DILIGENT:
Deploying Virtual Research Environments on-demand

Diligent

From Digital Objects
to Content across
eInfrastructures

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Outline

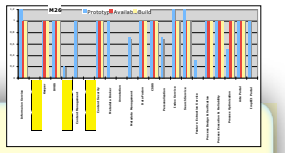
- Motivations & overview
- Achievements
  - DL related services
  - DILIGENT Infrastructure
  - ImpECt application
- D4Science

Motivations – from DLs to VREs

- DLs are evolving into “Virtual Research Environments” (Collaboratoria)
  - Distributed frameworks for carrying out cooperative activities like “in silico experiments”, data analysis and processing, production of new knowledge using specialised tools
  - Largely based on retrieval and access of always updated knowledge from diverse heterogeneous content sources
  - The knowledge produced is preserved and made available for other usages inside and outside the VRE

VREs trend

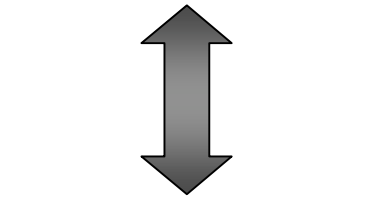
Highly dynamic, created and dismissed on-demand



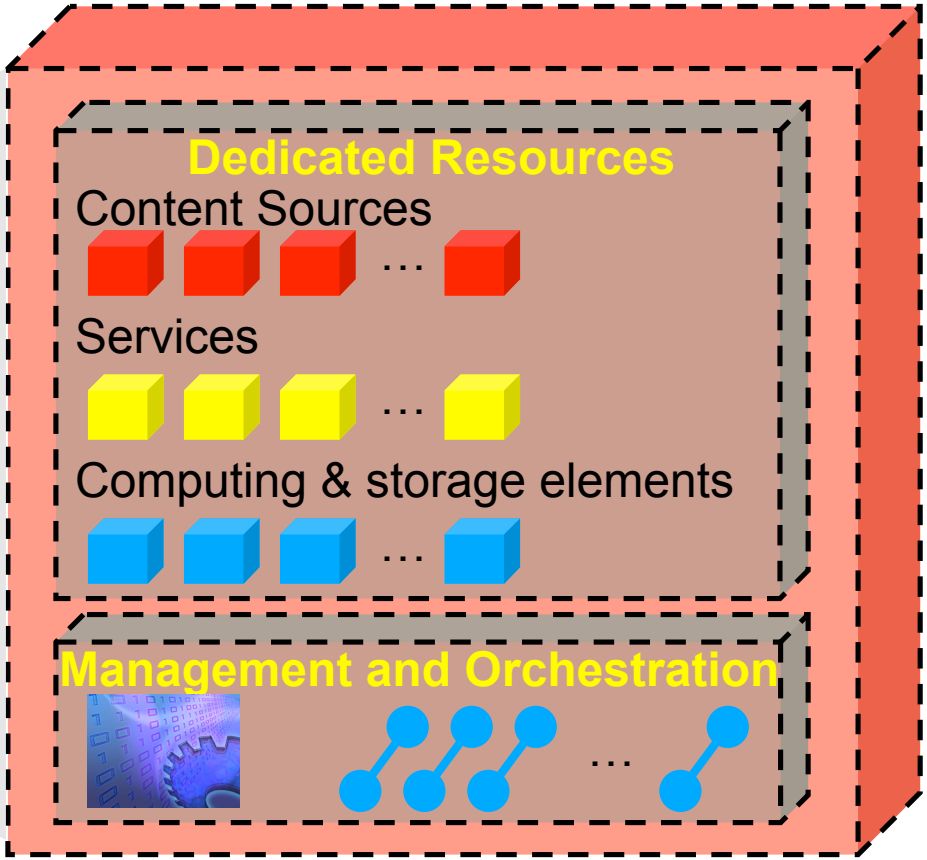
Based on specialised tools which support the generation of new knowledge

