A Grid-based Infrastructure for Distributed Retrieval

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Research trend

e-Science scenarios (multidisciplinary and co-operative) face novel challenges

- highly-evolving requirements
- large scale resources and players distribution
- heterogeneity

. . . making standard development approaches often too "expensive" (and not sustainable)

- "from-scratch" development of ad-hoc solutions
- HW investment (even if intermittently needed)

The "magic" formula to reduce costs

sharing & reuse

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[Grid-based] Infrastructures as enabling technologies

A physical and organisational structure based on the principle of resource sharing to serve one or more communities and support their operation

- current-generation focuses on low-level resources, e.g. network, storage, computing
- next-generation builds on top of the previous to extend the vision into application domains, e.g. retrieval services

The impact is potentially non-trivial

- co-ordinated sharing of these resource may invalidate cost analysis of current solutions, i.e. “expensive” solutions may be outsourced to the infrastructure
- novel solutions tackling classic problems (e.g. Information Retrieval) in novel ways can be realised

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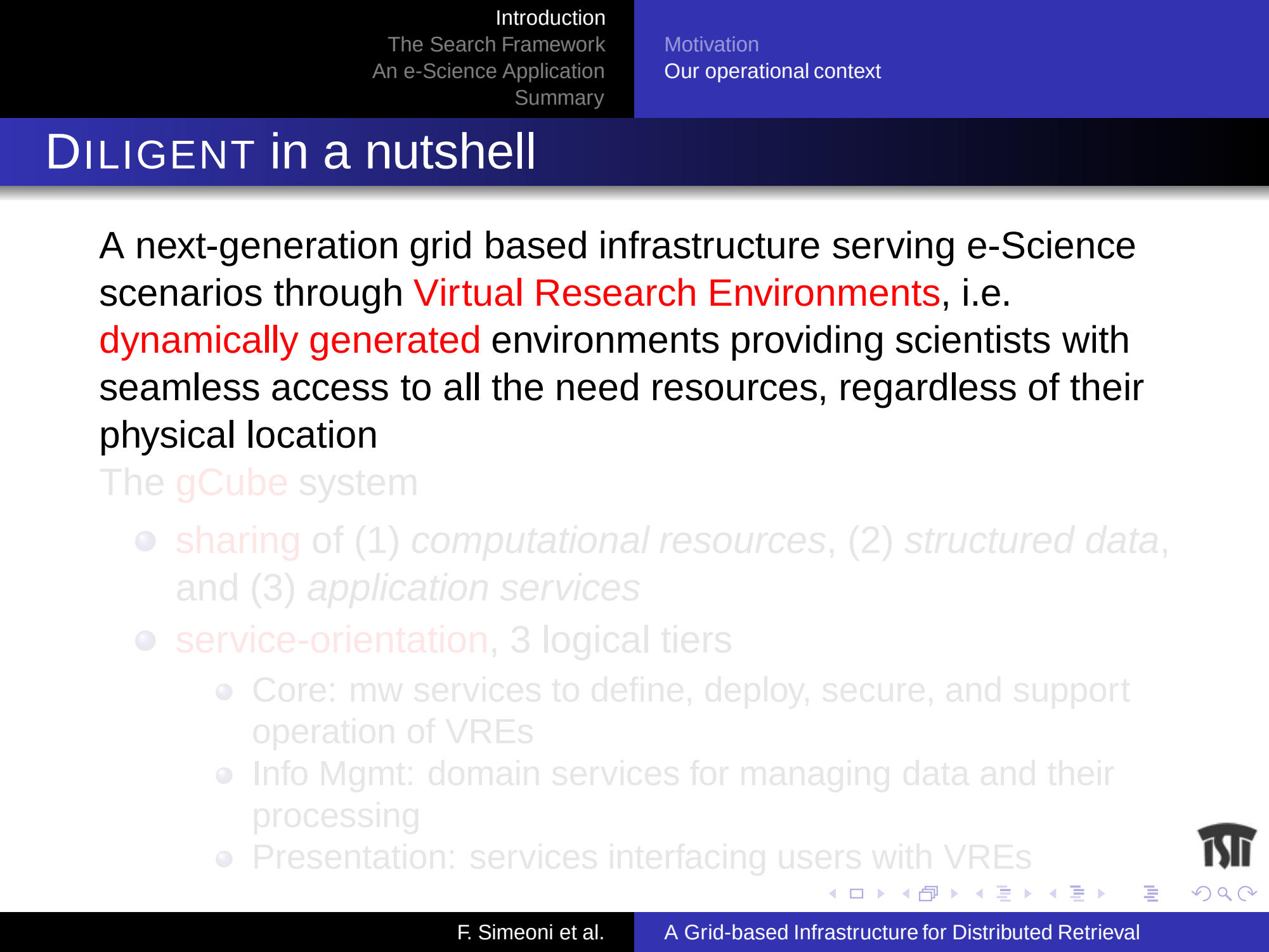
DILIGENT in a nutshell

