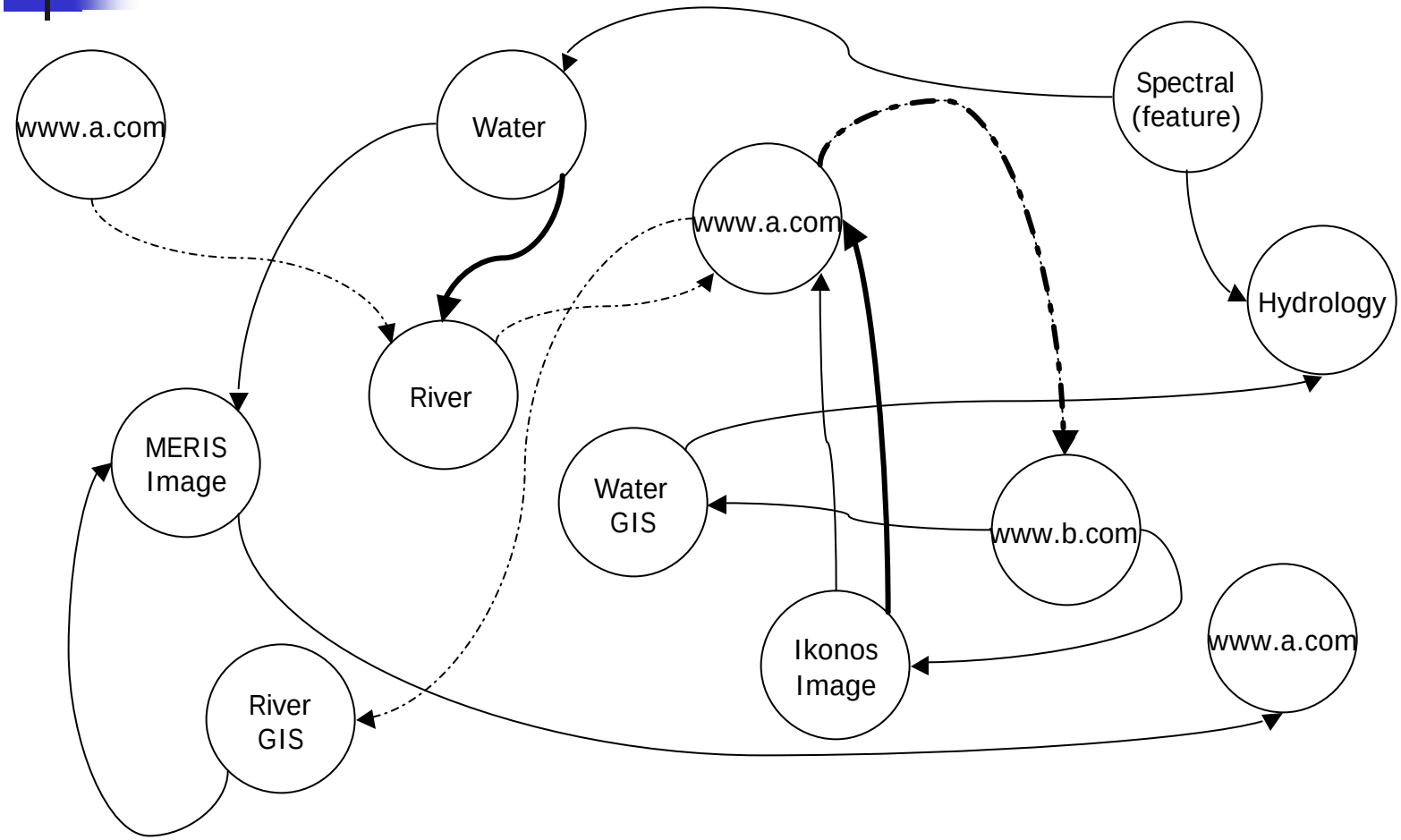
Implicit and explicit knowledge transfer

- The KIM prototype permits to associate weighted combinations of primitive features to image features. While defining features, the user explicitly transfers knowledge to the system, which is stored and made available to the same or other users.
- In addition there is a further type of knowledge (implicit) that could be discovered: if the user domain of interest is known, by observing the user interactions with the system during search and browsing, it is possible to infer the data of likely user interest and link it with the pertinence domain.