VRE system

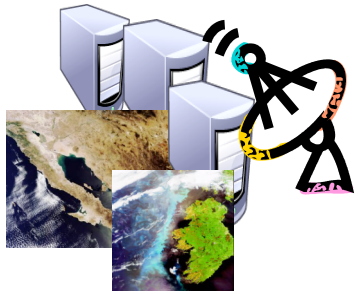
VRE



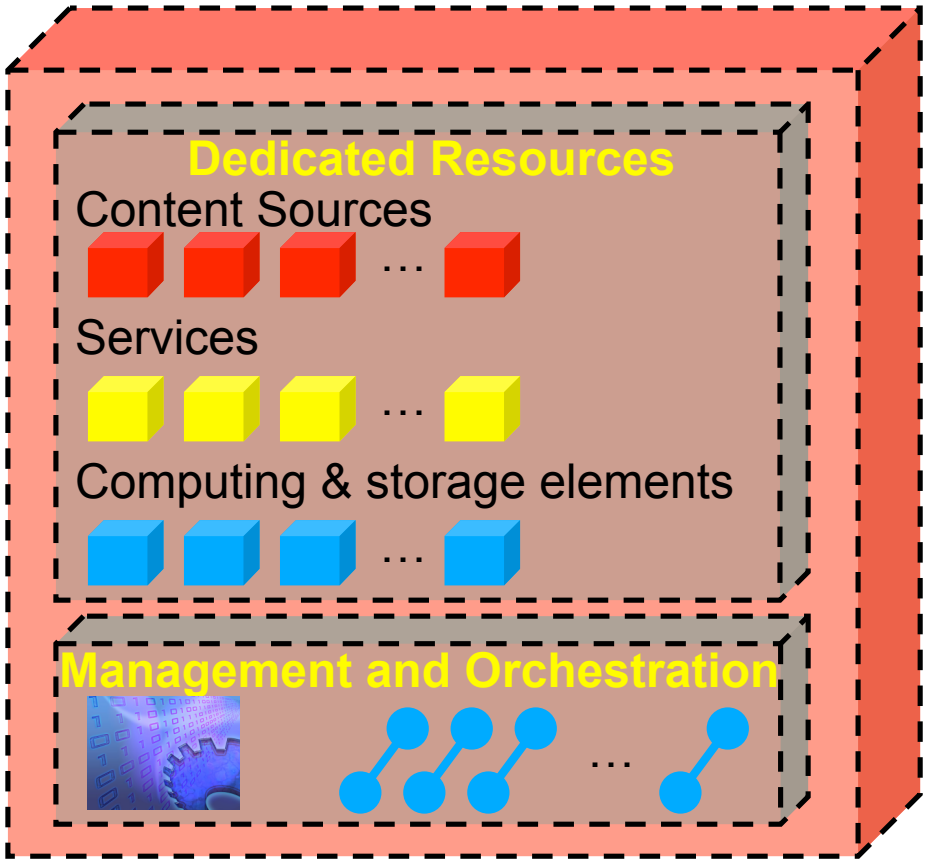
VRE System



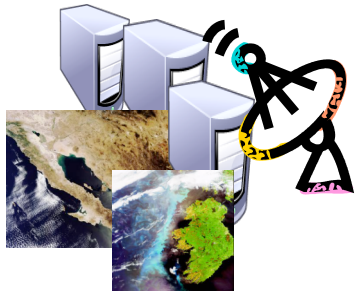
1-to-1 model: sustainability

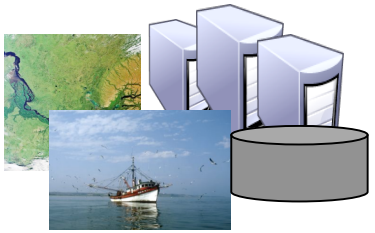


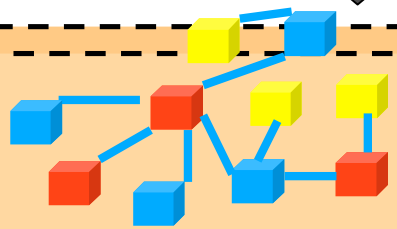
- The cost of a dedicated system can be too high for volatile VREs that use many resources

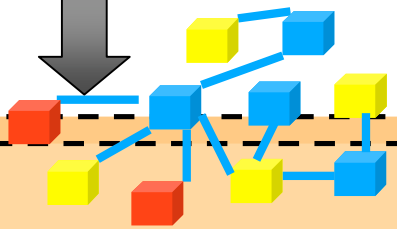


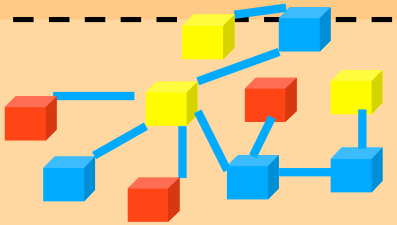
Outsourcing to the e-Infastructure



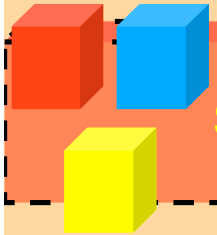








e-Infrastructure



Shared Resources

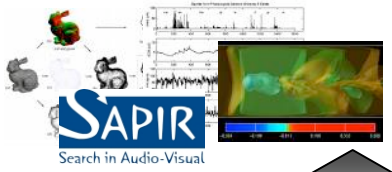
Management and Orchestration

Success factors/challenges

- Infrastructure sustainability
  - Mechanisms for reducing the cost of the infrastructure mng
- Supported VREs
  - Flexible and high quality solutions for satisfying the needs of many different applications domains
  - Simple procedures for creating VREs

