

# **Building Spatial Data Infrastructures successfully based on Free and Open Source GIS Software?**

Stefan Steiniger  
University of Calgary

# Last time I talked about FOS Desktop GIS...

OrbisGIS

GIS Editor

Desktop GIS

JUMP

MapWindow

Thuban

uDig

SAGA

GRASS

Kosmo

QGIS

iGeoDesktop

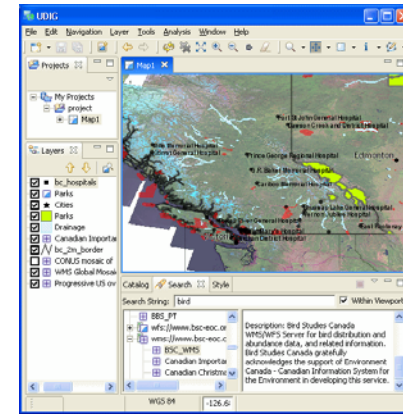
OpenJUMP

ILWIS

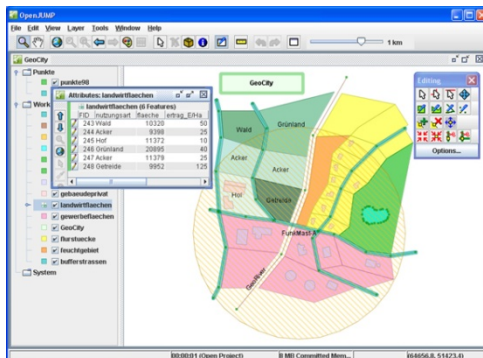
GIS Analyst

gvSIG

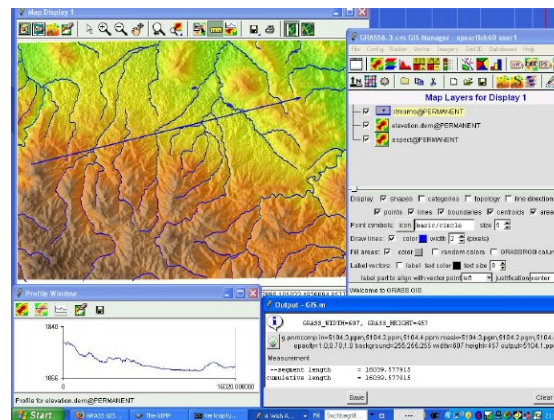
GIS Viewer



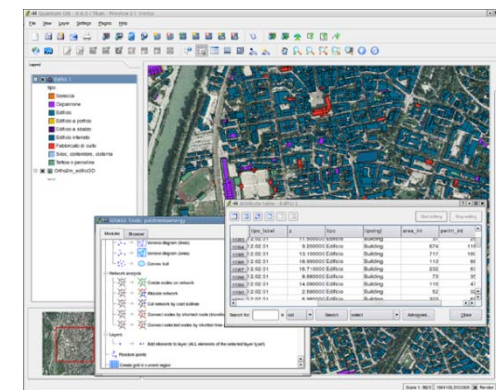
uDIG, Image: Refractions.net



OpenJUMP, Image: Uwe Dallüge



GRASS GIS, Image: M. Lennert (<http://grass.itc.it>)



Quantum GIS, Image: M. Neteler ([pinus.chinju.ac.kr](http://pinus.chinju.ac.kr))

Today I want to look at **Spatial Data Infrastructures (SDIs)**

**Questions** I want to answer:

- **What** is a SDI?
- What are the **software requirements** to realize an SDI?
- What free **software** is out there to build the technical components?
- Can we **implement** SDIs with FOSS – **successfully**?



# Outline

1. What is an SDI?
2. Technical Requirements for SDI implementations
3. FOSS Software for SDIs
4. How to select among FOSS software
5. Conclusions

# What is an SDI?

The **challenge**:  spatial

*“[...] islands of data of different standards and quality [...]”*



--- Smits (2003)

...islands can be different government agencies, different city departments, NGOs, company departments, etc.

