Building the Canadian Spatial Data Foundry

An online portal for large scale spatial analysis

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Boreal Avian Modelling Project

cfr Centre for Forest Research

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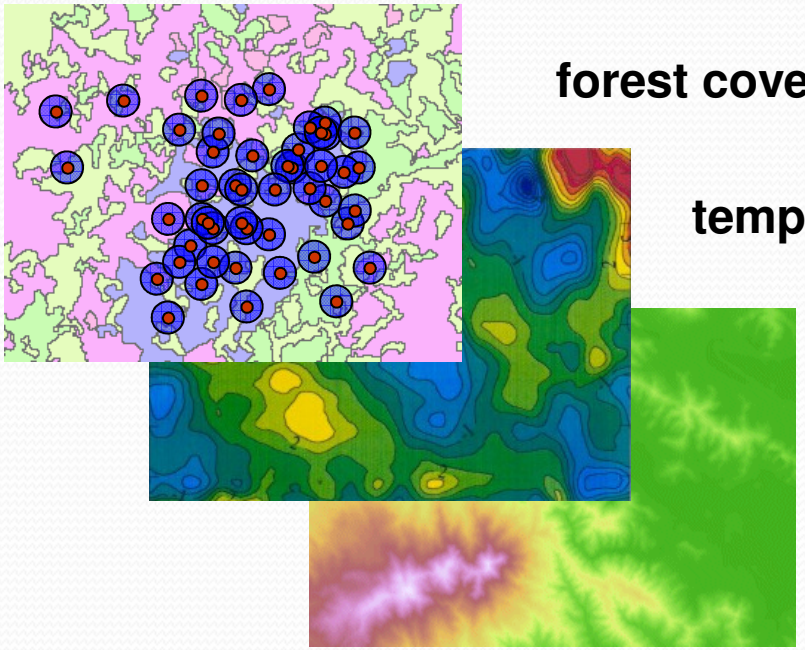
Context I

- Researchers in forestry, ecology and environment
- Doing buffer analysis over HUGE raster and vector datasets (covering the extent of Canada)



forest cover

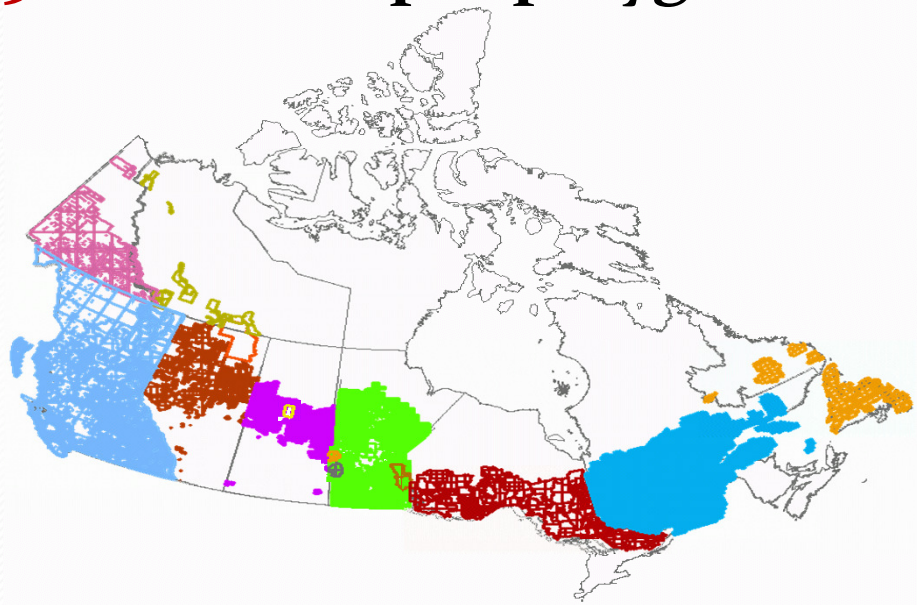
temperature

elevation, etc…

geom	obsID	cutProp	meanTemp	elevation	etc…
polygon	1	75.2	20.3	450.2	…
polygon	2	26.3	15.5	467.3	…
polygon	3	56.8	17.5	564.8	…
polygon	4	69.2	10.4	390.2	…
…		…	…	…	…