A next-generation grid based infrastructure serving e-Science scenarios through Virtual Research Environments, i.e. dynamically generated environments providing scientists with seamless access to all the need resources, regardless of their physical location

The gCube system

- sharing of (1) *computational resources*, (2) *structured data*, and (3) *application services*
- service-orientation, 3 logical tiers
  - Core: mw services to define, deploy, secure, and support operation of VREs
  - Info Mgmt: domain services for managing data and their processing
  - Presentation: services interfacing users with VREs



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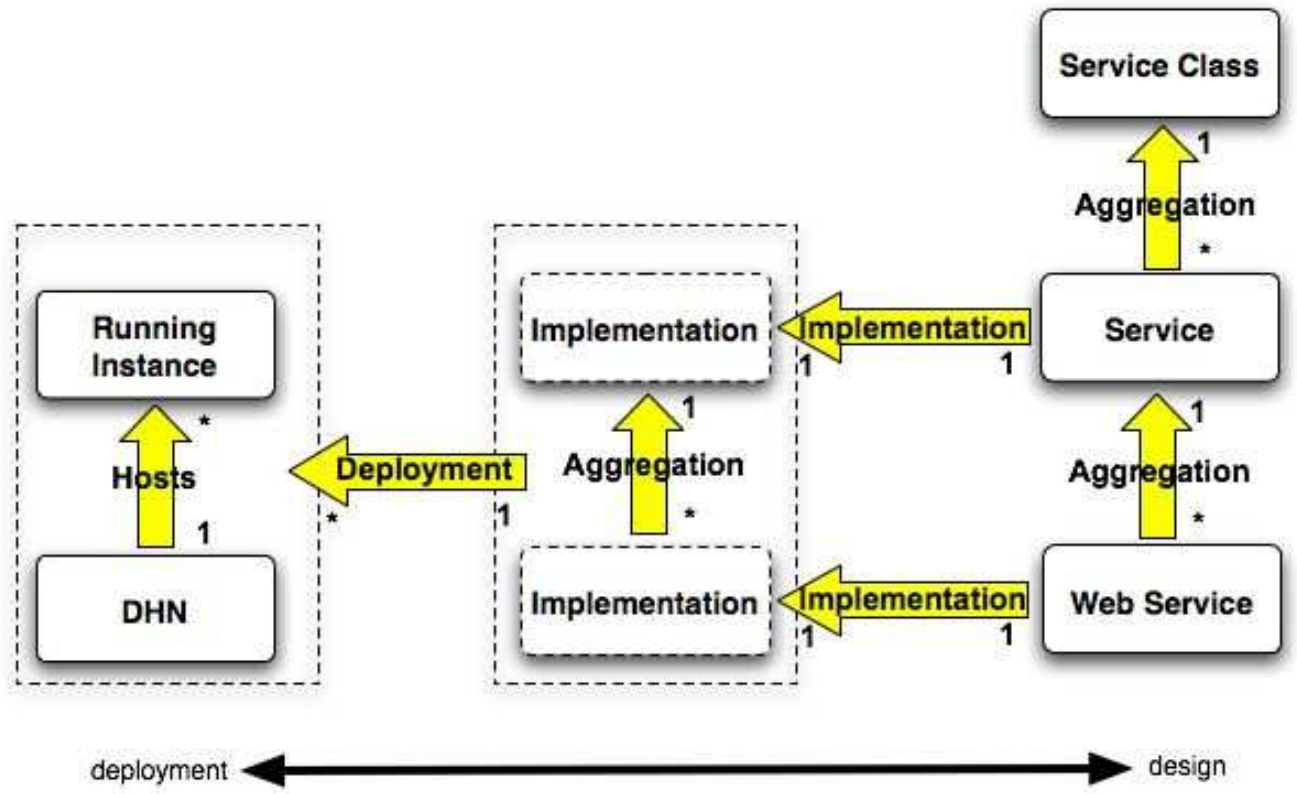
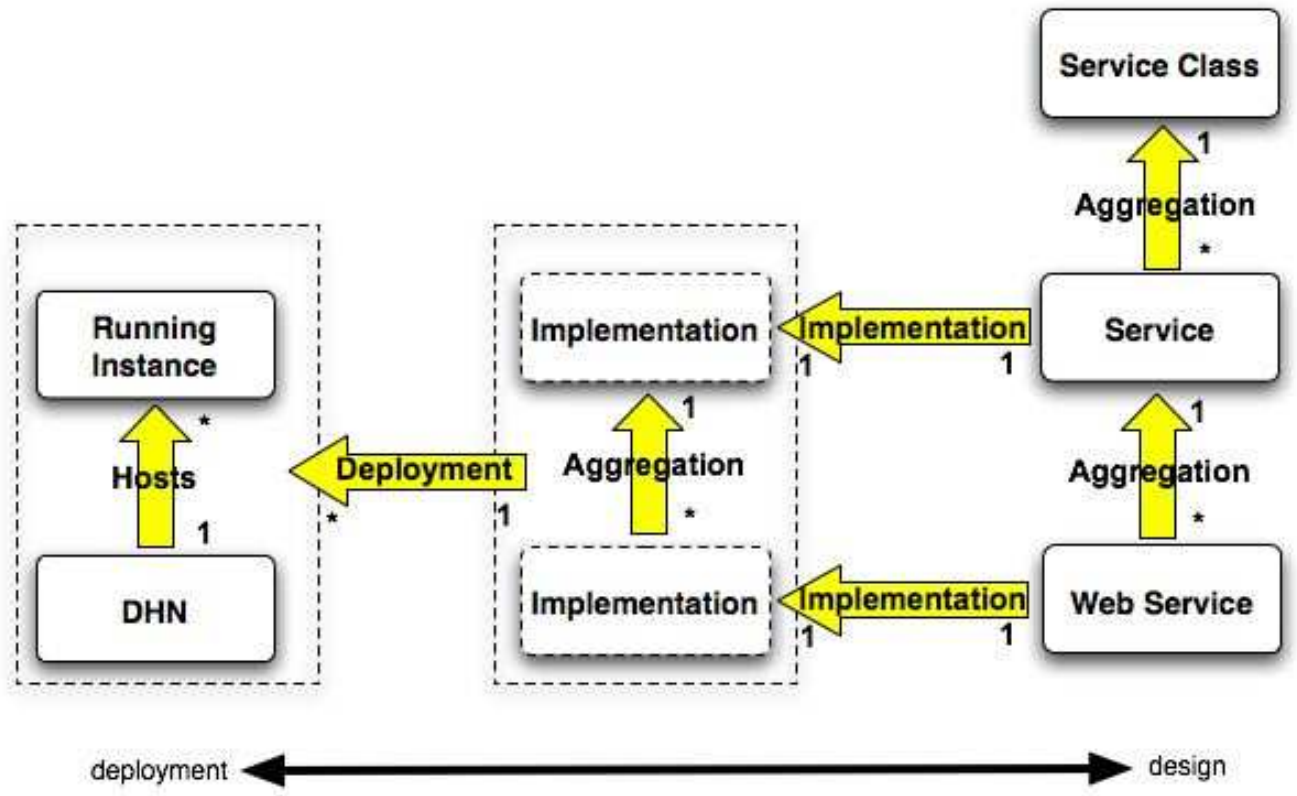
The Service Model

