CYCLOPS Project

CYber-Infrastructure for CiviL protection Operative ProcedureS

Stefano Nativi

Italian National Research Council
IMAA

Information Society and Media

IBERGRID
2nd IBERIAN GRID INFRASTRUCTURE CONFERENCE
Porto (Portugal) May 12 - 14 2008

Outline

- CYCLOPS Overview
- Where CYCLOPS comes from
- Towards a CP Cyber-infrastructure (e-Infrastructure)
  - The proposed Architectural Framework
- The interoperability experiments
  - The Spatial Data Infrastructure (SDI) services implementation for the Use Cases

nativi@imaa.cnr.it

nativi@imaa.cnr.it

THE PROJECT OVERVIEW

The CYCLOPS Project

- CYber-Infrastructure for CiviL protection Operative ProcedureS
- EGEE Specific Support Action (FP6 – Research Infrastructures)
- Duration
  - 28 months (01/06/2006 – 30/09/2008)
- Management
  - Project Management: Italian Civil Protection
  - Technical Management: Italian National Research Council
- Keywords
  - GMES, GRID, Geospatial information, Civil Protection, Geoinformatics (Earth Science Informatics)
- Collaboration with:
  - PREVIEW, Risk EOS, RISK-AWARE, BOSS4GMES, DEGREE, EGEE

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The CYCLOPS Project objective

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- EGEE Support Action

  to bridge the gap between Grid and GMES communities making Civil Protection people be aware of the services provided by Grid infrastructures, and, at the same time, letting Grid researcher to be aware of Civil Protection specific requirements and service enhancement needs.

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Participants

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Civil Protection Agencies

- **ANPC** (Autoridade Nacional de Protecção Civil)
- **CP-CH** (Civil Protection of Chania Prefecture)
- **DDSC** (Direction de la Défense et de la Sécurité Civiles)
- **DPC** (Dipartimento della Protezione Civile)

Scientific/Technological partners (GRID and GI communities)

- **ARMINES-LGEI** (Ecole Nationale Supérieure des Techniques Industrielles des Mines d'Alès)
- **IMAA-CNR** (Istituto di Metodologie per l'Analisi Ambientale del Consiglio Nazionale delle Ricerche)
- **INFN** (Istituto Nazionale di Fisica Nucleare)
- **TEI-CR** (Technological Educational Institute of Crete)
- **UMINHO** (Universidade do Minho)

CYCLOPS Activities

- Definition of research and innovation strategies
  - Research strategies for enabling CP applications on Grid infrastructure
    - EGEE Request for Enhancements
  - Guidelines for CP innovation towards the adoption of Grid technologies
- Cross-dissemination between GRID (EGEE) community and GMES (Civil Protection) community.
  - Seminars, workshops, tutorials directed to CP personnel
  - Reports to EGEE Working Groups
- Interoperability experiments to implement standard geospatial information services on the top of GRID middleware
  - OGF – OGC Interoperability experiment for EGEE

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Use Case #1:
Wild Fires Risk Assessment

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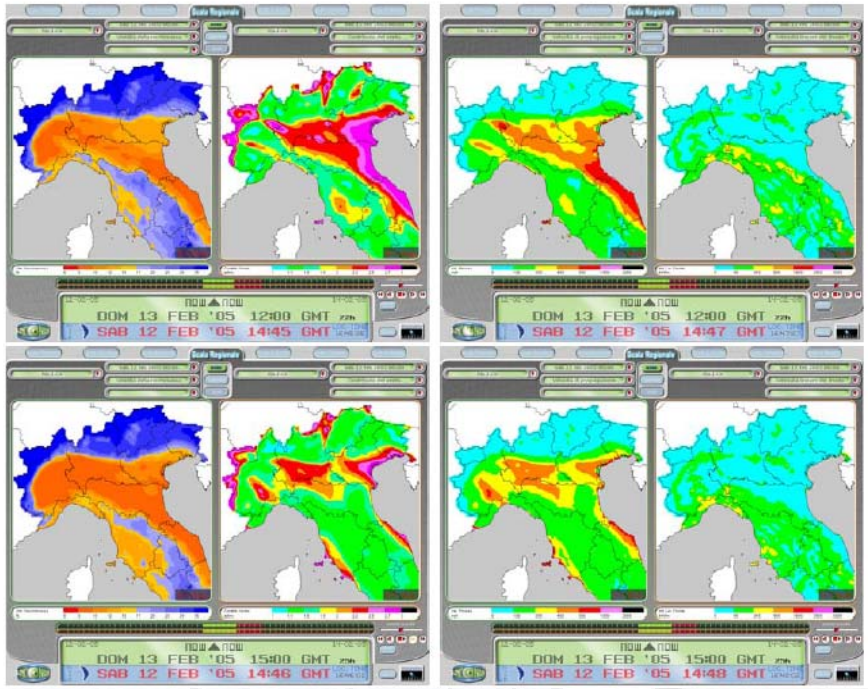

- Operational application of the Italian CP
- Linked to the PREVIEW GMES service

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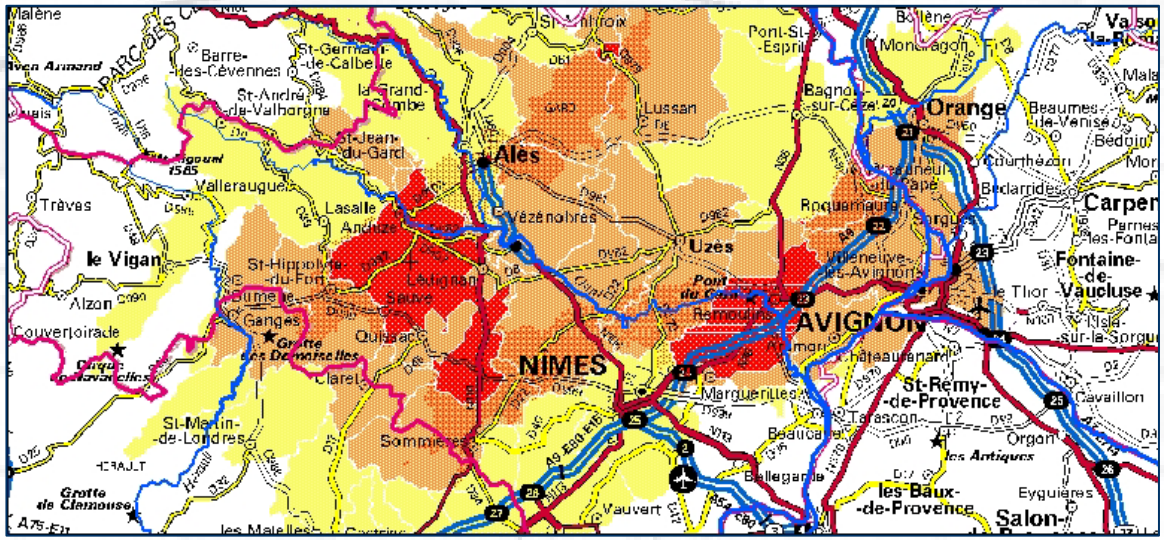
Use Case #2: Flood Forecast



- Operational application of the French CP
- Linked to GMES flash flood anticipation service

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The Rationale

WHERE CYCLOPS COMES FROM

Information Society's Need

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- Growing demand of Society to discover, access and use Earth Information, in a seamless, effective and NRT way:
  - Applications and initiatives
    - Decision Support Systems (DSS)
    - Global Monitoring for Environment and Security (GEOSS, GMES, SEIS)
    - Spatial Data Infrastructures (INSPIRE, NSDI, NFGIS)
    - Observatory systems (NEON, BON)
    - Science Digital Library (NSDL)
  - Technological drivers
    - Increasing resolution and availability of remotely sensed data
    - Growing number of operational satellites and sensor networks
    - Ubiquitous connectivity throughout the Society
    - Growing computing and storage capabilities

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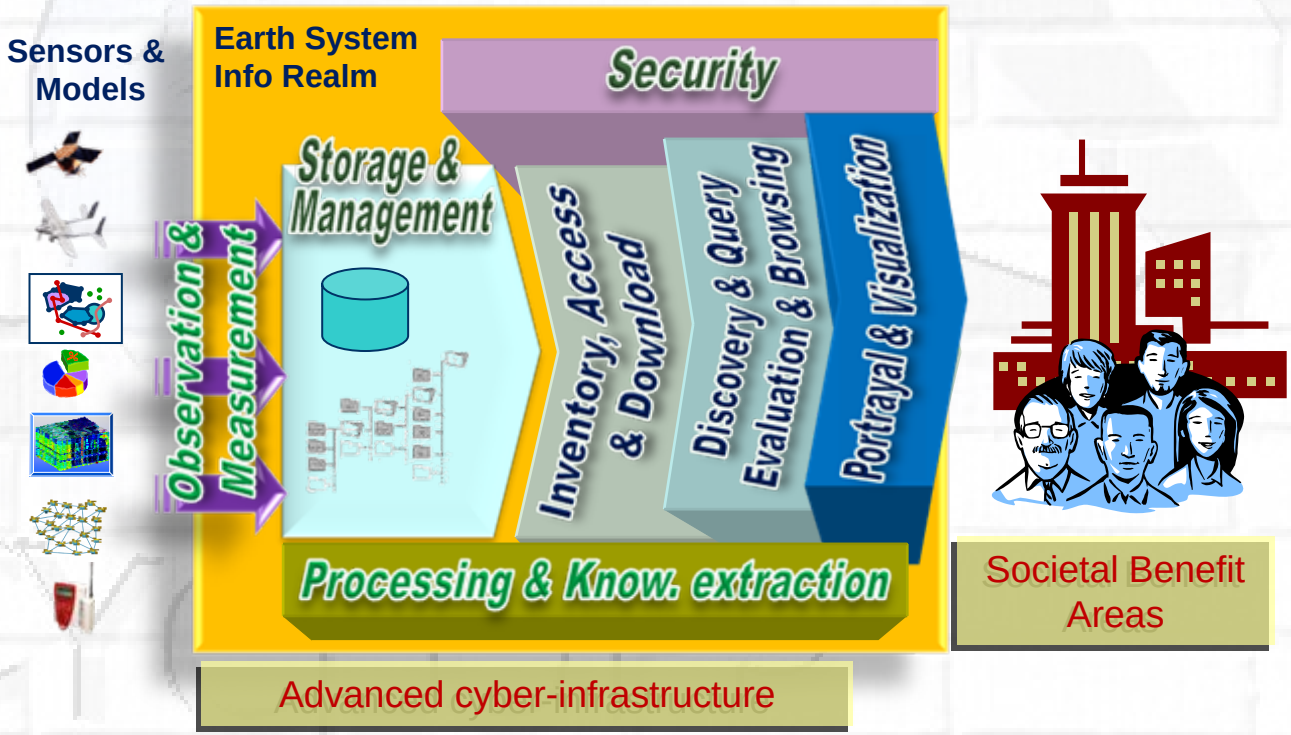
Advanced Cyber-infratructures for Earth System Science Information

- Advanced cyber-infrastructures can support the formation and operation of distributed, multidisciplinary collaborative teams
- To integrate multidisciplinary knowledge to understand the properties of the Earth system
- This is a real challenge for information technology as much as it is for scientists



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Environmental Policymaking

- To shift from a “traditional” data centric approach to a more advanced service-based solution for Earth System Science information
- Environmental policymaking is *key driver* for the development of advanced Spatial Information Infrastructures

  - air quality
  - climate change
  - water
  - energy
  - risk zones
  - ecosystems
  - ...