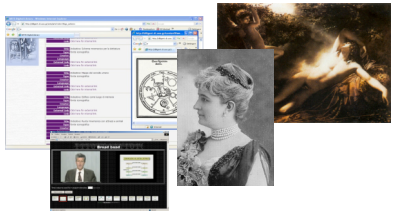
DILIGENT achievements

SAPIR-enabled AV search



ImpECt Environmental Monitoring

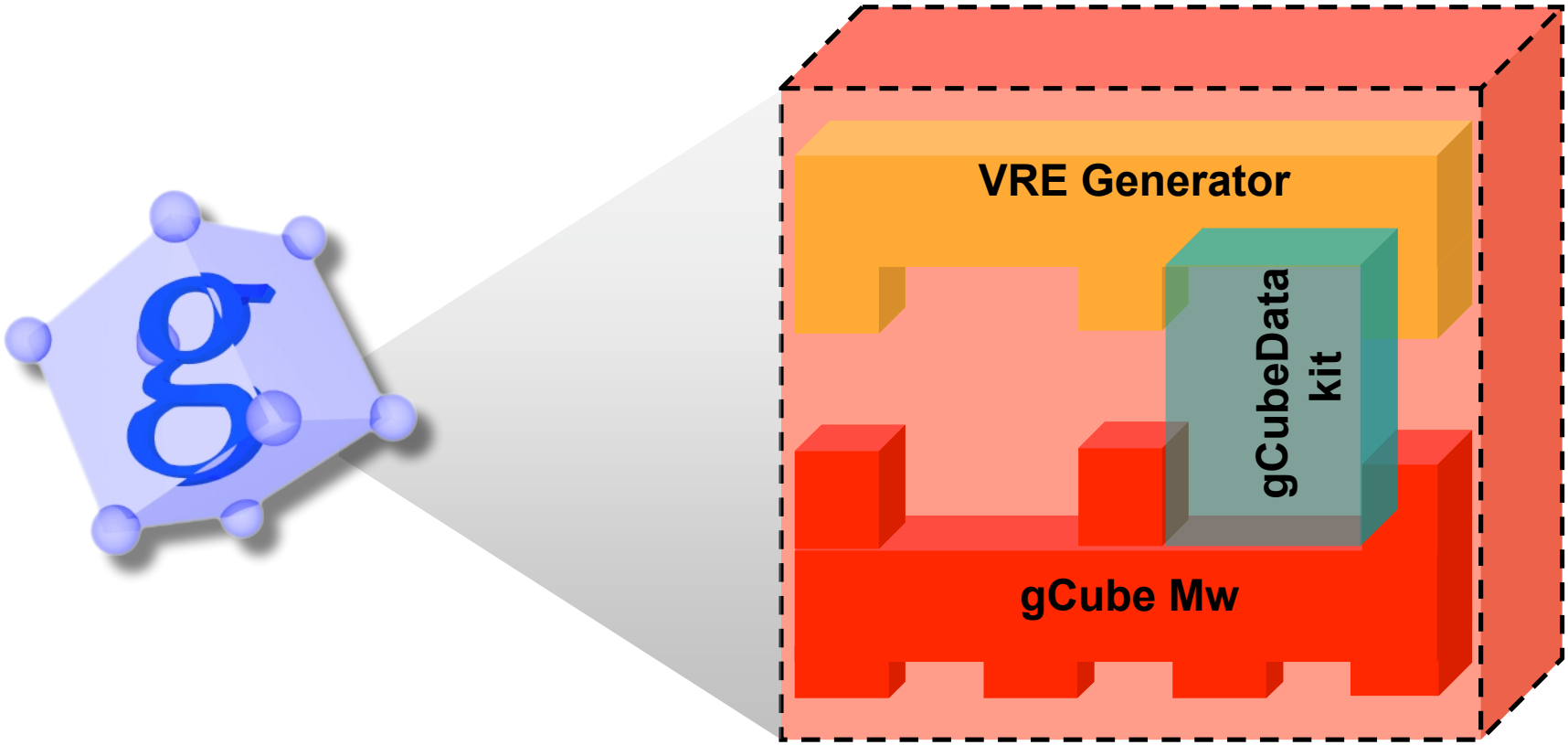
ARTE Education in the Humanites

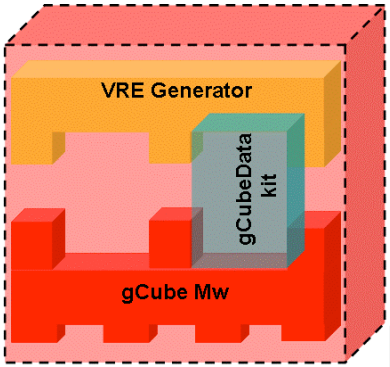


DILIGENT Infrastructure

gCube System

gCube overview



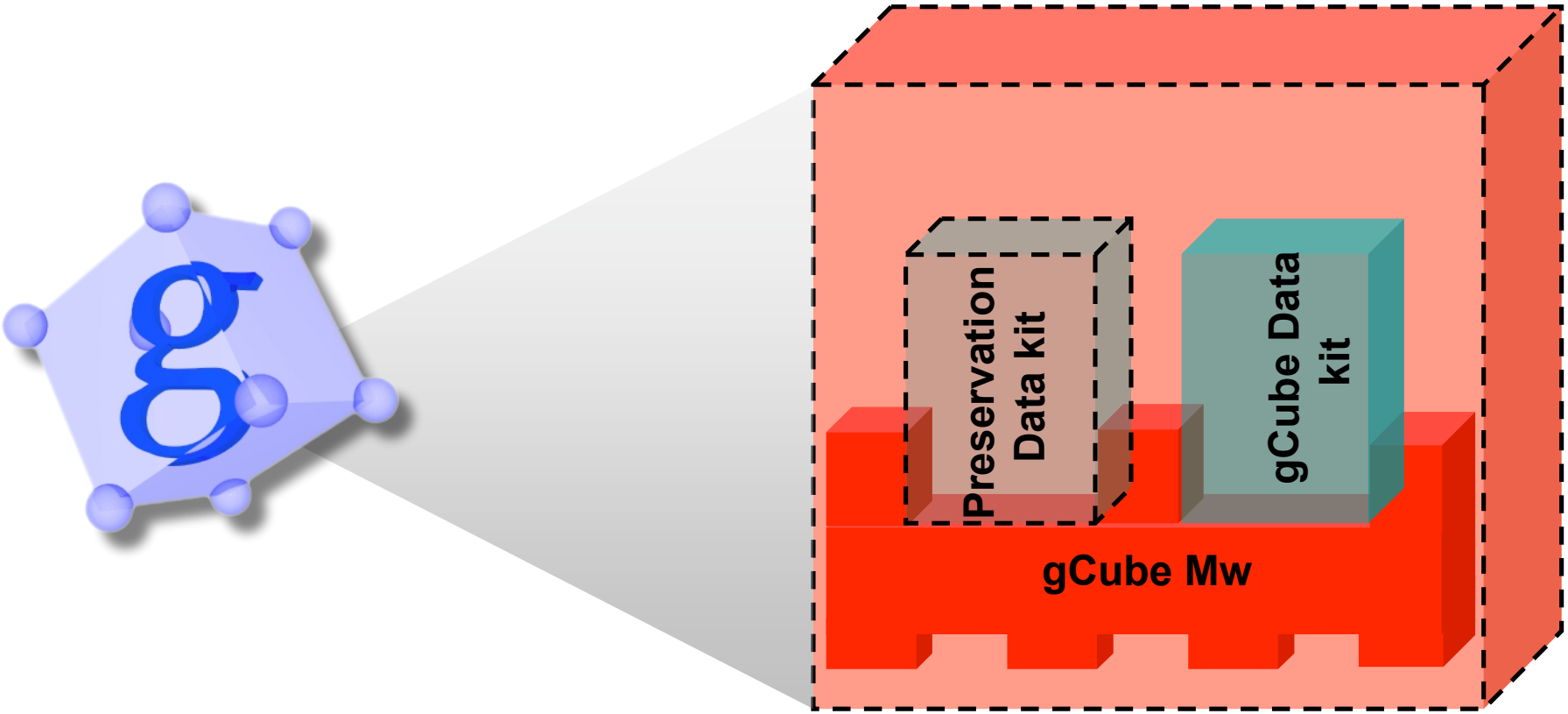


Simplifies the infrastructure management

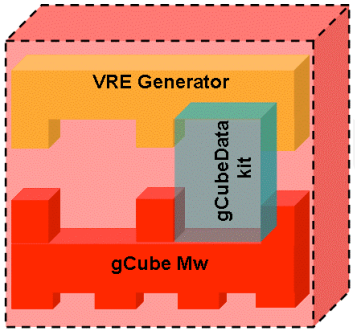
- Resources registration, monitoring, notification,…
