



# Introduction to Web Mapping Web Services

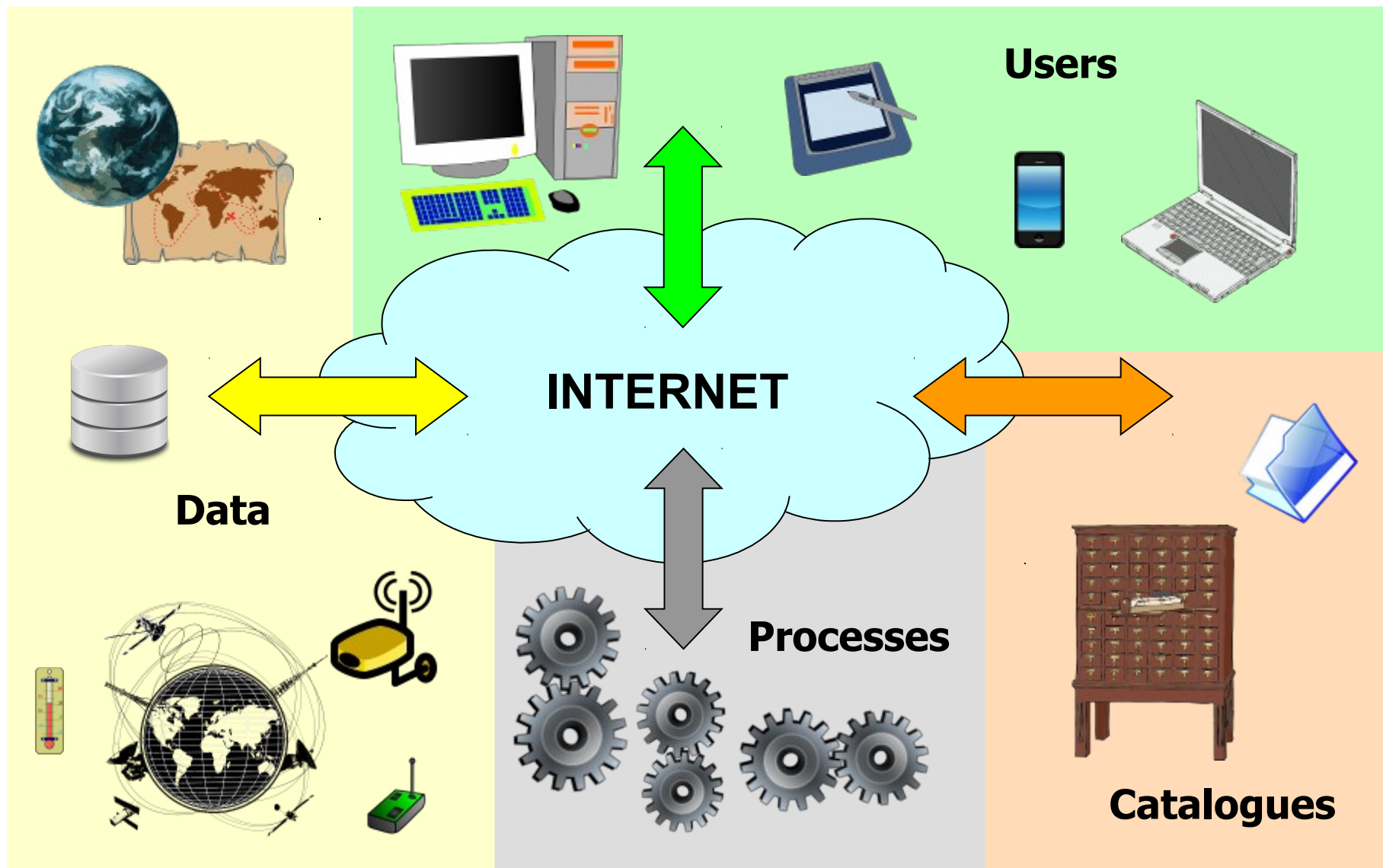
Maria Antonia Brovelli  
Politecnico di Milano



POLITECNICO MILANO 1863



# Geospatial Web

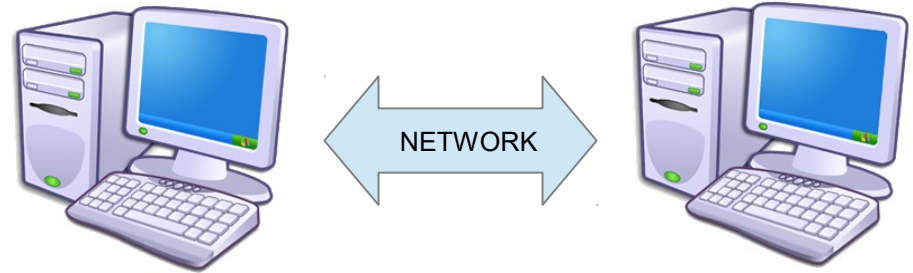




# Geospatial Web Services

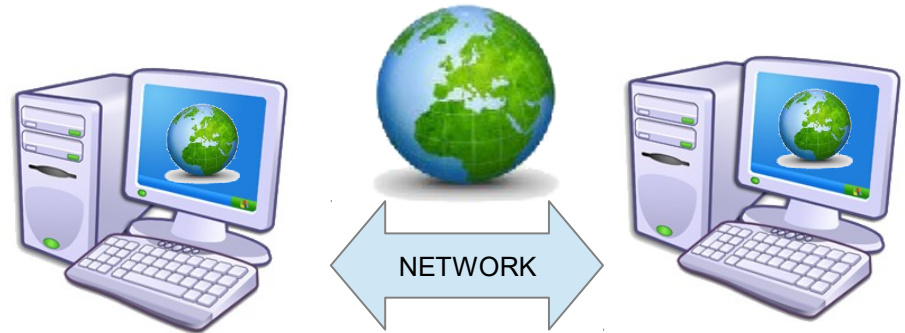
## Web Service

“...a software system designed to support interoperable machine to machine interaction over a network”



## Geospatial Web Service

“...allows geospatial data and functions to be interoperable”





# Interoperability

Interoperability is the capability to communicate, execute programs or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units (ISO/IEC 2382-01, Information Technology Vocabulary, Fundamental Terms)

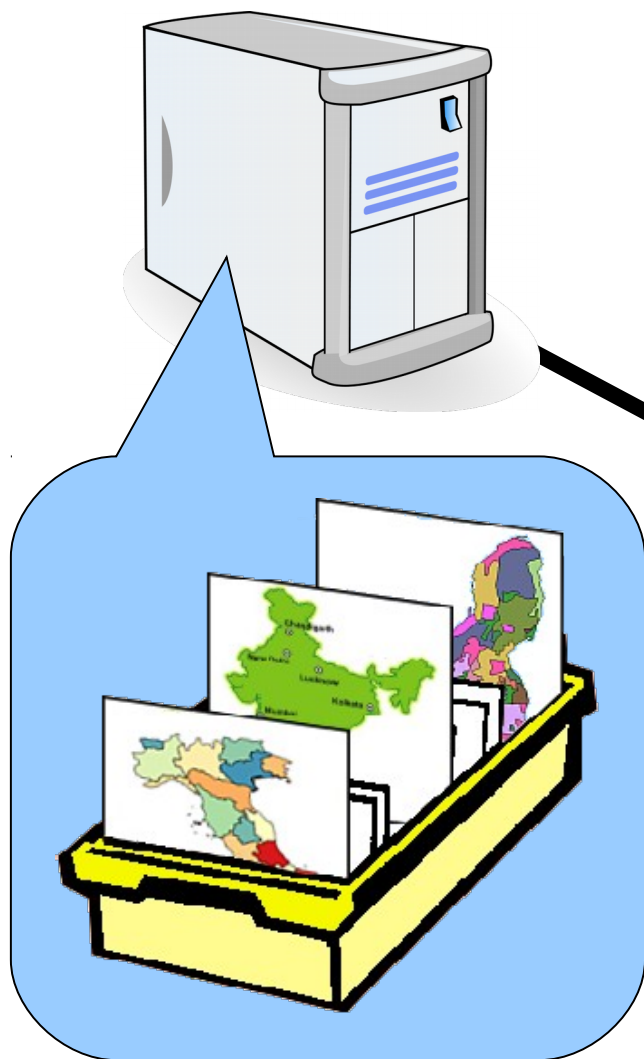
Examples of interoperable components needed by a distributed GIS:

- Catalogues (collections of metadata, that is information on available objects and operators)
- Data archives
- Viewers and editing tools
- Operators (e.g. for transformation, filtering, integration,...)