service classes, i.e. flat groupings of services within the same functional area (e.g. the *Index* class)



The Service Model

services, i.e. abstract instances of service classes (e.g. the *LookupService* in the Index class)



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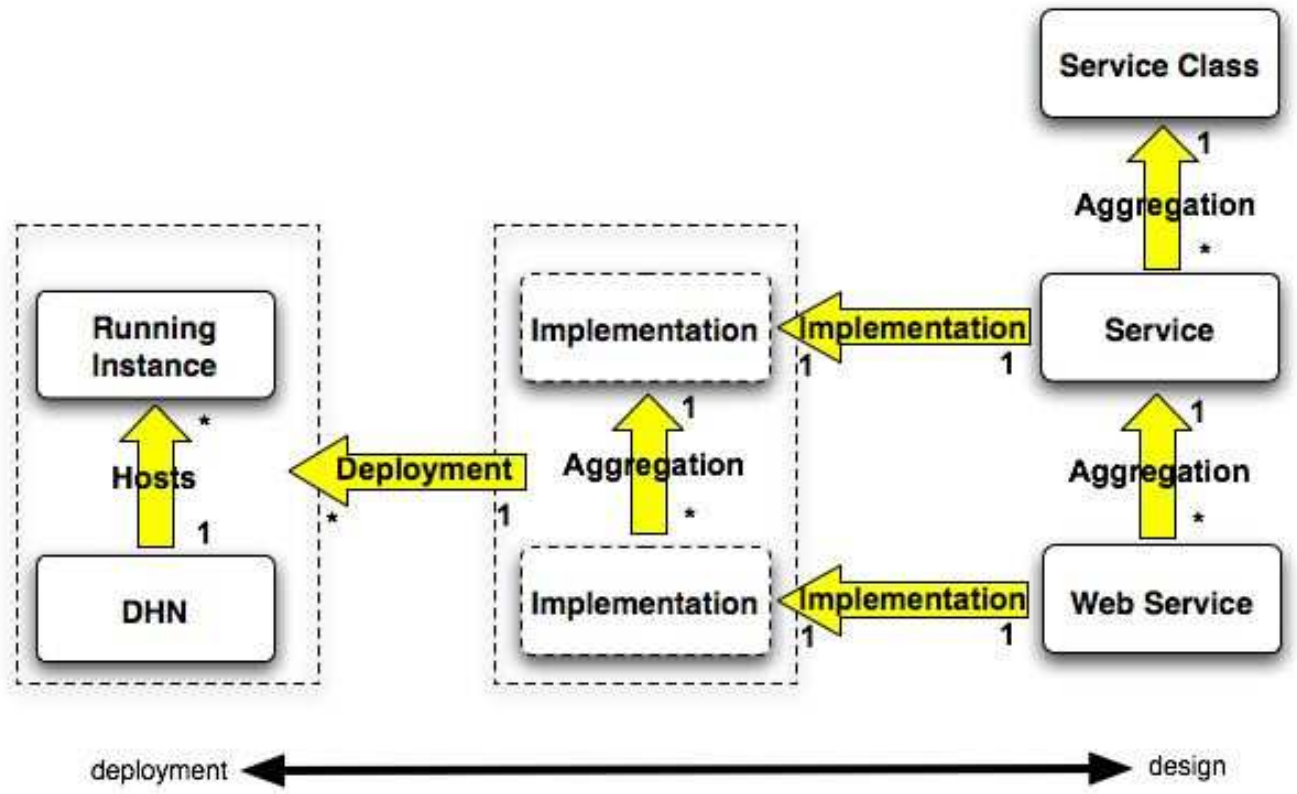
web services, i.e. entry-points to concrete implementations of abstract services (e.g. the *LookupFactoryService*)