  (earth-sciences)

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GMES (Global Monitoring for Environment and Security)

- GMES concept was endorsed by the EC to gather and use all available data and information
- To create innovative and value-added services
- To use these services to
  - enable decision makers to better anticipate or mitigate crisis situations
  - manage issues related to the environment and security

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GMES (Global Monitoring for Environment and Security)

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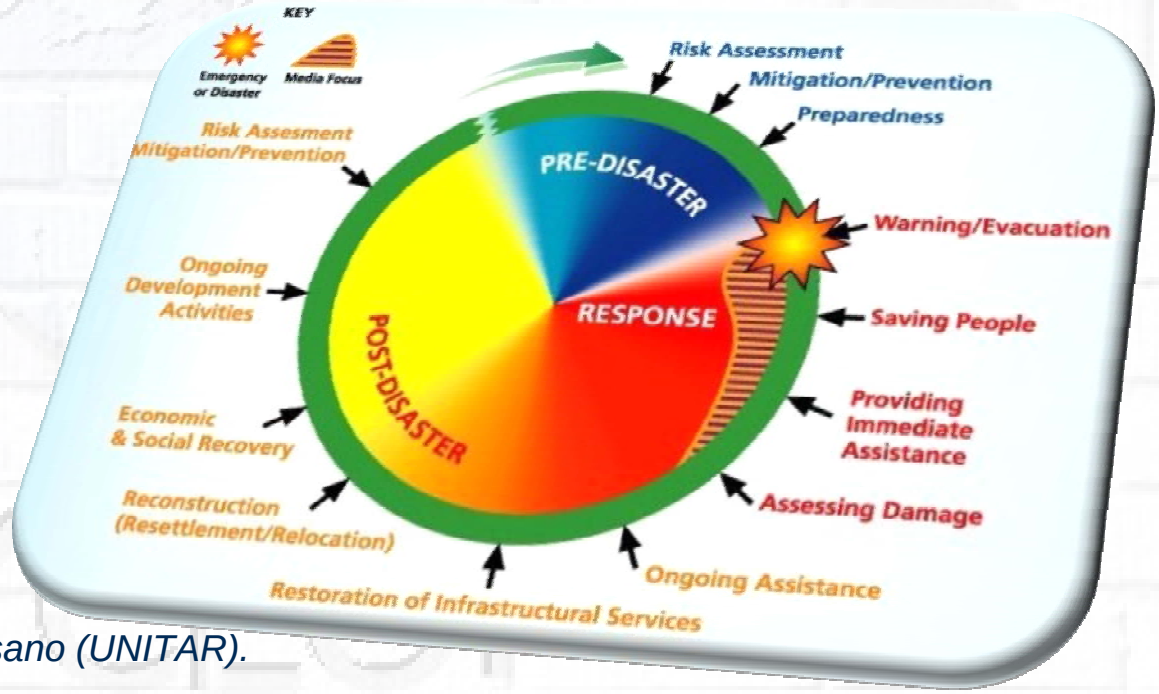
- The Final Report for the GMES Initial Period
  - Recognized the European Civil Protection as a valuable GMES service category
  - Outlined the importance to develop enabling e-infrastructures and virtual organization services to serve specific GMES applications



The risk circle: F. Pisano (UNITAR).

CYCLOPS vision: Communities Interoperability

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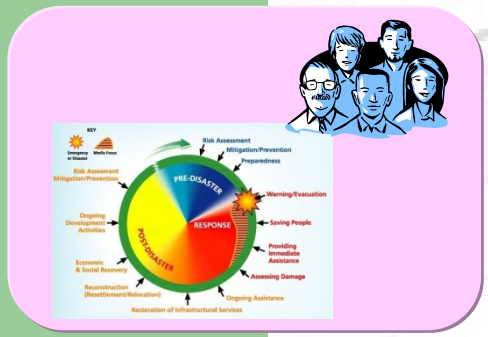
Application Domain Semantics



GMES & CP Communities

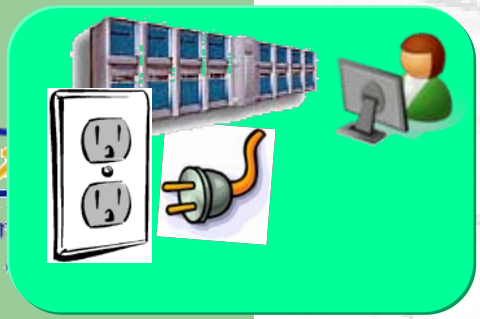
Strategic Applications

Web Service
SOA

Earth System Information Co

Geospatial Services

Grid Service



GRID Community

Resource Provision

Interoperability by Standards

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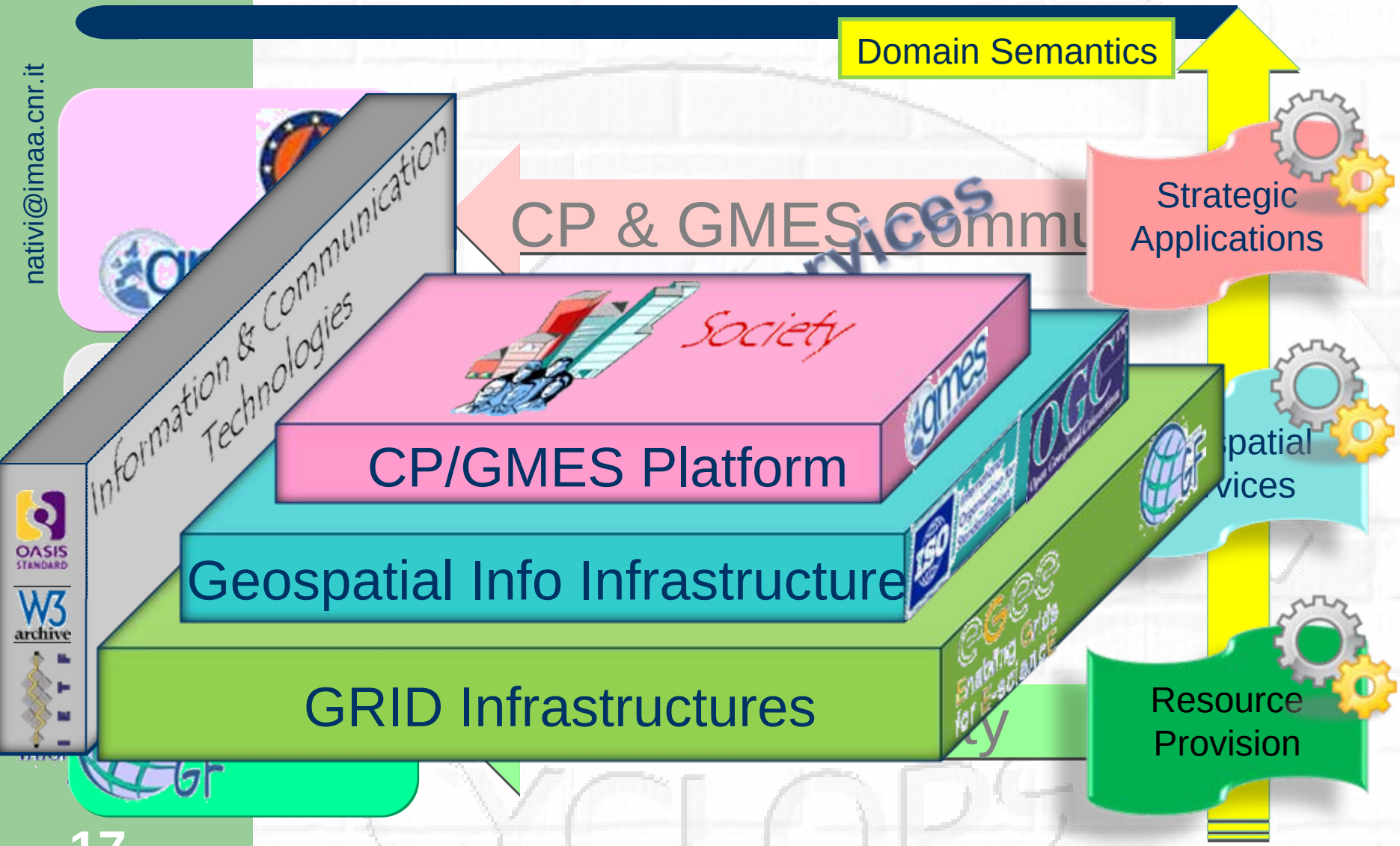

CP & GMES Requirements

- Civil Protection and GMES applications/systems have specific requirements:
  - to access infrastructure, run models and search information in a real-time (RT) or near-real-time (NRT) way
    - privileging time of response instead of accuracy
  - to control sensors networks and acquisition systems and modify their acquisition strategy and processing chain
  - to share geospatial information that has complex characteristics:
    - Huge amounts of remotely-sensed observations, which are multidimensional and frequently updated
  - To formalise the knowledge required to analyse data and provide decision-makers with effective information
  - To implement the strict data policy and the security requirements typical of dual systems (civil/military);

nativi@imaa.cnr.it

CYCLOPS Research Strategy

- Conceive a complete Grid-based platform underpinning Geospatial Information services to support Civil Protection/GMES applications through

  The CYCLOPS platform

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The proposed Architectural Framework

Towards a CP Cyber-infrastructure (e-Infrastructure)

CYCLOPS Architectural Framework

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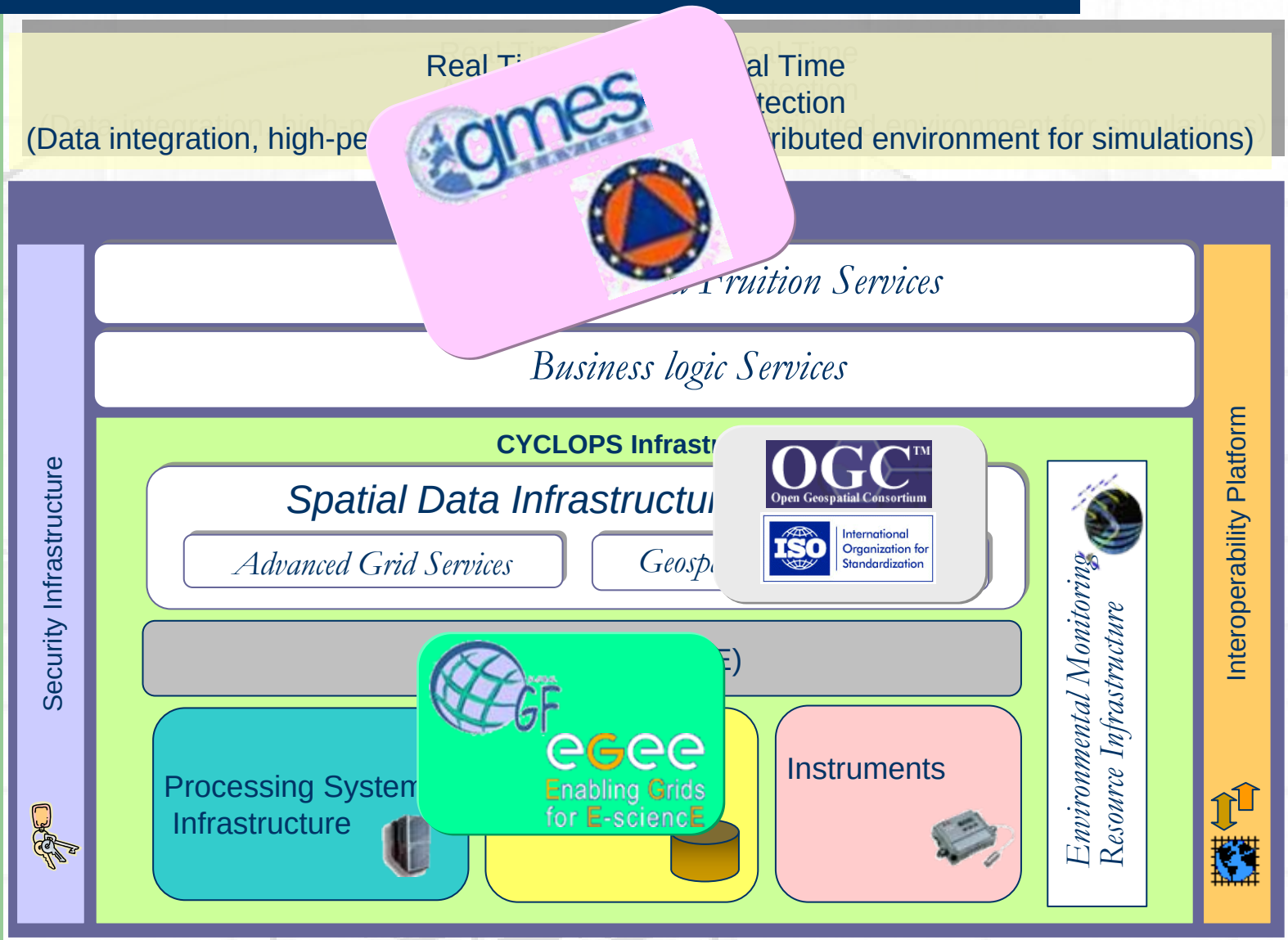

