Web processing with OGC WPS Specification

What do you expect from the tutorial?

- What is your level of experience?
  - WPS
  - 52n WPS
  - Java
- What is your goal in using WPS?
  - Project-related
  - Research

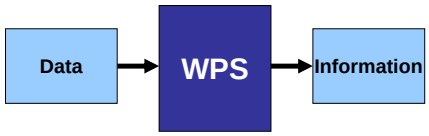
What questions will be answered?

- What is WPS about?
- Which projects are running WPS?
- What is the 52n WPS architecture about?
- What are the current issues @ 52north geoprocessing research?
- How can I play with 52n WPS?

WPS 101 – What is WPS about?

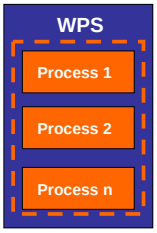
WPS

- What is a WPS?
  →Web Based Processing



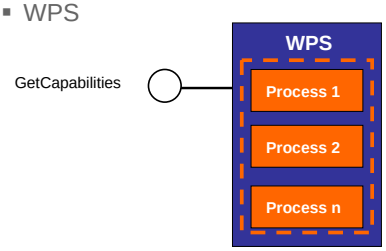
WPS

- WPS



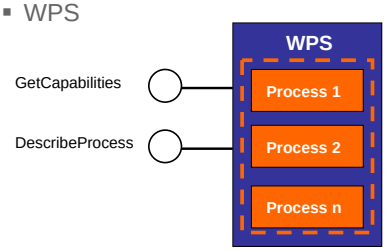
WPS

- WPS



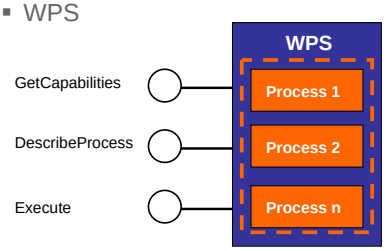
WPS

- WPS



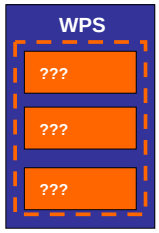
WPS

- WPS



WPS

- Example

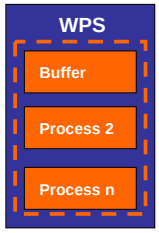


WPS

- Discovery
  → GetCapabilities

WPS

- Example

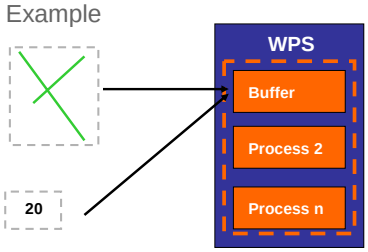


WPS

- Discovery
  → DescribeProcess

WPS

- Example

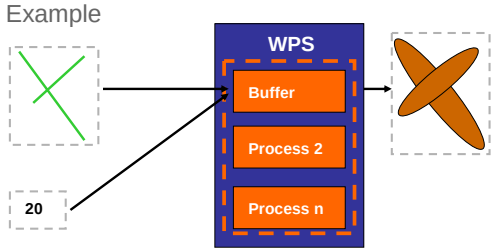


WPS

- Execution
  → XML Execute Request

WPS

- Example



WPS additional features

- Execution

WPS additional features

- Execution
  →Synchronous
  →Asynchronous

WPS additional features

- Execution
  - →Synchronous
  - →Asynchronous

  - →Wrapped XML payload
  - →Raw data payload

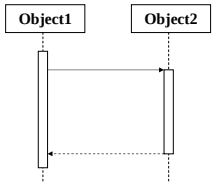
WPS additional features

- Execution
  - →Synchronous
  - →Asynchronous

  - →Wrapped XML payload
  - →Raw data payload

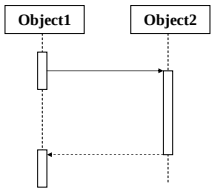
  - →Referencing data (HTTP-GET & HTTP-POST

Execution synchronous



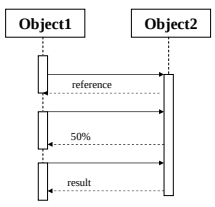
Execution asynchronous

- Push-model



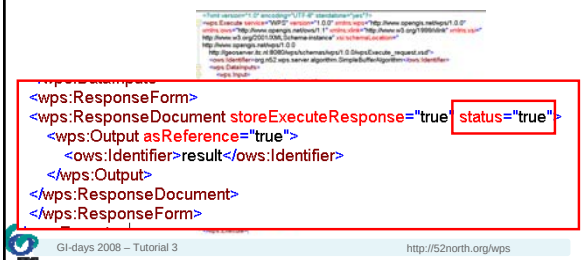
Execution asynchronous

- Pull-model



Execution asynchronous

- Request



Execution asynchronous

- Response


```
<ns:ExecuteResponse xsi:schemaLocation="http://www.opengis.net/wps/1.0.0 http://geoserver.itc.nl:8080/wps/schemas/wps
serviceInstance="http://geoserver.itc.nl:8080/wps100/WebProcessingService?SERVICE=GetCapabilities&SERVICE="WPS" x
statusLocation="http://geoserver.itc.nl:8080/wps100/RetrieveResultServlet?id=1213091000334">
  <ns:Process ns:processVersion="2">
    <ns1:Identifier>org.n52.wps.server.algorithm.SimpleBufferAlgorithm</ns1:Identifier>
    <ows:Title>Create a buffer around a polygon.</ows:Title>
  </ns:Process>
  <ns:Status creationTime="2008-06-10T11:43:20.334+02:00">
    <ns:ProcessStarted percentCompleted="33"/>
  </ns:Status>
</ns:ExecuteResponse>
```