# What is an SDI?

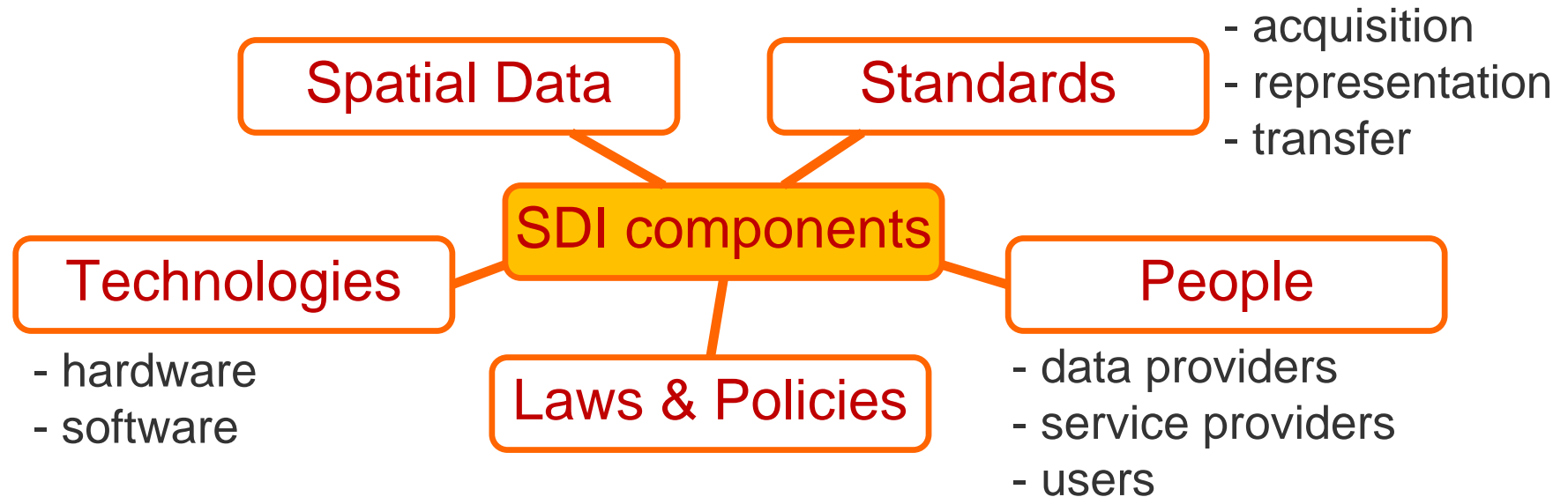
## Objectives of a Spatial Data Infrastructure

- **Distribution** of geographic data to multiple users
- Providing a central **access** point to geographic data ( $\Rightarrow$  requires cataloguing)
- **Data maintenance by** the “**experts**” that created the data
- **Standardize** storage and acquisition
- **Saving resources** by avoiding duplication of efforts (data acquisition, distribution, updating)

# What is an SDI?

A **definition** of SDI by Kuhn (2005):

*An SDI is a coordinated series of agreements on **technology standards**, **institutional arrangements**, and **policies** that enable the discovery and use of geospatial **information** by **users** and for purposes other than those it was created for.*