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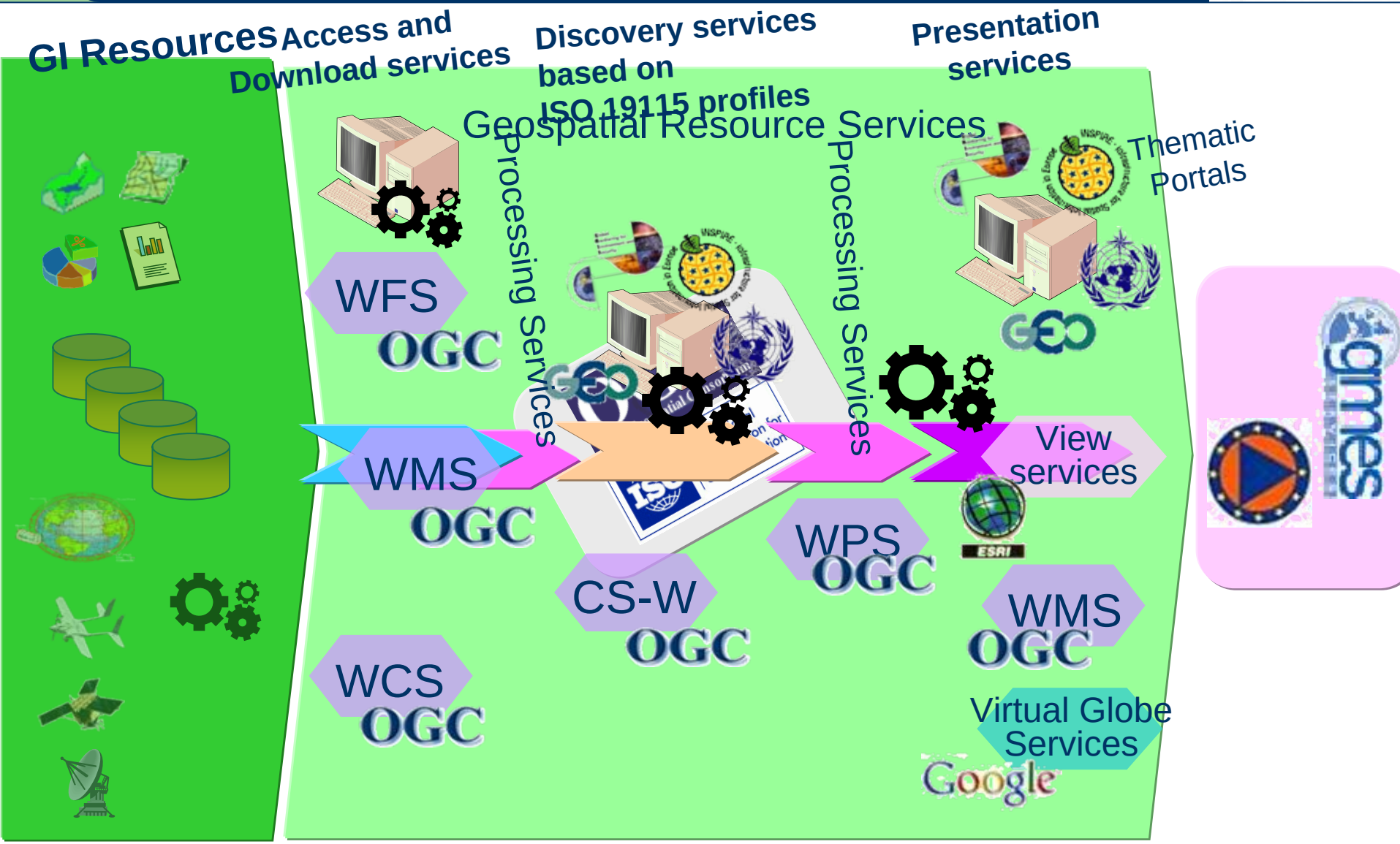
Geospatial resource service tiers



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The Spatial Data Infrastructure (SDI) services implementation for the Use Cases

THE INTEROPERABILITY EXPERIMENTS

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Use Case #1:
Wild Fires Risk Assessment

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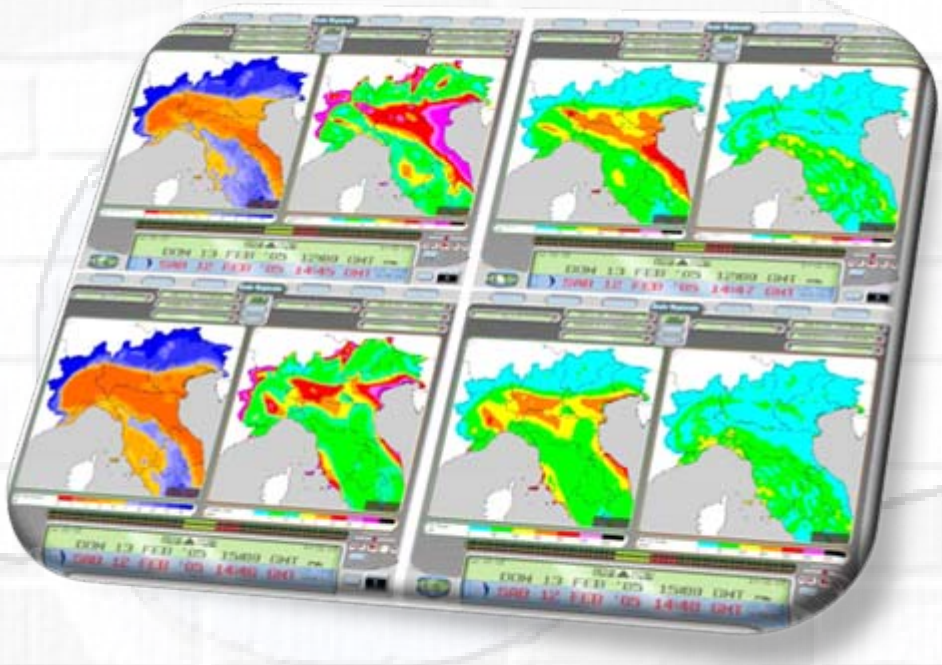

- Linked to the PREVIEW GMES service

The RISICO (RISchio Incendi e Coordinamento) application

- RISICO is the Italian Civil Protection Department (DPC) application for wild fires risk assessment
- Designed and developed by the CIMA (International Centre for Environmental Monitoring) Research Foundation
- RISICO implements a wild fires risk assessment model (based on the Canadian Fire Weather Index – FWI) providing a daily potential fire danger
- It currently runs once a day providing 1km square risk maps over the entire Italy surface

nativi@imaa.cnr.it

mazzetti@imaa.cnr.it

RISICO Flow Diagram

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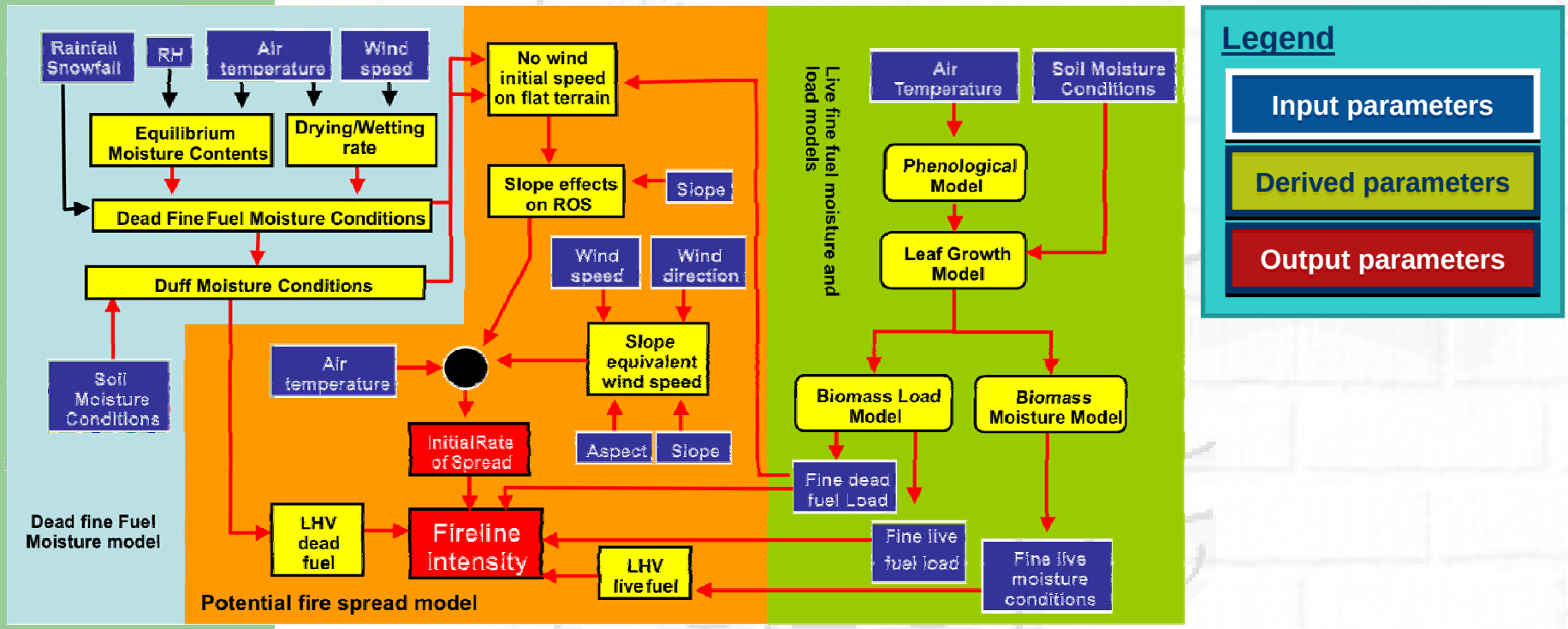
The system is made of two main models:

- the fuel moisture model
- the potential fire spread model



G-RISICO: Porting RISICO on the CYCLOPS Platform

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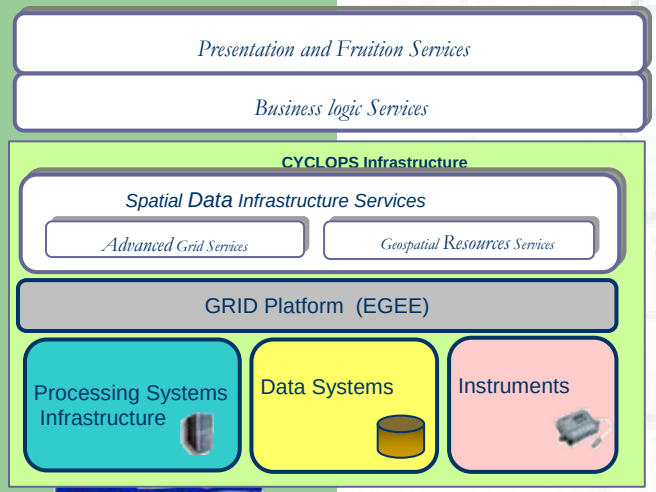
- Presentation Services
  - GUI services for user interaction
- Business Logic services
  - RISICO model business logic
- Spatial Data Infrastructure services
  - Input and output data access services:
    - OGC standard WCS (Web Coverage Service) interface and protocol specification;
    - CF-NetCDF standard data format and encoding;
  - Processing expose services
    - OGC standard WPS (Web Processing Service) interface and protocol specification;
- Storage and processing middleware (grid-enabled):
  - EGEE gLite middleware;