Execution asynchronous

- Response (process finished)


```
<ns:Status creationTime="2008-06-10T11:43:20.428+02:00">
  <ns:ProcessSucceeded>Process successful</ns:ProcessSucceeded>
</ns:Status>
...
xsd" href="http://geoserver.itc.nl:8080/wps100/RetrieveResultServlet?id=1213091000334@result"/>
```


Wrapped XML

- Request


```
</wps:Input>
</wps:DataInputs>
<wps:ResponseForm>
  <wps:ResponseDocument storeExecuteResponse="false">
    <wps:Output asReference="false">
      <ows:Identifier>result</ows:Identifier>
    </wps:Output>
  </wps:ResponseDocument>
</wps:ResponseForm>
</wps:Execute>
```


Wrapped XML

- Response

Wrapped XML

- Response

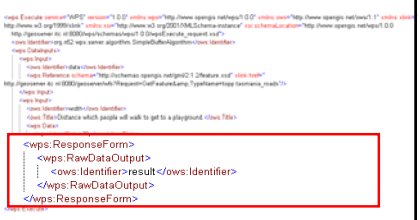

```
<ns:Process ns:processVersion="2">
  <ns1:Identifier xmlns:ns1="http://www.opengis.net/ows/1.1">org.n52.wps.server.algorithm.SimpleBufferAlgorithm</ns1:Identifier>
  <ows:Title xmlns:wps="http://www.opengis.net/wps/1.0.0" xmlns:ows="http://www.opengis.net/ows/1.1" xmlns:xlink="http://www.w3.org/1999/xlink
>Create a buffer around a polygon.</ows:Title>
</ns:Process>
<ns:Status creationTime="2007-09-22T18:01:38.092+02:00">
  <ns:ProcessSucceeded>The service successfully processed the request.</ns:ProcessSucceeded>
</ns:Status>
<ns:ProcessOutputs>
  <ns:Output>
    <ns1:Identifier xmlns:ns1="http://www.opengis.net/ows/1.1">result</ns1:Identifier>
    <ows:Title xmlns:wps="http://www.opengis.net/wps/1.0.0" xmlns:ows="http://www.opengis.net/ows/1.1" xmlns:xlink="
http://www.w3.org/1999/xlink">Buffered Polygon</ows:Title>
    <ns:Data>
      <ns:ComplexData>
        <pac:GMLPacket xmlns:pac="http://www.opengis.net/examples/packet">
          <pac:packetMember>
```


WPS additional features

- Execution
  - →Raw Data
- Advantages
  - →Less overhead
  - →Especially interesting for binary data

Raw Data

- Request



Raw Data

- Response

WPS additional features

- Execution
  - →Referencing data
- Advantages
  - →Decreases communication overhead
  - →References allow caching
  - →Service-chaining

Referencing data

- HTTP-GET
  - Request

Referencing data

- HTTP-POST
  - Request

WPS Profiles

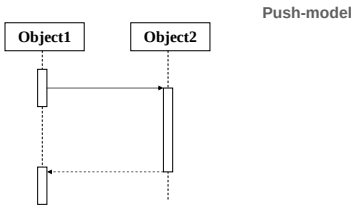
- Problem
  - Specification too generic
  - no process interoperability (process/parameters semantics missing)
  - No interoperability level of other standards (e.g. WMS, WFS)
- Goal
  - Standardizing interfaces for processes

WPS Profiles (contd.)

- Described in WPS 1.0.0 section 6.4
- Consist of
  - URN, uniquely identifying the process
  - DescribeProcess response document
  - Human readable description (optional)
  - WSDL description (optional)
- Profile is referenced in the getCapabilities & describeProcess of each WPS

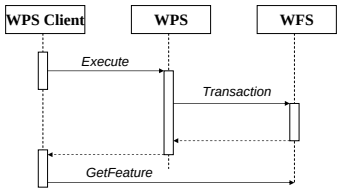
Open issues

- Asynchronous (with Notification Service)



Open issues (contd.)

- Storing of process results in OWS
  - Easy & scalable access to process results



Open issues (contd.)

- Validating process communication
  - Syntatically (xsd?)
  - Semantically (?)
- … issues addressed @ 52north geoprocessing research

Current WPS projects

Location of WPS projects

Projects overview

- Web Generalization Services
- Persistent testbed initiative (PTB)
- Orchestra project
- Finish Geodetic Institute
- University of Bonn
- University of Muenster
- University Jaume I, Castellon, Spain

Projects overview

- **Web Generalization Services**
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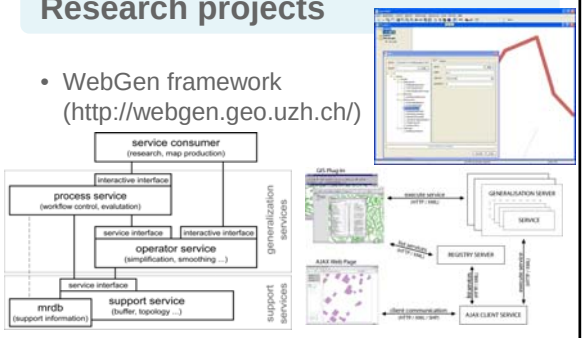
Web Generalization Services (WGS)

- Started as a research platform in 2003
- Overcoming the lack of knowledge about
  - generalization
  - algorithms
- Network and processing capabilities available
- Also in line with early activities of OGC
  - Transforming data to information
  - The next step after data dissemination

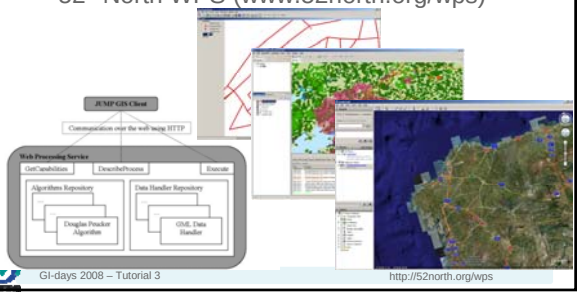
Research projects

- WebGen framework (http://webgen.geo.uzh.ch/)



