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A service oriented approach for geographical data sharing

Authors

L. Vaccari [1], A. Ivanyuckovich [2], and M. Marchese [2]

[1] Autonomous Province of Trento, Trento, Italy
[2] Department of Information and Communication Technology, University of Trento, Trento, Italy

Outline

- The context:
  - eGovernment activities in a local Government
  - geographical data management for a Local Government
- Web Services standards
- Web functionalities for G.I.S.
- Application development: simple service composition of cartographic services for a back office use case
- Conclusions and Future Work

E-Government

- Public Administrations (PAs) all over the world are undergoing important innovation processes as a result of eGovernment projects such as provision of new services (eServices) to citizens

- the arena of eGovernment is one of fast change as services are modernized and integrated

- new concept of public service are emerging and they involve:
  - the breaking down of barriers between departments and units
  - the negotiation and implementation of multi-disciplinary and multi-agency networks and protocols and
  - more efficient and effective communication, transaction and co-ordination

Local eSociety working group

PA internal organizational and IT managers

Other entities involved in OSS operation

IT Consulting firm

PA internal users: managers and operators

Representatives of end-users

University

eGovernment Maturity Model

First Generation

- introduction of new channels and media in the delivery of public services
- information Web Sites

M.Martin, B. Wessels, Y. Dittrich, S. Eriksén, M.Marchese and G.Jacucci – "eGoss" initiative

- issues of editorial control, maintenance and co-ordination
- requirements to go beyond simple form handling and the introduction of electronic transactions

Second Generation

- services integration and intermediation
- support transactions associated with service access and delivery.

- new demands and opportunities for restructuring the administration processes
- context of significant changes at organisational and policy levels

Third Generation

- integration within and outside PA
- service brokerage support
- supporting Environments for users

Trentino "maturity" state-of-the-art

	Intranet	Extranet
First generation	▪ Electronic archives, databases, GIS ▪ Distributed local document repositories	▪ Regional Web Site ▪ Major Municipalities Web sites ▪ Local Municipalities Web sites
Second generation	▪ Tools to support navigation and editing/updating ▪ Tools to support collaborative work between units in associated services ▪ Extension to all back-office/front-office services	▪ Design of municipal OSS for selected procedures ▪ National distributed document repositories ▪ Design of Regional OSS ▪ Electronic signature to support transactions
Third generation	▪ Back-office architectures supporting workflows management and transactions ▪ Supporting environments for knowledge creation and sharing ▪ Architectures supporting security	▪ Full deployment of OSS front-offices (physical and virtual) ▪ Supporting environments for OSS service delivery

Finished projects

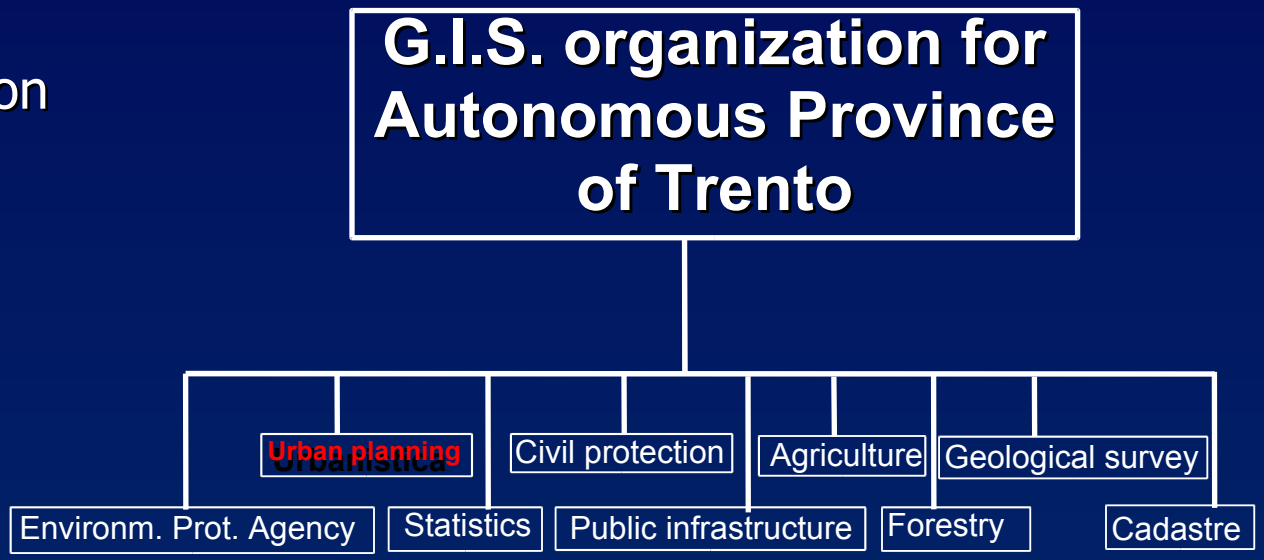
- Design and implementation of local part of national distributed data repositories
  - "NormeInRete"
  - GIS metadata
- Web portal for GIS data
- Feasability study for regional OSS

the GIS context

Autonomous Province of Trento

Geographical data

- Gathering
- Storing
- Metadata extraction and annotation
- Maintenance/ Updating
- Use
  - Analysis
  - Cartography
- Sharing data
  - CDRom
  - Web