- Service deployment, dynamic reallocation, …
- Service composition

Resource | Service | Content Source | Comp&Storage

gCube Middleware [cont.]



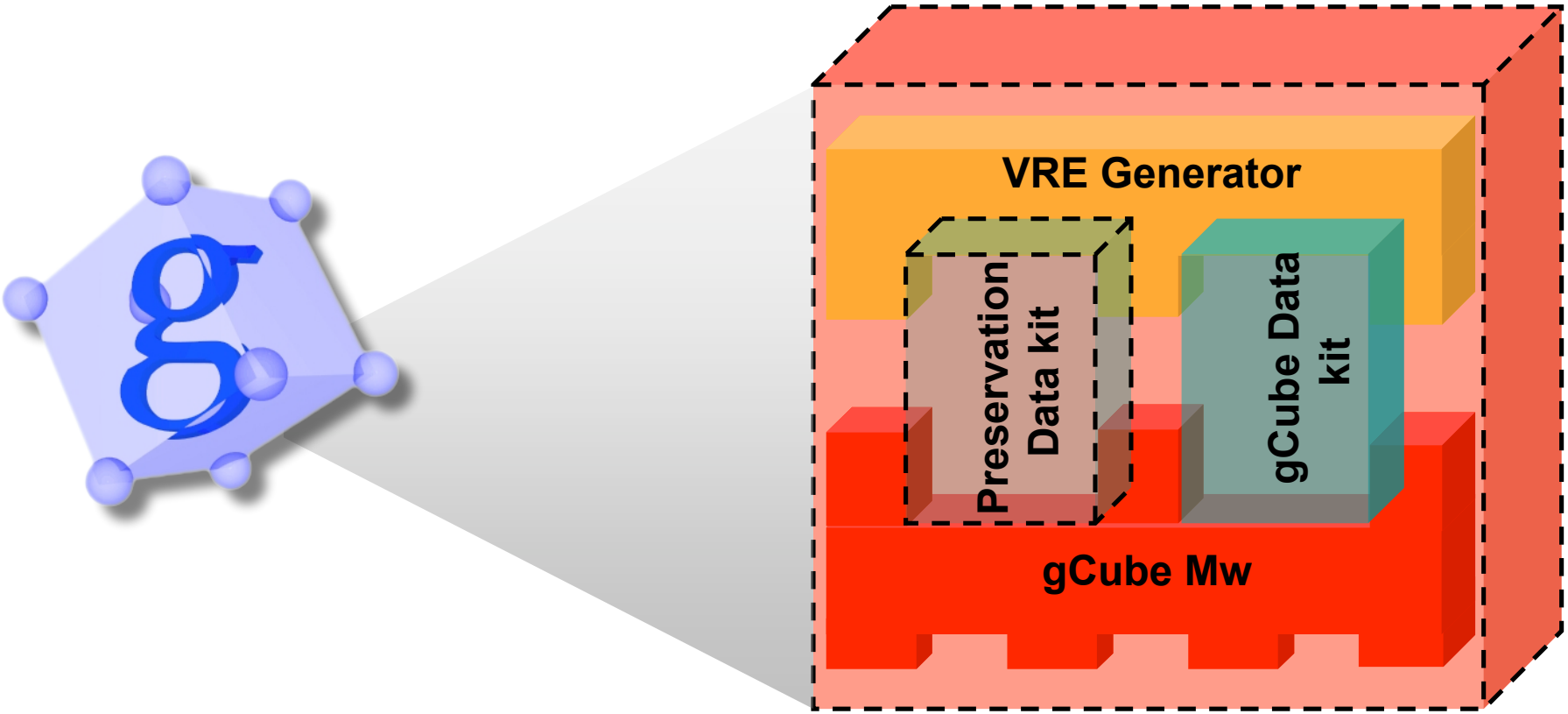
VRE generator



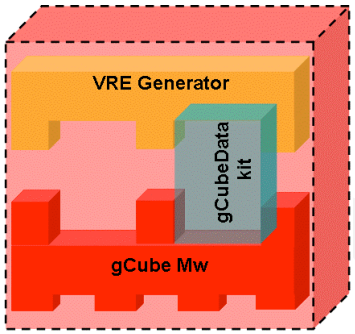
Simplifies the construction of a VRE system

- Transparent selection and orchestration of resources by
  - Offering a GUI
  - Abstracting over complexity
  - Abstracting over heterogeneity