A Canada Wide Forest Inventory

- A Canadian wide forest inventory already exist but it is only based on a sampling
- A higher precision alternative is to standardize and merge 24 provincial photo interpreted inventories into a single one
- 26 000 000 polygons, 69 attributes per polygon
- 40 GB of vector data



Context II

Researchers must…

…learn lots of ArcGIS, to use few operations

…search for, download and assemble large datasets

- **historical data are often lost**
- **data are delivered in many different formats**
- **documentation is generally written for GIS experts**
- **datasets are too large to fit in one file (shp limited to 2 GB, complete forest cover for Canada is 40GB, complete DEM for Canada is 9 GB, etc…)**
- **computation is often too difficult for ArcGIS (800 buffers over 5 000 000 polygons)**

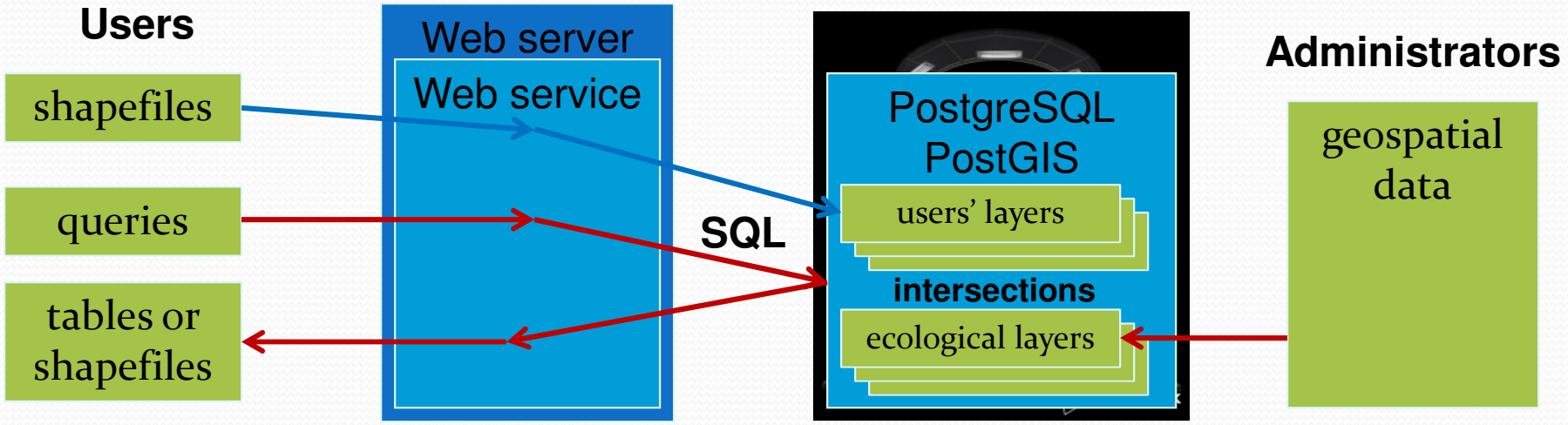
…struggle for weeks, if not months, to get their data table ready for statistical analysis…

In brief: researchers waste much energy on tasks unrelated to their main priority: research!

The Canadian Spatial Data Foundry

- A **web site** (or service)
- Backed by a **spatial database** hosted on a **supercomputer**
- **GIS administrators** upload **preassembled** datasets of **ecological layers** (vector & raster, historical data)
- **Users with accounts upload** their datasets (**shapefiles**)
- **Create intersection queries** with the ecological layers
- Obtain results in the form of **shapefiles** or **tables**

A Spatial Data Infrastructure (SDI) Dedicated to Large Scale Analysis



What Do We Need?