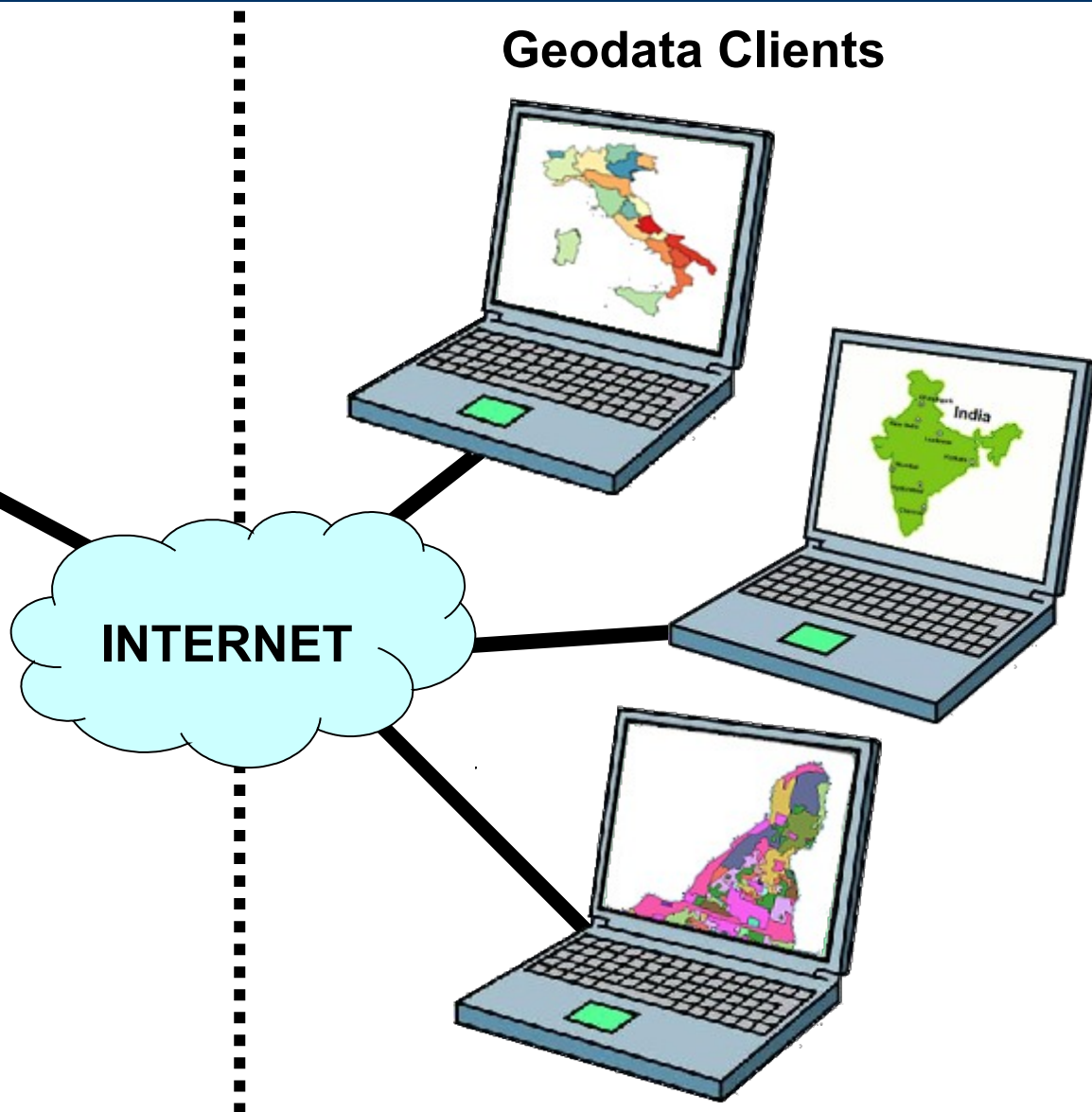


# Web mapping

**Geodata Servers**



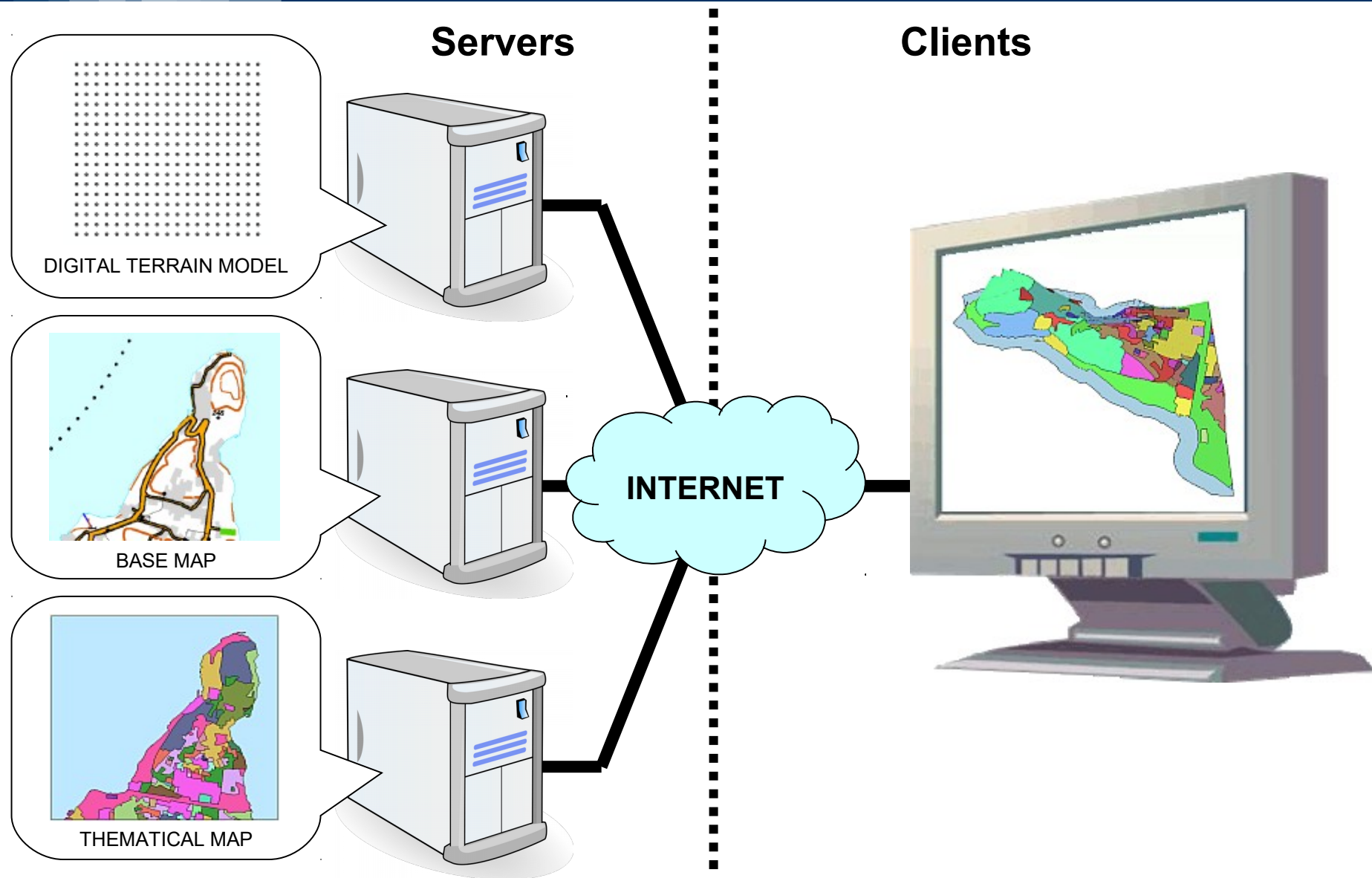
**Geodata Clients**







# Map mashing-up





# Standardization

In order to obtain the interoperability standards are needed

De facto standard: technical instruction used by a noteworthy number of people and/or organizations (i.e. shp, dxf, ...)

De jure standard: technical instruction set by national and/or international standardization organizations (W3C, ISO, OGC, National standards, ...)



(TC211 - geographic  
information and geomatics)





# OGC Web Services (OWS)

- OGC Web Services expose geographical functionality to Web users through a standard Web protocol
- XML based: the use of the “eXtensible Markup Language” allows to encoding data, rules and functions in a format that is both human-readable and machine-readable:

## **Web Services are platform and OS-independent**

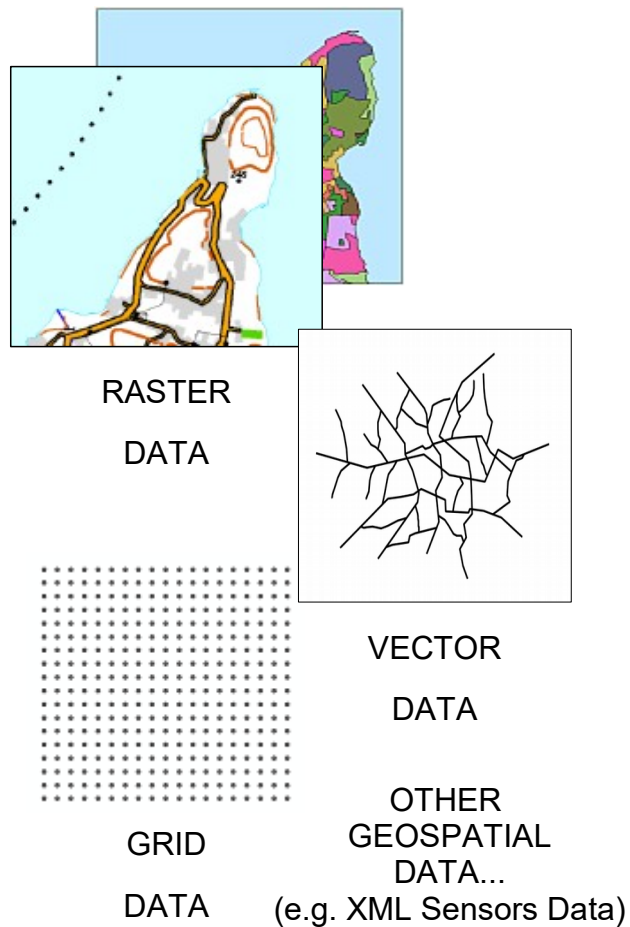
- The functioning of OWS can be described in four steps:
  - the client contacts the server and queries it about its functionalities
  - the server sends back to the client an XML document containing the functionalities of the supported service
  - the client asks the server for data
  - the server provides the data as requested