Web mapping: www.gis.provincia.tn.it

GIS Catalogue: www.provincia.tn.it/urbanistica

WebGIS

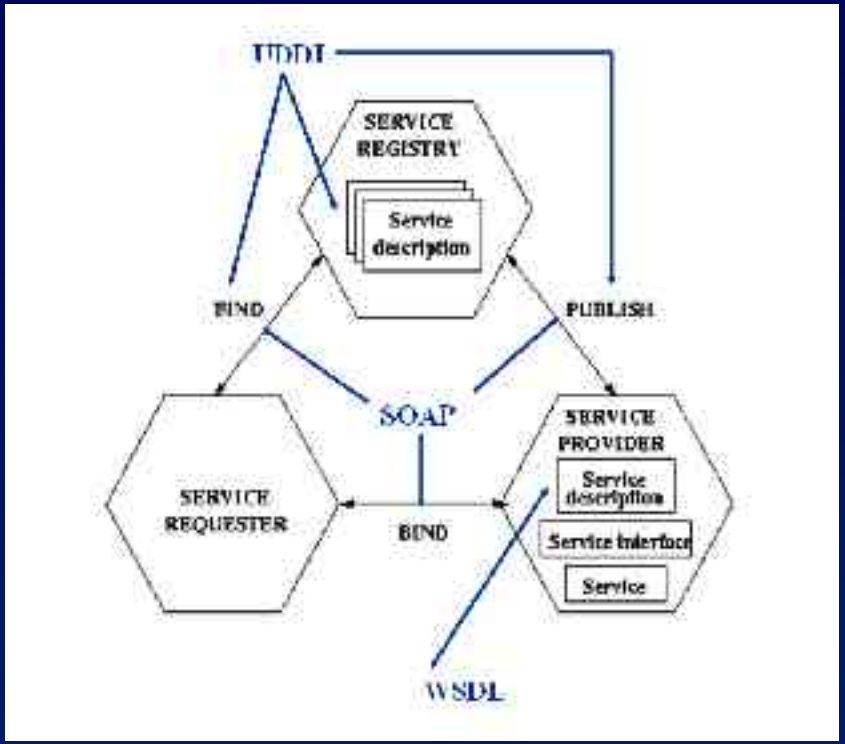
- Portal access to GIS data
  - Internal and External users
  - for Human - Computer Interaction
- Interoperability issues

Web Services - Introduction

Service Oriented Architectures (SOA) are rapidly becoming the standard in the domain of distributed systems. A popular interpretation of SOA services is based on IBM's service architecture based on three elements:

- Service requester: The potential user of a service
- Service provider: The entity that implements the service and offers to carry it out on behalf of the requester
- Service registry: A place where available services are listed and which allows providers to advertise their services and requesters to query for services

The goal is just-in-time integration of applications by discovering and orchestrating network-available services

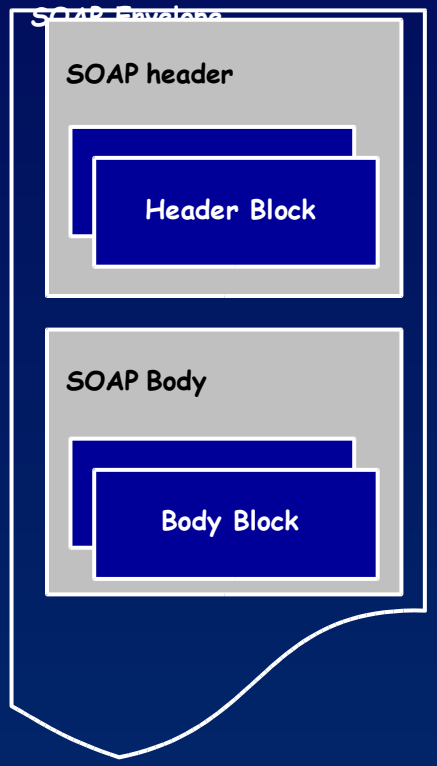


Web Services (a specific implementation of SOA) are based on two main concepts:

- Leveraging from existing architecture of synchronous middleware platforms
- Use XML-based standard languages: SOAP (Simple Object Access Protocol, WSDL (Web Services Description Language) and UDDI (Universal Description and Discovery Protocol).