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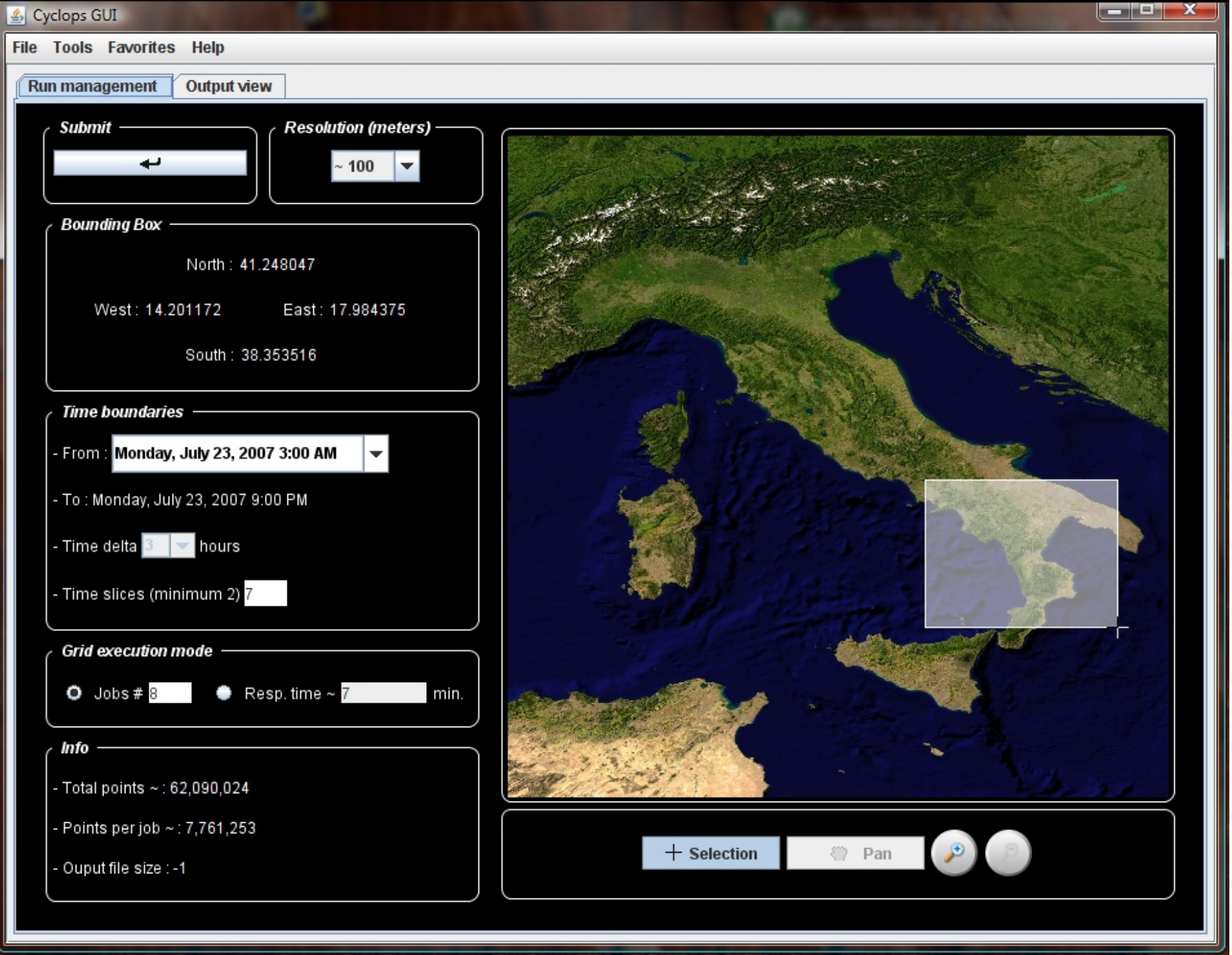
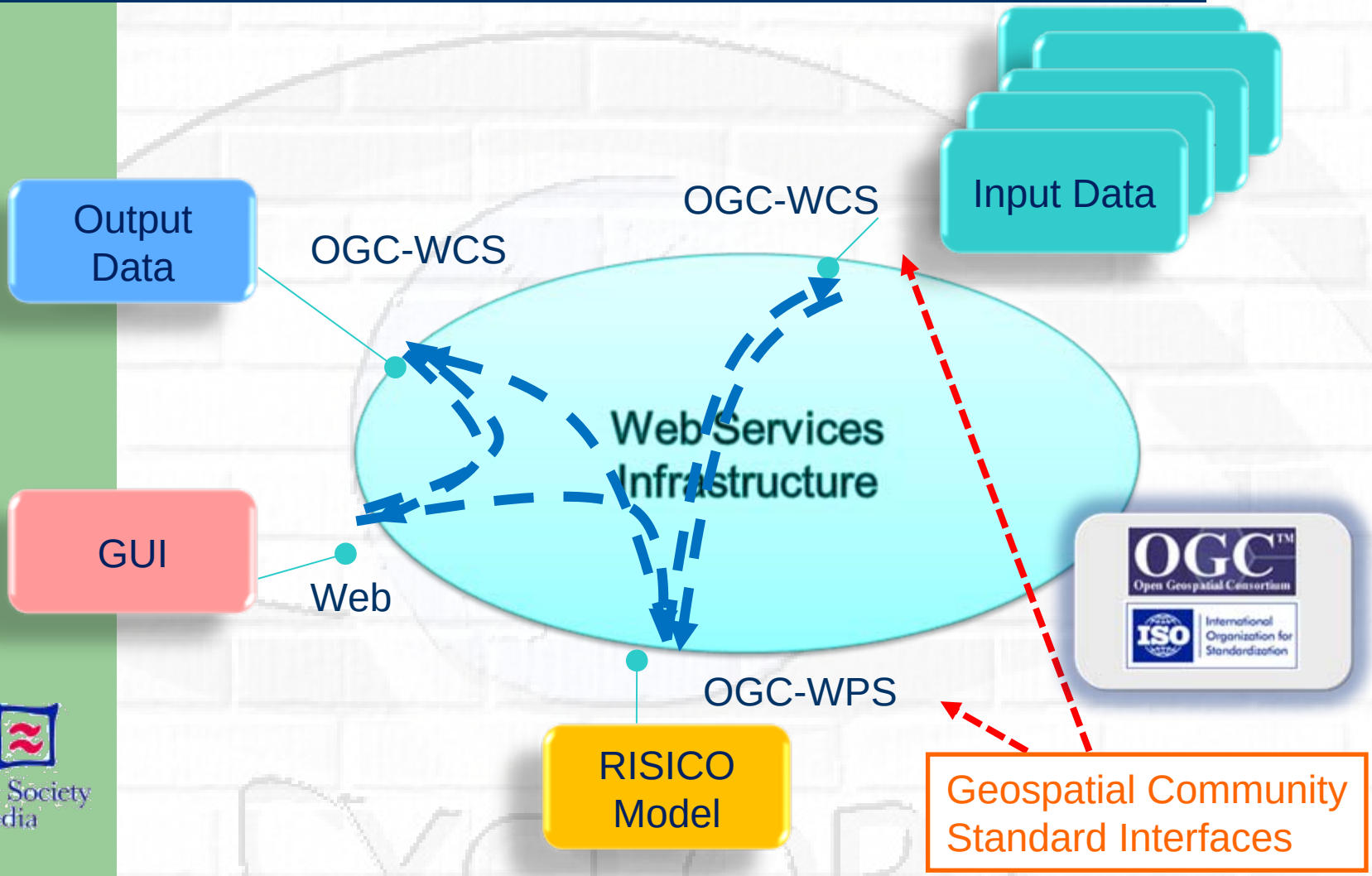

Cyclops GUI
File Tools Favorites Help
Run management
Output view
Submit
Resolution (meters)
~ 100
Bounding Box
North : 41.248047
West : 14.201172
East : 17.984375
South : 38.353516
Time boundaries
- From : Monday, July 23, 2007 3:00 AM
- To : Monday, July 23, 2007 9:00 PM
- Time delta 3 hours
- Time slices (minimum 2) 7
Grid execution mode
Jobs # 8
Resp. time ~ 7 min.
Info
- Total points ~ : 62,090,024
- Points per job ~ : 7,761,253
- Ouput file size : -1
Selection
Pan

G-RISICO: Service View



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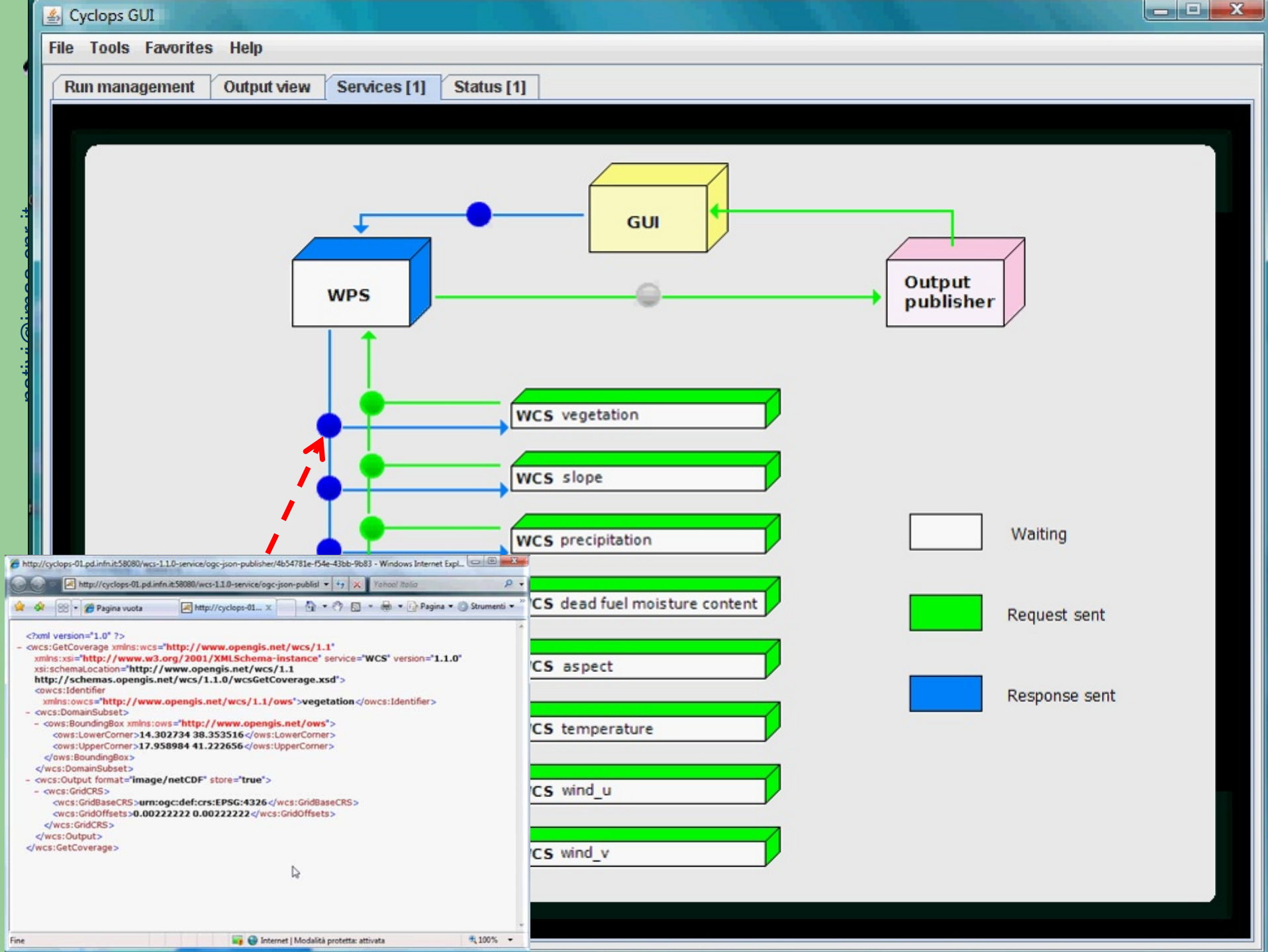
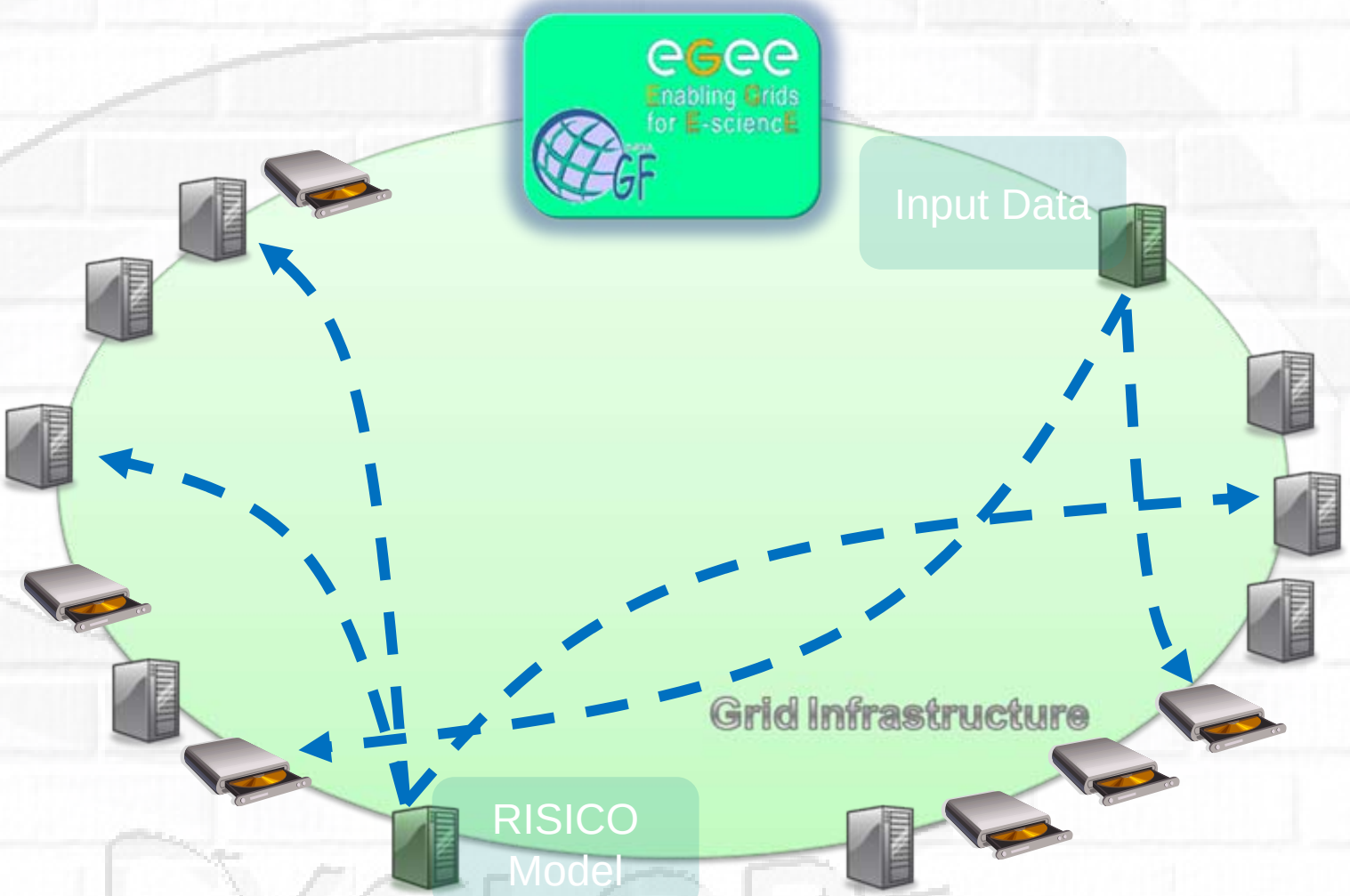