1. **A good storage solution**
   - HUGE datasets (26 000 000 polygons, 30 gig Landsat derived tiled raster coverages and many more)
2. **A robust and powerful raster/vector geoprocessing engine**
   - Intersecting SEVERAL, sometimes LARGE buffers with HUGE datasets
3. **A web interface to**
   - upload shapefiles in the store
   - document administrators and users datasets using a simple ISO 19115 profile
   - build intersection queries
6. **Optionally a web mapping engine**
   - To show datasets (and results) in a geographical context

Storage & Geoprocessing Options

- **Storage**
  - Files in the file system
  - Relational database (ArcSDE, Oracle, PostGIS)
- **Raster/vector geoprocessing engine**
  - Spatial database geoprocessing (ArcSDE, Oracle, PostGIS)
  - In house development (GEOS (C), JTS, SEXTANTE (Java), R)
- **Both solutions are intrinsically linked**
  - Storing in the file system implies non DB solution for geoprocessing
  - Storing in the DB implies geoprocessing in the DB

PostgreSQL/PostGIS

- **A secure/professional spatial database management system**
- **VERY robust and powerful geometric operations engine**
- **VERY large file capacity**
- **Multiple queries (users) at the same time**
- **Queries simple to write (SQL), no development needed**
  - shp2pgsql c:/temp/buffers.shp buffersTable | psql foundrydb
  - SELECT ST_Intersection(l.geom, b.geom)
    FROM lakesTable l, buffersTable b
    WHERE ST_Intersects(l.geom, b.geom)
- **Clean & secure storage**
- **Simple to deploy and scale**
- **Free!**
- **But missing raster capacities…**

PostGIS Raster

- **Open Source project adding support for rasters in PostGIS**
- **Loader based on GDAL –» support for MANY raster formats**
- **Takes nodata values into account, multiple bands, tiled and indexed (much faster), overviews**
- **SQL API**
  - get & set raster properties, georeference, convert to/from geometries, export to other raster formats
  - resample, reclass, reproject
  - compute statistics, intersect with geometries, map algebra
- **Almost transparent queries, familiar to PostGIS users**
  - raster2pgsql c:/temp/*.tif rastTable | psql foundrydb
  - SELECT ST_Intersection(a.rast, b.geom)
    FROM rastTable a, bufferTable b
    WHERE ST_Intersect(a.rast, b.geom)
- **2 years development involving many organizations**
- **Released with PostGIS 2.0 April 3th 2012**

Back on Our Requirements

1. **A good storage solution** ✓
2. **A robust and powerful raster/vector geoprocessing engine** ✓
3. **A web interface to**
   1. upload shapefiles in the store
   2. document administrators and users datasets
   3. build intersection queries
4. **Optionally a web mapping engine**

- **Capacity to develop a complete customizable geoweb application**
- **Ideally without (or with minimal) programming**

A Simple and Complete Metadata Profile

- **ISO 19115 is way too complex to maintain for small organizations**
  - +400 fields of information
  - VERY technical language
  - Designed for governmental organizations having a lot of resources
- **Feature documentation (all the attributes of a feature layer) is not part of ISO 19115 –» ISO 19110**
- **Our simpler subset (profile) of ISO 19115 and ISO 19110**
  - 29 mandatory fields, 32 optional
  - mix of ISO 19115 and ISO 19110 fields
  - vocabulary adapted for non GIS experts

GeoNetwork?

- **Web cataloging solution used as base for many SDI**
- **Store in many mtetadata standards (ISO 19115, ISO 19110, ISO 19119, ISO 19139, FGDC, Dublin Core)**
- **Serve in many protocols (CSW, Z39.50, GeoRSS, WebDAV)**
- **Search in and harvest from other catalogs**

GeoNetwork Opensource

Pros

- **Complete standard search/view/edit metadata solution**
- **Very good connection with other software**

Cons

- **Poor web usability, hard to customize**
- **Very hard to embed into an existing web application**
- **Poor data exploration mode, no facets**
- **Top down approach –» From experts for users**
- **Hardly relational when it should be**
  - no reuse of already entered entities other then was is provided by templates
- **Hard to implementation a profile not trivial**
- **No geoprocessing**

GeoNode?