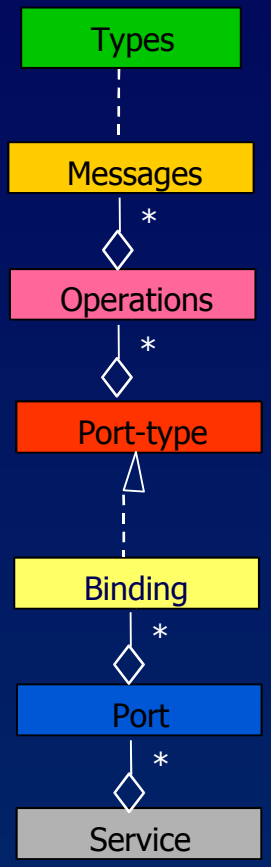
Web Services - Standards

- **Simple Object Access Protocol (SOAP):**
  - **Messages exchanges**
  - use of XML as intermediate representation between systems
    - very simple message structure
    - mapping to HTTP for tunnelling through firewalls and using the Web infrastructure

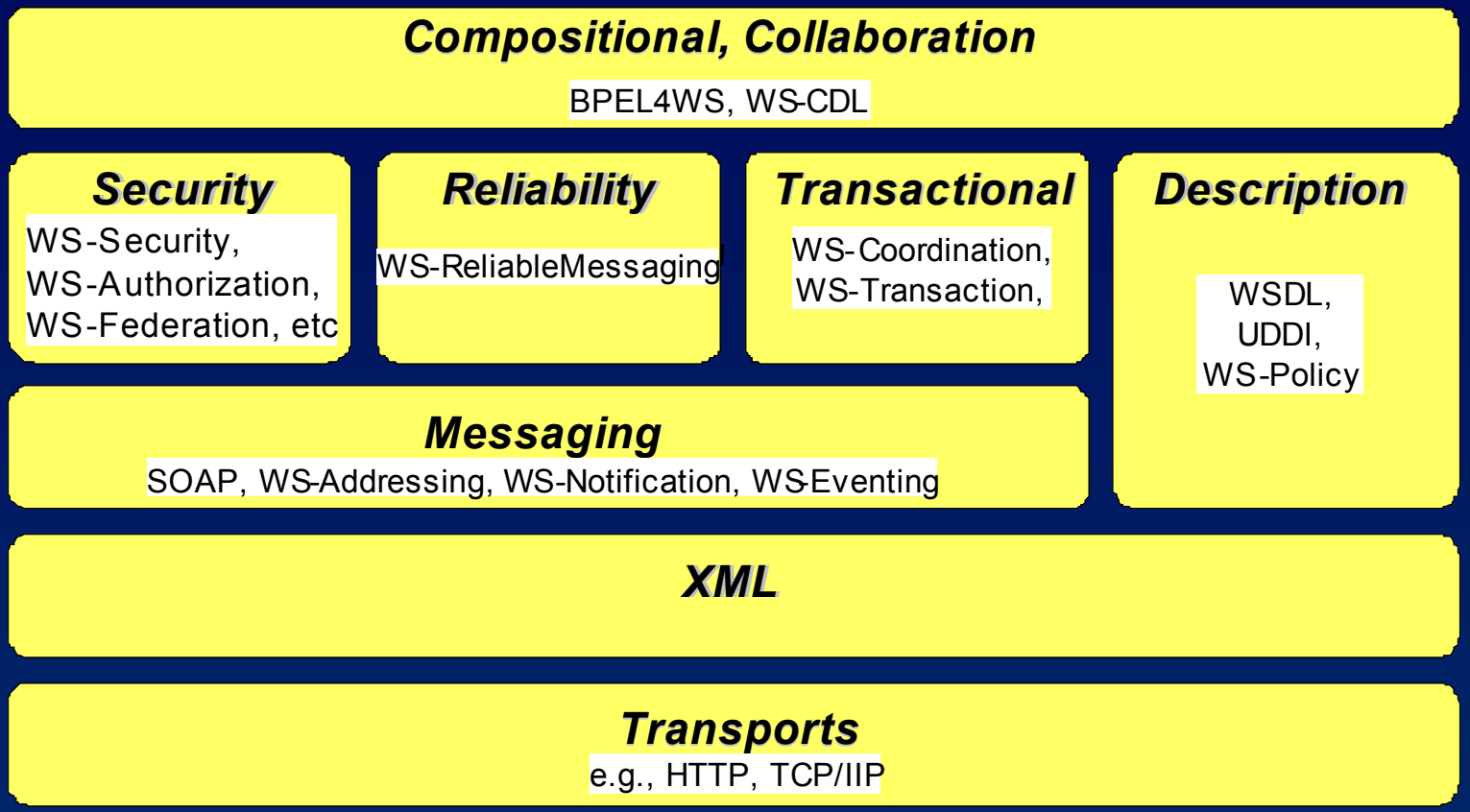


Web Services - Standards

- **Web Service Description Language (WSDL)**
- **WSDL is an XML document that describes the mechanics of interacting with a particular web service.**
- **It plays a similar role of conventional IDL**
  - It describes a service;
  - It can be used to automatically generate the code needed to invoke the service
  - As other IDL, does not contain semantic information.