Knowledge transfer



Knowledge Graph



Knowledge Discovery

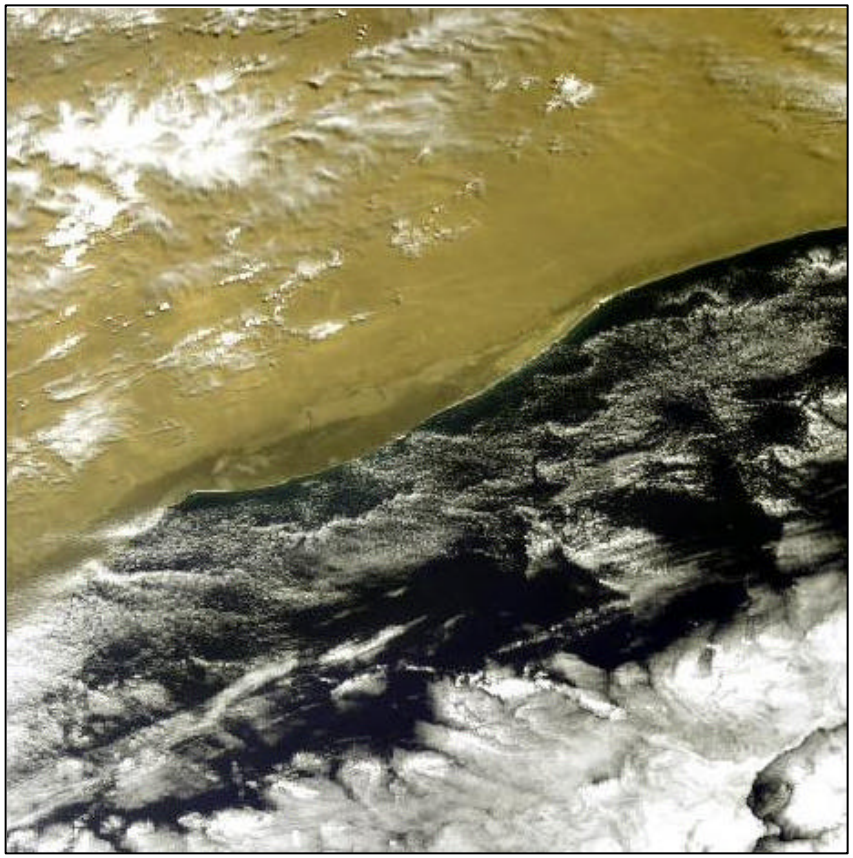
Exploring this graph means discovering the user's knowledge

KIMV (KIM Validation)

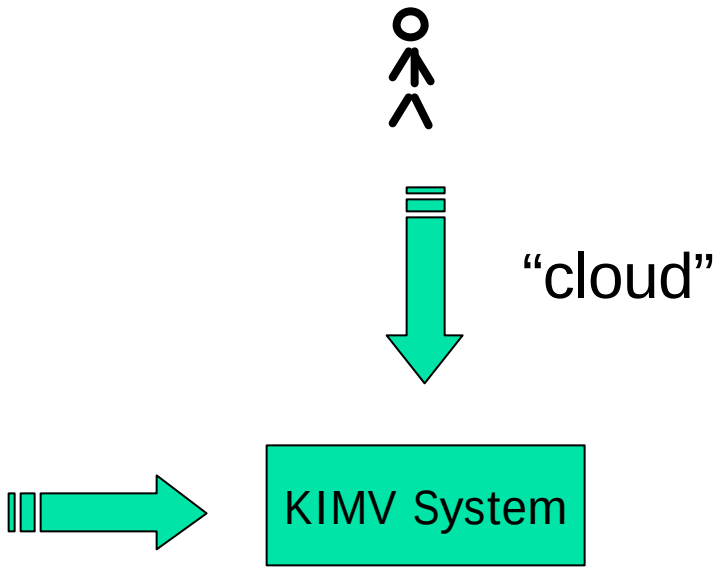
A practical case study:

Automatic cloud classification in MERIS images

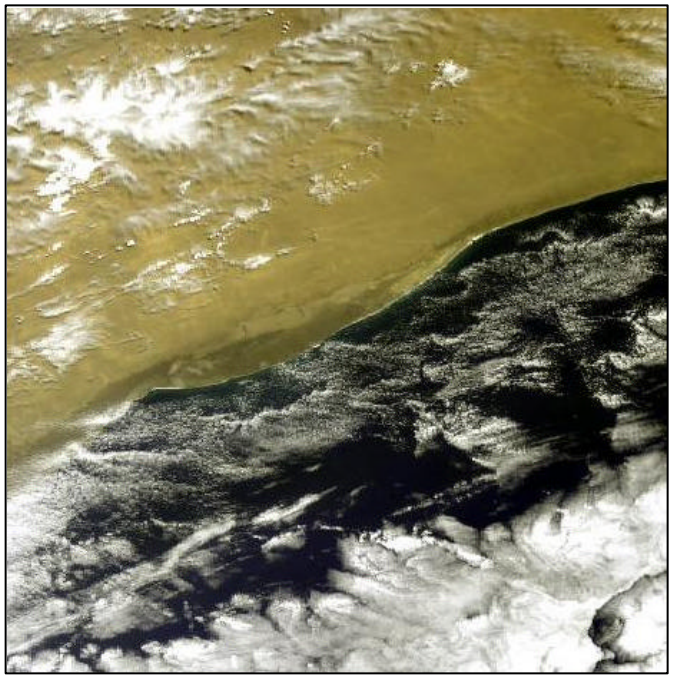
Cloud Cover Characterization



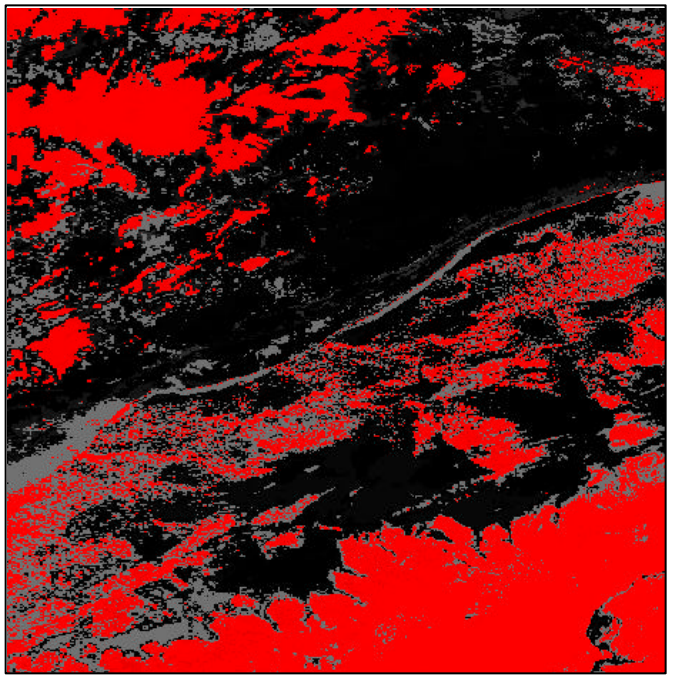
MERIS Level 1 – Reduced Resolution



Cloud cover characterization