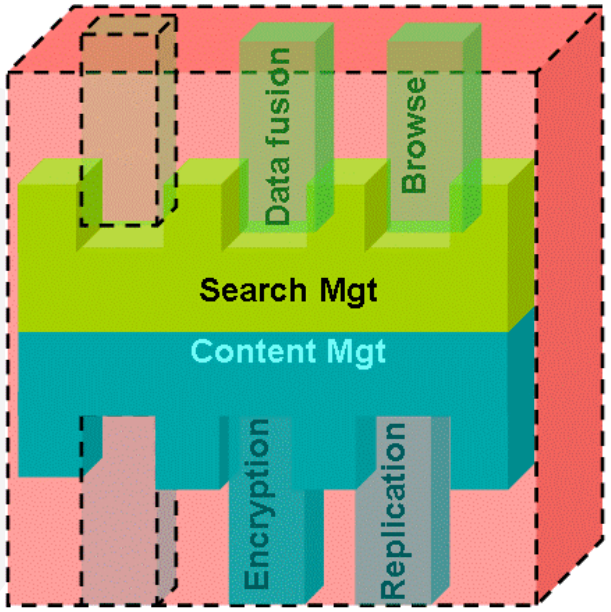
VRE generator [cont.]



gCube Data Kit

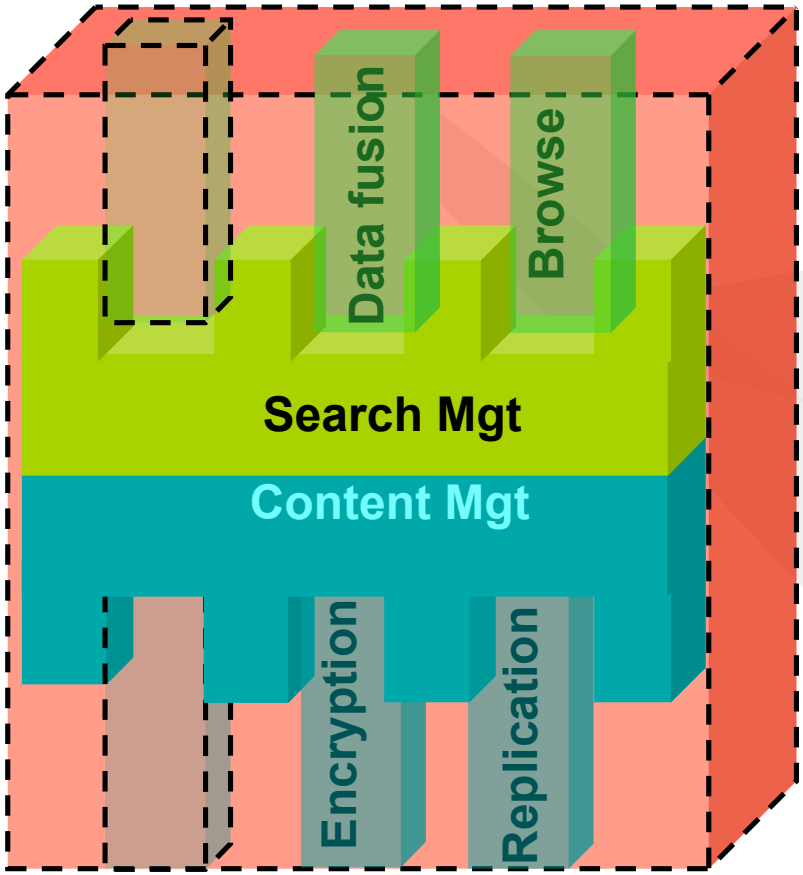


Provides flexible search and management functionality



Data Fusion	Browse	Source sel.	Feature extr.

Focus: Search Management



Most important framework for Information Spaces

Most important functionality / service in Information Access

Main Objectives

- An open, feature-rich, inherently-distributed Search Engine
  - Composed out of diverse, autonomous, pluggable elements
  - Capturing complex application scenarios combining
    - Information retrieval
    - Data processing
- Maximization of resources placed at the disposal of VRE managers and users
  - Ease of sharing of resources, avoiding mis-utilization and misuse
  - Reduction of cost of ownership and use

Objective: Optimal Utilization of Resources

- Essential for:
  - Maintaining QoS contracts
  - Confronting infrastructure-raised challenges
  - Attracting resources to the Grid
- Special challenges:
  - Uncontrolled and dynamic environment
  - High-dimensional search space
  - Multi-facet quality metrics
  - Heterogeneity

Search Management Kit

- Search Management: orchestration of search services
- Operation highlights:
  - Planning & Optimization
  - Distributed Information Retrieval
  - Incremental result delivery

Retrieval of Distributed Information

Distributed Retrieval of Information

Distribution #1: Information Sources

- System diversity
  - Internal, registered/indexed by the system
  - External, Google, JDBC data sources, ISIS/OSIRIS system
- Data diversity
  - Structured and semi-structured (xml)
  - Images
  - Geospatial and temporal
  - Potentially thematically focused
- Processing diversity
  - Metadata structures
  - Querying cost
  - Ranking estimation

Distribution #1: Information Sources

- THE CHALLENGE
  - Characterizing and indexing a diversity of sources
  - Selecting the appropriate sources
  - Fusing/Merging the results in meaningful lists

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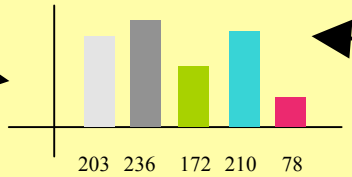
Indexing for Content Based Search

Portal | Feature Extraction | Index Mgt | Metadata & Content Mgt | Content & Metadata