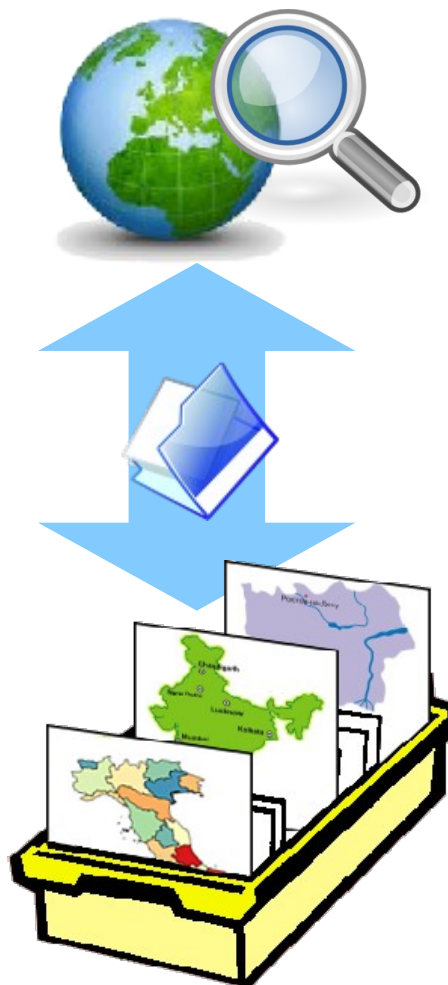


# OWS Services

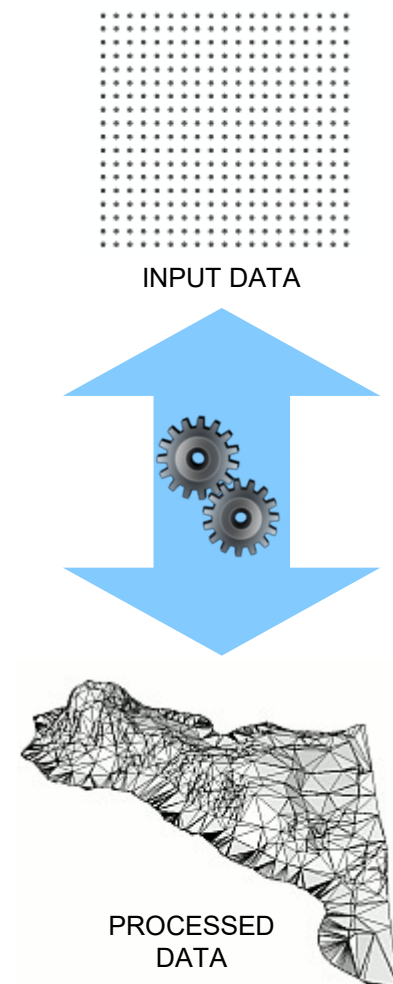
## DATA DELIVERY



## CATALOGUE



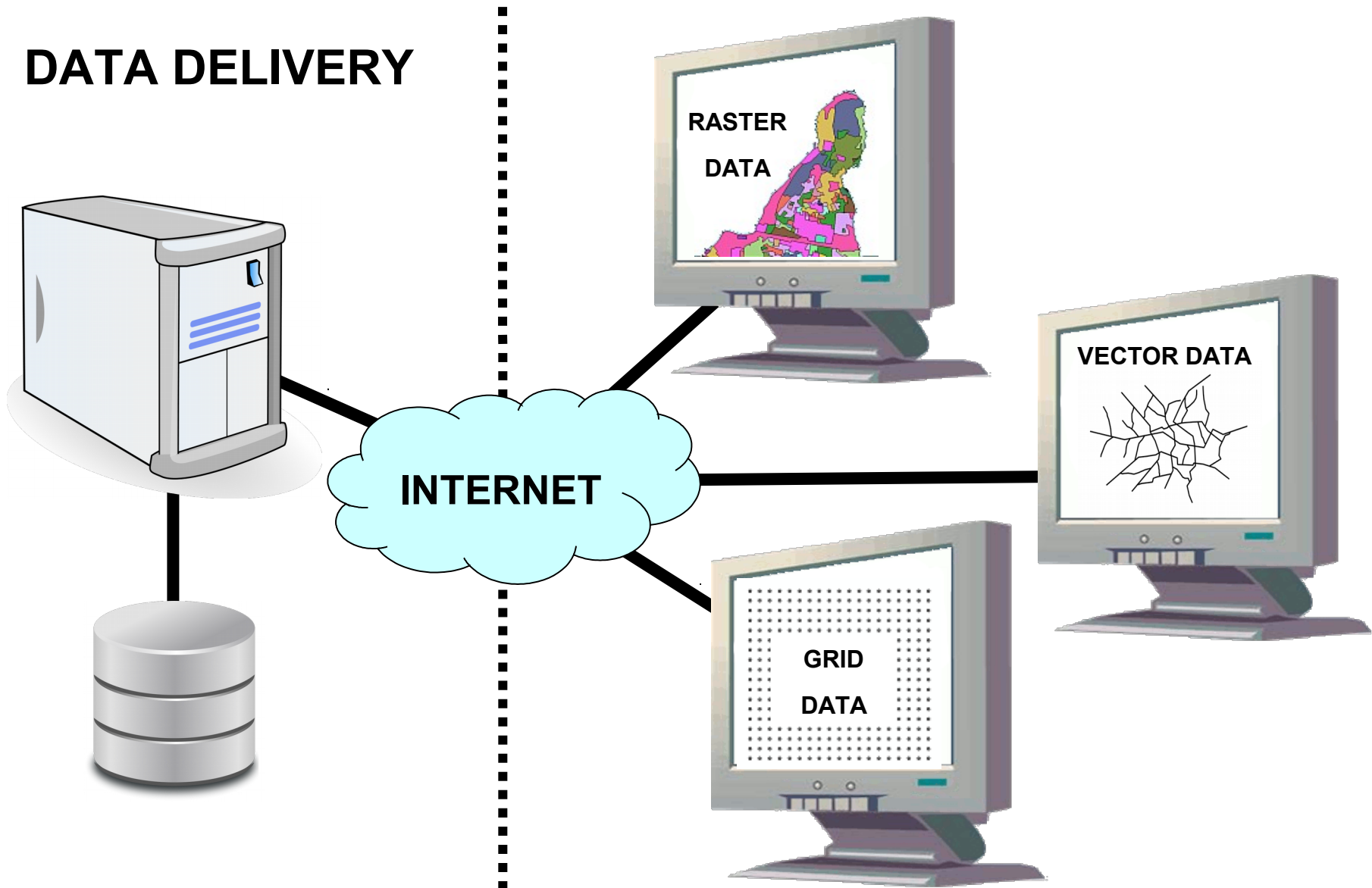
## PROCESSING





# OWS - Data Delivery Services (1)

## DATA DELIVERY





# OWS - Data Delivery Services (2)

- **WMS:** service that generates maps and makes them available as images → RASTER
- **WFS:** service that generates geographic entities or features. If the service is “transaction” (**WFS-T**), data manipulation is allowed → VECTOR
- **WCS:** service that generates geospatial coverages, that are geospatial information representing space-varying phenomena (fields) → GRID
- **SOS:** service that generates metadata and observations from heterogeneous sensor systems → DATA (XML)



# Web Map Service (WMS)

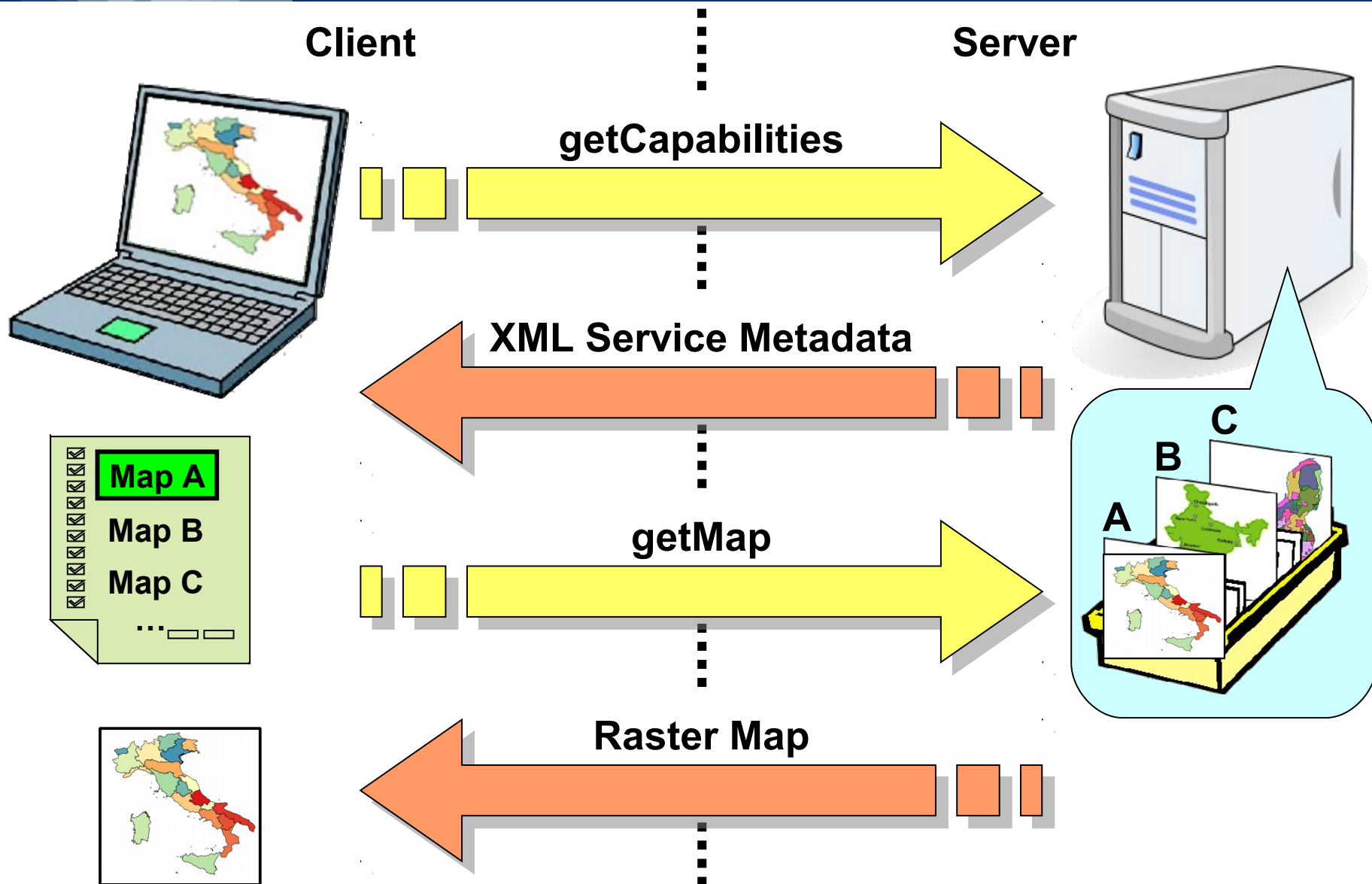
- The WMS service is composed by three basic functions, supported by three interfaces:
  - **GetCapabilities:** provides human and computer understandable description of the available data and the parameters related to the requests accepted by the service
  - **GetMap:** supplies the requested data
  - **GetFeatureInfo:** provides other information (map content and attributes of map features)