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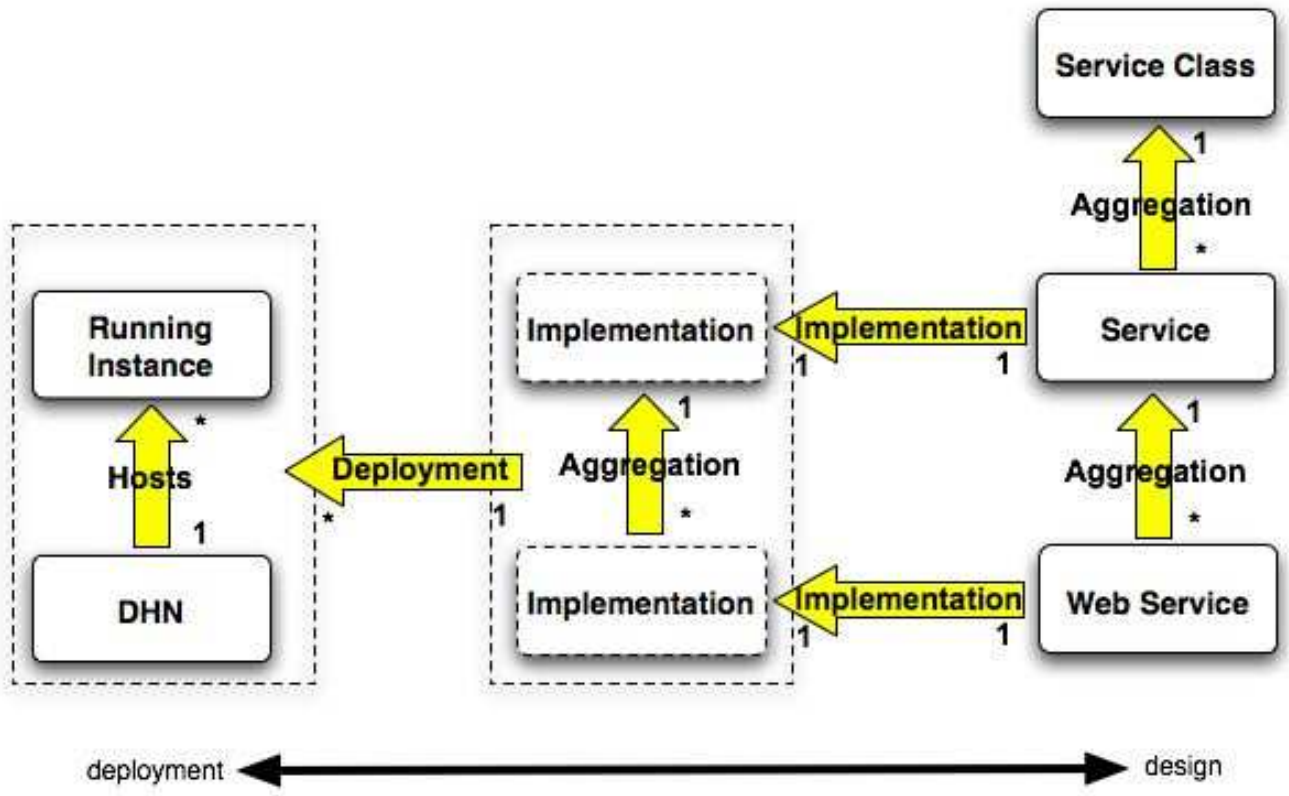
running instances, i.e. service implementations dynamically deployed on available hosting nodes