- **Specifically developed to build a SDI**
- **Built with geo web development framework GeoDjango**

Pros

- **Very (Too?) simple metadata schema**
- **Bottom up approach –» From users for users :-)**

Cons

- **No support for ISO 19110 (only attribute names, no type, no description, no code list)**
- **Poor exploration mode, no facets**
- **No geoprocessing**
- **Very hard to embed into an existing web application**
- **Same problems with ESRI Geoportal Server**

A Geo CMS/Wiki?

- **All the services offered by a CMS or a Wiki**
  - Online site building
  - No HTML, no CSS, skin based
  - Easy form creation
  - Multi users and secure
  - Plenty of plugins for specialized functionalities
  - Many already integrate OpenLayers for mapping

- **What's missing?**
  - **GeoNetwork services**
    - for storing, publishing and editing metadata
  - **GeoServer (or MapServer) services**
    - for uploading data to the DB
    - for publishing them as geoweb services (WMS, WFS, WPS)
  - **Web Processing Services (WPS) interface**
    - configurable with CMS forms
    - plugable on many geoprocessing engines

- Geo services interfaces can be ***adapted*** to different ***classes*** of web application (like OpenLayers already does).
- ***GeoDjango*** is near from this but still requires ***Python development skills.***
- ***EasySDI*** is another attempt using ***Joomla.***

Our Direction…

- **Considering**
  - The complexity/time required to customize/simplify/extend GeoNetwork, GeoServer or GeoNode interface for our own application
  - The time required to develop a pluggable set of PHP drivers for GeoNetwork and/or GeoServer for a particular CSM or wiki
  - The fact that most services other than cataloging are not mandatory (mapping, WMP, WFS, WPS, CSW) for our application
- **We decided to develop the site using Semantic Mediawiki**
  - Semantic extension to the most used wiki in the world – Wikipedia – A database
  - Everything is customizable, no HTML, no CSS, no programming -> skins
  - Strong community building capacities, user management, security, change history
  - Many tools for search and exploration
  - VERY easy to build complex forms
  - Geo services will be implemented as they are needed
    - upload shapefiles to PostGIS
    - link a form to the geoprocessing engine
    - spatial search
    - export metadata to ISO 19139, 19110

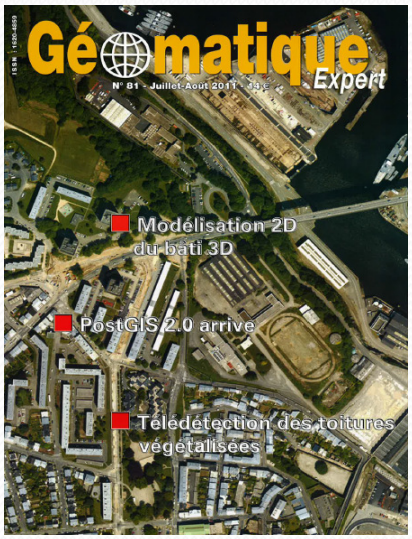
We should progressively end up with a full Web GIS in Mediawiki!