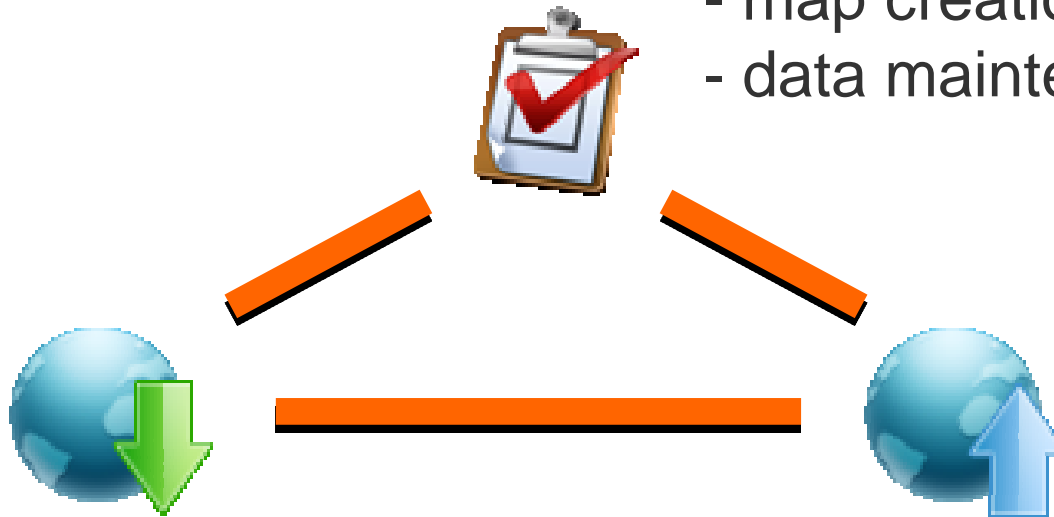


# What is an SDI?

## SDI case study – National Mapping Agencies, e.g. IGN France

### objectives:

- map creation
- data maintenance & delivery



### data users:

- in-house (map creation)
- governmental admin.

### data deliverers:

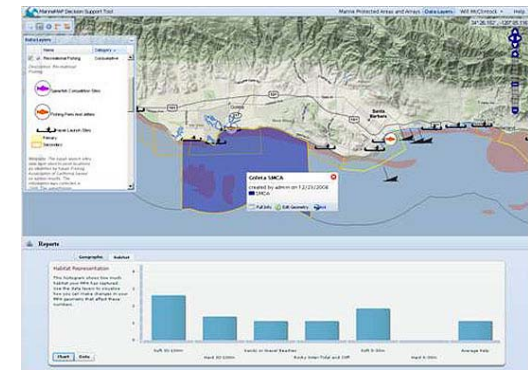
- in-house
- forestry admin.
- road admin.

# What is an SDI?

## SDI case study – *Marine Map* Information System (CA, USA)

### objectives:

Decision support for designing marine protected areas



### data users:

- resource managers
- scientists
- public

### data deliverers:

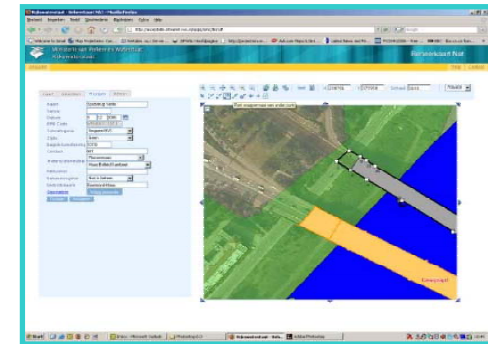
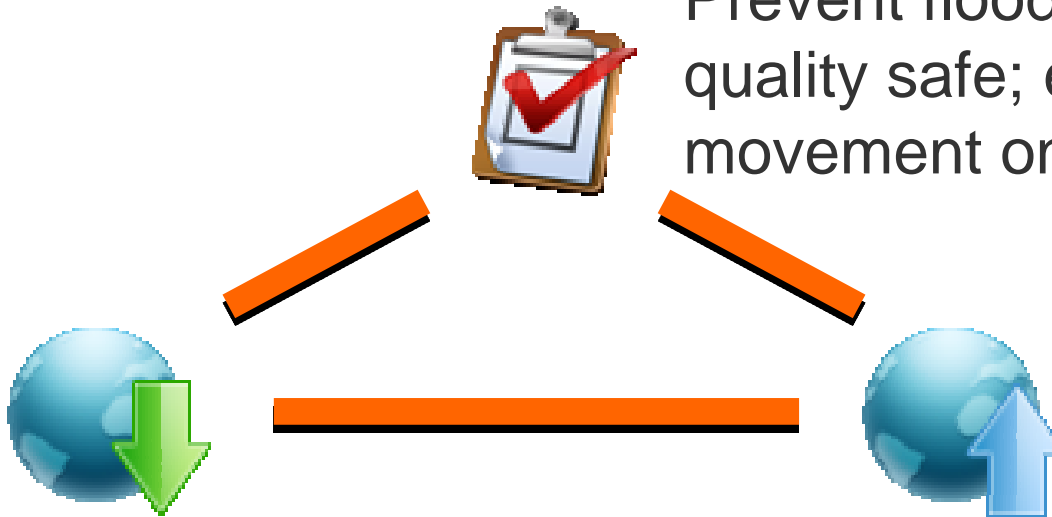
- Department of Fish & Game
- private contractors
- scientists, etc.