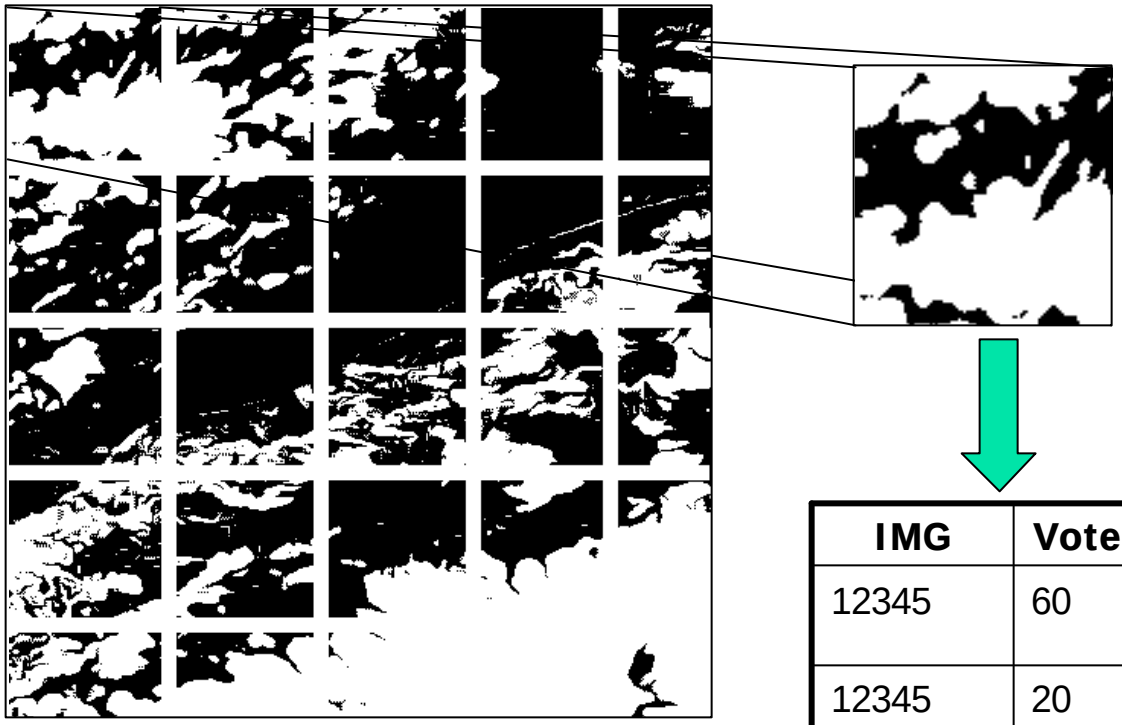
Map of Cloud object



MAP Object Extraction

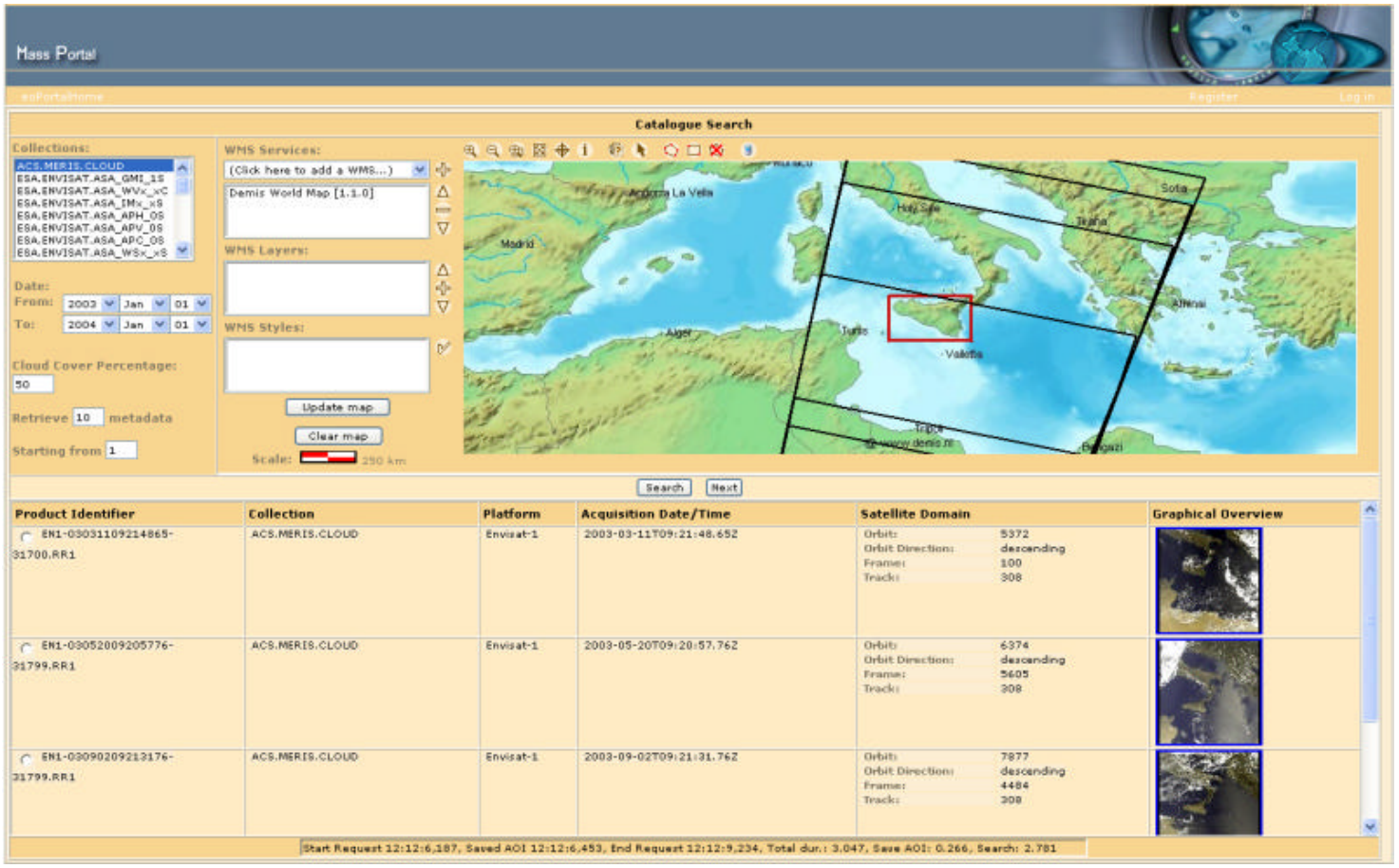
Binarized, closed
MAP of “cloud” label

Tiling



IMG	Vote	Shape
12345	60	(x1,y1)-(x2,y2)....
12345	20	(x1, y1)-(x2,y2)...