Web Services Protocol Stacks



G.I.S. Services-Introduction

The Open Geospatial Consortium (OGC) is a consortium of public and private organizations that proposes specifications for interfaces and protocols for the geographical and environmental data management and sharing.

OGC is supporting a number of standard specifications. We focused on :

- Web Map Service (WMS) → Raster data sharing.
- Web Feature Service (WFS) → GML data sharing.

WMS e WFS can be invoked by submitting requests in the form of URLs (GET/POST requests).

Web Map Service (1)

The OGC Web Map Service specification (ISO 19128 document) defines three operations:

- GetCapabilities (Mandatory): The purpose of the mandatory GetCapabilities operation is to obtain service metadata (an XML document). The client can use the results of this operation to formulate the next request. Moreover, it can build a catalogue useful for the user that can choose the desired geographical layer.

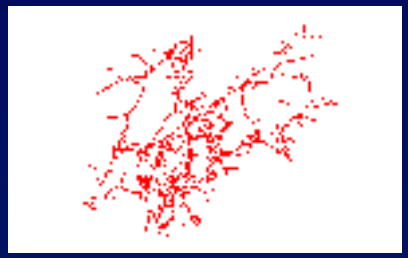
- GetMap (Mandatory): the response to a valid GetMap request is a map of the spatially referenced information layer requested, in the desired style, and having the specified coordinate reference system, bounding box, size, format and transparency.

- GetFeatureInfo (Optional): The GetFeatureInfo operation is designed to provide clients of a WMS with more information about features in the pictures of maps that were returned by previous Map requests.

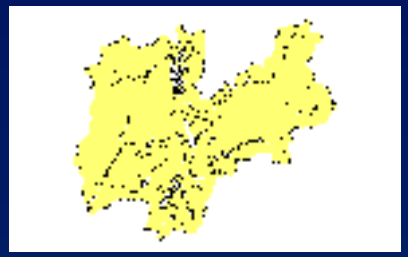
Web Map Service (2)

WMS – GetMap(….,<list of layers>,…)