The first two operations are mandatory, the third is optional (queryable WMS)

The access to a WMS can be carried out using a standard browser, with the parameters set in the URL (GET method) or in a hidden way (POST method)

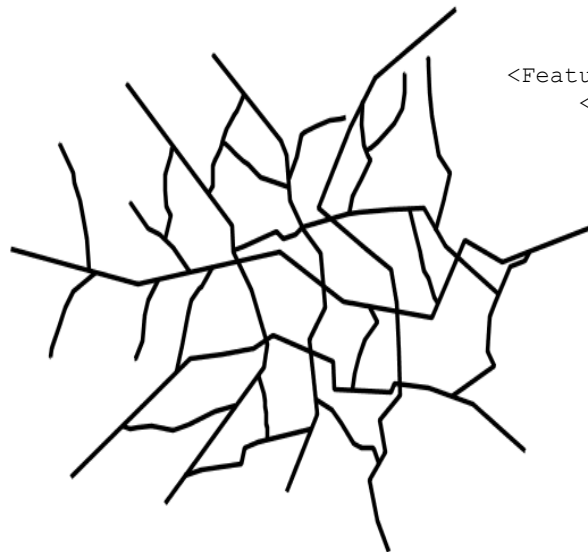


# WMS Example



# Styling of WMS: SLD standard

The Styled Layer Descriptor (SLD) defines an encoding that extends the WMS standard to allow user-defined symbolization and coloring of geographic and coverage data



```
<FeatureTypeStyle>
  <Rule>
    <LineSymbolizer>
      <Stroke>
        <CssParameter name="stroke">#FF0000
      </CssParameter>
    </Stroke>
    </LineSymbolizer>
    <TextSymbolizer>
      <Label>
        <ogc:PropertyName>name</ogc:PropertyName>
      </Label>
      <LabelPlacement>
        <LinePlacement />
      </LabelPlacement>
      <Fill>
        <CssParameter name="fill">#000000
      </CssParameter>
    </Fill>
    </TextSymbolizer>
  </Rule>
</FeatureTypeStyle>
```







# Web Feature Service (WFS)

- While in a WMS a query returns merely a graphic result, in the case of WFS the result involves geographic entities or features
- A feature is an object with a certain number of properties. Each property is characterized by the fields “name”, “type” and “value”. If at least one property is geometric, then we’re dealing with a geometric feature. The geometry is described by simple geometric elements such as points, curves, surfaces and solids
- The main problem is that geographic data are generally modeled in heterogeneous ways; therefore when transferring them, the scheme used for the model must be transferred too
- The data exchange mechanism provided by the OGC is GML (Geographic Markup Language), KML and GeoJSON



# Basic WFS functions

The WFS service is composed by the following basic functions supported by interfaces:

- **GetCapabilities:** provides the readable description of the available features and the parameters related to the requests accepted by the service
- **DescribeFeatureType:** provides the description of the features (data scheme)
- **GetFeature:** supplies the “Feature”-type objects (instances). It must also know which properties have to be provided and it must be able to make spatial and non-spatial selections.
- data manipulation, for example operations such as “create”, “update” e “delete” (**Transaction**)
- the application of a lock-request to one or more instances during a transaction (**LockFeature**)



# WFS Classification

The WFS service are described as:

- **Basic:** they support the 'GetCapabilities', 'DescribeFeatureType' and 'GetFeature' operations. These are the 'read-only' mode WFS
- **Transactional:** they supports transaction requests. A transaction request facilities the creation, deletion, and updating of geographic features
- **Complete:** Includes the LockFeature support to the suite of transactional level operations



# Web Coverage Service (WCS)

- Service that supports electronic retrieval of geospatial coverages, that are geospatial information representing space-varying phenomena
- Unlike the WMS which portrays spatial data to return static maps (rendered as pictures by the server), the WCS provides available data together with their detailed descriptions; defines a rich syntax for requests against these data; and returns data with its original semantics (instead of pictures) which may be interpreted, extrapolated, etc. – and not just portrayed
- Unlike WFS, which returns discrete geospatial features, the WCS returns coverages representing space-varying phenomena that relate a spatio-temporal domain to a (possibly multidimensional) range of properties



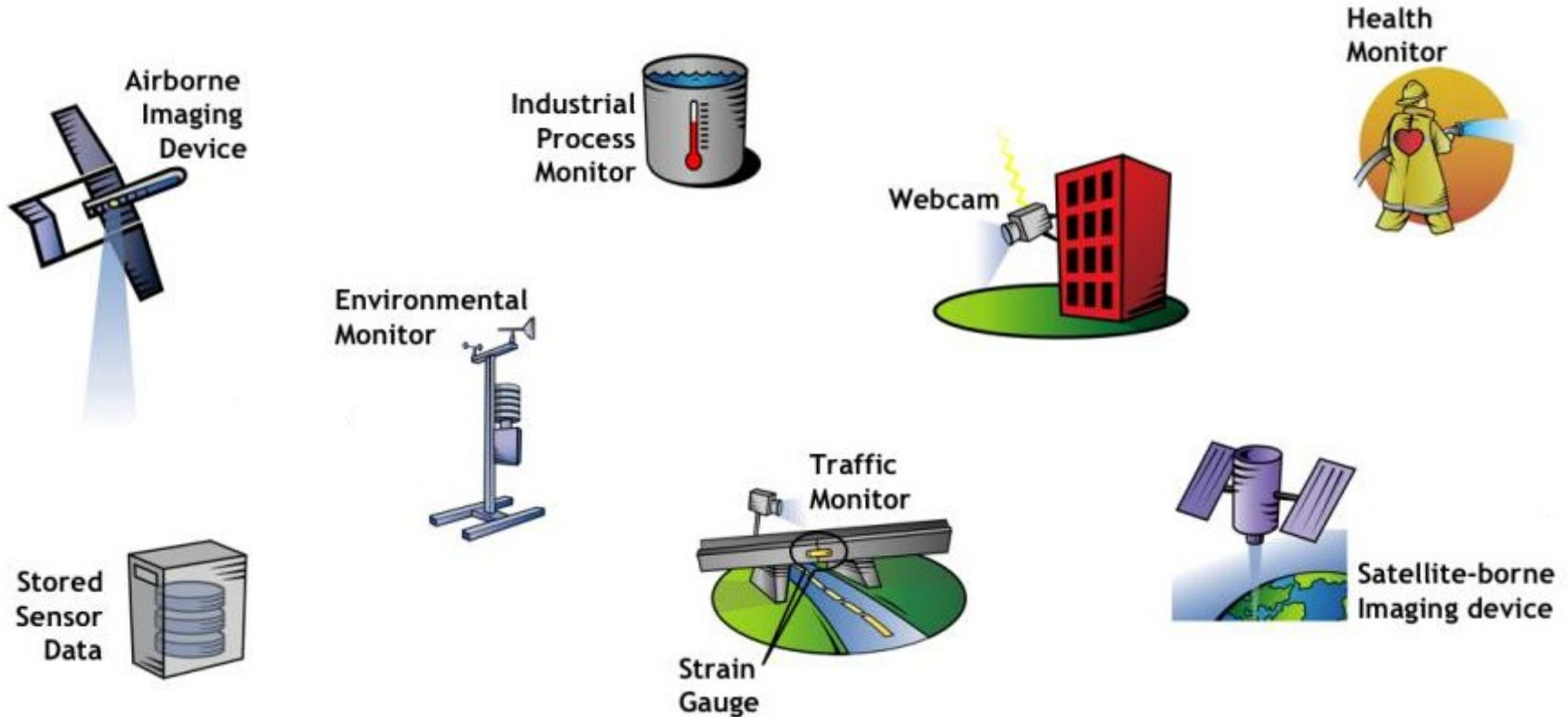
# Basic WCS functions

The WCS service is composed by three basic functions, supported by three interfaces:

- **GetCapabilities:** returns an XML document describing the service and brief descriptions of the coverages that clients may request
- **DescribeCoverage:** lets clients request a full description (in XML format) of one or more coverages served by a particular WCS server
- **GetCoverage:** returns a coverage (that is, values or properties of a set of geographic locations), encoded in well-known coverage format

# SWE – Sensor Web Enablement

The OGC's Sensor Web Enablement (SWE) standards enable developers to make all types of sensors, transducers and sensor data repositories discoverable, accessible and usable via the Web







# SWE Example – SOS (1)

The Sensor Observation Service (SOS) provides a standardized interface for managing and retrieving metadata and observations from heterogeneous sensor systems

This standard:

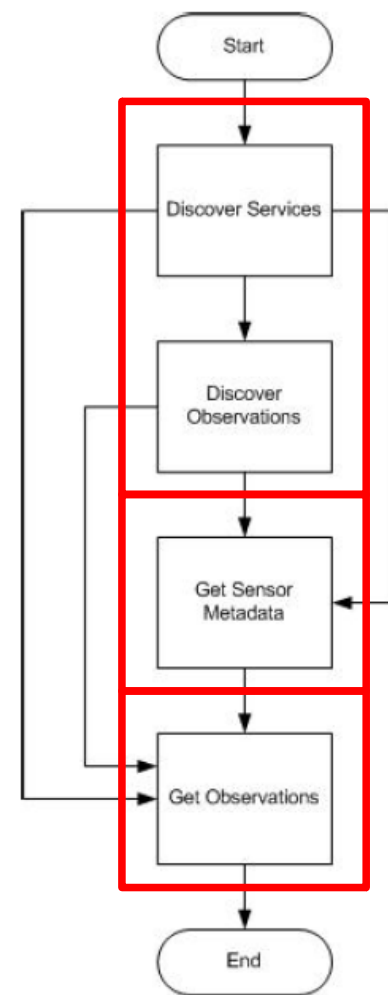
- specifies how observations, sensor descriptions, as well as computational representations of observed features are accessed in an interoperable and standardized way
- defines means to register new sensors and to remove existing ones
- defines operations to insert new observations as well as to efficiently insert and retrieve observation result values
- specifies SOS functionality in a binding independent way