Query

Extract features



Build Index

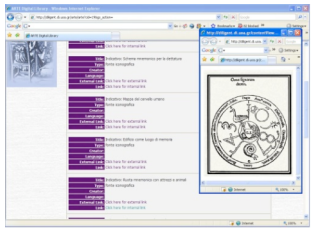
Index

Query Index

MD

Feed

Present results

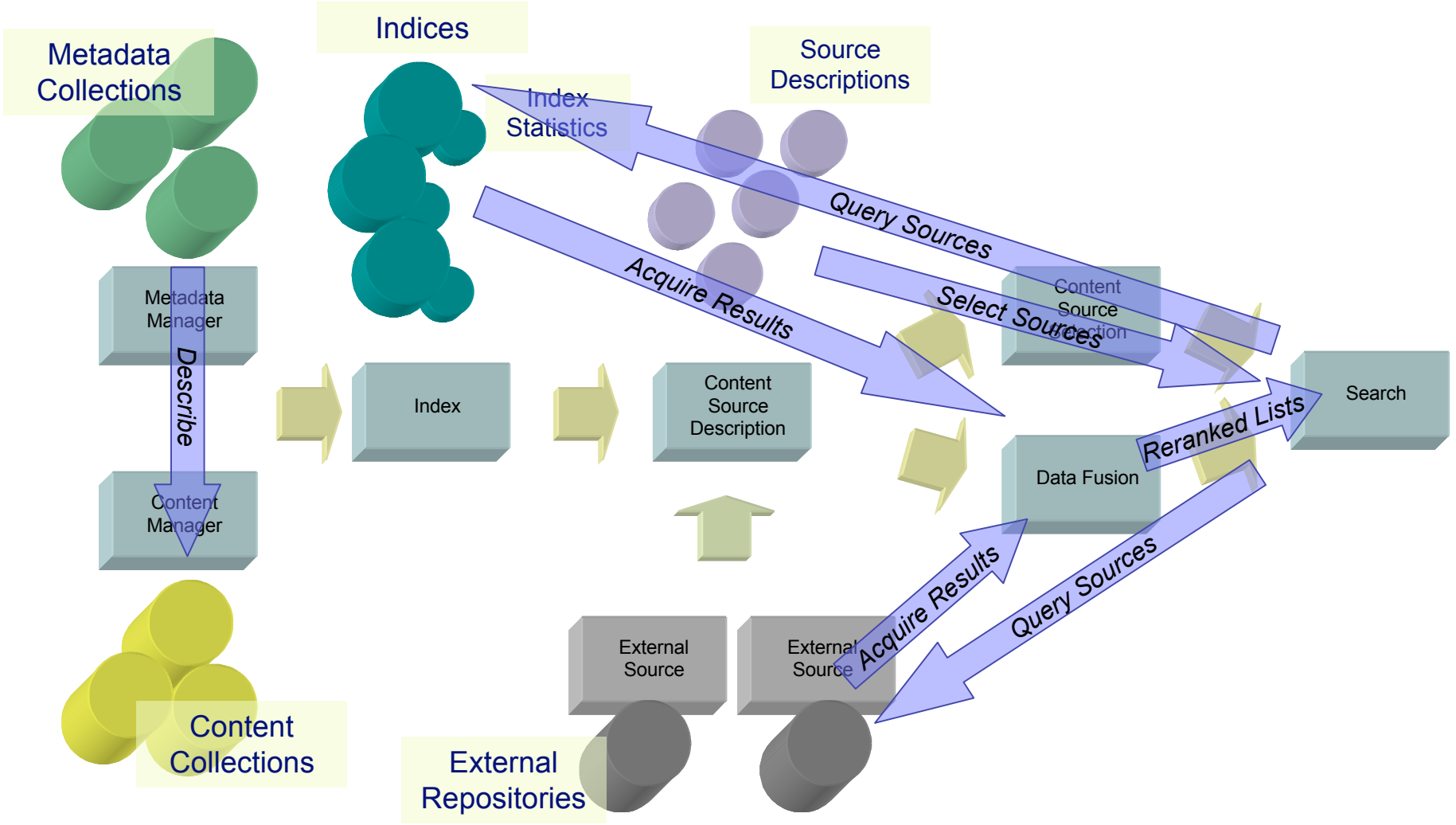


Access metadata & create ResultSet

Feature Extraction Service

Feature Index

Selecting Sources and Fusing Results



Distribution #2: Information Retrieval

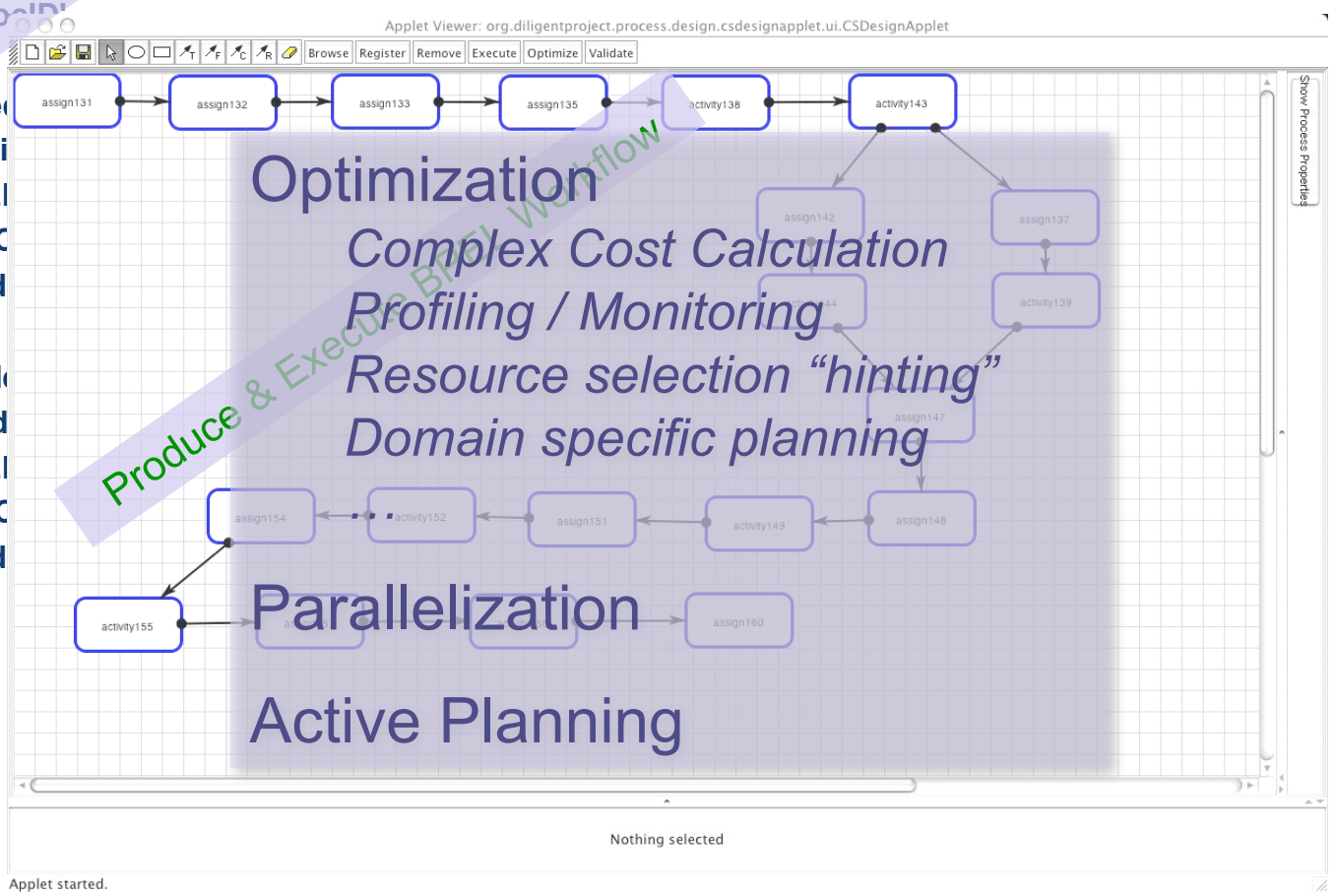
- Numerous Search services, for info retrieval & processing
  - Structured data and XML processing (scanners, sorters, joiners, filterers, transformers, retrievers)
  - Lookups (indices, FT indices, XML indices, Geo indices)
  - Content-based searches
  - External source probes
  - Fusion / Merging of results
- Query language (internal) for interfacing
- Workflow language (BPEL) for execution
- Data transport mechanism (ResultSet) for communication

Query and Workflow Management

```
project by 'title', 'description', 'subject'
    on (keeptop 20
        on (sort ASC by 'DocID'
            on (merge
                on (fielde
                    by 'ti
                    in 'El
                    on 'C
                    as 'd

                and (fielde
                    by 'd
                    in 'El
                    on 'C
                    as 'd
                )
            )
        )
```

Query

Produce & Execute BPEL Workflow



Optimization

Complex Cost Calculation

Profiling / Monitoring

Resource selection "hinting"

Domain specific planning

Parallelization

Active Planning

Queries & Workflows: It can get complex...