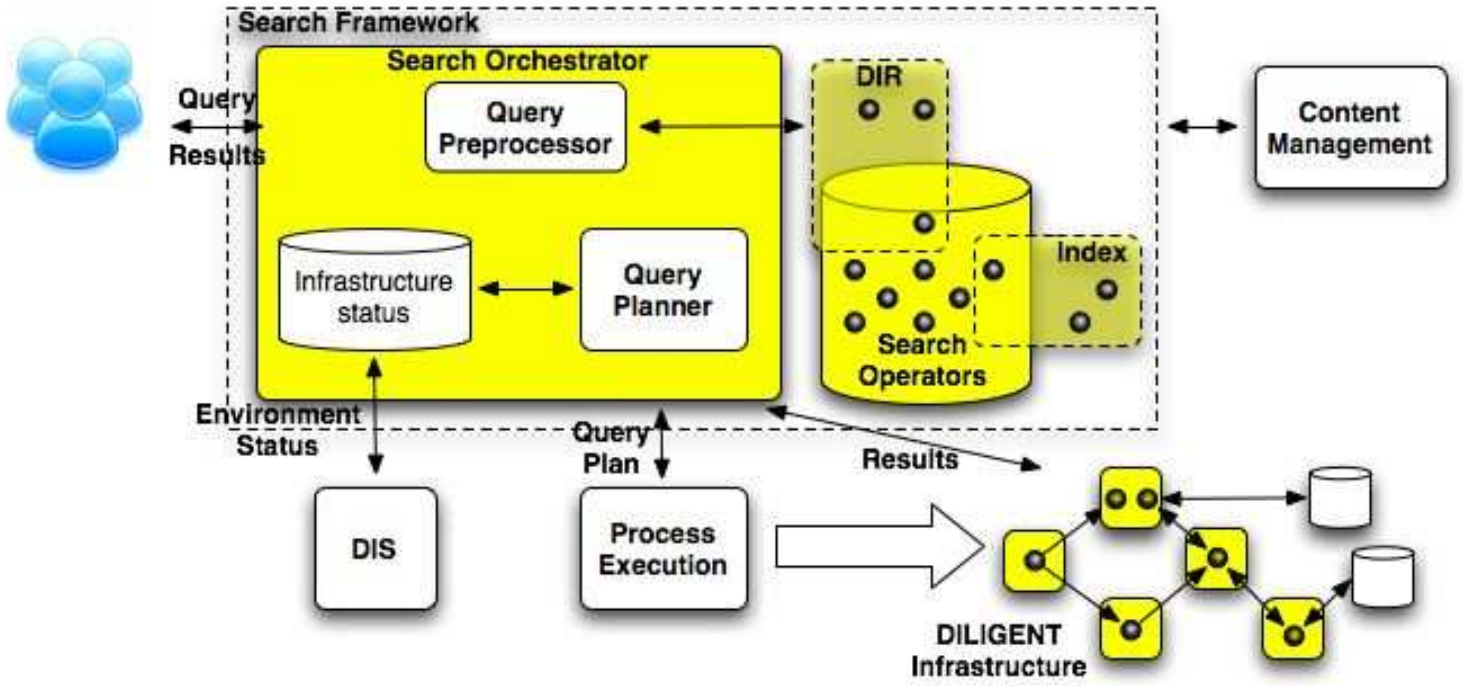
Goal

Equip the gCube system with a search framework (not a "simple" search engine!)

- modular
  - diverse, autonomous, and pluggable elements
- suited to maximise infrastructure exploitation and support
  - state-of-the-art IR solutions implementations on-board
  - optimal search elements (and resources) consumption (avoid mis-utilisation and misuse)
  - capabilities to capture complex application scenarios by combining information retrieval and data processing procedures
  - operational framework for experimentation with novel IR technologies and solutions