Cyclops GUI
File Tools Favorites Help
Run management
Output view
Services [1]
Status [1]
GUI
WPS
Output publisher
WCS vegetation
WCS slope
WCS precipitation
CS dead fuel moisture content
CS aspect
CS temperature
CS wind_u
CS wind_v
Waiting
Request sent
Response sent
<?xml version="1.0" ?>
<wcs:GetCoverage xmlns:wcs="http://www.opengis.net/wcs/1.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" service="WCS" version="1.1.0"
xsi:schemaLocation="http://www.opengis.net/wcs/1.1
http://schemas.opengis.net/wcs/1.1.0/wcsGetCoverage.xsd">
<owcs:Identifier
xmlns:owcs="http://www.opengis.net/wcs/1.1/ows">vegetation</owcs:Identifier>
<wcs:DomainSubset>
<ows:BoundingBox xmlns:ows="http://www.opengis.net/ows">
<ows:LowerCorner>14.302734 38.353516</ows:LowerCorner>
<ows:UpperCorner>17.958984 41.222656</ows:UpperCorner>
</ows:BoundingBox>
</wcs:DomainSubset>
<wcs:Output format="image/netCDF" store="true">
<wcs:GridCRS>
<wcs:GridBaseCRS>urn:ogc:def:crs:EPSG:4326</wcs:GridBaseCRS>
<wcs:GridOffsets>0.00222222 0.00222222</wcs:GridOffsets>
</wcs:GridCRS>
</wcs:Output>
</wcs:GetCoverage>

G-RISICO: Grid View



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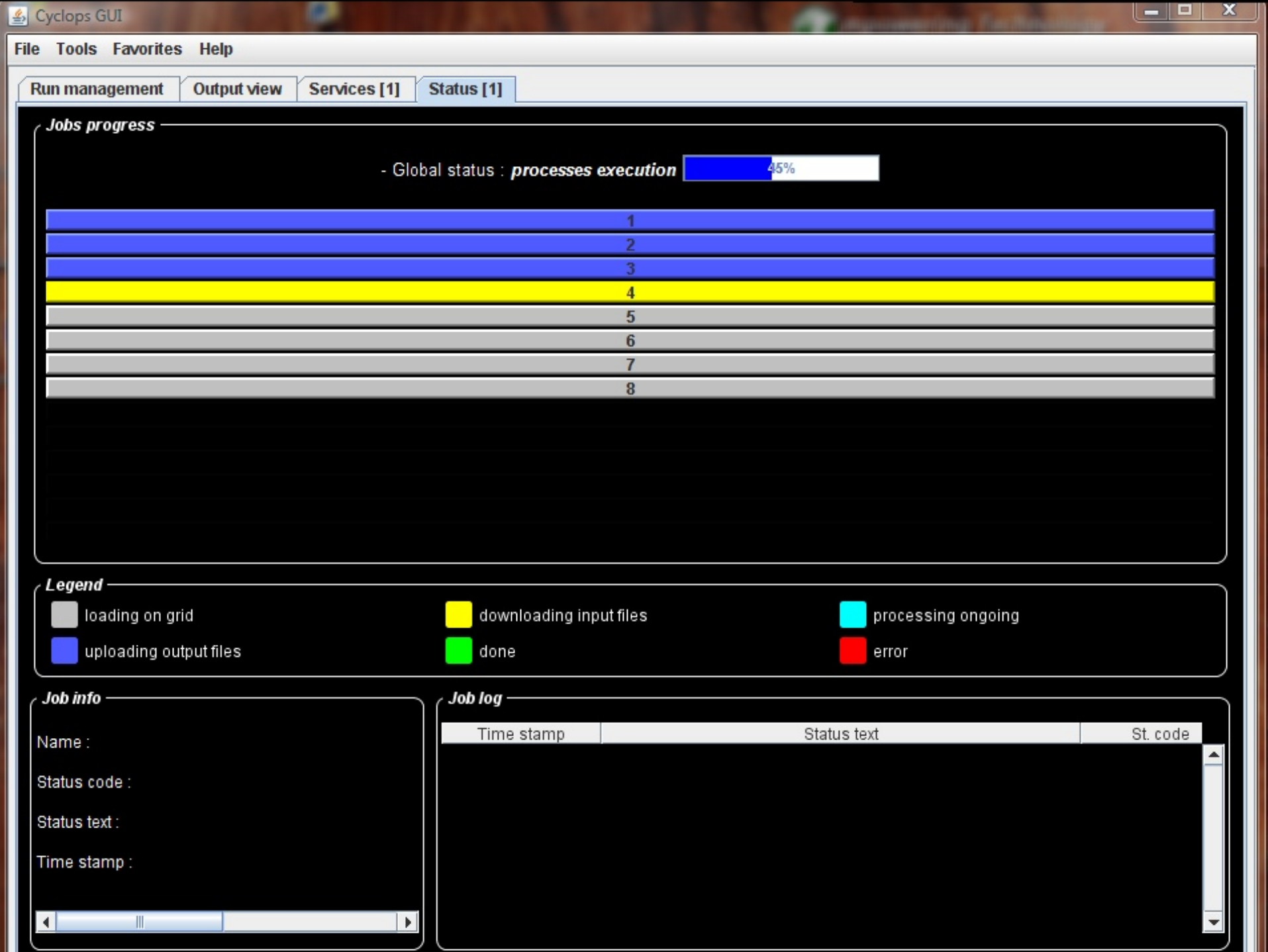
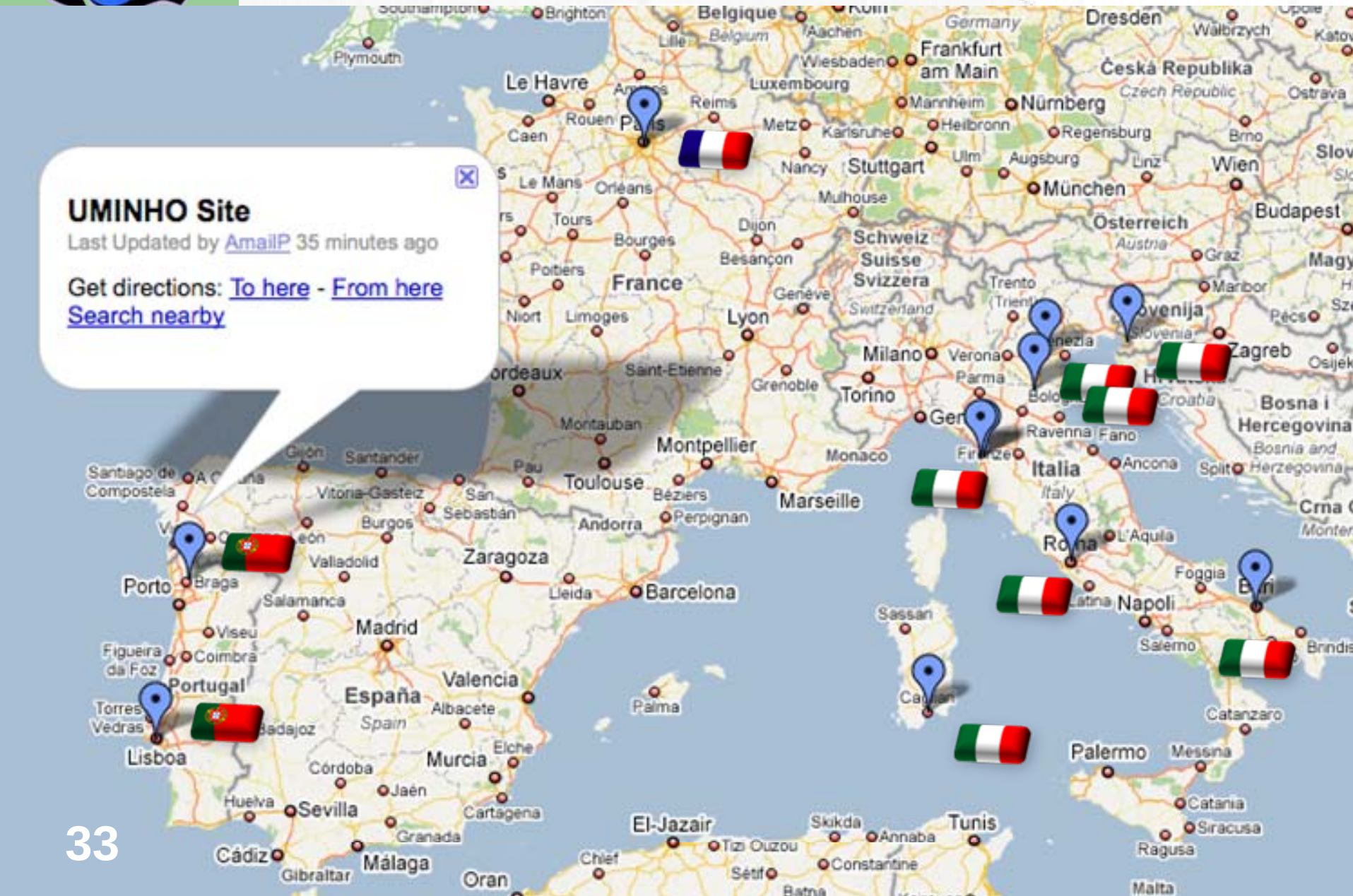
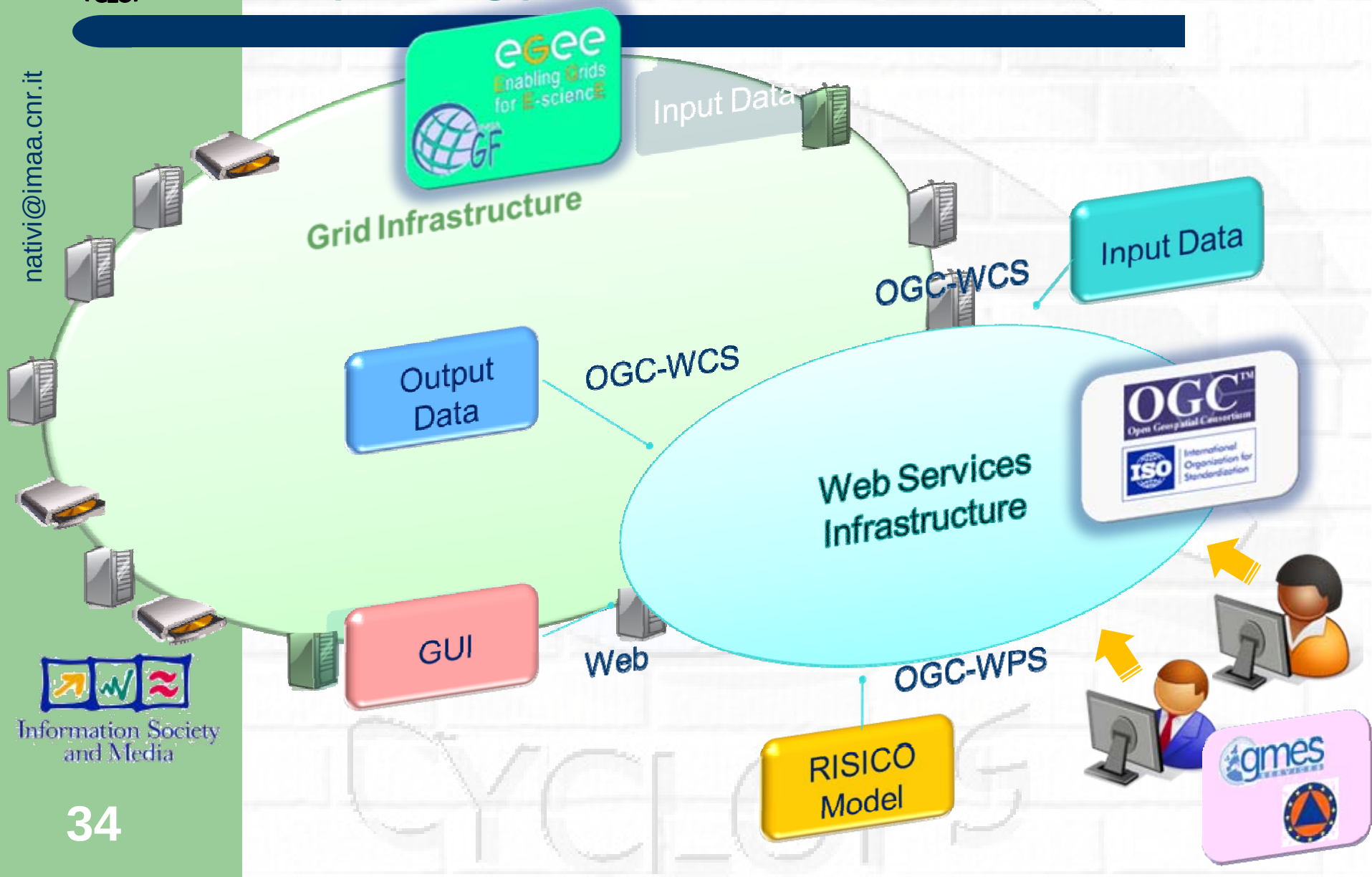