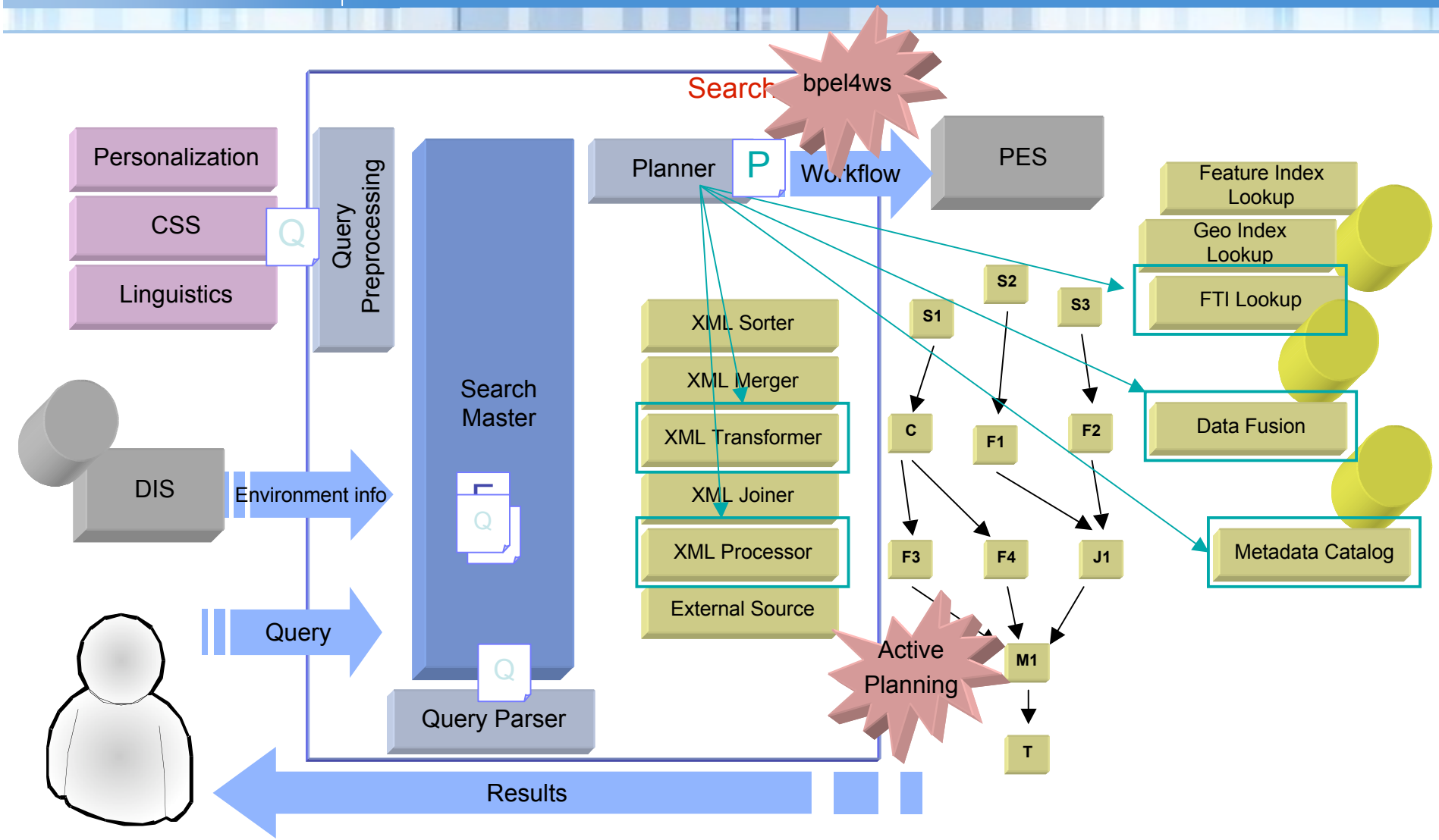
```
project by 'title', 'date' on
    (sort ASC by 'DocID' on
        (merge on
            //MAP REPORTS
            keeptop 8 on
                (sort ASC by 'RankID' on
                    (join inner by 'DocID' on
                        (fulltextsearch by 'Mediterranean' in 'ENGLISH' on 'd369b3e0-fa4c-11db-a297-9c01d805f283')
                        and
                        (fulltextsearch by 'Environmental' in 'ENGLISH' on 'd369b3e0-fa4c-11db-a297-9c01d805f283')))

            keeptop 8 on (sort ASC by 'RankID' on (join inner by 'DocID' on (fulltextsearch by 'Mediterranean' in 'ENGLISH' on
'd369b3e0-fa4c-11db-a297-9c01d805f283') and (fulltextsearch by 'Environmental' in 'ENGLISH' on 'd369b3e0-fa4c-11db-a297-
9c01d805f283')))
            // EEA reports
            keeptop 8 on
                (sort ASC by 'RankID' on
                    (fieldedsearch by 'date' contains '*1999*' on
                        (join inner by 'DocID' on
                            (fulltextsearch by 'air polution' in 'ENGLISH' on '25ad3c50-fa41-11db-a270-9c01d805f283')
                        and
                            (fulltextsearch by 'european' in 'ENGLISH' on '25ad3c50-fa41-11db-a270-9c01d805f283')
                        )
                    )
                )
        )
    )
```

Optimal Utilization of Resources

- Pre-query optimization:
  - Monitoring and adaptation of VRE layout for optimal resource use
- Content Source Selection:
  - Filtering of collections unlikely to contain useful data
  - Query terms and automatically pre-constructed Content Source Descriptors
- Query Planning:
  - Cost based optimization
  - Heuristics and space-search

- Process Execution:
  - Process optimization selects and allocates appropriate resource for tasks
- On-The-Spot processing:
  - ResultSet mechanism to allow local filtering of large XML chunks of data
- Further mechanisms to facilitate efficient searches:
  - Indices
  - ResultSet transport mechanism

Information Retrieval: How it Works



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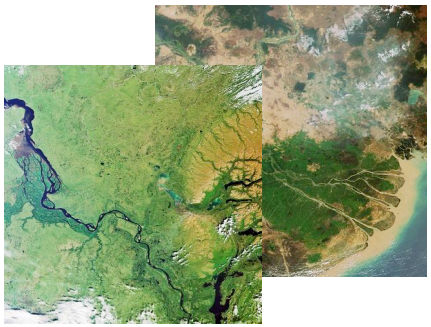
From Digital Objects
to Content across
eInfrastructures

from theory ...

... to reality

Next step: DILIGENT for Science

- Provide and operate a production D4Science e-Infrastructure
- Consolidate and extend gCube
- Built VREs serving Environmental Monitoring and Fishery Resources Management domains



Main technological challenges

- Provide and operate a production D4Science e-Infrastructure
  - Define the operational procedures for sites (sitess include content and service sites)
- Consolidate and extend gCube
  - Extend the the Data Kit to deal with very large and heterogenous content sources (e.g. textual repositories, satellite images, statistical databases) and other content-related resources (e.g. gazetters, ontologies, thesauri)
- Build VREs serving Environmental Monitoring and Fishery Resources Management domains
  - Serve the needs of a multitude of researchers and decision-makers from many disciplines (biologists, climatologists, GIS experts, socio-economists, fishery managers, etc.) operating with many different tools

http://www.diligentproject.org

http://www.d4science.org/

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Thank you!

Questions?

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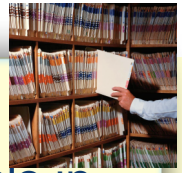
Additional

Slides

- An **application framework** for the development of services that can be outsourced to a grid-enabled infrastructure
- An advanced **container** for the hosting of WS on the grid
- A **runtime environment** for the
  - provision of information about shared resources
  - management of services and applications
  - execution of VRE build-in services: content and metadata management; indexing, selection, fusion, extraction, description, annotation, transformation, a presentation of content

VREs: new requirements



Persistent and consolidated

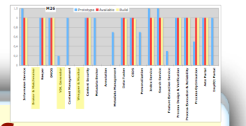
e.g. serving a team of individuals in addressing the mission of an institution

Focus on publication

e.g. supporting the publishing and archival of content

Highly dynamic, created and dismissed on-demand

e.g. supporting the activities of a project addressing a specific challenge



Analysis and production of new knowledge

e.g. serving a research team which produces new results through complex analysis and simulation