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?

- What is a WPS?
  → Web Based Processing

WPS
WPS

- Discovery
  - DescribeProcess

Example

WPS

- Execution
  - XML Execute Request

WPS additional features

- Execution
  - Synchronous
  - Asynchronous
WPS additional features

- Execution
  - Synchronous
  - Asynchronous
  - Wrapped XML payload
  - Raw data payload

Execution synchronous

- Object1
- Object2

Execution asynchronous

- Push-model

- Pull-model

Execution asynchronous

- Request

<ows:ResponseDocument>
  <ows:ExecuteResponse status="true">
  <ows:Identifier result="ows:Identifier">
    <ows:Output>
      <ows:ResponseDocument>
        <ows:ResponseForm>
          ...
        </ows:ResponseForm>
      </ows:Output>
    </ows:Identifier>
  </ows:ExecuteResponse>
</ows:ResponseDocument>
Execution asynchronous

- Response

```
<GetCapabilitiesResponse xmlns:ows="http://www.opengis.net/ows/1.1" xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/1.0 http://www.opengis.net/ows/1.1/ows-1.1.xsd">
  <ows:Capabilities version="1.1.0">
    <ows:ServiceIdentification>
      <ows:ServiceType>WPS</ows:ServiceType>
      <ows:ServiceTypeCode>WPS</ows:ServiceTypeCode>
    </ows:ServiceIdentification>
    <ows:OperationList>
      <ows:Operation>
        <ows:OperationName>getCapabilities</ows:OperationName>
        <ows:Abstract>Get the information about the server</ows:Abstract>
      </ows:Operation>
      <ows:Operation>
        <ows:OperationName>execute</ows:OperationName>
        <ows:Abstract>Execute a service request, e.g., a projection</ows:Abstract>
      </ows:Operation>
    </ows:OperationList>
    <ows:ProcessList>
      <ows:Process>
        <ows:ProcessName>getCapabilities</ows:ProcessName>
        <ows:ProcessAbstract>Get the information about the server</ows:ProcessAbstract>
      </ows:Process>
      <ows:Process>
        <ows:ProcessName>execute</ows:ProcessName>
        <ows:ProcessAbstract>Execute a service request, e.g., a projection</ows:ProcessAbstract>
      </ows:Process>
    </ows:ProcessList>
  </ows:Capabilities>
</GetCapabilitiesResponse>
```

Wrapped XML

- Request

```
<GetCapabilitiesRequest/>
```

- Response

```
<GetCapabilitiesResponse>
  <GetCapabilitiesResponse/>
</GetCapabilitiesResponse>
```

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
  - Syntactically (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

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

• 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

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

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

Source: London Transport Museum

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

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

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

- (0) provide execution parameters
- **MAS** = Map Access Service (≈ OGC WMS)
- **FAS** = Feature Access Service (≈ OGC WFS & WCS)
- **FAS-X** = Translating FAS Client
- OA Info-Structure Service
- OT Support Service
- OT Risk Specific Service Processing Service (≈ OGC WPS)

Damage Assessment

- (1) Request flood simulation for certain flood level
- (2) Retrieve administrative units
- (3) Create event extent for “flood”
- (4) Create exposure “population density”
- (5) Create damage “number of affected people”
- (6) Aggregate impact per admin unit
- (7) Normalise impact by area
- (8) Render features in a map

Population density

Flood Simulation Damage Assessment
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

Background on the research - INSPIRE (1)

- 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 especially 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, a triangular affine transformation between the old national CRS and the newer EUREF-based CRS is used.

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 its 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.

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.

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

WPS Processes

Basic GIS Functionality:
- Buffer
- Intersection
- Distance
- Aggregation
- PointInPolygonJoin
- PointInPolygonJoinAggregation
- PolygonIntersectsPolygonJoinAggregation
WPS Processes

Raster Data Functionality:
- Aspect
- Slope
- Classification

WPS Processes

Domain specific processes:
- BombThreatScenario
- BombThreatScenario3D
- ToxicGasScenario
- ToxicGasScenario3D
- SupplyAreasOsnabrueck
- SiteSelectionOsnabrueck

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)

3D-WPS

Housing Market Analysis

SiteSelection:

“Where do I have to look for a house?”

1. Buffer
2. Intersection

Kindergarten
Elementary School
Supermarket

Result of the intersected buffers
Housing Market Analysis

Supply Areas:
- "Where do I not have customers yet?"
- Accessibility Analysis
- Intersection + Aggregation
  - Supermarkets
  - Building blocks including number of residents
  - Supply areas including aggregated number of residents on a pro-rata basis

Work in progress:
- Delaunay-Triangulation
- Raster Data Analysis
- Viewshed Analysis
- 3D Building and Roof Generation
- Geotesselation
- Terrain Generalisation
- Spatial Partitioning
- Relevance Sorting
- Landmark Selection

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

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

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 - a 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 University 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)
- XML support (beta)
- Support of raster processing (beta)

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

Binding

WPS
Process 1
Process 2
Process n

HTTP-GET
HTTP-POST

OGC DMS-1 Toolkit
developed general
guidelines/recommendations
Repository Concept

- Discovery

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

Repository Concept

- Discovery

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

Repository Concept

- Discovery

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

Repository Concept

- Discovery

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

Repository Concept

- Discovery

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

Repository Concept

What is a WPS?
Execute via HTTP GET

  service=WPS&
  version=1.0.0&
  Identifier=org.n52.wps.server.process.network.PseudoNodeRemover&
  DataInputs=FEATURES=@mimeType=text/xml@href=http%3A%2F%2Fgs.MapServer%2Fwfs%3Fservice%3DWFSS%26version%3D1.0.0%26REQUEST%3DGetFeature%26typeName%3Dgml%26APIPEZ1@Schema=http://schemas.opengis.net/gml/2.1.2/feature.xsd
  &RawDataOutput=MERGED_LINES@mimeType=application/vnd.google-earth.kml+xml@schema=http://www.opengis.net/kml/2.2

Deployment

- Maven
  - fast
  - easy
  - modularized

WPS-Server

WPS-IO

WPS-Webapp

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)


Thanks

Questions?
foerster@itc.nl
schaeffer@uni-muenster.de
joejoe@uni-muenster.de
http://52north.org/wps