# What is an SDI?

## SDI case study – *Rijkswaterstaat* (NL)

### objectives:

Prevent flooding; ensure water quality safe; ensure unimpeded movement on roads & waterways



### data users:

- in-house
- other public agencies

### data deliverers:

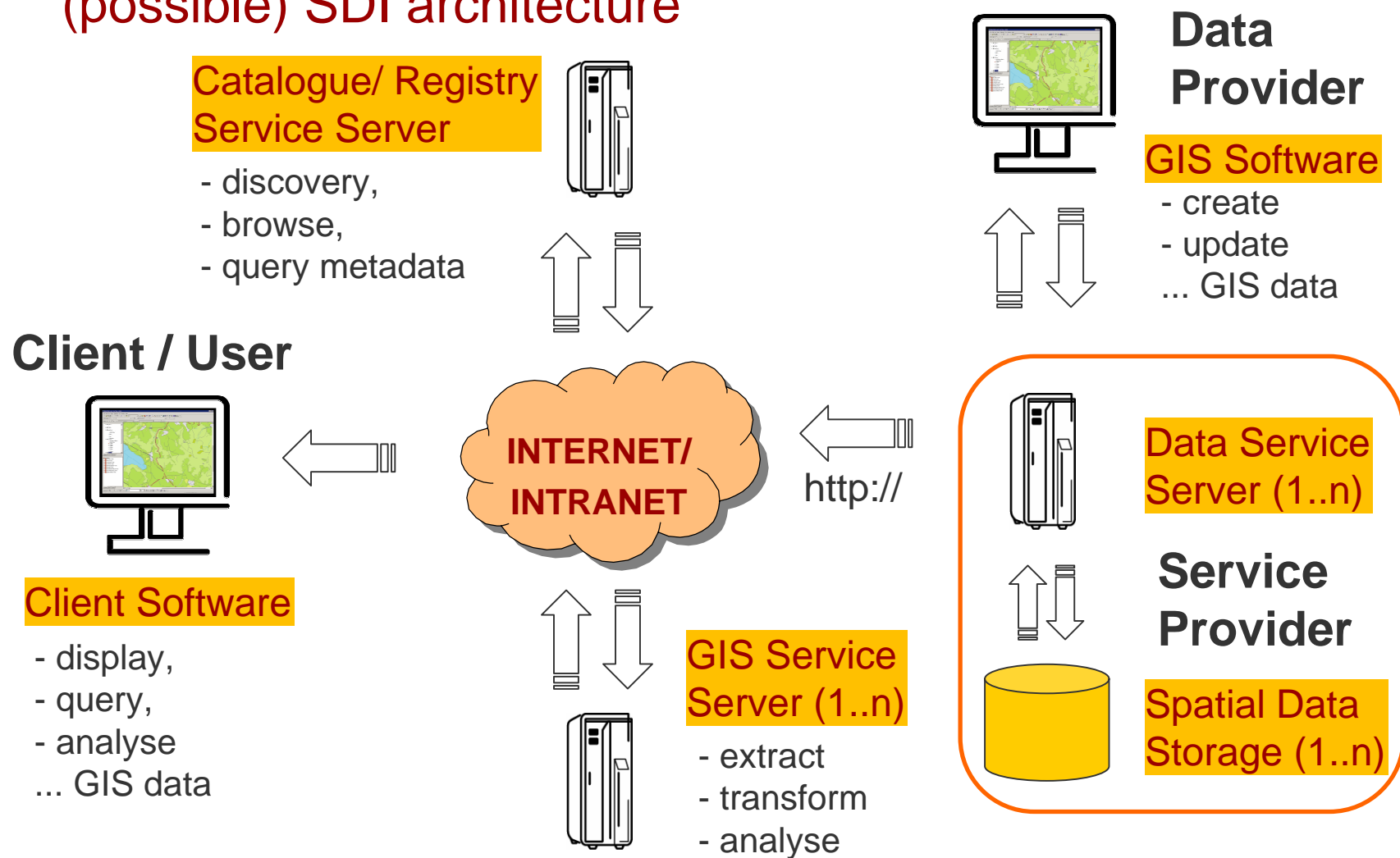
- in-house (road&water, sensors)
- other public agencies (topography, soil, policy,...)