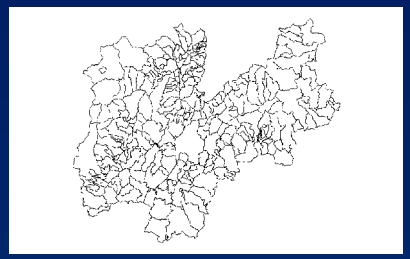
Raster/Features Layers



Viability

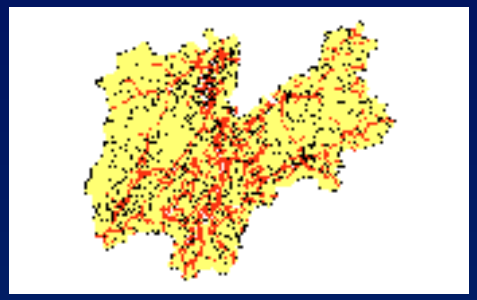


Environment protection



Administrative boundaries

WMS Server



Raster map

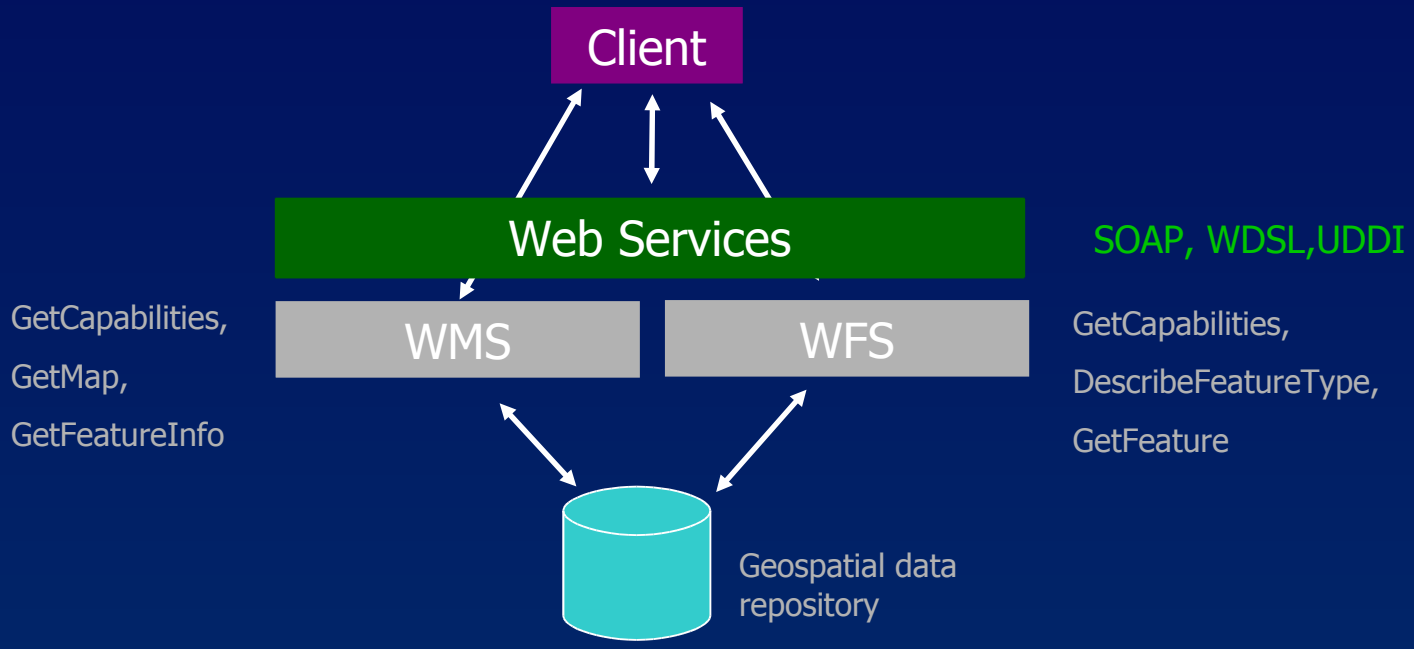
Web Feature Service

A server that implements the OGC WFS specification can distribute geographic features to a client application The WFS offers the possibility to the users to load GML (Geographic Markup Language) vector data. To support transaction and query processing, the following operations are defined in WFS:

- GetCapabilities (Mandatory): As in WMS a WFS must be able to describe its capabilities. Specifically, it must indicate which feature types it can service and what operations are supported on each feature type.
- DescribeFeatureType (Mandatory): A WFS must be able, upon request, to describe the structure of any feature type it can service.
- GetFeature (Mandatory): A WFS must be able to service a request to retrieve feature instances. In addition, the client should be able to specify which feature properties to fetch and should be able to constrain the query spatially and non-spatially.
-Transaction (Optional): A web feature service may be able to service transaction requests. A transaction request is composed of operations that modify features; that is create, update, and delete operations on geographic features.
- LockFeature (Optional): A WFS may be able to process a lock request on one or more instances of a feature type for the duration of a transaction. This ensures that serializable transactions are supported.

Web Services & WMS,WFS

- We propose to implement the operations offered by WMS and WFS following OpenGIS Web Services initiative
- Benefits: enhanced interoperability, improved availability and usability of geographical information



Application: use case

We have experimented the proposed architecture in the context of integration of GIS legacy services in a back-office scenario:

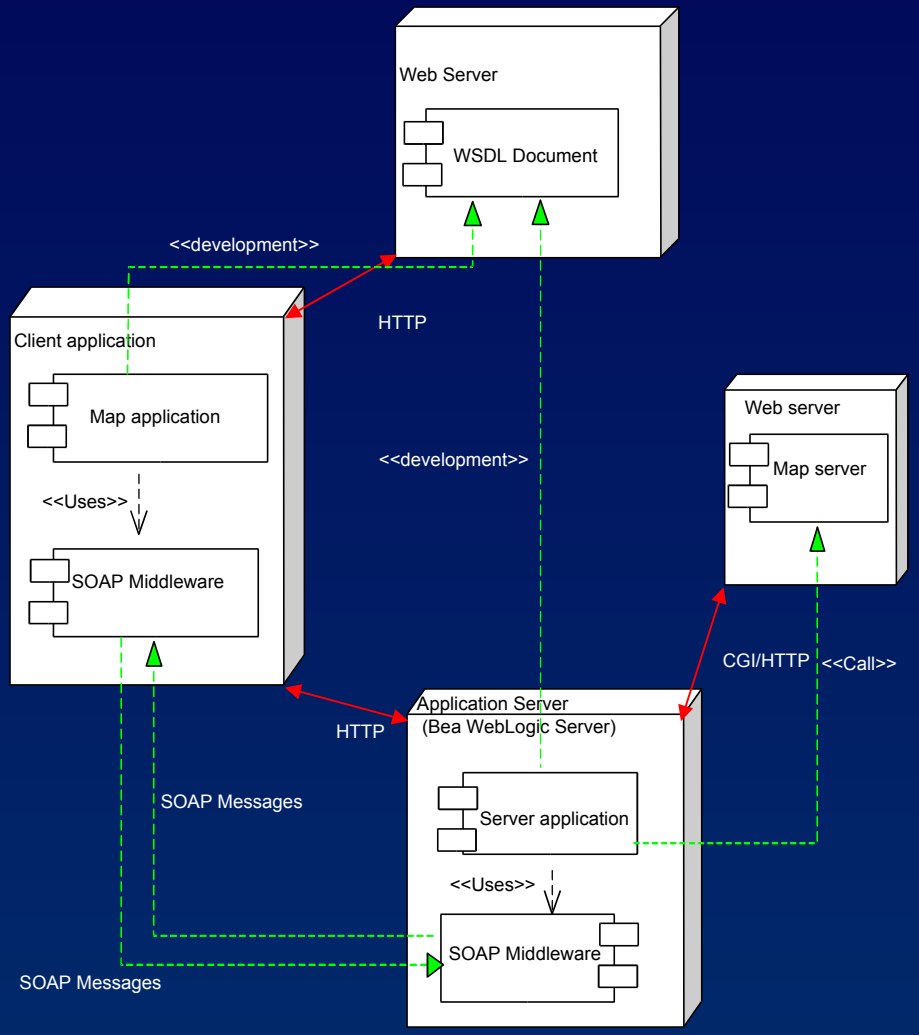
- a user that need to navigate in a spatial database (location search and feature layer selection),
- insert a map in a document (download of dynamically user-specified raster image centered on searched location),
- navigate the image (pan & zoom),
- insert related information in a text document (legend insertion) and
- download locally the selected feature layers in Geographic Markup Language (GML) format (metadata extraction).