Research projects

- 52° North WPS (www.52north.org/wps)



Current situation

- Still generalization functionality isolated
  - Data structures
  - Algorithms
  - Generalization workflow facilities
- Growing interest in Web Generalization Services

Web Generalization Services are not interoperable

Workshop results

- Requirements of participants towards WGS
- Ensure sustainable work by constant involvement of main bodies in the field of generalization
  - ➔ Memorandum of Understanding
- Technical solution should be generic & standards-based
  - ➔ Technical Task Force

Memorandum of Understanding

- Ensures commitment of different bodies
  - Promoting the platform
  - Developing clients/servers
  - Enriching/hosting the platform
- Increases the visibility of the efforts of the community to the outside
- Has to be signed by the major bodies
  - ICA (etc.)

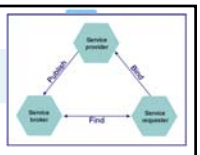
Drawbacks of OGC WPS

- No specification of specific format for parameters
  - Constraints
  - Data structures
  - Common exchange format
- No support of semantic descriptions
  - Operator descriptions
  - Comparison of functionality

Task Force results

- Registry for WPS
- Established a standardized data model for generalization purposes
- Extended WPS.DescribeProcess
- Implementation of the requirements in a new version of WebGen

Registry for WPS



- Important component in SOA
- Allows finding functionality hosted on remote services
- Finding appropriate functionality is enabled by generalization operator classification
  - Described as keywords
  - Example: ica.genops.modelgen.Collapse

Standardized data model of WPS

- Common data model enhances interoperability
- Complex data types
  - Geometry (GML2)
  - Feature (GML2)
  - FeatureCollection (with constraint or symbolization) (GML2)
  - List
  - Map
  - Placeholders (Constraints, Tree, Symbolization, MesoObjects

Outlook

- Discussion of the preliminary results of the working group
- Solving issues of namespaces
- Testing and using the new developed platform
- Completing and submitting the MoU

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PTB – CGS/ITC Use Case

- Center of Geospatial Science, University of Nottingham (CGS)
  - Geography
  - Computer Science
  - Engineering Surveying + Geodesy
  - Human Factors
- In collaboration with ITC, CGS has created a Web Processing Service for *map schematization*.

Example - Schematic map

Source: London Transport Museum

Example – Mobile devices

Small form factors require greatly reduced detail

Details

- Currently implemented schematizing algorithms:
  - Hill climbing, Simulated Annealing
  - (Reactive) Tabu Search
  - Genetic and Memetic Algorithms
- Geotools\52North WPS
- Demonstrates that it is possible to host nontrivial algorithms in an OCG-compatible form.

Scenario

- Schematization of Pipeline network
  - Analysis
- Process chain
  - Pseudo node removal
    - Removing any nodes with degree of 2
  - Schematization
- gitestbed.eu

Projects overview

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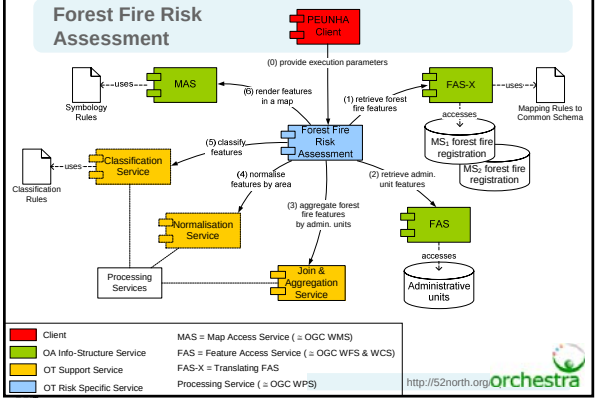
Processing Services

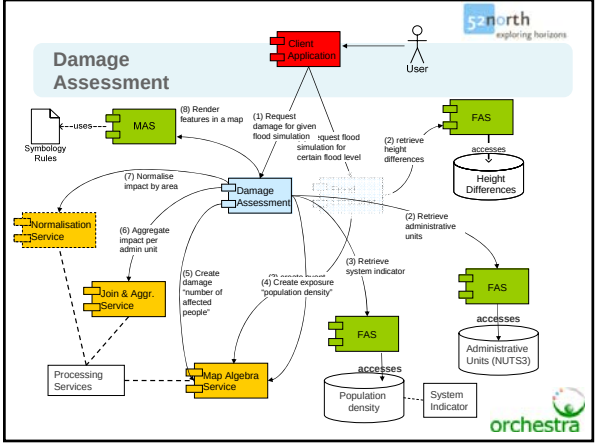
- Join and Aggregation service operations
  - Joins to feature collections and applies aggregate function on a given attribute
- Normalisation service operations
  - Normalizes an attribute in a feature collection by area | fixed value | attribute
- Classification service operations
  - Classifies a feature collection based on a given classification schema. Can also be used for symbolization purpose
- Map Algebra service operations
  - Applies various Local and Zonal map algebra operations

Specified for and used within distributed geo processing for pilot applications in an ORCHESTRA Service Network

Forest Fire Risk Assessment



Damage Assessment



http://www.eu-orchestra.org

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Background on the research - INSPIRE (1)

- The INSPIRE Directive came into force on the 15th May 2007
- According to the INSPIRE Directive: *"Member States shall establish and operate a network of the following services... : … (d) transformation services"*
- Transformation Services are needed to help the other types of INSPIRE-related Web Services to achieve INSPIRE-compliancy and to work in conformance with the related Implementing Rules (IRs)
- Member States are required to bring into force national legislation, regulations, and administrative procedures necessary to comply with the Directive by the 15th May 2009!