Conclusion

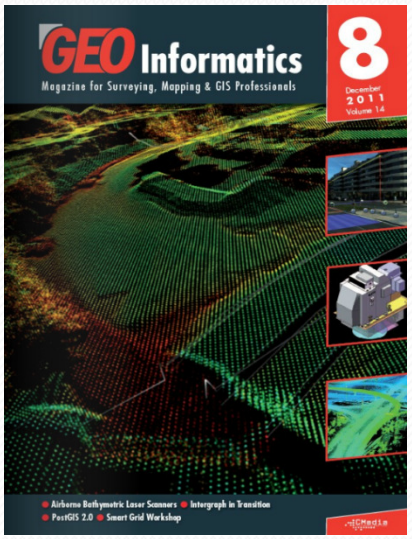
- **PostGIS with raster support provides a viable and robust storage solution offering geoprocessing engine**
- **There is not yet a easy/complete/flexible solution to implement a SDI**
  - GeoNetwork is for experts and is has numerous usability issues
  - GeoNode is hardly configurable and lack many functionalities
  - GeoDjango is a step toward the right direction but still requires developer skills
  - We need common geo services to be embeddable into existing web development tools like CMS or Wiki for easy specific application building
  - Not sophisticated/expert SDI solutions hard to adapt for our own specific needs
- **The trend is toward bottom up, social portals**
- **Still a lot of development to do to get easy tools**
- **In our case, all the features provided by a semantic wiki outmatch the services provided by GeoNetwork/GeoNode/ GeoDjango**
- **We will progressively tranform Semantic Mediawiki into a geo web site building tool and database**

Questions

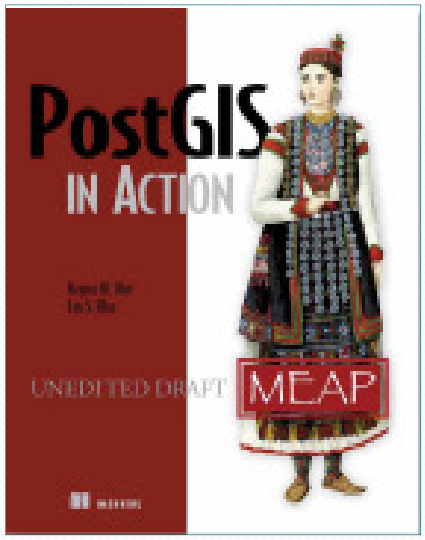
WKT Raster
Brazil FOSSGIS
June 2011



PostGIS 2.0 Arrive
Géomatique Expert
July 2011



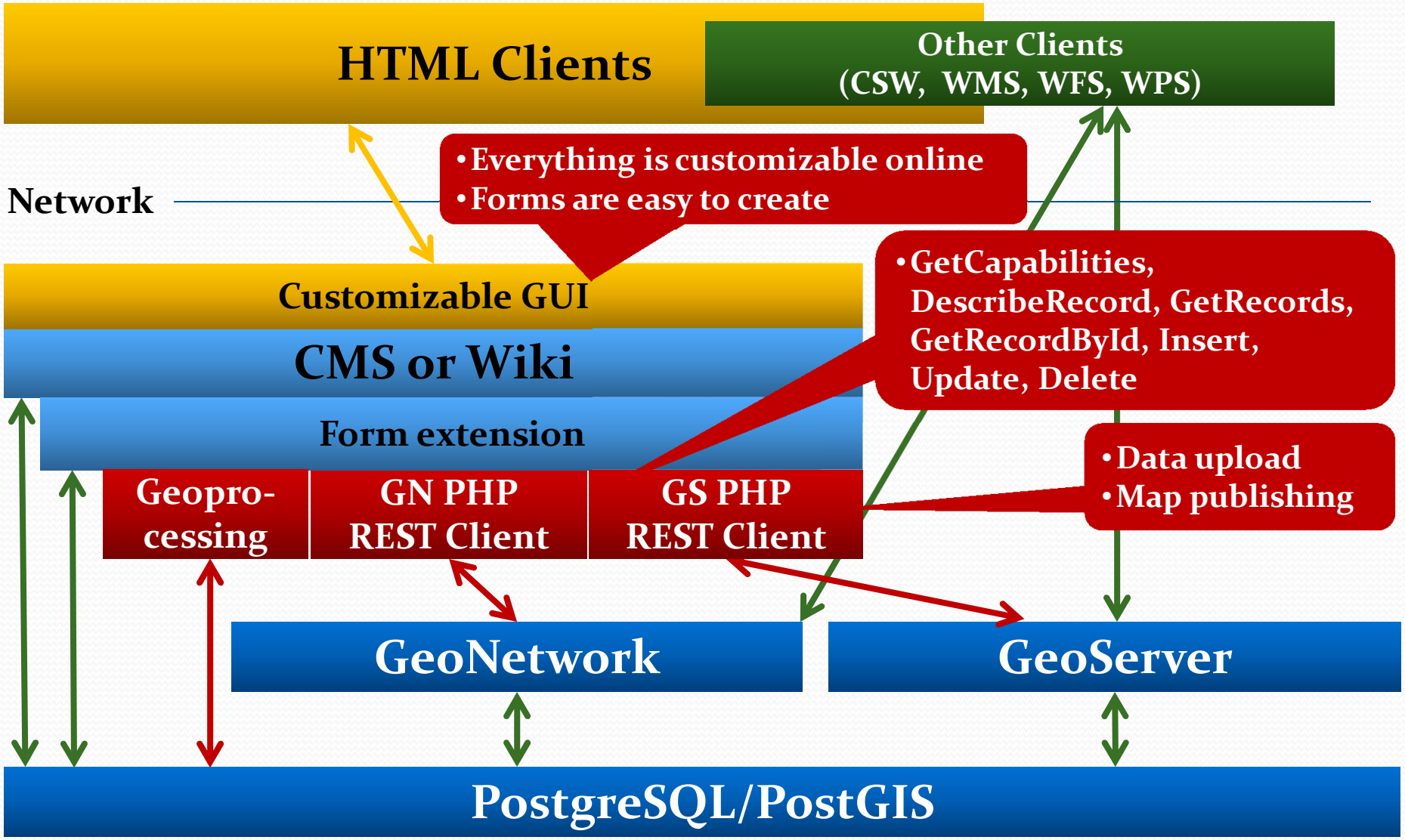
PostGIS In Action
GEO Informatics
December 2011