# Outline

1. What is an SDI?
2. **Technical Requirements for SDI implementations**
3. FOSS Software for SDIs
4. How to select among FOSS software
5. Conclusions

# crequirements

## (possible) SDI architecture



# Technical requirements

Necessary **standards** to ensure interoperability between the components:

- Communication protocols between servers, and clients
- Data formats
- Data and service description

Standards defined by:

- Open Geospatial Consortium (OGC)
- see next slide
- International Standard Organisation (ISO)
- 19115: Metadata
- 19119: Geographic Information Services
- World Wide Web Consortium (W3C)
- e.g., HTML, XML, SVG, SOAP, WSDL, etc.



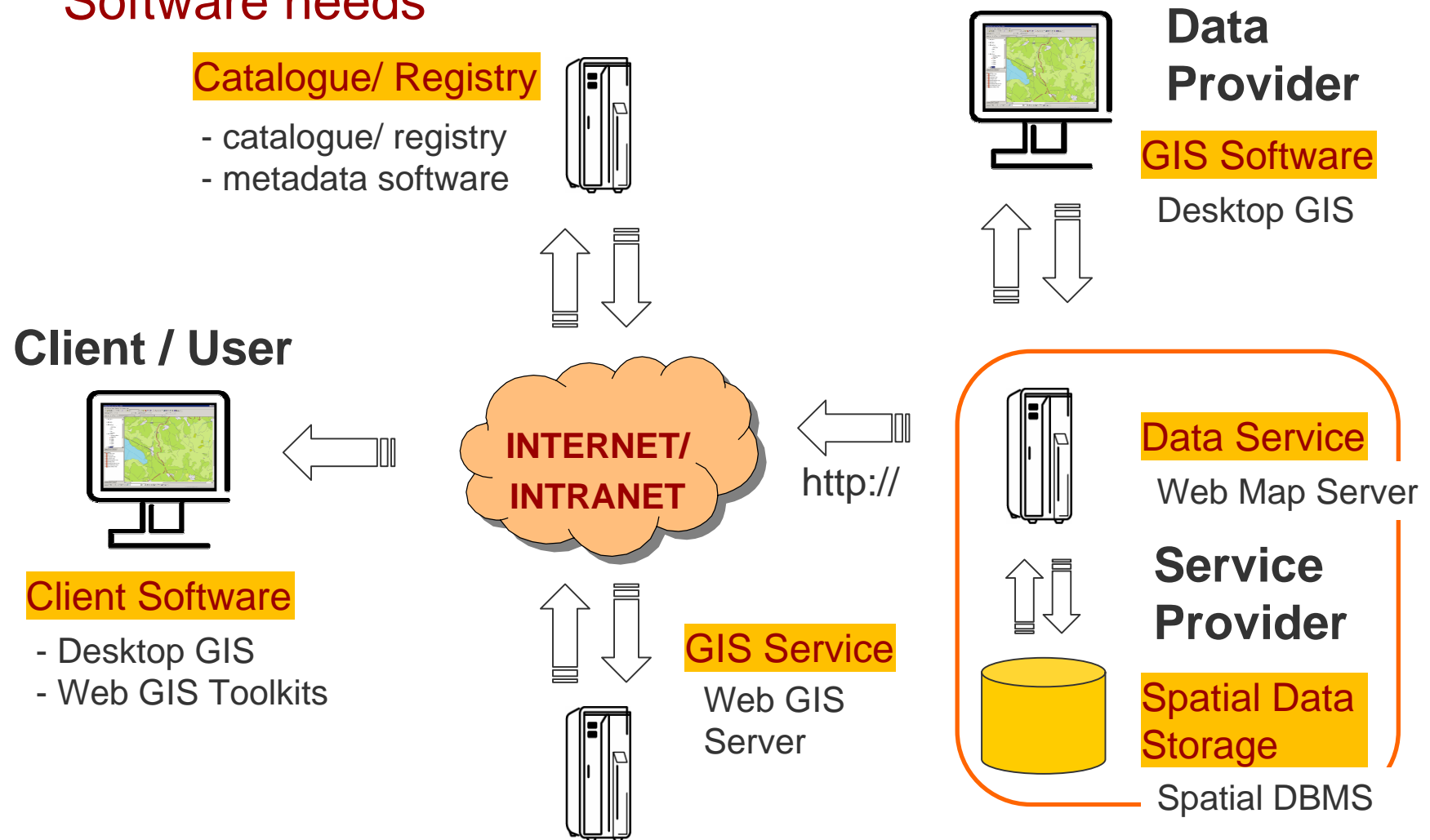
# Technical requirements

## Open Geospatial Consortium Standards **relevant** for SDIs:

- **OGC data delivery** standards
  - Web Mapping Service (WMS)
  - Web Feature Service (WFS), & transactional (WFS-T)
  - Web Coverage Service (WCS)
- **OGC data format** standards
  - Simple Feature Standard (SFS)
  - Geography Markup Language (GML)
  - Keyhole Markup Language (KML)
- **OGC data search** standards
  - Catalogue Service (CSW)
  - Gazetteer Service (WFS-G)
- **other** OGC standards:  
Web Processing Standard (WPS), Coordinate Transformation Service (CTS), Web Terrain Service (WTS), Styled Layer Descriptor (SLD), Web Map Context (WMC)

# Technical requirements

## Software needs



# Outline

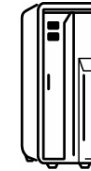
1. What is an SDI?
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# FOSS for SDI