Cyclops GUI
File
Tools
Favorites
Help
Run management
Output view
Services [1]
Status [1]
Jobs progress
- Global status : processes execution
45%
1
2
3
4
5
6
7
8
Legend
loading on grid
downloading input files
processing ongoing
uploading output files
done
error
Job info
Name :
Status code :
Status text :
Time stamp :
Job log
Time stamp
Status text
St. code

Active sites for G-RISICO prototype



Web Services and Grid Synergy



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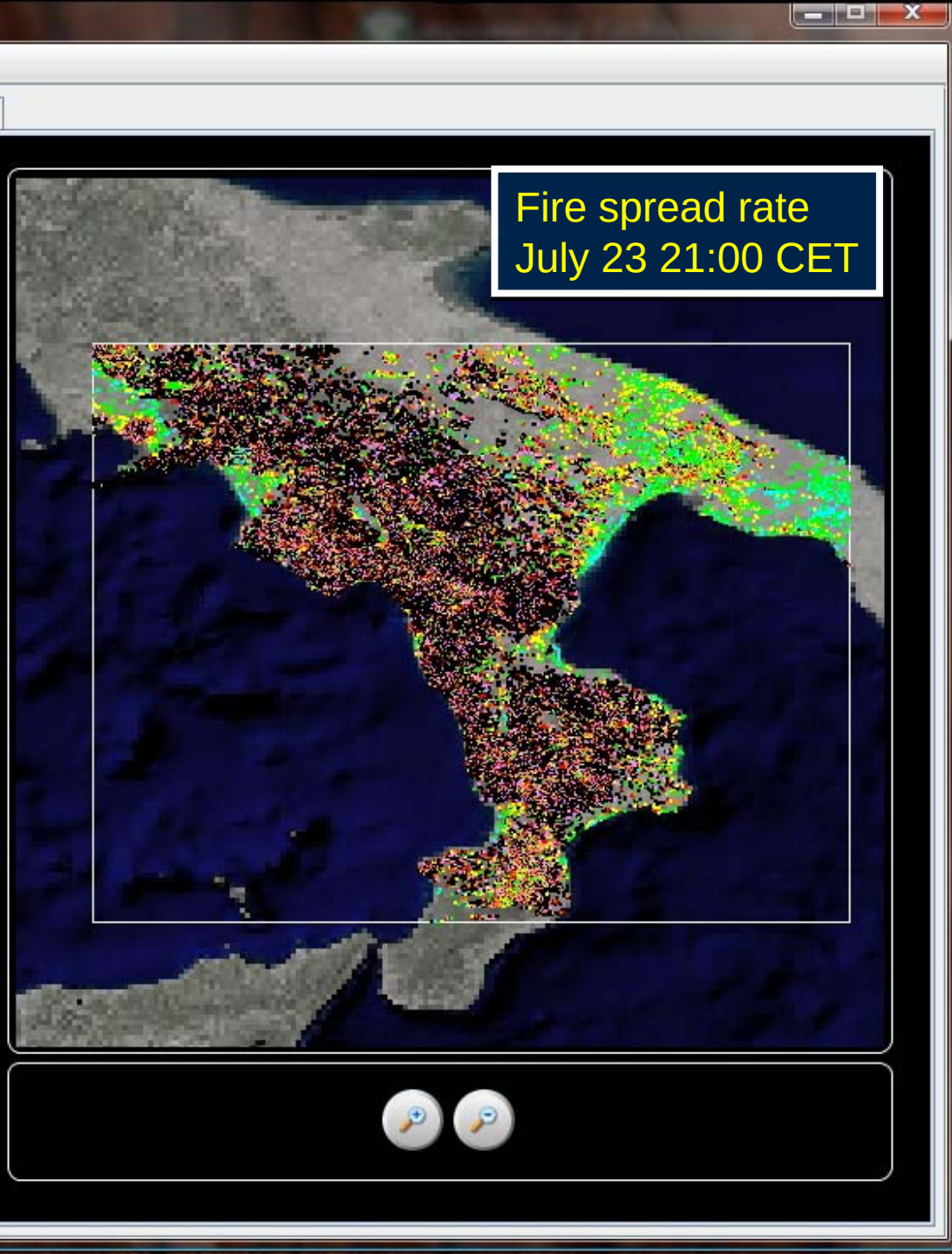
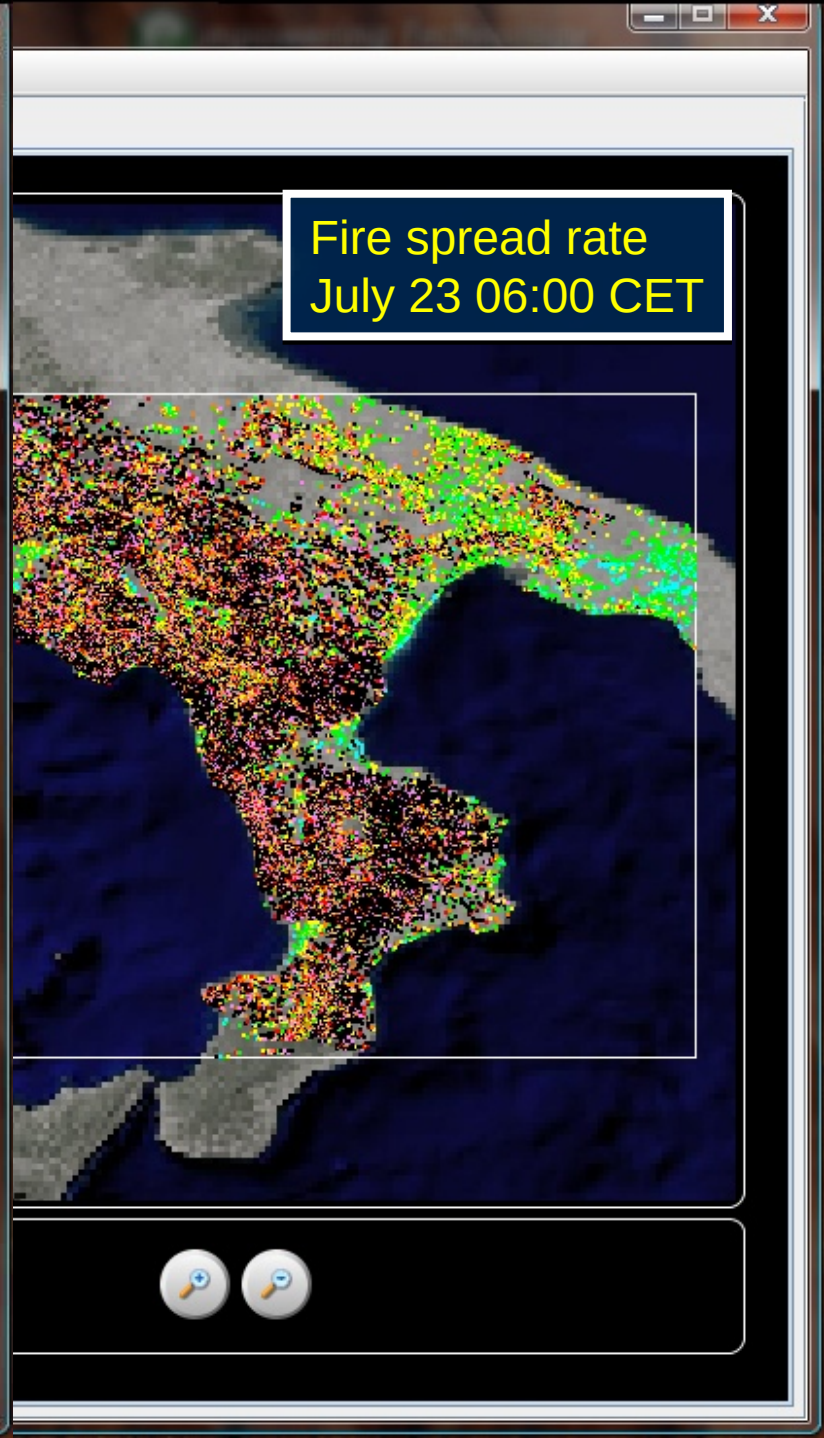

Fire spread rate
July 23 21:00 CET


Fire spread rate
July 23 06:00 CET

Use Case #2: Flood Forecast

- Linked to GMES flash flood anticipation service

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SPC-GD application (Service de Prevision des Crues- Grand Delta)

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- In France the floods warning services (SPC) perform the dangerous phenomena forecasting
- SPC-Grand Delta (SPC-GD) covers the whole tributaries in right and left bank of the third downstream of the Rhône river.
- French Floods warning service (SPC) is based on:
  - **A network of telemetry** (recording rain-gauges and water level stations)
  - **Tools of information and weather forecasting**: service Météo +® of Meteo-France; CALAMAR® tool (Rainfall calculation using the Radar);
  - **Tools of modeling: hydraulic models** (like ALHTAÏR flash floods forecasting system) allowing to estimate the discharge propagation between two sites.