Background on the research - INSPIRE (2)

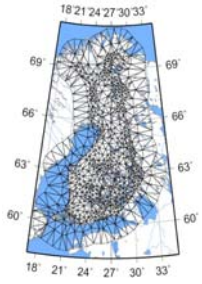
- Transformation Services should be free of charge
- An essential category of the Transformation Services are Coordinate Transformation Services
- The current proposal is to use the Web Processing Service interface to access the transformation processes
- The process's input and output parameters are based on the OGC's Web Coordinate Transformation Service (WCTS) standard's mandatory Transform-operation.
- The WCTS standard does not yet have an official status
- All implemented coordinate transformation processes should conform to a single Application Profile (AP)

Background to the research – National needs (1)

- The national coordinate reference systems (CRSs) have to be updated from time to time. For instance the heights in Finland change 2-7 mm yearly.
- The municipalities do not update their CRSs at the same rate as the national systems get updated. Additionally, several municipalities even have their own local systems.
- Problems arise when this multitude of CRSs is in use at the same time. This happens for instance while offering, processing and viewing data via Web Services.
- The INSPIRE Directive can additionally create a demand to publish data in the ETRS-LAEA and ETRS-LCC CRSs for coherent statistical analysis and pan-European cartographic mapping (when scale < 1:500000)

Background to the research – National needs (2)

- Coordinate Transformation Services are expecially needed when the demanded transformation accuracy is high
- In such cases the coordinate transformations might use some rare method for transforming the coordinates
- For instance in Finland is used a triangular affine transformation between the old national CRS and the newer EUREF-based CRS



The triangular network of the affine transformation used in Finland

Prototype implementation (1)

- The aim was to empirically test how a Coordinate Transformation Service as a WPS process could be implemented
- The prototype was based on the 52° North's implementation of the WPS
- The prototype was implemented not to care about the feature types or application profile of the GML data
- To manage this, a dummy data parser and generator was added to the 52° North's WPS to enable a process to have it's own parser and generator
- The possibility of the XML schema conflicting with predefined parsers and generators was taken into account

Prototype implementation (2)

- The prototype implementation can handle GML2 and GML3 data.
- The process's transformation capabilities were built on top of the GeoTools project giving the implementation the benefit of supporting all the same CRSs as the GeoTools project offers.
- The capabilities were extended with a variety of accurate transformations related to the national needs

Transformation	Source CRS	Target CRS	Note
Transformation URN	-	-	The CRSs are found from the transformation
-	CRS URN	CRS URN	Transformation created according to the CRSs.
Conversion/Concatenated operation URN or as a WKT string	CRS URN or WKT string	CRS URN or WKT string	A coordinate conversion does not define the CRSs so they need to be provided.
Transformation as a WKT string	CRS URN or WKT string	CRS URN or WKT string	A WKT does not define the CRSs so they need to be provided.
-	-	CRS URN or WKT string	The Source CRSs are found from the GML

Input parameter options of the process for coordinate transformations.

WPS OpenLayers client

- OpenLayers was decided to be used for demonstrating how the WPS works with a light Web browser mapping client
- To access WPS services outside the HTTP servers domain a proxy needs to be used. A servlet was created as an alternative for a cqi-bin based proxy

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Cartography universitätbonn Geographie

WPS Processes

Basic GIS Functionality:

- Buffer
- Intersection
- Distance
- Aggregation
- PointInPolygonJoin
- PointInPolygonJoinAggregation
- PolygonIntersectsPolygonJoinAggregation

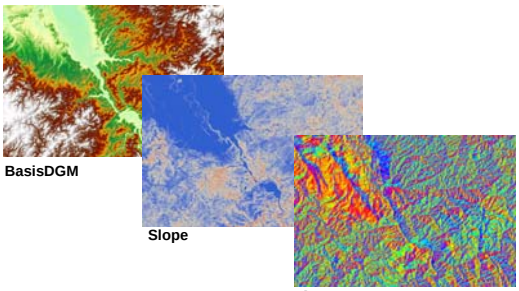
WPS Processes

Raster Data Functionality:

- Aspect
- Slope
- Classification

Raster Data Analysis

Example:



BasisDGM

Slope

Aspect

WPS Processes

Domain specific processes:

- BombThreatScenario
- BombThreatScenario3D
- ToxicGasScenario
- ToxicGasScenario3D

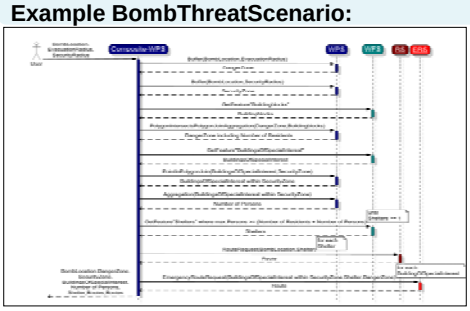
} **Disaster Management**

- SupplyAreasOsnabrueck
- SiteSelectionOsnabrueck

} **Housing market**

Composite-WPS

Example BombThreatScenario:

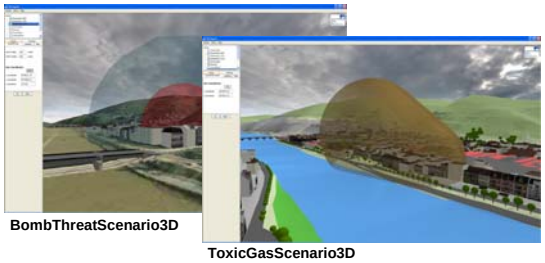


Chaining several processes (and other services) within a new WPS process

3D-WPS

Integration of WPS processes into 3D-CityModels:

(XNavigator – CityModel of Heidelberg)