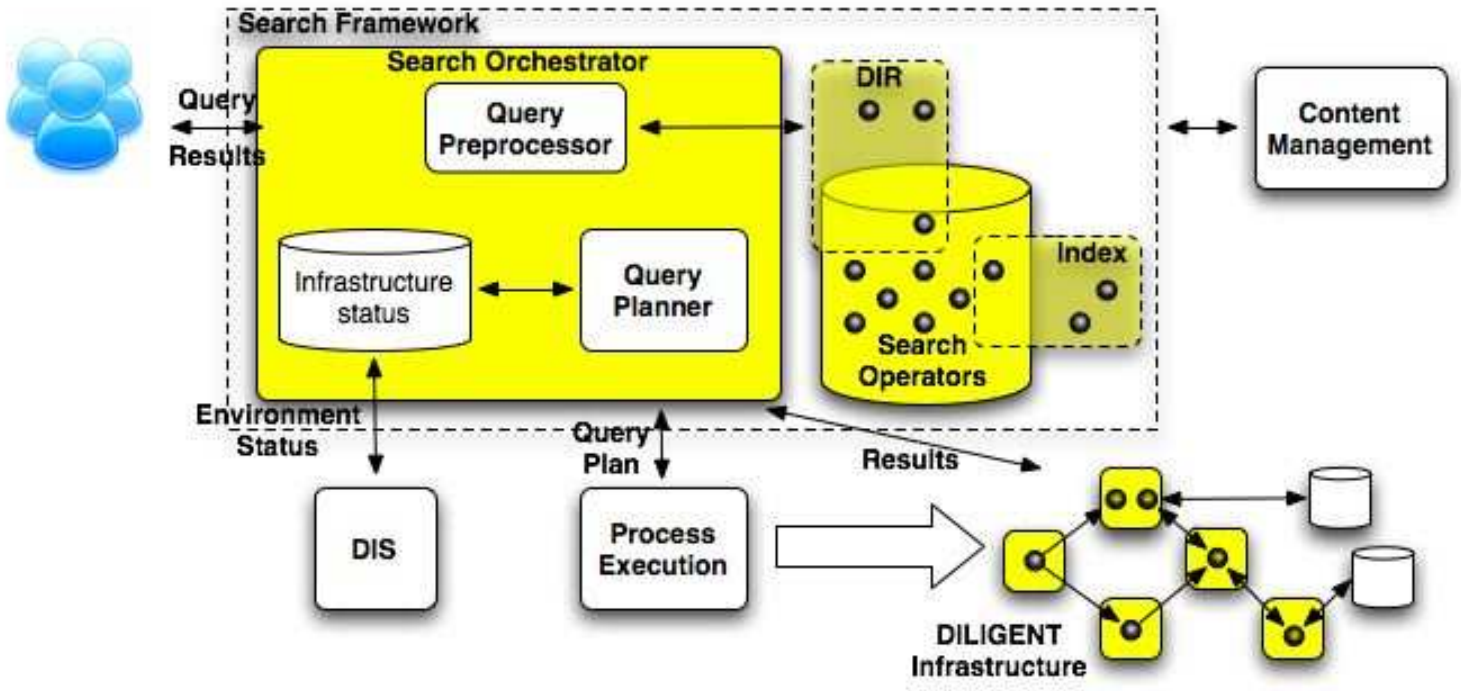
Overall View

Search Orchestrator: manages the whole query process by relying on available resources and operators