# SOS - Core Operations

The SOS service is composed by the following basic functions:

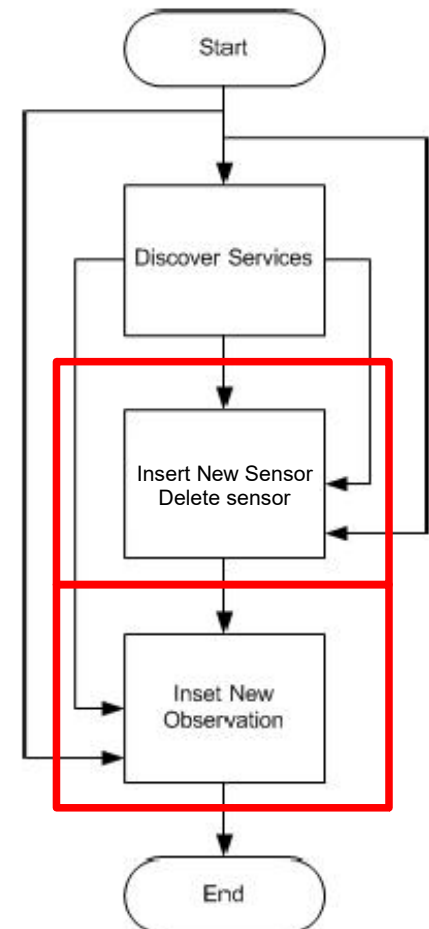
- **GetCapabilities:** provides access to metadata and detailed information about the operations available by an SOS server
- **DescribeSensor:** provides access to detailed information about the sensors and sensor systems available by an SOS server
- **GetObservation:** provides access to observations from sensors and sensor systems selected by spatial, temporal and thematic filtering



# SOS - Transactional Extension

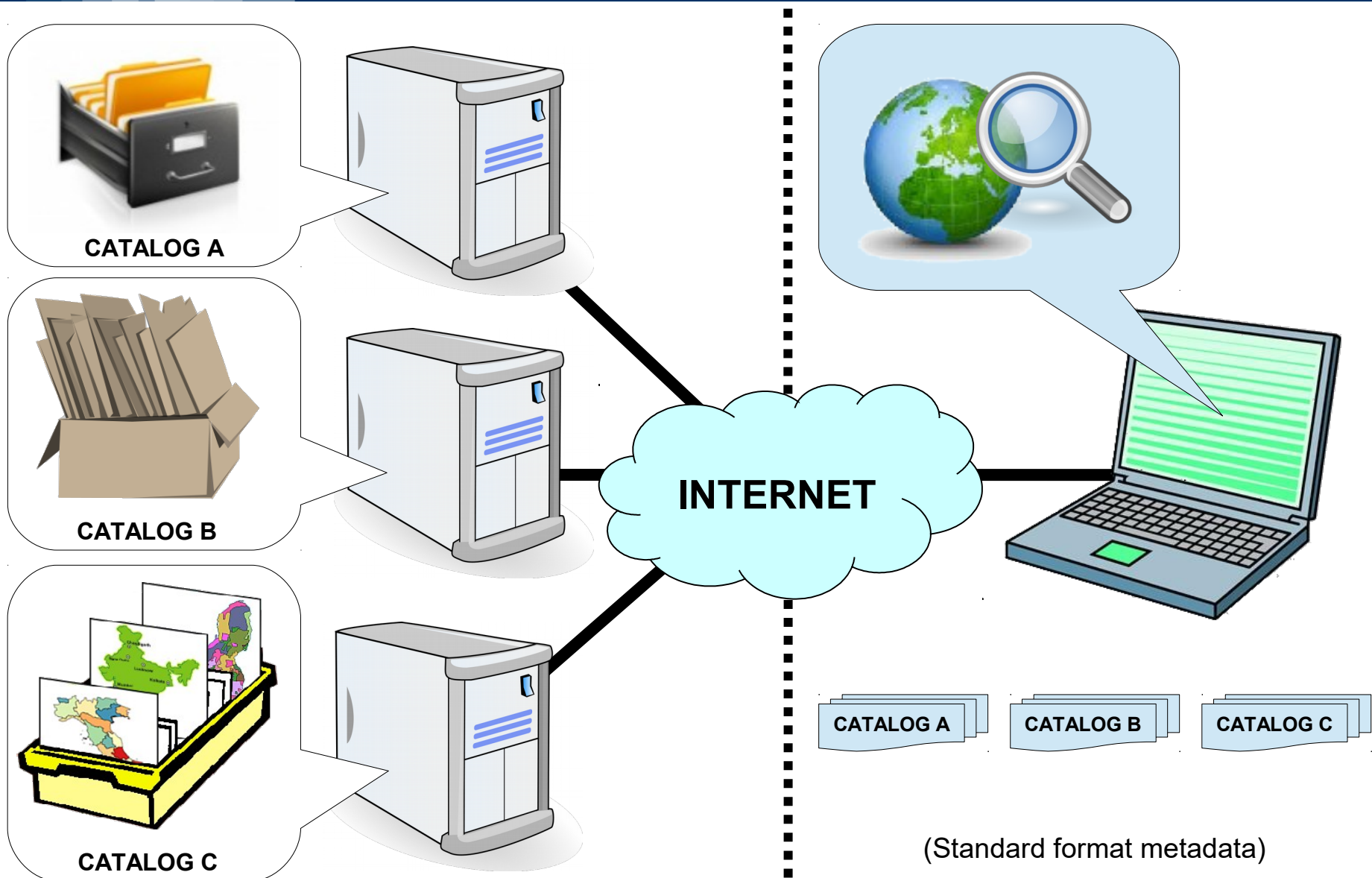
The SOS transactional extension is composed by the following basic functions:

- **InsertSensor:** allows registration of new sensors at the SOS
- **DeleteSensor:** allows the deletion of registered sensors and all their associated observations
- **InsertObservation:** allows the insertion of observations in an SOS server