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SPC-GD current implementation

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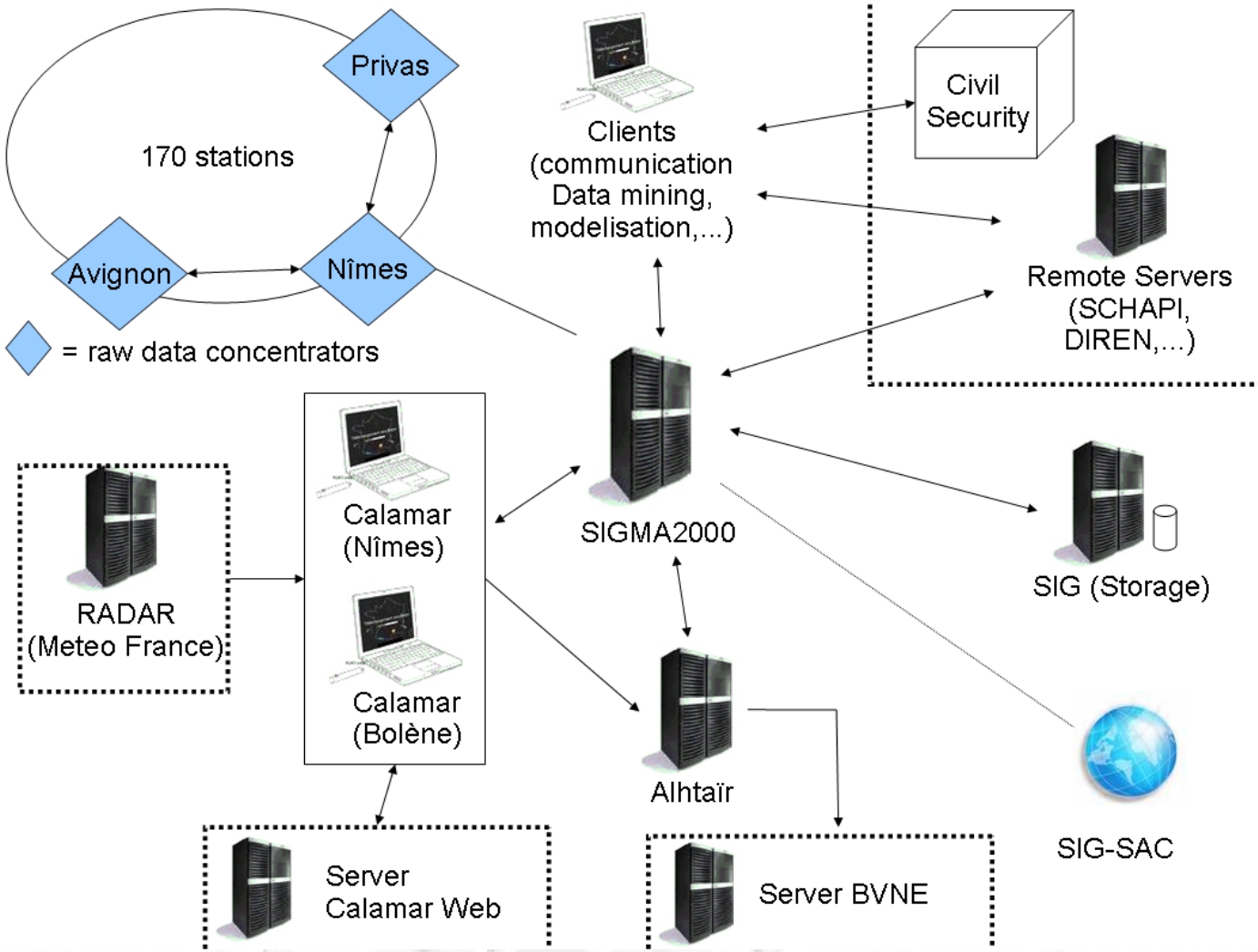

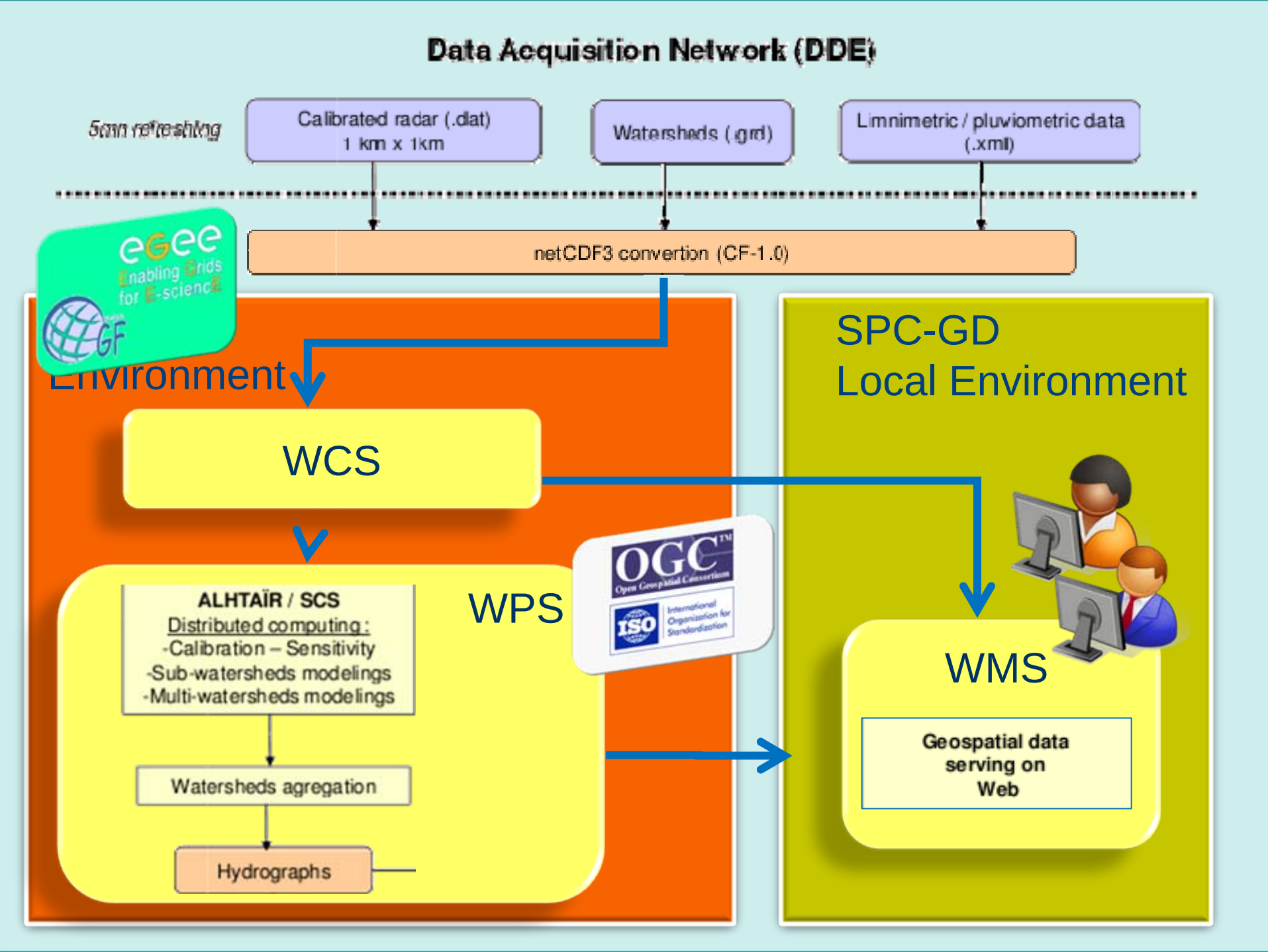
Data Acquisition Network (DDE)
5mn refreshing
Calibrated radar (.dat)
1 km x 1km
Watersheds (.grd)
Limnimetric / pluviometric data
(.xml)
netCDF3 convertion (CF-1.0)
eGee
Enabling Grids for E-sciencE
GF
Environment
WCS
WPS
ALHTAÏR / SCS
Distributed computing :
-Calibration – Sensitivity
-Sub-watersheds modelings
-Multi-watersheds modelings
Watersheds agregation
Hydrographs
OGC
Open Geospatial Consortium
ISO
International Organization for Standardization
SPC-GD
Local Environment
WMS
Geospatial data serving on Web

CYCLOPS platform: main expected benefits

nativi@imaa.cnr.it

- **Scalability**. The grid infrastructure provides high processing and storage capabilities on-demand, allowing to
  - improve output data resolution
  - improve Models complexity
  - improve the time response
  - widen the covered area

- **Flexibility&Interoperability**. The geospatial services layer allow to:
  - integrate/assimilate new and heterogeneous input data;
  - integrate output in a higher level application chain;
  - facilitate Models interoperability/composablity
  - be interoperable with other “standard-based” infrastructures (e.g. INSPIRE, GEOSS)

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Expected G-RISICO execution times for spatial accuracy

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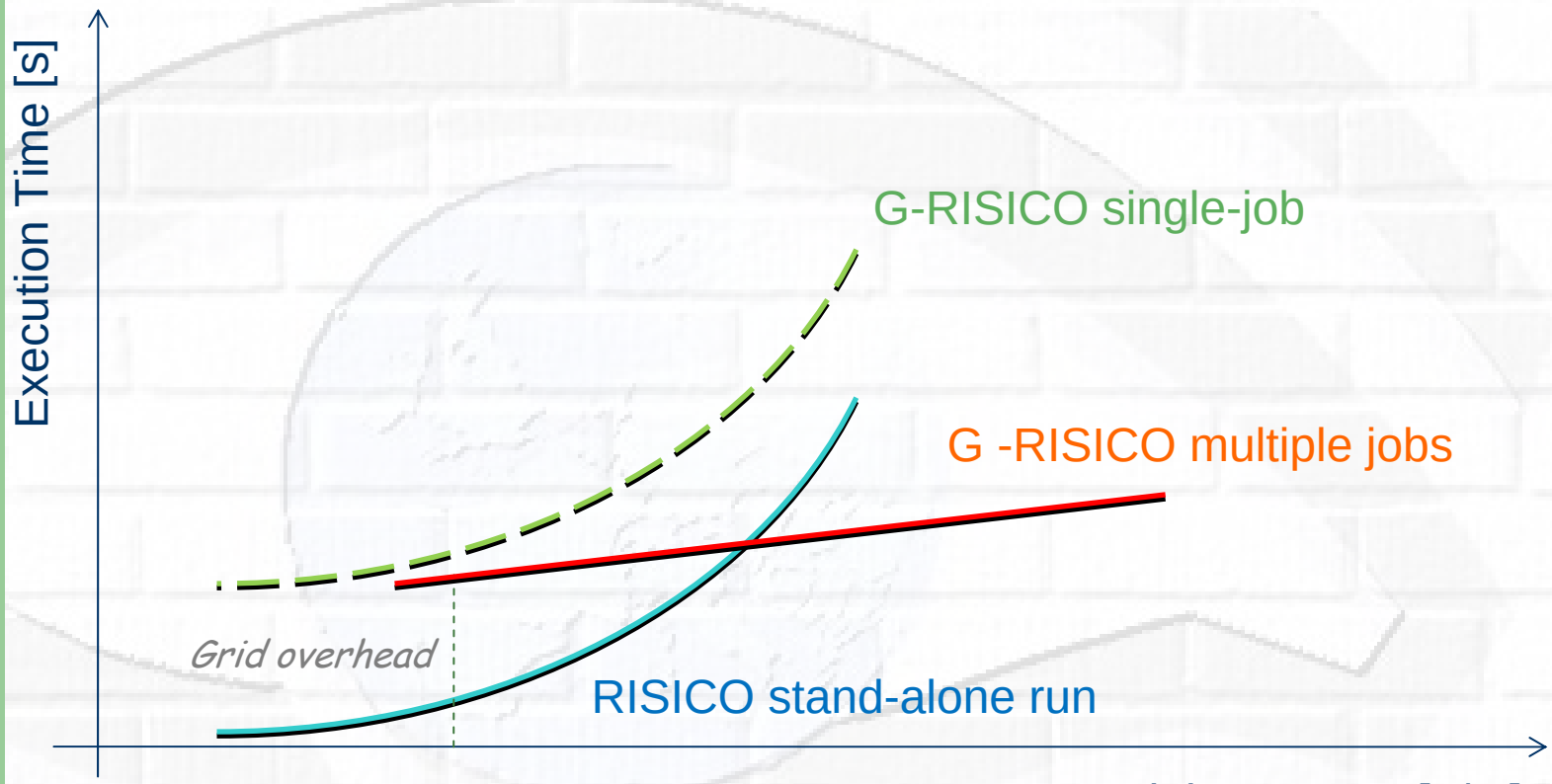