Chapter 13 on
PostGIS Raster
April 2011

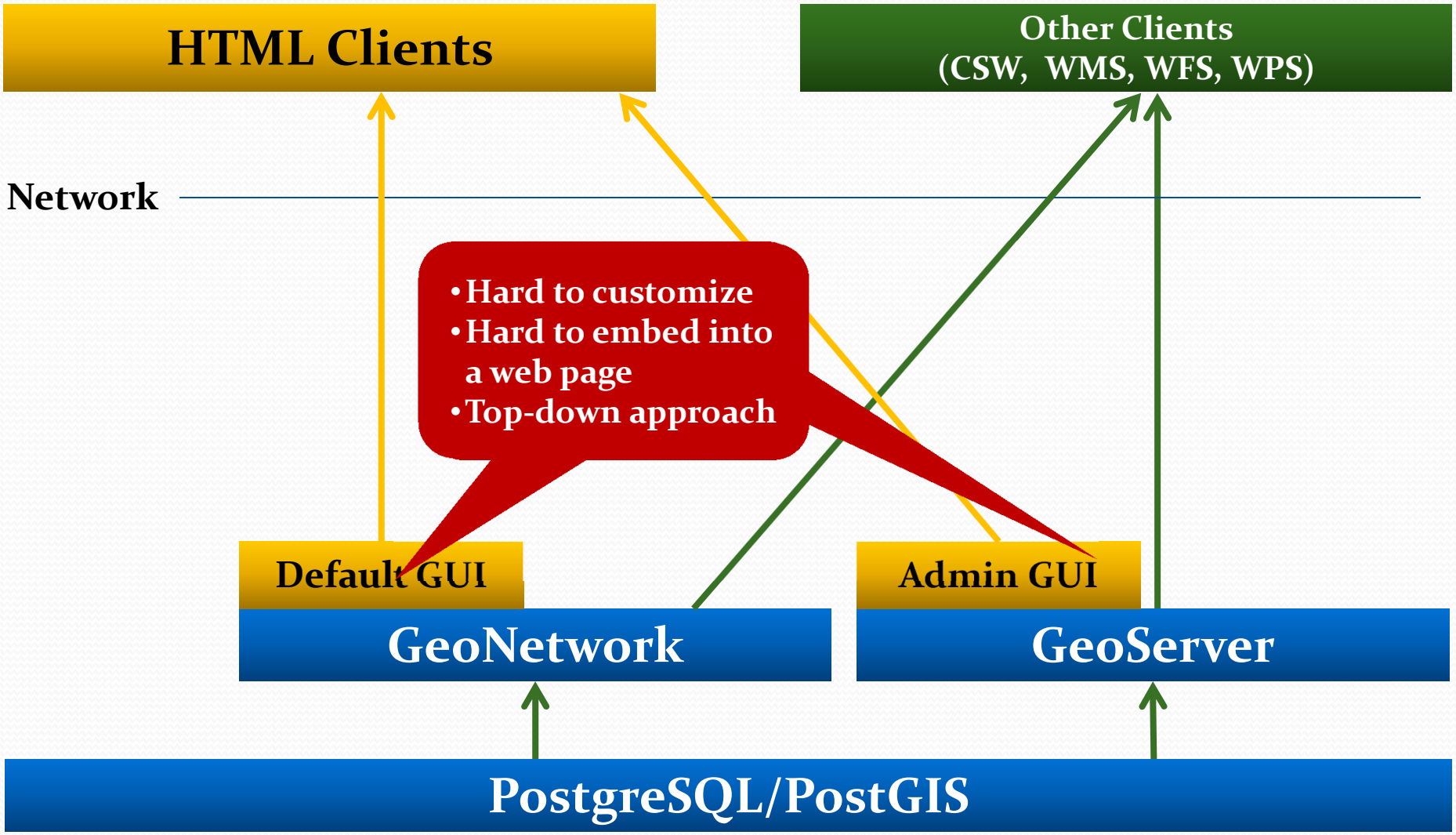
Thanks!