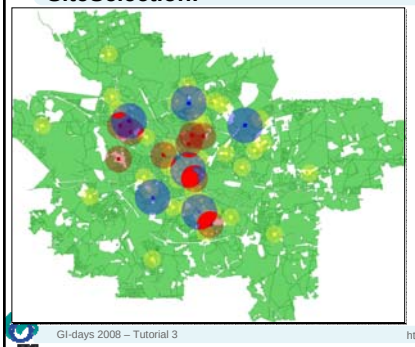


BombThreatScenario3D

ToxicGasScenario3D

Housing Market Analysis

SiteSelection:



„In which area do I have to look for a house?“

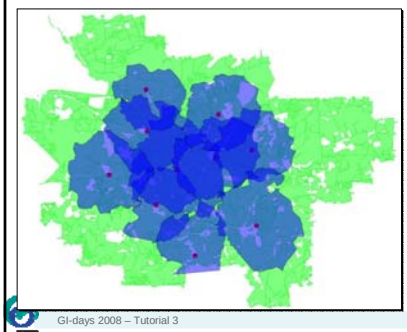
1. Buffer
2. Intersection

- Kindergarten
- Elementary School
- Supermarket

Result of the intersected buffers

Housing Market Analysis

SupplyAreas:



„Where do I not have costumers yet?“

1. AccessibiltyAnalysis
2. Intersection + Aggregation

- Supermarkets
- Buildingblocks including number of residents
- Supply areas including aggregated number of residents on a pro-rata basis

WPS Processes

Work in progress:

- Delaunay-Triangulation
- RasterData-Analysis
- Viewshed-Analysis
- 3D-Building- and Roof-Generation
- Geotesselation
- Terrain-Generalisation
- Spatial-Partitioning
- Relevance-Sorting
- Landmark-Selection

WPS

GetCapabilities:

http://karto.giub.uni-bonn.de:8080/deegree/services?Request=GetCapabilities&SERVICE=WPS

Contact:

Beate Stollberg
Working Group Cartography
Department of Geography
University of Bonn
http://www.geographie.uni-bonn.de/karto
stollberg@geographie.uni-bonn.de

Projects overview

- Web Generalization Services
- Persistent testbed initiative (PTB)
- Orchestra project
- Finish Geodetic Institute
- University of Bonn
- **University of Muenster**
- University Jaume I, Castellon, Spain

Real-time mapping of environmental radioactivity

Main objective of INTAMAP: to develop an **interoperable framework** for real time interpolation of environmental variables by extending spatial statistical methods and employing **open**, **web-based**, **data exchange and visualisation tools**.

Test bed: EURDEP (EUropean Radiological Data Exchange Platform)

RAISIN Prototype

(REM's Automatic Interpolation Service for INTAMAP)

•WPS 0.4.0 server providing automatic Kriging interpolation from point data to maps

Build with:

PyWPS

RAISIN Prototype

(REM's Automatic Interpolation Service for INTAMAP)

•Location:

http://remwps.jrc.it

Input: GML 2.1.2 as ComplexValue

GML either generated by another processes supported by server (CSV2GML) or with tool ogr2ogr from GDAL

Output: GML 2.1.2 as ComplexValue, file location as GML 2.1.2 or Geotiff

Eurdep Interpolation Prototype

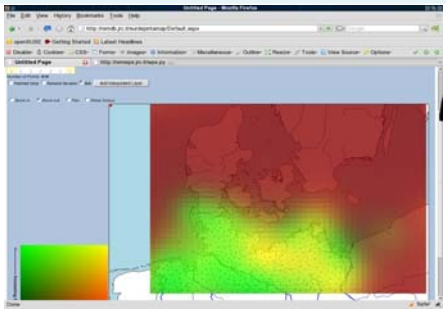
•Location:

http://remdb.jrc.it/intamapeurdep

•GUI client that send EURDEP data to the interpolation server (RAISIN)

•Client processes the WPS request/response. The user only has to select the data it wants

Eurdep Interpolation Prototype



Projects overview

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Context

- GMES: Global Monitoring for Environment and Security.
  - Set of initial long-term services (Earth Observation emphasis).
- GMES-funded AWARE Project (2005-2008)
  - AWARE Team
    - Hydrologists, remote sensing specialists, (G)IS researchers.
  - AWARE uses terms like…
    - SRM model, depletion curves, discharge...
  - AWARE output
    - Web-based tool for running models

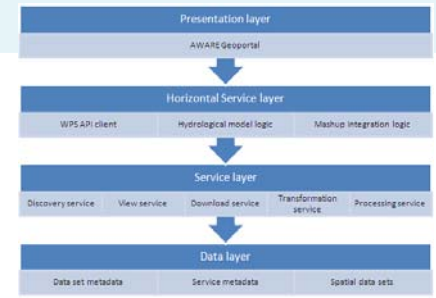
AWARE Goals

- Improve scientific workflow of spatial and non-spatial tasks
- Scientists (hydrologists, geologist, etc) disconnected *a priori* from SDI
  - Connect scientists with their data and routines using geoprocessing services.
  - Using not only basic services (WMS, WFS, etc.) but also processing services (WPS) ⇨ not only remote data but also remote processing.

Assumptions

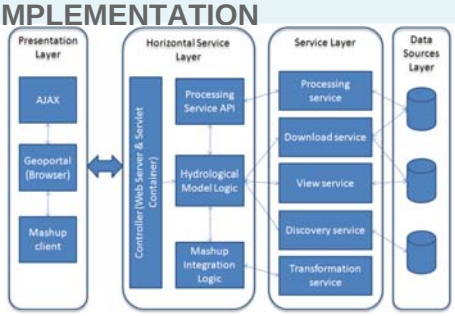
- Interactive workflow.
- Heterogeneous data:
  - EO data, in-situ hydrological and meteo (T,P) data, vector data (basin boundaries), DEM, etc.
- OGC Web Processing Services (**WPS**):
  - Specification to define a common interface to **GEO**processing services.
- AWARE extends WPS use:
  - Encapsulate GIS and NON GIS operations (spatial analysis, buffer, plot creation, interpolation, vectorize, etc.)
  - Scientific-related operations. Complex steps of hydrological models as a chain of WPS.