Traditionally the user would ask the assistance of a GIS technician to produce the overall data. Most of the time she/he will not be satisfied by the results and interactions with the GIS technician will be iterated.

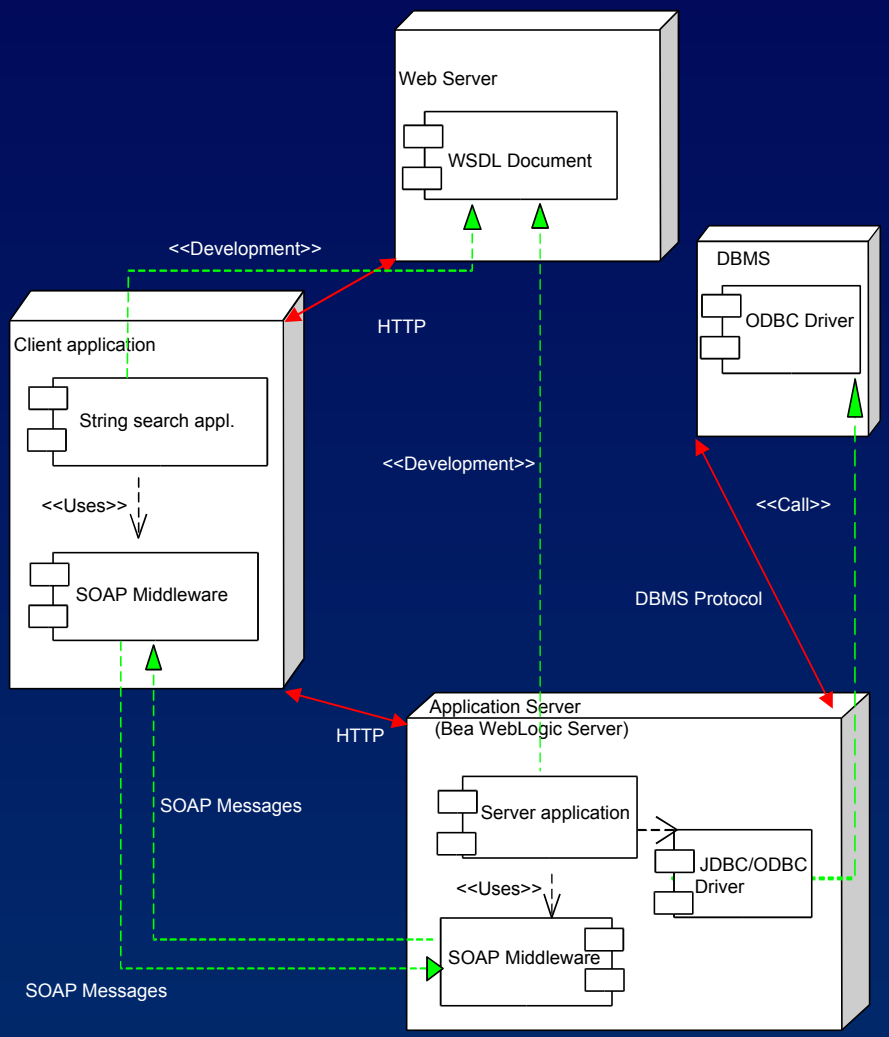
In our proposed architecture the user can automatically and independently create and insert the current version of the searched geographical data in his/her document using a web service architecture based on OGC specifications. Moreover this can also be done automatically

Application: System Architecture

Component View (WMS/WFS services)



Component View (TopService)



Application project

We have design and implemented THREE main services that provide the user with the appropriate functionalities, namely:

- **TOPService** : **service provider of location search by label**; this service guides the user in the search of a location from all recognize labels present in the spatial database. The search is implemented in a two-step procedure: first the service searches for a particular string (user input) in the database and delivers the list of all labels that contain the string; second it locates the geographical x, y coordinates associated to a specific label (user input).