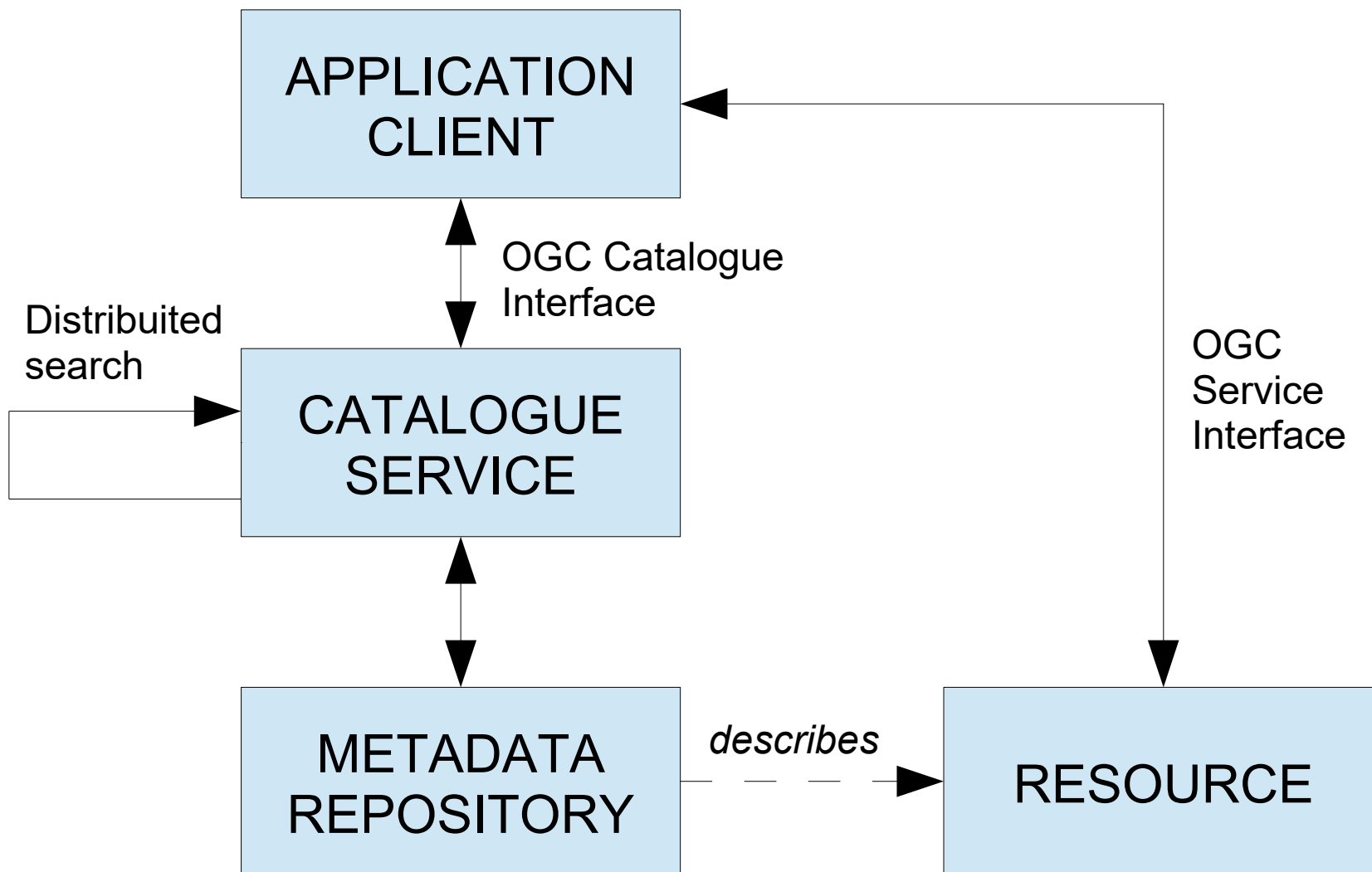


# OWS Catalog Service



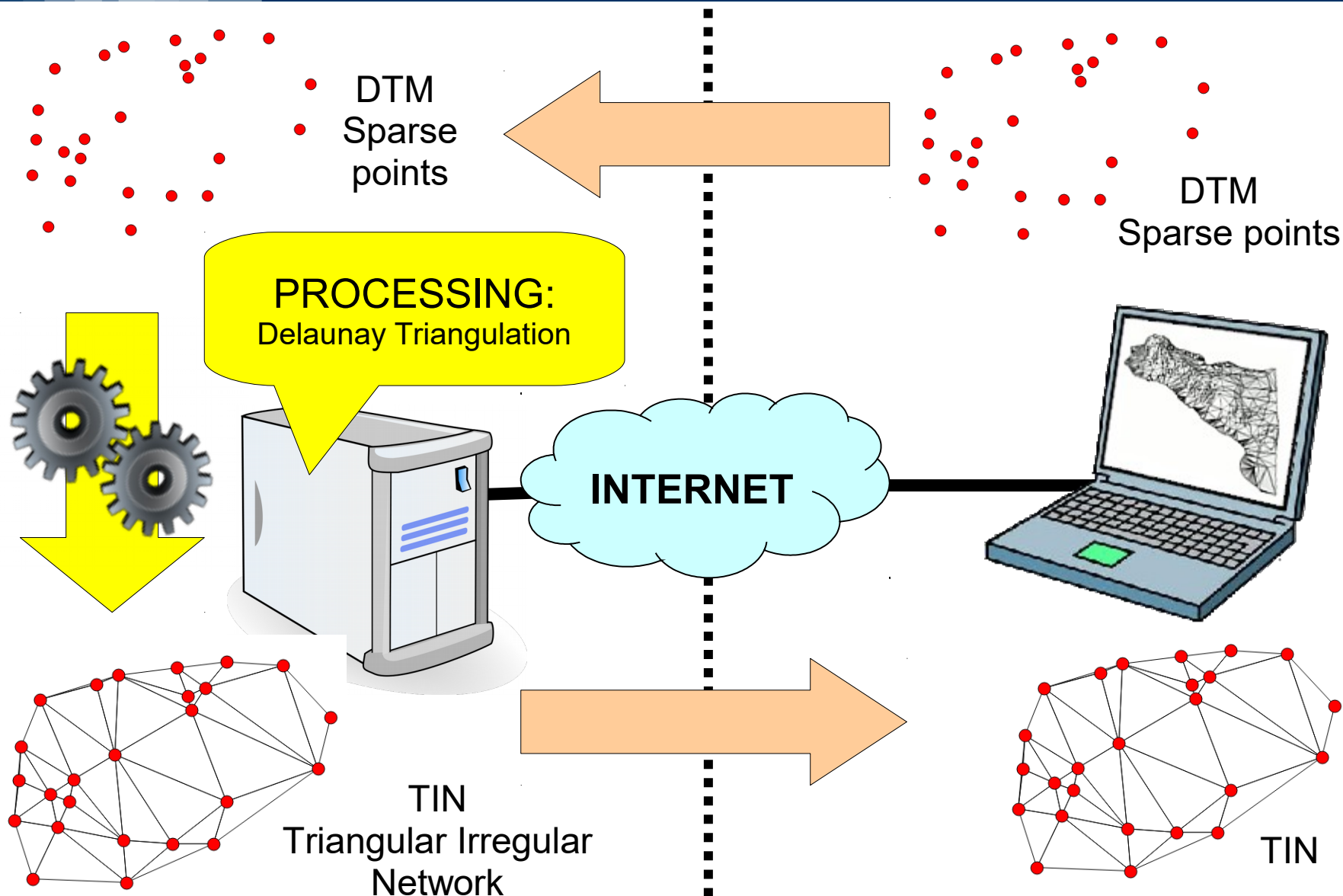


# CSW – Model Architecture





# OWS Processing Service







# WPS functions

WPS defines three operations:

- **GetCapabilities:** returns service-level metadata
  - Service description
  - Access description
  - Brief process descriptions
- **DescribeProcess** returns a description of a "process" including its inputs and outputs
- **Execute** returns the output of a "process"



# Other OCG Standards

## Data formats:

- **SFS**: Simple Feature Standard
- **GML**: Geography Markup Language
  - **CityGML** : storage of virtual 3D city models
- **KML**: Keyhole Markup Language
- **NetCDF**: OGC Network Common Data Form
- ...

## Services and specification:

- **WMTS**: Web Map Tile Service
- **CTS**: Coordinate Transformation Service
- **WCPS**: Web Coverage Processing Service
- GeoAPI Implementation
- Filter Encoding
- ...



# FOSS Software for an SDI

## Server Side



**MapServer**  
open source web mapping



**GeoServer**

**GeoNetwork**  
opensource

**deegree**



**geomajas**



**52north**  
exploring horizons

**ZOO**

• • • • •

## Client Side



**uDig**



**OpenLayers™**



**Mapbender**



**geomajas**



**gvSIG**

**p.mapper**

**OPEN JUMP**



**mapfish**



**GRASS**



**Quantum GIS**

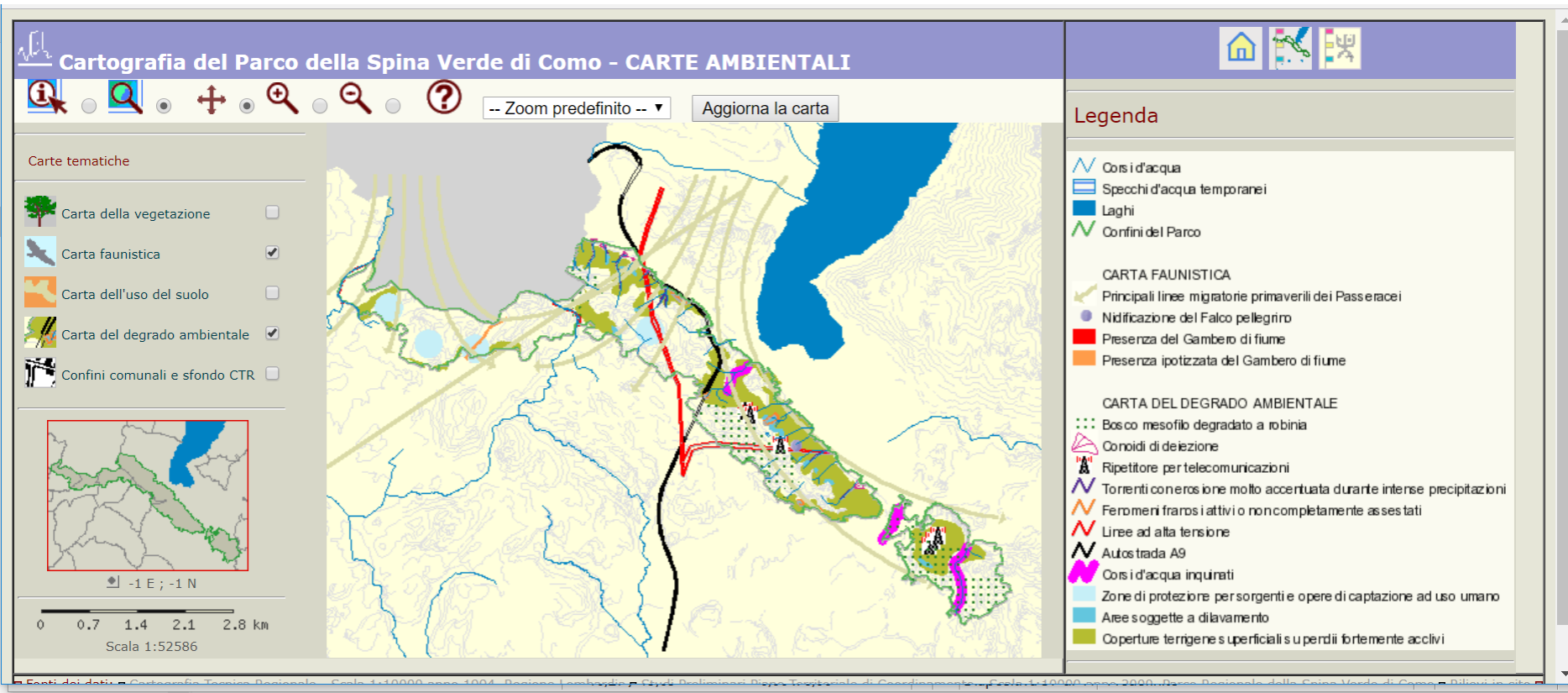
• • • • •



# Web Map and Geodata Clients (1)

- They are interactive viewers in the most of cases simply running in a web browser (Mozilla Firefox, Chrome, Opera, Safari, Internet Explorer, etc.)
- New generation web map and geodata clients are completely independent from the server application that lies behind them: they communicate indifferently by means of OGC open protocols with every OGC compliant server
- The clients allow to:
  - contact different services on different machines
  - render maps
  - navigate maps, zoom in, zoom out, pan
  - query information
  - turn layers on and off or add more maps
  - edit map features (if data are served by a WFS-T Service)
  - build own maps and save them to be used at any time or to be shared.