AWARE ABSTRACT ARCHITECTURE



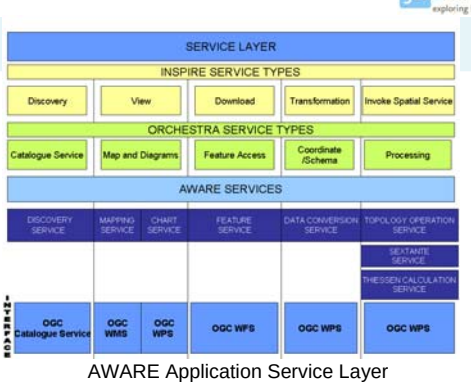
AWARE architecture overview. Based on INSPIRE Technical Architecture

AWARE ARCHITECTURE IMPLEMENTATION

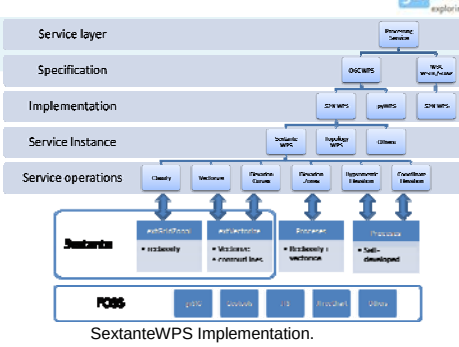


WPS Design Methodology

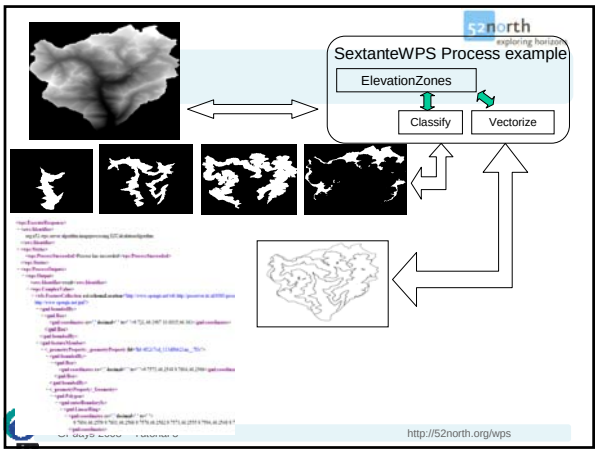
- Decompose routines into atomic, general tasks
  - Each task is a **basic WPS** ⇔ general, to be reused in other scenarios
  - Added value for future combinations
  - Loosely coupled WPS. Functional independence.
- Compose atomic tasks to form specific steps
  - Each step is a **customized WPS** .
  - Each customized WPS make sense in a concrete scenario
  - Scientific domain specific
- Several steps form a routine
  - Web forms (**geoportal**) guide users through steps
  - Web forms use **WPS API** to interact programmatically with WPS needed in each step.

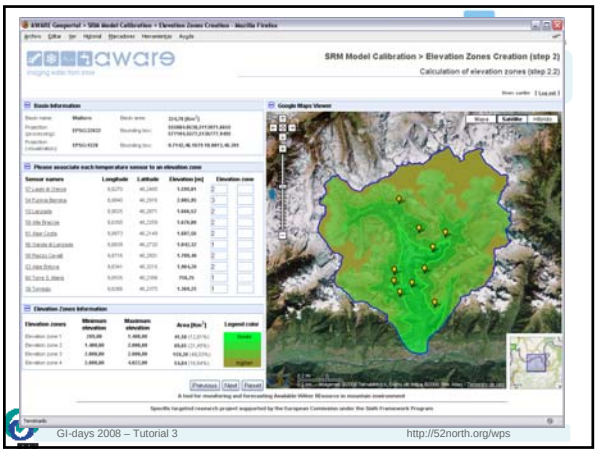


AWARE Application Service Layer



SextanteWPS Implementation.





AWARE INFO

- AWARE Project Web Site
  - http://www.aware-eu.info/
- AWARE Application Geoportal
  - http://geoportal.dlsi.uji.es/aware/
- About Universiy Jaume I
  - http://www.geoinfo.uji.es/

Introduction to 52°North WPS

52N geoprocessing products

- 52n WPS
- 52n WPS client udig
- 52n WPS client jump
- 52n WPS client lib

52N geoprocessing affiliated organizations

- Finish Geodetic Institute, FGI
  - openLayers
- University Jaume I, Castellon, Spain
- University of Dresden
  - Grass integration
- OpenRoads Consulting

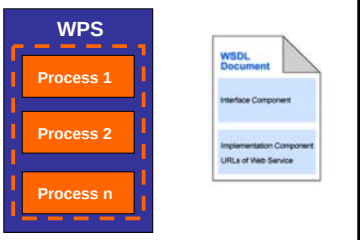
52°North WPS Features

- Overview
  - → Features (version 1.0.0)
    - →Full java-based Open Source implementation
    - →Pluggable framework for algorithms and XML data handling
    - →Build up on robust OS libraries (JTS, geotools, xmlBeans, servlet API, derby)
    - →Supports full logging of service activity
    - →Supports exception handling according to the spec
    - →Storing of execution results
    - →Execute via HTTP-GET
    - →Full GML2 support for ComplexValues (i.e. FeatureCollections)
    - →KML support (beta)
    - →Support of raster processing (beta)