## Client Software

- A - Desktop GIS
- B - Web-GIS development toolkits



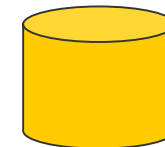
## Server Software

- A - Web Map Server
- B - Web GIS Server

## Catalogue/Registry Metadata



## Spatial Database Management Syst.



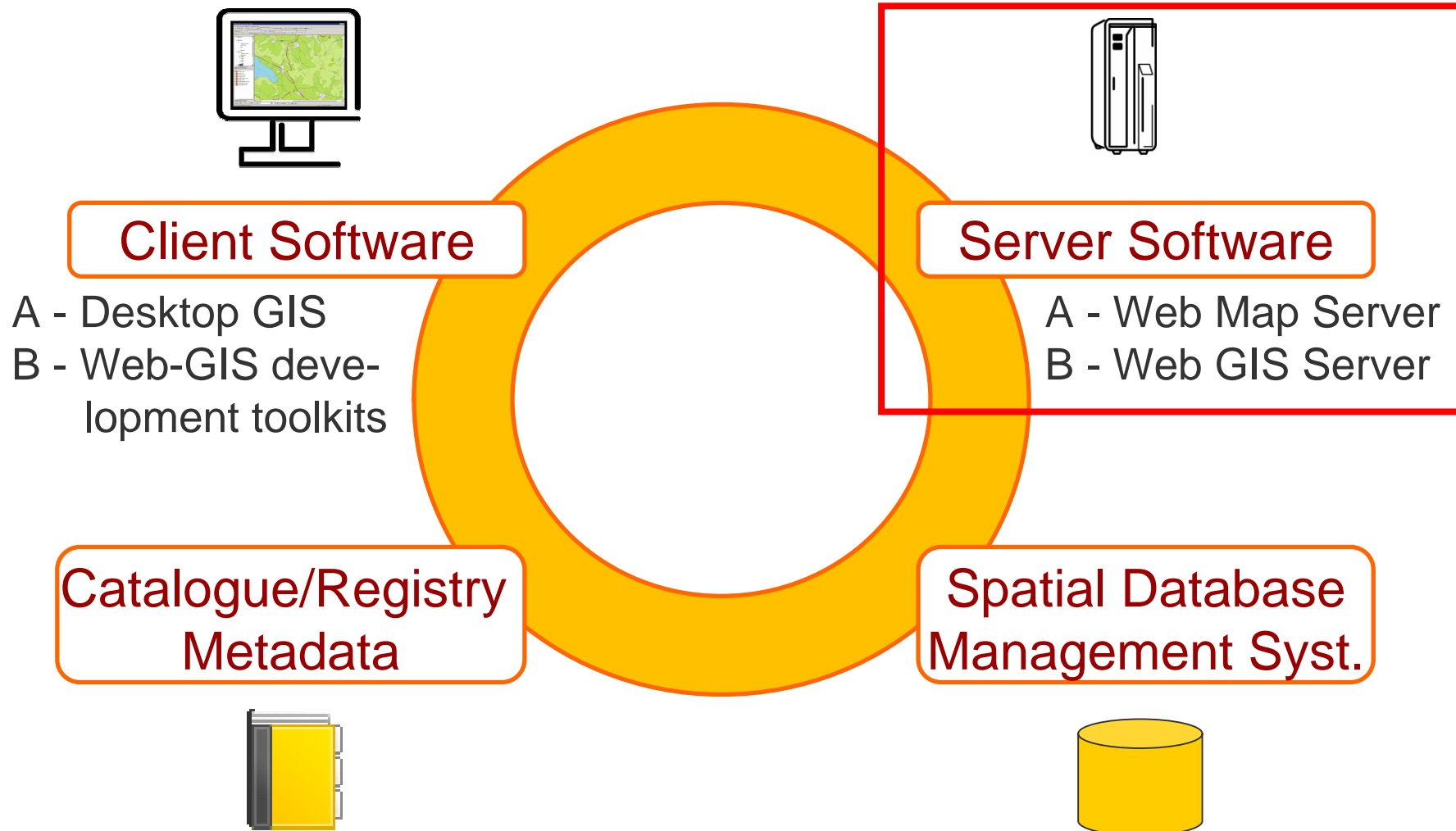
# FOSS for SDI - actors

## Drivers of FOSS development

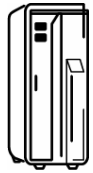


- building SDIs is of interest for **governments** and **NGOs**, hence they financially support software development
- other actors are:
  - **Companies**
  - **Research/Universities**
  - **Enthusiasts**
- From all FOSS4GIS projects (that survived), I estimate that only **1/10** has been **founded by enthusiasts**. Most web-mapping/web-services based developments have its origin in university projects.

# FOSS for SDI



# SDI Web Map Server Projects



Server Software



Web Map Server

Serving spatial data:

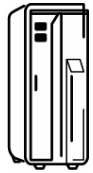
- OGC WMS: maps as an image