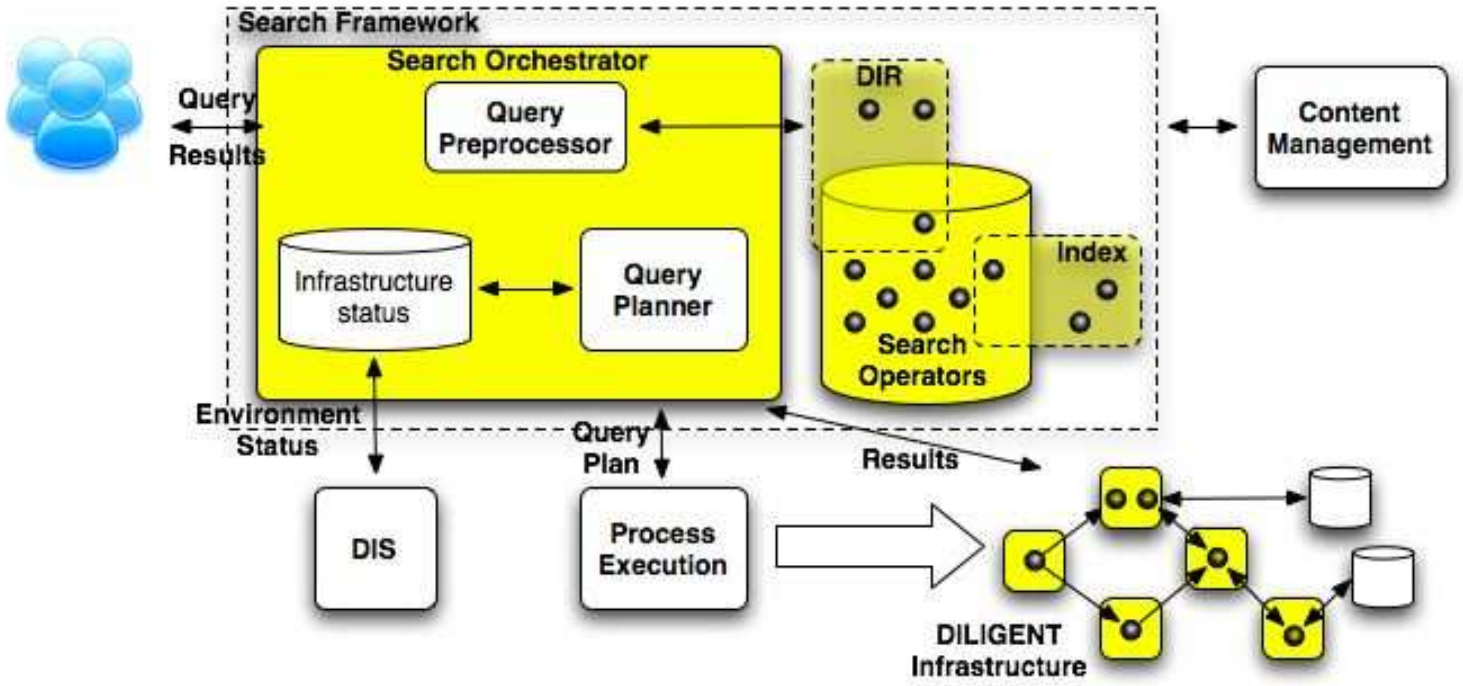
Overall View

Index: provides for indices enhancing query response



Overall View

DIR (Distributed Information Retrieval): provides for searching across multiple sources



Search Services

A complex service class consisting of

- A Search Orchestrator of Information Retrieval processes
  - Consolidates query and environment information
  - Prepares and plans retrieval execution (outsourced to grid)
- Numerous “worker” services provide data processing features, e.g.
  - XML processing (joiners, sorters, transformers, filterers)
  - Lookups (Index, etc.)
  - Results merging (DIR)
- A data transport mechanism (ResultSet)
  - Overcomes environment restrictions towards performance
  - Standardizes information exchange among IR workers

Index Services

An Index is a service that replies to queries by relying on a data structure (full index). Different structures imply different indexes

- Full Text, Forward, VA files and Geographical Index (R-Tree)
- *delta files* to manage replication

Different services for different roles:

- *Manager*, manages and represents one specific index
- *Updater*, consumes data source and generates delta files
- *Lookup*, replicates the index for queries lookup

For possible organisations:

- *All-in-one*, minimise latency
- *Lookup separated*, ideal for query intensive scenarios
- *Updater separated*, ideal for intense feeding scenarios
- *One Service per role*, updater and lookup replication

DIR Services

Three service classes:

- *Content Source Description*, generates and maintains summary descriptions of each source, e.g. partial indices
  - cooperative (index) vs uncooperative (query sampling)
- *Content Source Selection*, limits the routing of queries to the “best” target sources
  - various weighting algorithms
- *Data Fusion*, derive a total order of result sets produced by different data sources
  - various merging algorithms

Different services for different roles

- *access*, serves requests by relying on the current RI state
- *monitor*, observes of the environment for changes
- *factory*, creates the state of the RIs

ImpECt

ImpECt goal is to support Earth Observation community in managing the reports production task

- have seamless access to heterogeneous information sources
  - Environmental Reports, workshops proceedings, science papers, presentations
  - High level geophysical products, DEMs (Digital Elevation Models) and added value maps