52°North WPS Features

- Overview
  - →New features
    - → SOAP/WSDL support
    - → Repository concept
    - → Plug&Play data handlers
    - → GET interface
    - →Easy Maven deployment
    - →WPS configuration

Binding



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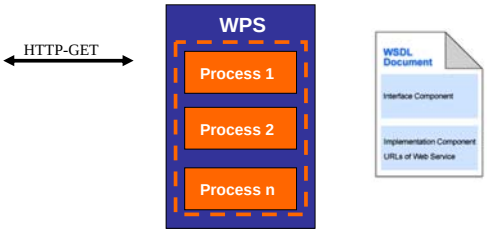

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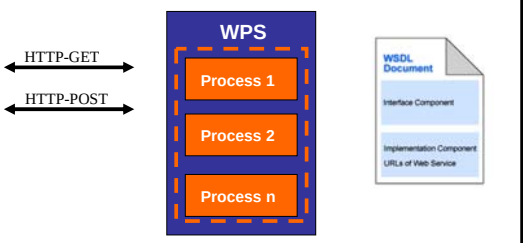

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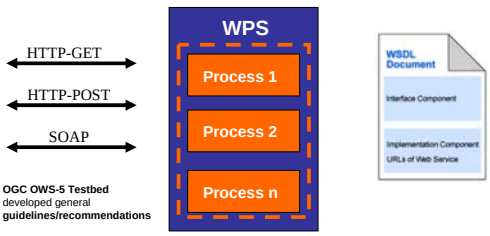


OGC OWS-5 Testbed developed general **guidelines/recommendations**

Repository Concept

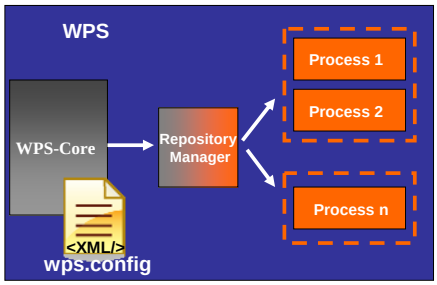
- Discovery

http://flumagisch.uni-muenster.de:8080/wps/WebProcessingService?Request=GetCapabilities&Service=WPS

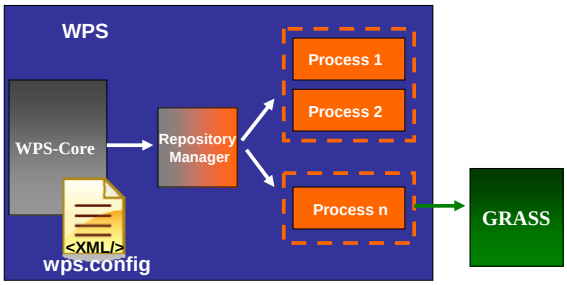
Repository Concept

- Discovery

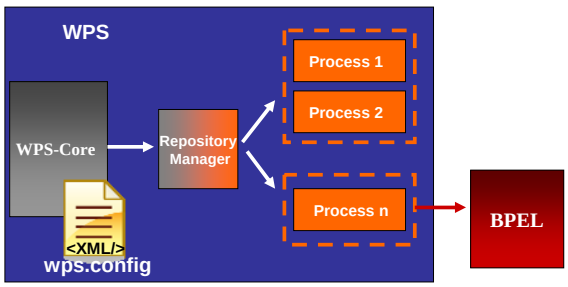
Repository Concept



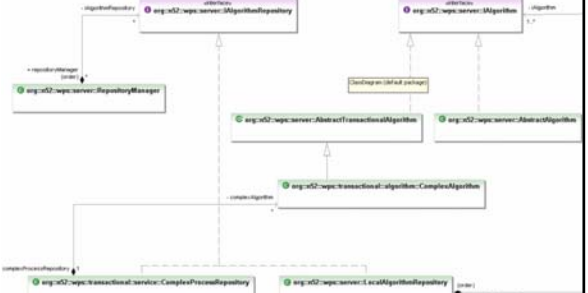
Repository Concept



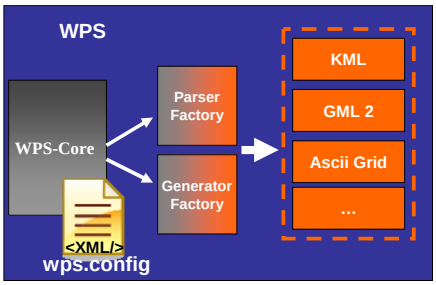
Repository Concept



Repository Concept



Plug&Play data handlers

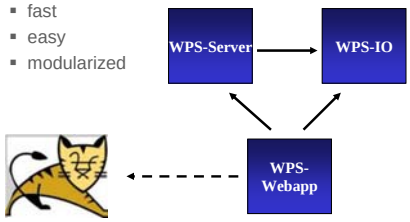


Execute via HTTP GET

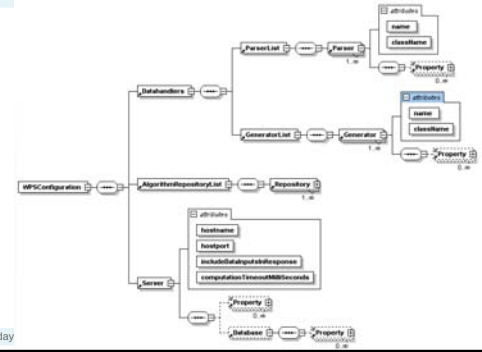
- http://geoserver:8080/wps/WebProcessingService?request=execute&
- service=WPS&
- version=1.0.0&
- Identifier=org.n52.wps.server.process.network.PseudoNodeRemover&
- DataInputs=FEATURES=@mimeType=text/xml@href=http%3A%2F%2Fcgs.nottingham.ac.uk%3A8080%2Fgeoserver%2Fwfs%3FSERVICE%3DWFS%26VERSION%3D1.0.0%26REQUEST%3DGetFeature%26typename%3Dgn%3APIPEZ1@Schema=http://schemas.opengis.net/gml/2.1.2/feature.xsd&RawDataOutput=MERGED_LINES@mimeType=application/vnd.google-earth.kml%2Bxml@schema=http://www.opengis.net/kml/2.2