A CMS/Wiki Based SDI

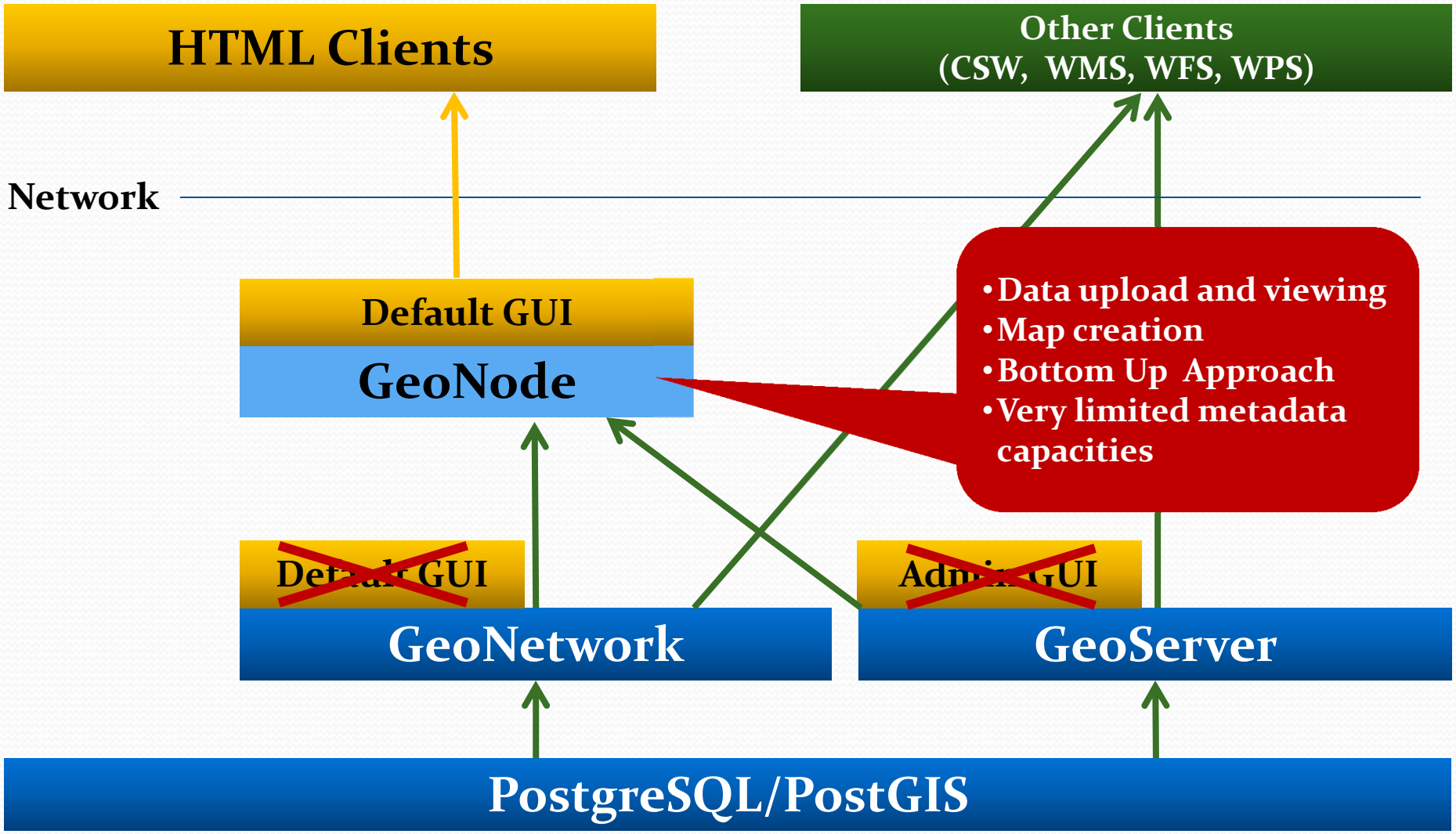


- **Some directions**
  - Implementing everything in Semantic MediaWiki
  - Integrating the functionalities of a SDI portal into an existing CMS or Wiki
  - Building everything using a geo web framework (GeoDjango)
  - Plug GeoNetwork as the documentation engine in GeoServer

A Simple GeoNetwork SDI



A GeoNode SDI



Do and do not when building an SDI

- **Focus too much on search and not enough on browse**
  - People often do not know what keywords to search for
  - Results in none or too many datasets
  - New users are in exploratory mode
  - Must be able to browse and restrict criteria (spatial, temporal, categorical, file type, etc…) at the same time (facets)
- **Focus too much on mapping**
  - Seeing the data is not what is the most important
  - Good facet (or criteria based) browsing is more important. Think about a library catalog: The same way a book reader is not a catalog, a map is not a catalog.
  - Too many buttons and feature, many do not work!
  - A preview is generally sufficient
- **Spliting products by mapsheet and returning each mapsheet when searching**
  - Once a product is found offer to cut it to a mapsheet or a specific area
- **Catalog base datasets, and derived datasets only to a certain point**
  - Criteria: how many applications can use this data
- **No users collaboration**
  - User knowledge is precious, let them document, comment, correct errors
- **Have strict policies on names and description**
  - Actually avoid names! Should be « Theme for location for time », Elevation for Canada
- **Propose preferred datasets and link to similar datasets**
- **Ideally everything should be centralised but licence restrictions and security make centralized data repository not wishable howeverlicensing does not prevent centralized metadata repository**
- **Be verbose and use a lot institutional jargon, not follow web usability rules**
  - Use all the screen!

Beyond the Traditionnal SDI

- **From a Download Oriented SDI**
- **To an Upload and Analysis SDI**

- **From an Organization Controlled SDI Paradigm**
  - Organization provide data, users consume data and results of analyses
- **To a User contributed SDI Paradigm**
  - Users consume, upload and analyse data
- **To a Social Network SDI Paradigm**
  - Users consume, upload and share data and analyses and about data and analyses