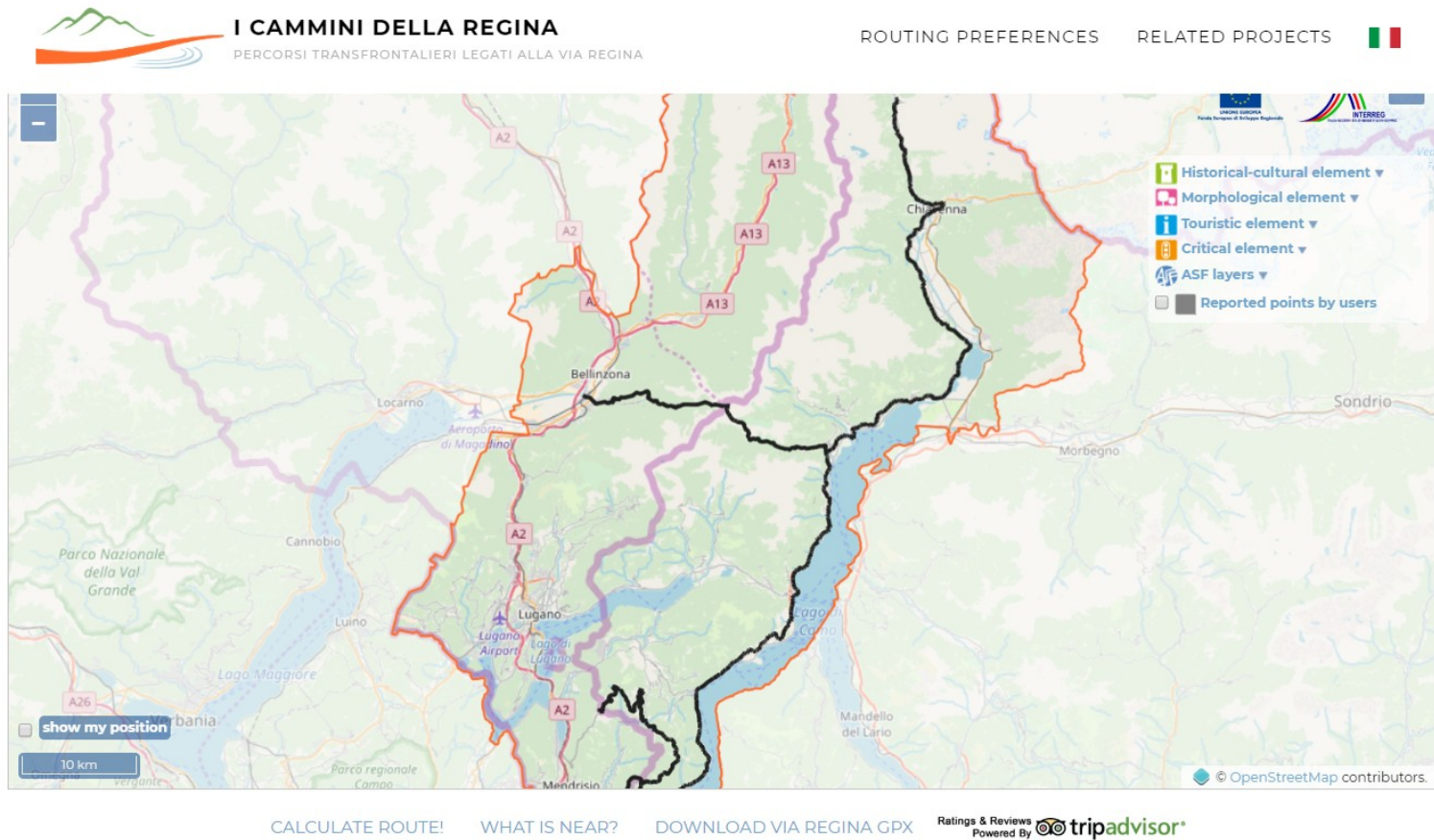
# The first webGIS developed by us (2002)



<http://webgis2.como.polimi.it/agew/>



# An example of recently developed WebGIS



<http://viaregina3.como.polimi.it/ViaRegina/index-en.html>





# An example of recently developed WebGIS

WHICH POINTS OF INTEREST DO YOU WANT  
YOUR ROUTE TO PASS BY?

~ ROUTING PREFERENCES ~



☒ RELIGIOUS



☒ CIVIL



☒ MUSEUM



☒ RURAL



☒ ARCHAEOLOGICAL



☒ MILITARY



☒ FACTORY



☒ PANORAMIC





☒ GEOLOGICAL

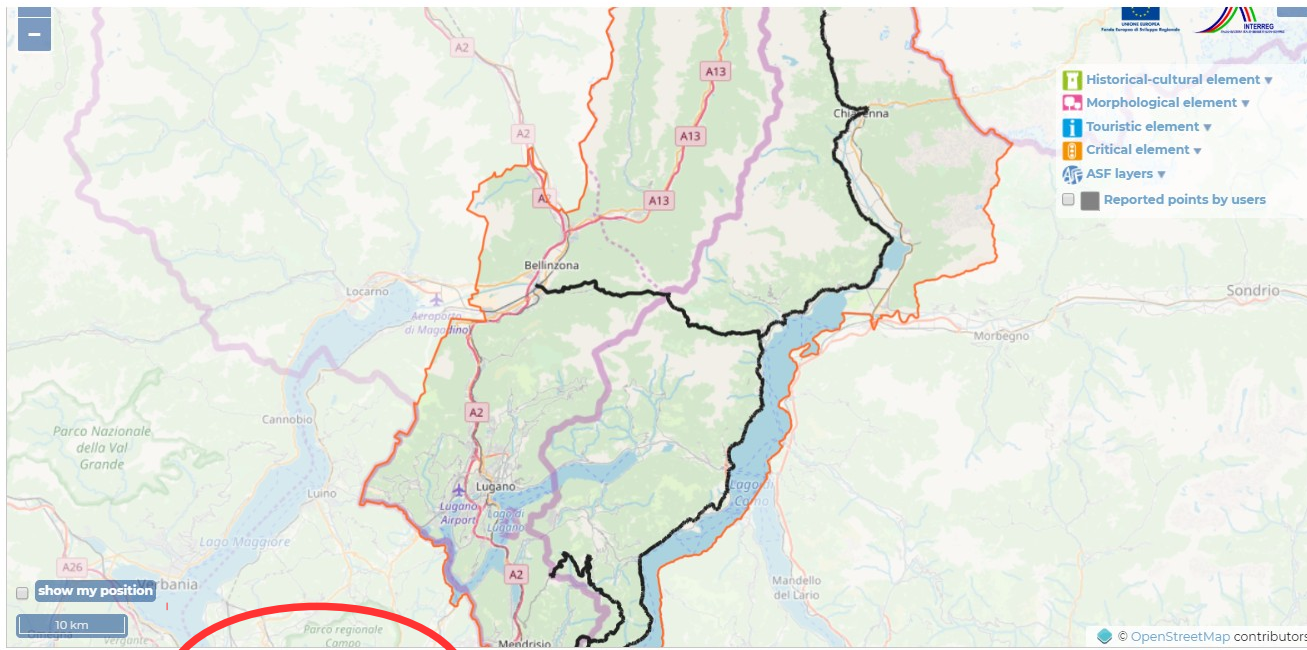
~ GO BACK TO MAP ~




# An example of recently developed WebGIS

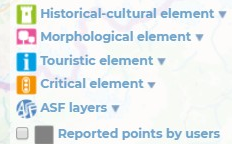
 **I CAMMINI DELLA REGINA**  
PERCORSI TRANSFRONTALIERI LEGATI ALLA VIA REGINA

[ROUTING PREFERENCES](#) [RELATED PROJECTS](#) 



☐ show my position

[CALCULATE ROUTE!](#) [WHAT IS NEAR?](#) [DOWNLOAD VIA REGINA GPX](#) [Ratings & Reviews](#)  [tripadvisor](#)  
Powered By





- Historical-cultural element
- Morphological element
- Touristic element
- Critical element
- ASF layers
- Reported points by users

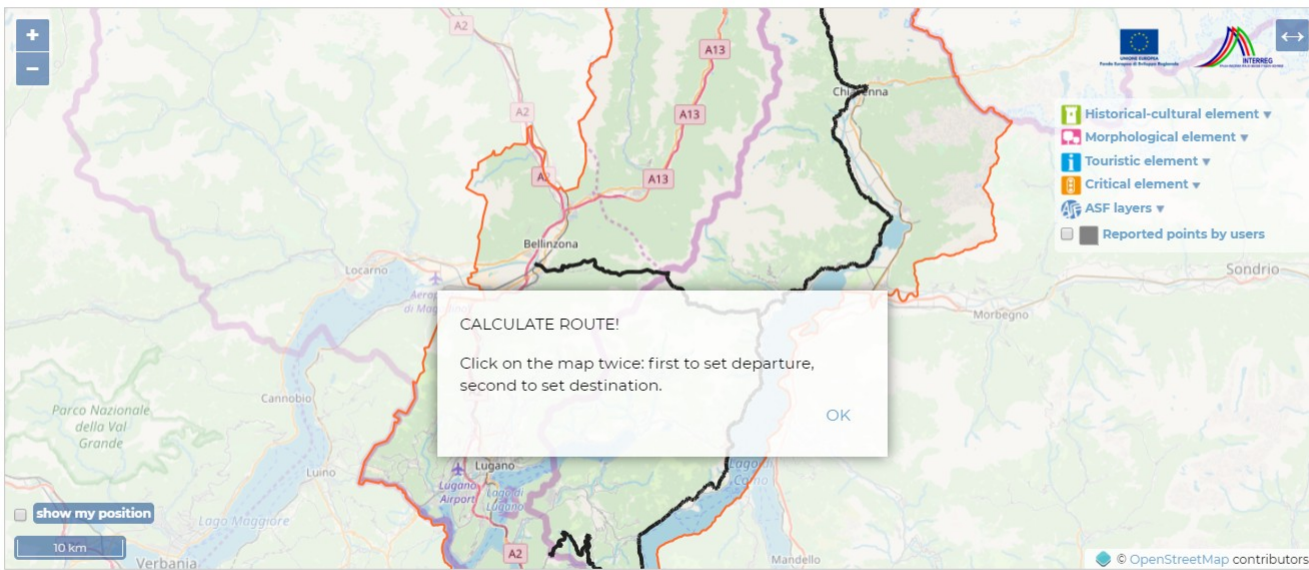
© OpenStreetMap contributors.