Deployment

- Maven
  - fast
  - easy
  - modularized



New WPS configuration



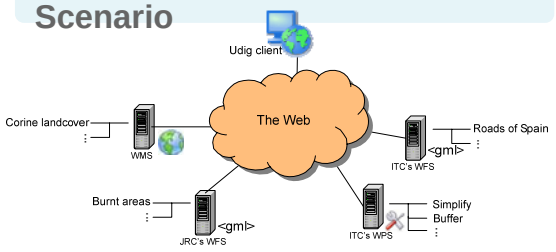
Geoprocessing research @ 52°North

52n WPS-Transactional
52n WPS-Grass

Geoprocessing demo

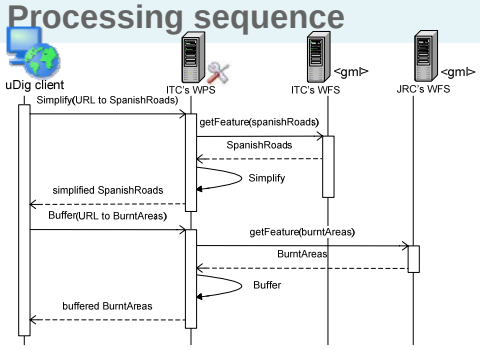
52n WPS udig client
Google Earth
Let's get your hands dirty!

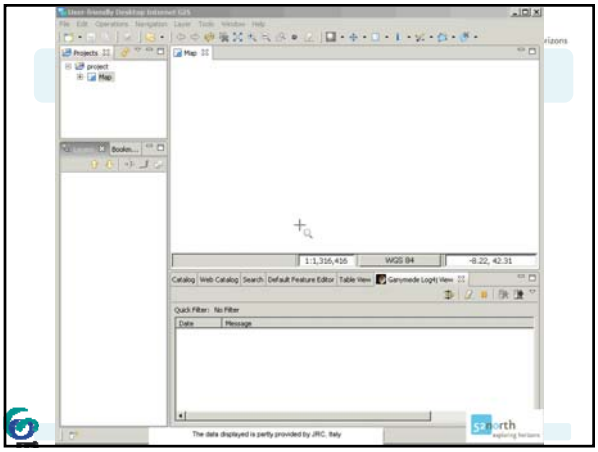
Distributed Processing Scenario



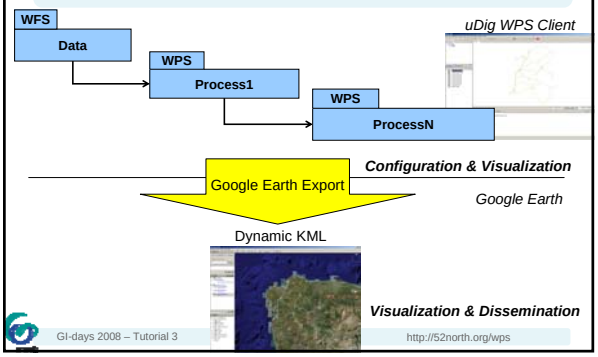
- Fire threat detection

Processing sequence

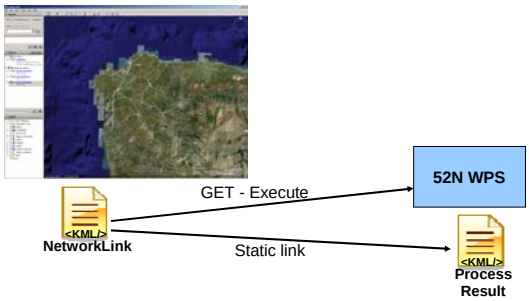




Scenario Workflow - extended



Google Earth process integration



URLs

- GI-days workshop wiki site
  - https://52north.org/twiki/bin/view/Processing/GIdaysWPSworkshop
- WPS
  - http://geoserver.itc.nl:8080/wps/WebProcessingService
- WFS
  - http://geoserver.itc.nl:8080/geoserver/wfs
    - Spanish_roads

Further readings (selection)

- Diaz, L.; Costa, S.; Granell, C. & Gould, M.: Migrating geoprocessing routines to web services for water resource management applications. Wachowicz, M. & Bodum, L. *(ed.)* : *10th AGILE International Conference on Geographic Information Science*, **2007**
- Foerster, T. & Schaeffer, B.:A client for distributed geo-processing on the web. Tayler, G. & Ware, M. *(ed.), W2GIS, Springer*, **2007**, *4857*, 252-263
- Friis-Christensen, A.; Ostlander, N.; Lutz, M. & Bernard, L.: Designing Service Architectures for Distributed Geoprocessing: Challenges and Future Directions. *Transactions in GIS, Blackwell Publishing*, **2007**, *11*, 799-818
- Kiehle, C.; Greve, K. & Heier, C.: Standardized Geoprocessing - taking spatial data infrastructures one step further. *9th AGILE International Conference on Geographic Information Science*, **2006**, 273-282
- Kiehle, C.; Heier, C. & Greve, K.: Requirements for Next Generation Spatial Data Infrastructures-Standardized Web Based Geoporcessing and Web Service Orchestration. *Transactions in GIS, Blackwell Publishing*, **2007**, *11*, 819-834

Thanks

Questions?

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http://52north.org/wps

GI-days 2008 – Tutorial 3 http://52north.org/wps