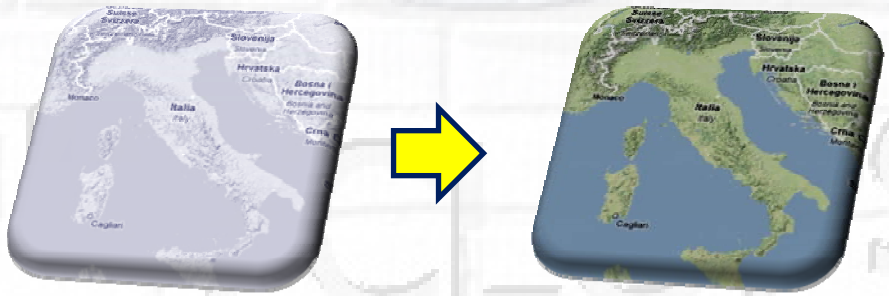

Expected G-RISICO execution times for spatial coverage

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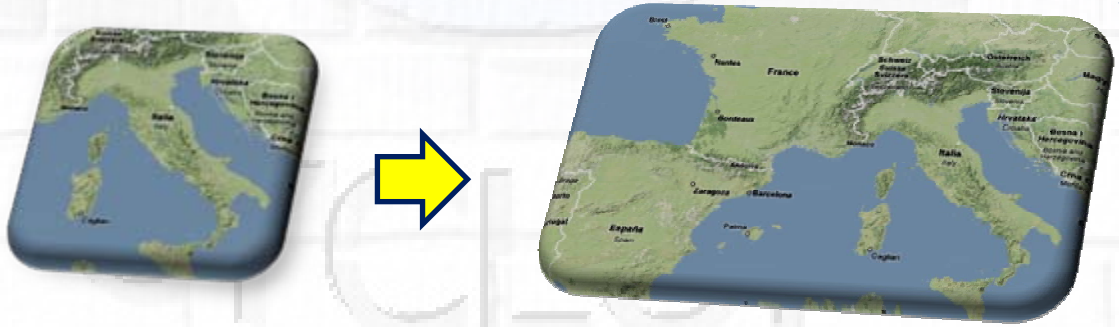

Preliminary statistical results for G-RISICO runs (spatial accuracy)

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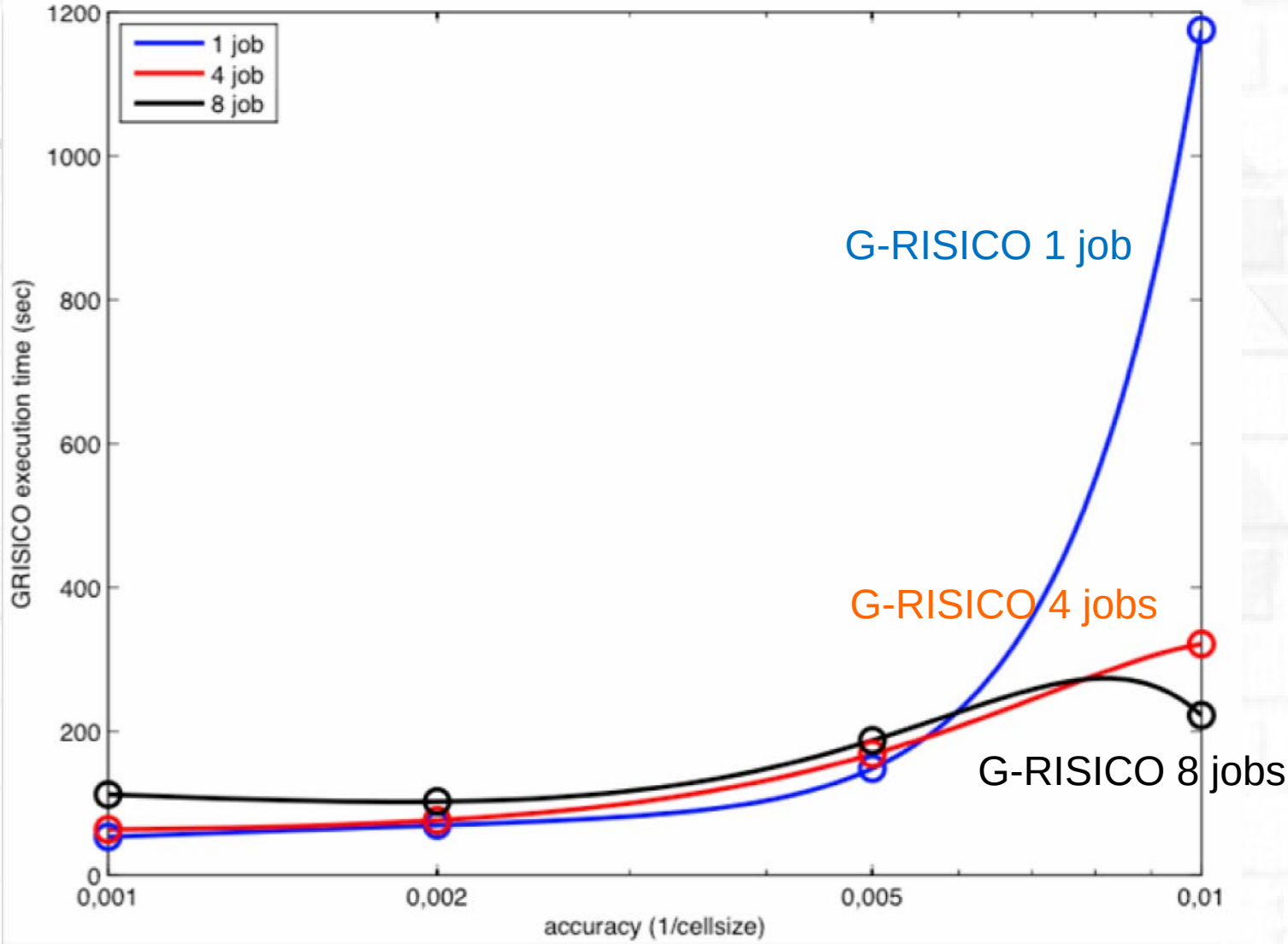

CYCLOPS main outcomes

- A reference architecture for the 3 communities interoperability
- A couple of architecture proofs of concept
  - Two CP prototypes for operational applications (the two use cases)

- Definition of research and innovation guidelines toward the design of an e-Infrastructure for Civil Protection applications

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Preliminary research themes

- Grid infrastructure enhancements
  - Job prioritization
  - Notification
  - Advanced Job Management (pause, restart, abort)
- Advanced Middleware
  - Grid-enabled geospatial services
  - Observation&Measurements access services
  - Sensor planning services
  - Specific domain ontology and semantics
- Security Infrastructure
  - Security and Data Policy services for CP applications
- CP Applications enablement
  - Parallelization strategies for CP applications
  - Interoperability standards for risk business and application logic
  - Forecast modelling interoperability and workflow
- Standardization process
  - Civil Protection/Risk Circle international best practises/standards
    - Pre-disaster
    - Response
    - Post-disaster

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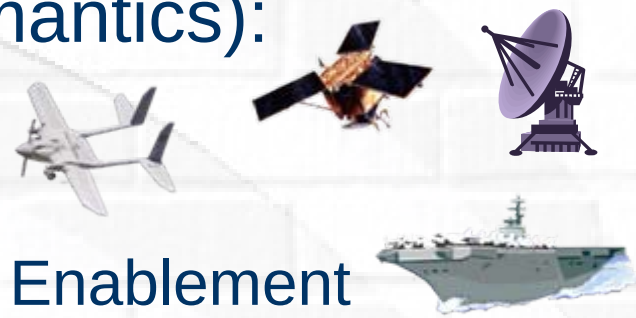
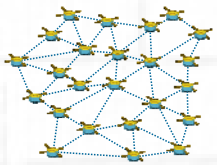
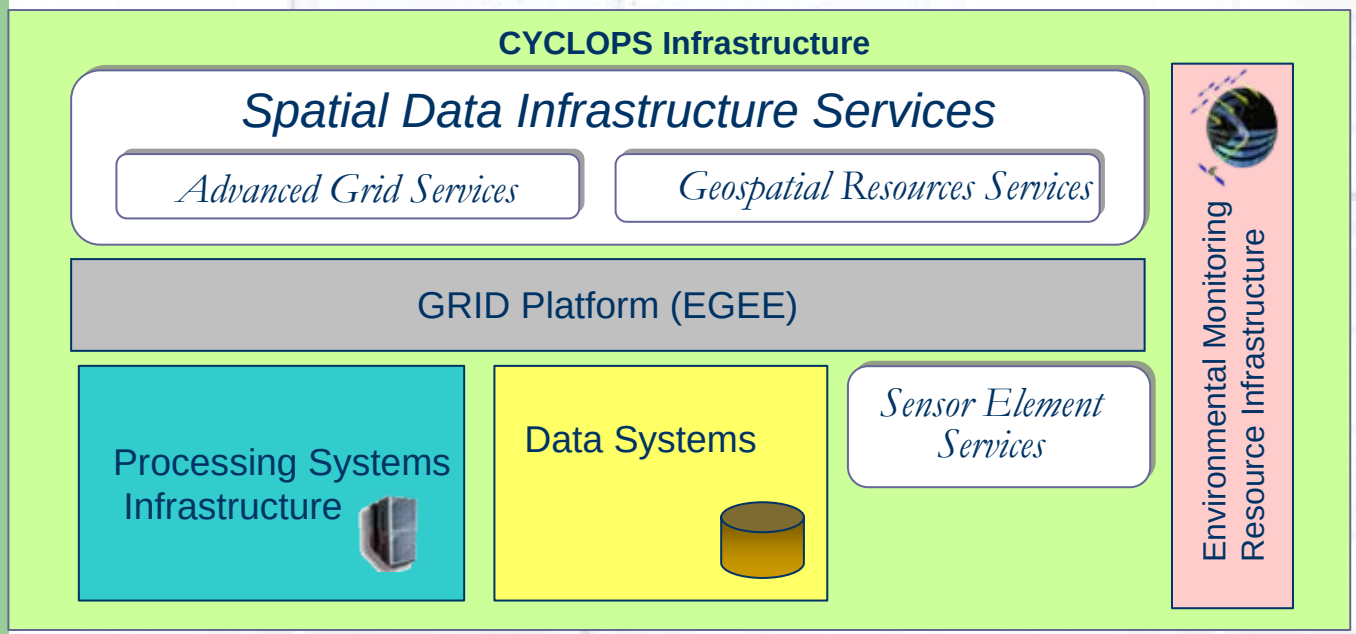
Sensors Virtualization

- Two approaches (diverse semantics):
  - A new Grid sensor element
    - Instrument Element
  - Make use of OGC Sensor Web Enablement services





Domain Semantics



nativi@imaa.cnr.it

nativi@imaa.cnr.it

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