# An example of recently developed WebGIS

 **I CAMMINI DELLA REGINA**  
PERCORSI TRANSFRONTALIERI LEGATI ALLA VIA REGINA

[ROUTING PREFERENCES](#) [RELATED PROJECTS](#) 

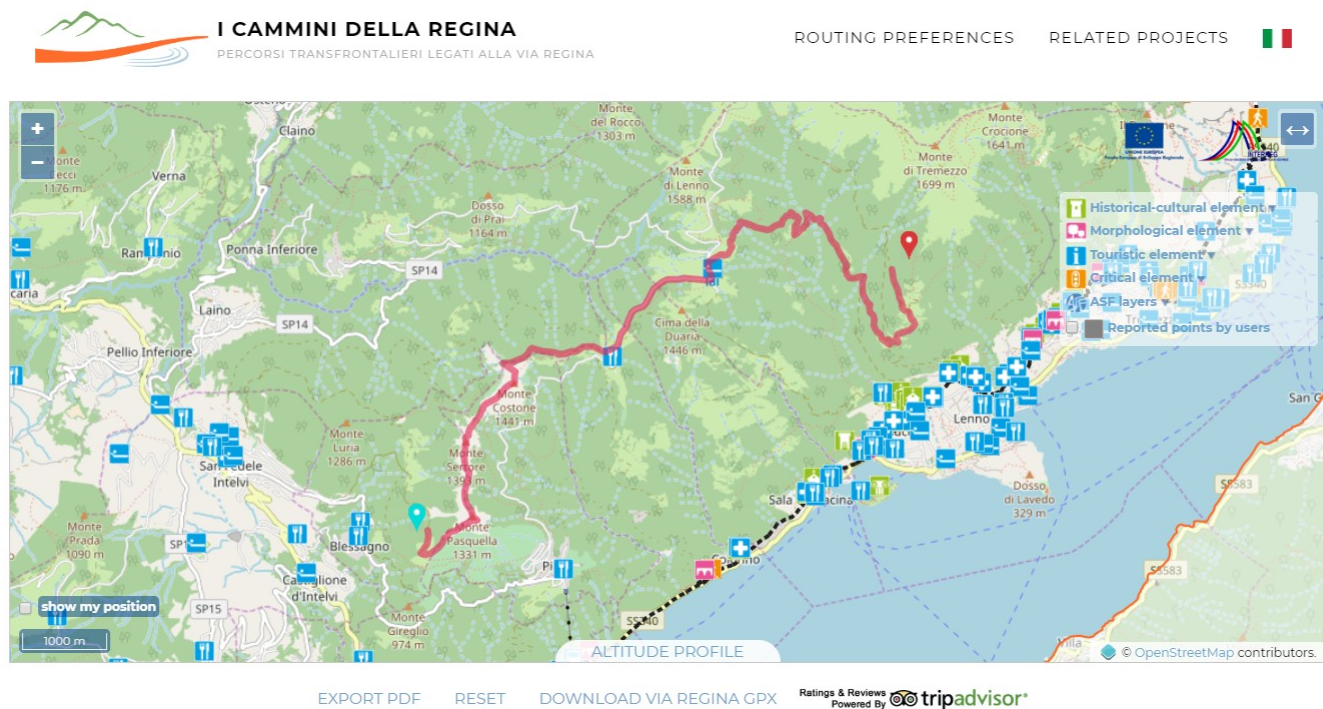


[show my position](#) 10 km

[CALCULATE ROUTE!](#) [WHAT IS NEAR?](#) [DOWNLOAD VIA REGINA GPX](#) [Ratings & Reviews](#)  [Powered By](#)



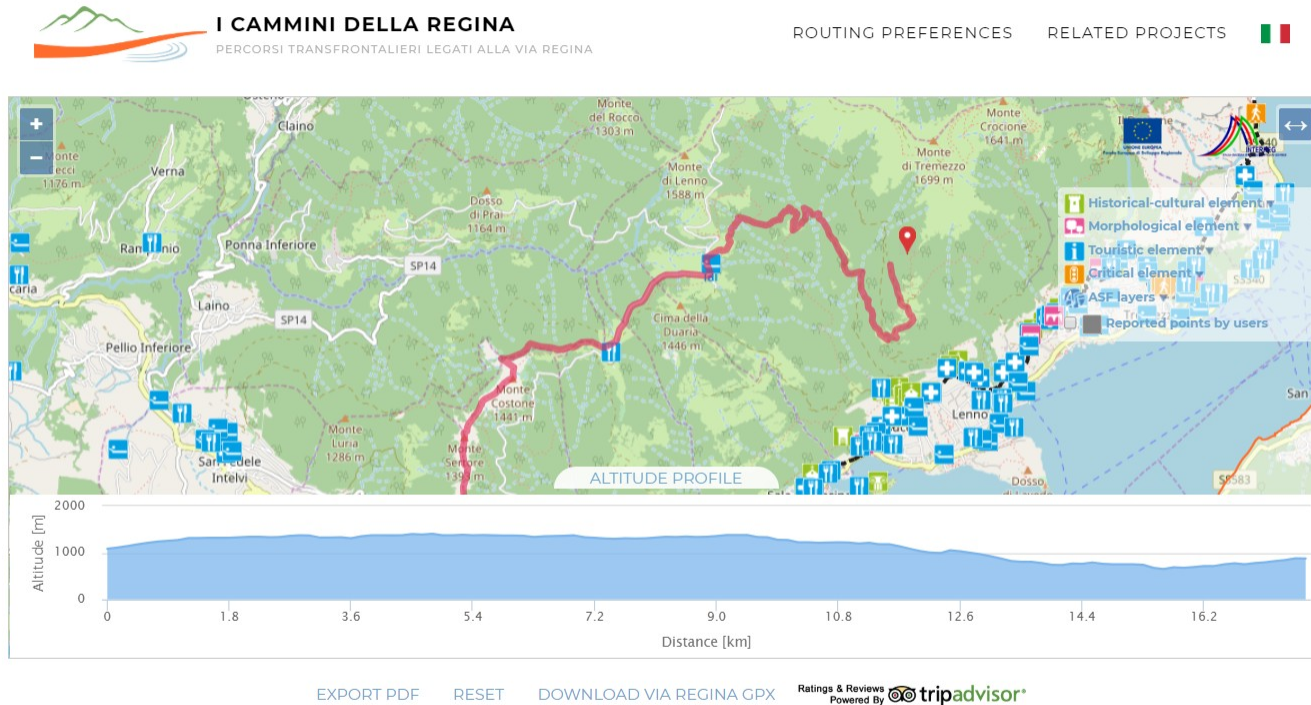
# An example of recently developed WebGIS



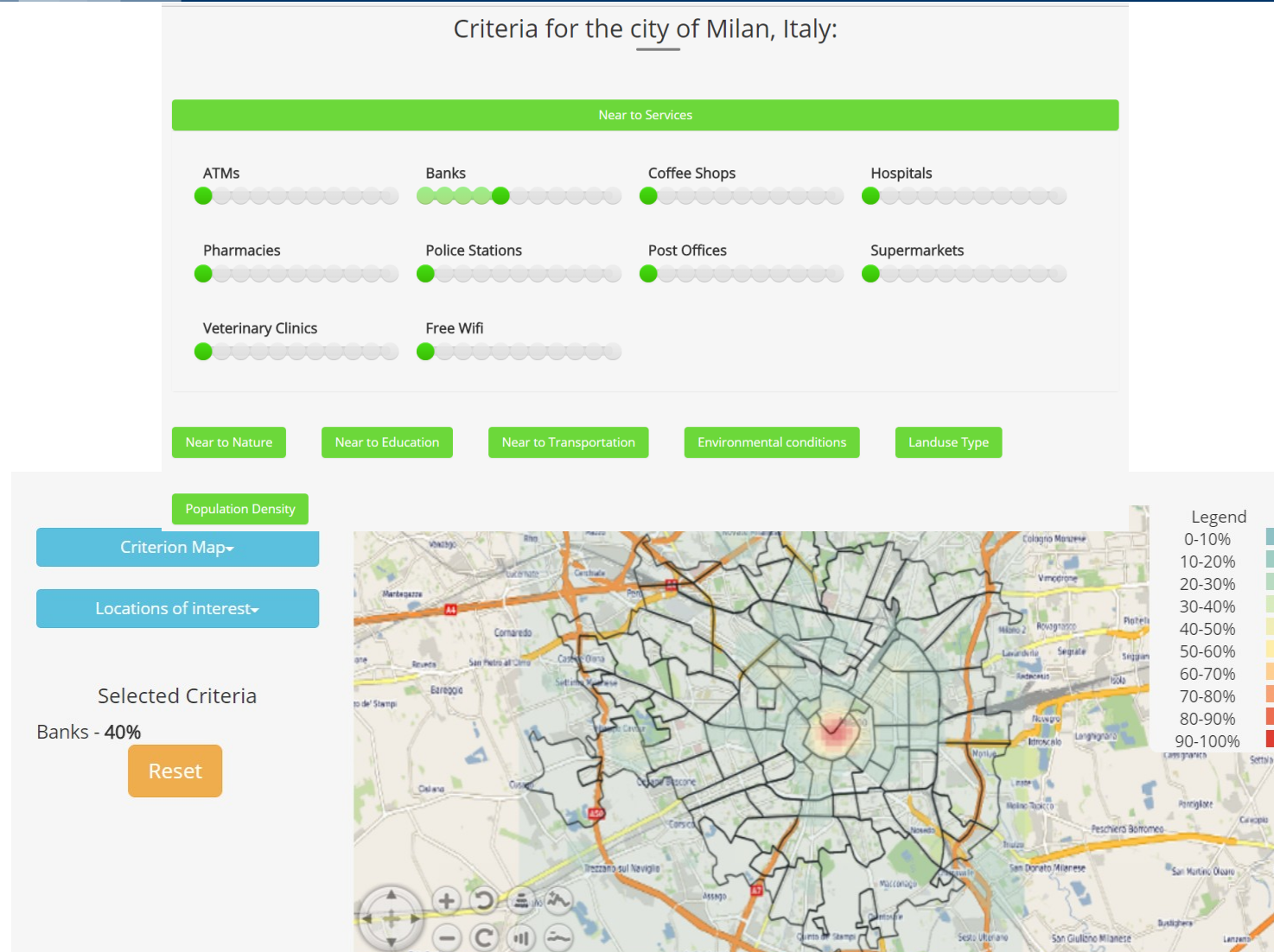




# An example of recently developed WebGIS



# WebGIS and Services



✓ <http://muvias.eoapps.eu/cityfocus/application.html>



# Virtual Globes – Some examples (NASA Java WorldWind)



# Virtual Globes – Some examples (NASA Web WorldWind)

<http://viaregina3.como.polimi.it/WorldWind/>