- **WMSmapService**: **service provider of raster data**; it wraps the functionalities defined in the WMS specification in a Web Service interface. Moreover **it returns the lists of available layers**. The specific supported WMS operations are: "GetCapabilities", "GetMap" and "GetLayers". In particular the last operation is implemented by analyzing the XML output of "GetCapabilities" operation.

- **WFSmapService**: **service provider of GML vector data**, also in this case we have developed appropriate wrapper WS interfaces to WFS functionalities, namely "GetCapabilities", "DescribeFeature", "GetFeature".

Application: implementation

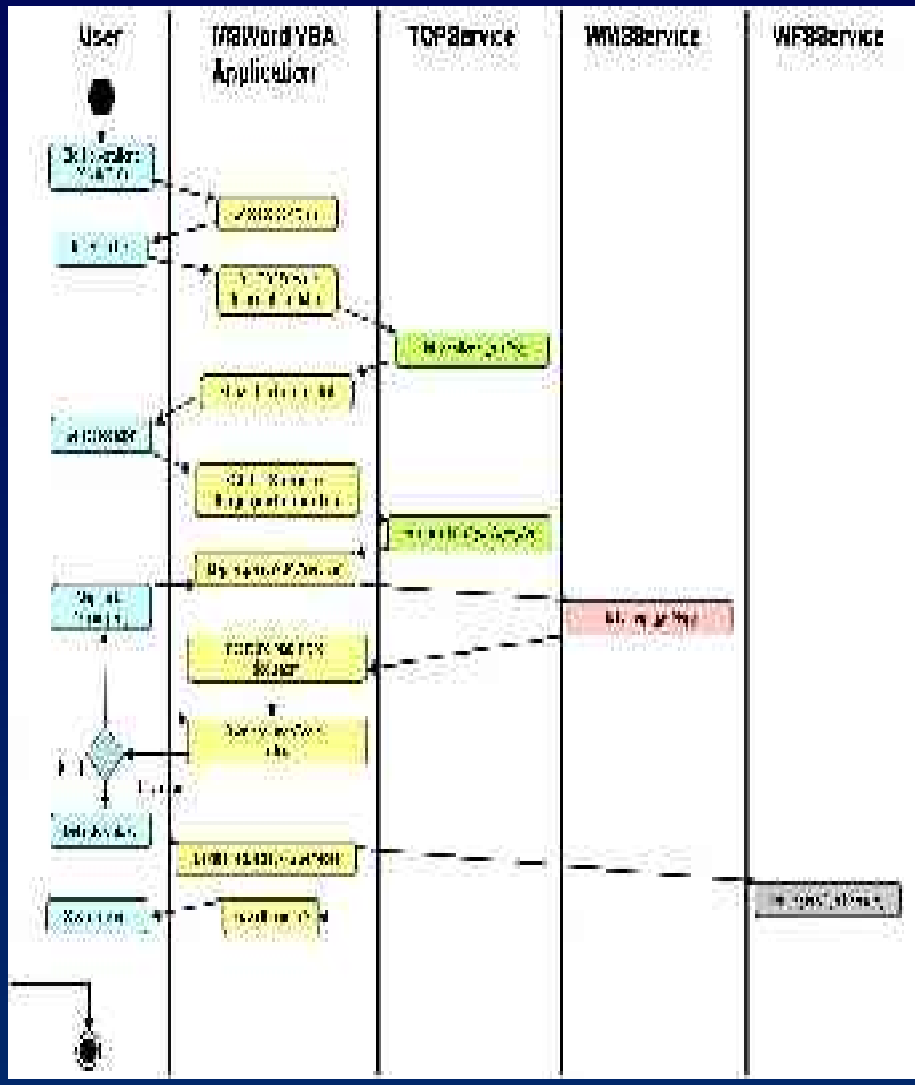
1. Cartographic data (ESRI Shape files) and places' names Database (Oracle) generation.
2. Service Definition WMS/WFS (Mapserver/Mapfile).
3. WSDL Definition.
4. Development of Server applications (Java – Bea Web Logic).
5. Development of Client applications (Java – Bea WebLogic).
6. Testing:
   a) WmsmapService.
   b) WfsmapService (GML File).
   c) TopService.
7. Development of a simple service composition

Bea WebLogic

Description	WMS/WFS layer Name
Ski areas	Piste_da_sci
Cableways & ropeways	Impianti_di_risalita
Environment Protection areas	Tutela_ambientale
Historical town centres	Centri_storici
Regional Parks	Parchi
Regional designed biotopes	Biotopi_provinciali
Local designed biotopes	Biotopi_comunali
Riparian woods	Boschi_ripariali
Fluvial parks	Parchi_fluviali
Regional springs	Sorgenti_PUP
Regional Wells	Pozzi_PUP
Regional cultural goods	Beni_culturali
Regional archaeological areas	Siti_archeologici
Regional quarries	Cave_in_zona_parco
Regional frame for maps at scale 1:25.000	Tavole_PUP
Regional administrative boundaries	Limiti_comunali
Regional topographic map	CTP_PAT (only WMS)

Application: simple service composition (1)

1. Ms Office document Model creation
2. Installation of "Microsoft Office Web Services Toolkit".
3. Generation of the client application for the automatic generation of mal extract in MS Word:
   a. Service composition
      WmsmapService +
      WfsmapService +
      TopService.
   b. Operations workflow.