MASS


Mass Portal
Catalogue Search
Collections:
ACS.MERIS.CLOUD
ESA.ENVISAT.ASA_GMI_1S
ESA.ENVISAT.ASA_WVx_xC
ESA.ENVISAT.ASA_IMx_xS
ESA.ENVISAT.ASA_APH_0S
ESA.ENVISAT.ASA_APV_0S
ESA.ENVISAT.ASA_APC_0S
ESA.ENVISAT.ASA_WSx_xS
Date:
From: 2003 Jan 01
To: 2004 Jan 01
Cloud Cover Percentage:
50
Retrieve 10 metadata
Starting from 1
WMS Services:
(Click here to add a WMS...)
Demis World Map [1.1.0]
WMS Layers:
WMS Styles:
Update map
Clear map
Scale: 250 km
Search
Next
Product Identifier
Collection
Platform
Acquisition Date/Time
Satellite Domain
Graphical Overview
EN1-03031109214865-31700.RR1
ACS.MERIS.CLOUD
Envisat-1
2003-03-11T09:21:48.652
Orbit: 5372
Orbit Direction: descending
Frame: 100
Track: 308
EN1-03052009205776-31799.RR1
ACS.MERIS.CLOUD
Envisat-1
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Orbit: 6374
Orbit Direction: descending
Frame: 5605
Track: 308
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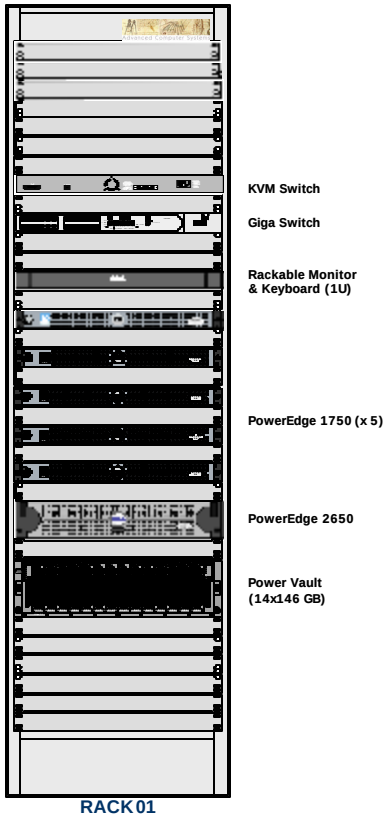
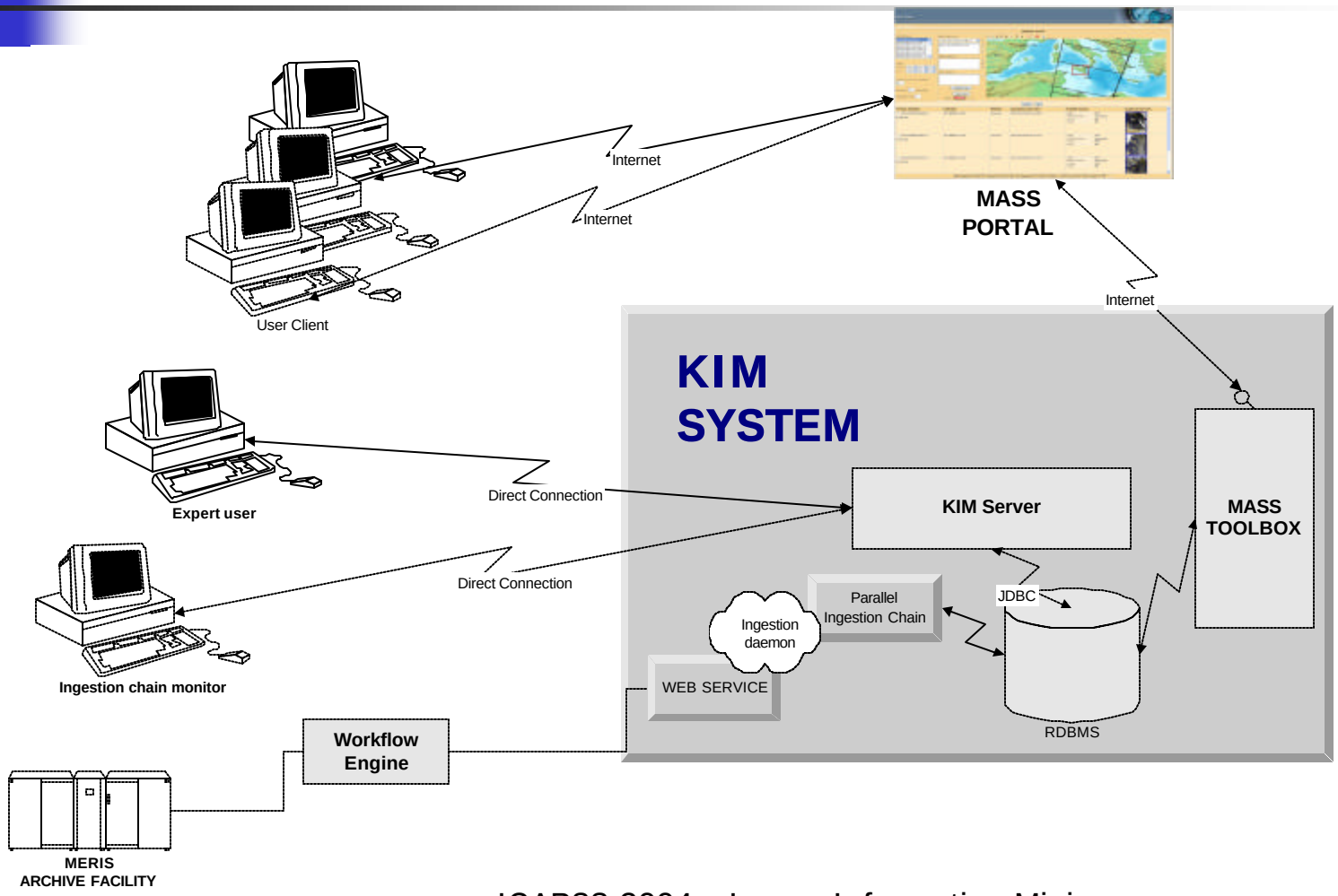
ACS.MERIS.CLOUD
Envisat-1
2003-09-02T09:21:31.762
Orbit: 7877
Orbit Direction: descending
Frame: 4484
Track: 308
Start Request 12:12:6,187, Saved AOI 12:12:6,453, End Request 12:12:9,234, Total dur.: 3.047, Save AOI: 0.266, Search: 2.781

Linux Cluster



- Cluster nodes: 10 Dell 1750, dual Xeon 3 GHz
- Database and Application Server: Dell 6600, 4 Xeon 2.8 GHz

System Context



KIM prototype

- http://www.acsys.it:8080/kim

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Visit the ACS stand for a demo