from

- ESA EO web portal (`www.eoportal.org`)
- ESA Grid on-demand (`eogrid.esrin.esa.int`)
- Geonetwork (`www.fao.org/geonetwork`)
- Web Map Servers
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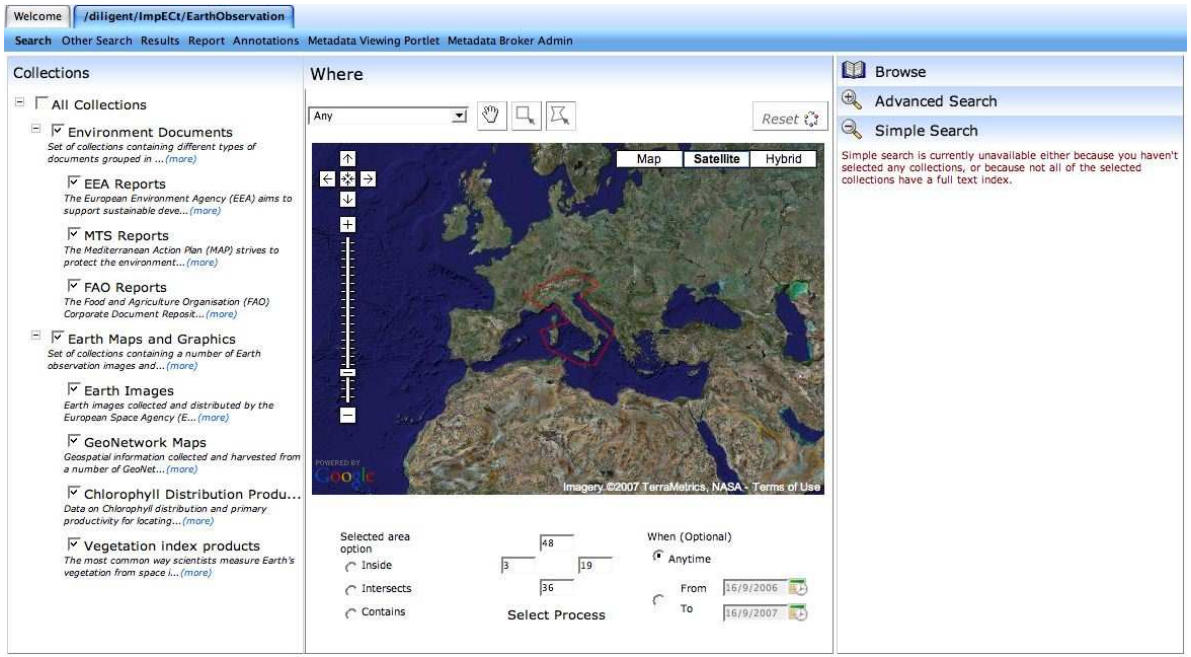
Search Facilities

By relying on the DILIGENT search framework the IMPECT heterogeneous data sources are seamlessly searchable

- TemporalRefiner and PolygonalRefiner refinement operators allow the user to refine the search results based on timestamp or polygonal shape



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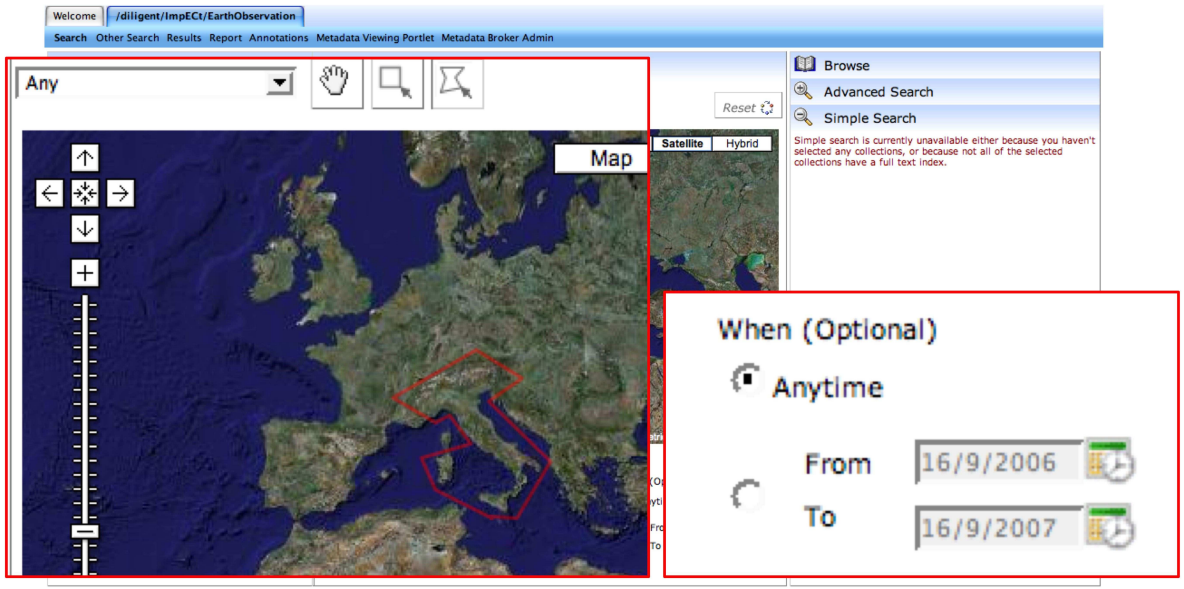

Summary

e-Science scenarios demand for infrastructure-oriented approaches to guarantee low-costs and sustainability

- the higher initial development cost than traditional ad-hoc solutions is well repaid by the long-term scale of adoption and maintenance

The gCube search framework:

- is equipped with a comprehensive set of state-of-the-art IR algorithms and techniques that can be easily reused
- has low adoption cost because the whole service is actually outsourced to the underlying infrastructure
- is open thus to guarantee the easy of use/adaptation in unexpected scenarios

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`http://www.diligentproject.org`
`http://www.gcube-system.org`