Application: simple service composition (2)

c. Implemented functionalities:

i. Location search by name

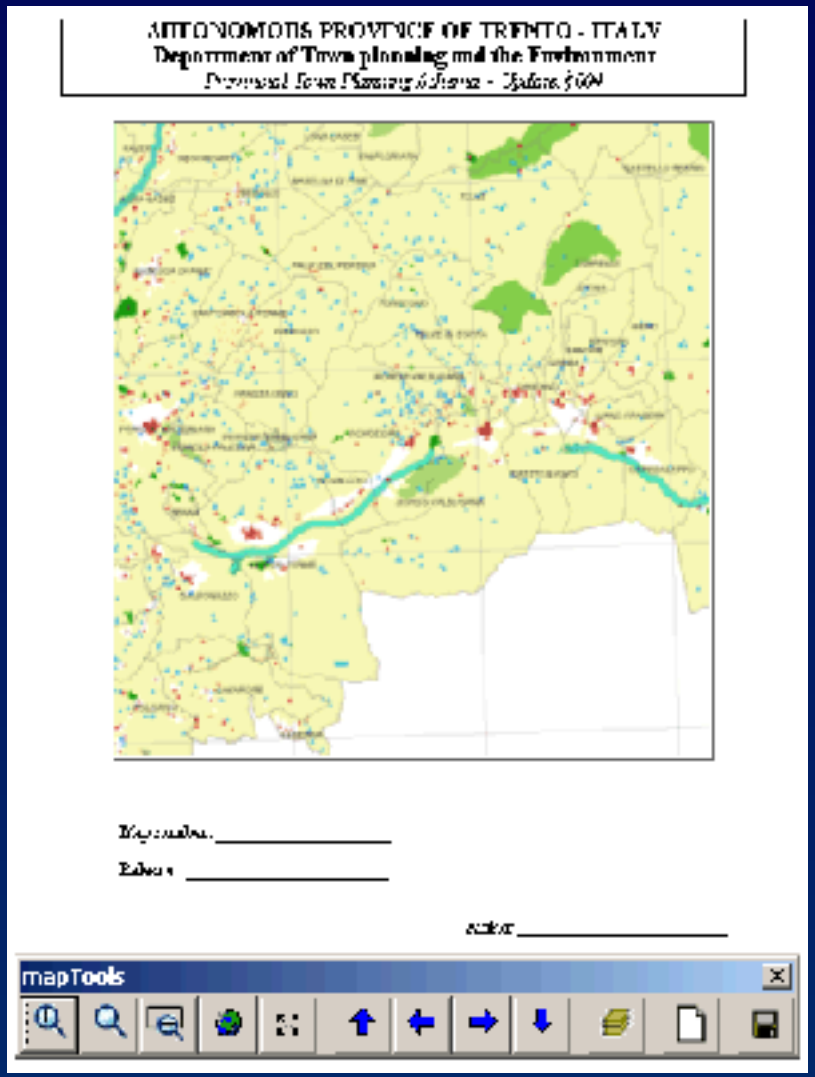
ii. Zoom (in,out,all,def)

iii. Horizontal and vertical pan

iv. Layers and scale selection

v. New search

vi. GML export



Conclusions:
G.I.S. (OGC) & Web Services:

- The interoperability between different system can be enhanced.
  Advantages:
    - loosely couple and platform agnostic geographical services
    - improved availability and usability of geographical information
    - standardized (open standards) data management and presentation logic
    - human-computer and computer-computer interactions
- The creation of new valued-added services out of a number of legacy GIS application can be supported
- Support for client implementation for other packages like Open Source Software.
    - example: toolbar for the Open Office package
- In future work, we will also consider:
    - Performance issues (Data streaming, data compression, distributed computing)
    - Security issues (Ws-Security, Ws-Policy Framework)

References

Web references:

- WSDL: HTTP://www.w3.org/TR/wsdl
- SOAP: http://www.w3.org/TR/soap
- UDDI: http://www.uddi.org/
- OGC: http://www.opengeospatial.org/
- Mapserver: http://mapserver.gis.umn.edu/
- Bea WebLogic Server: www.bea.com/products/weblogic/server/index.shtml