- OGC WFC: vector data
- OGC WCS: raster data
- additionally: OGC WPS & WFS-T



Proprietary equivalents:

- ESRI ArcServer, ESRI ArcIMS
- AutoDesk MapGuide, etc.

# SDI Web Map Server Project



Server Software

Web Map Server

## MapServer

MAPSERVER

license: X/MIT

web: [mapserver.org](http://mapserver.org)

OGC: WMS, WFS(-T), WCS, SLD, WMC, GML

## GeoServer



license: GPL

web: [geoserver.org](http://geoserver.org)

OGC: WMS, WFS, WFS-T, WCS, SLD, GML, KML

## AutoDesk MapGuide Open Source

license: LGPL

web: [mapguide.osgeo.org](http://mapguide.osgeo.org)

OGC: WMS, WFS

## deegree

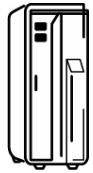


license: LGPL

web: [wiki.deegree.org](http://wiki.deegree.org)

OGC: WMS, WFS, WFS-(T &G), WCS, WMC, SLD, GML, WPS,

# SDI Web Map Server Projects



Server Software



Web Map Server

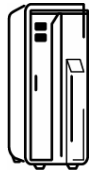
## Others:

- QGIS Web map server (WMS, SLD)
- REST based approaches (also for editing):
  - FeatureServer (WFS)
  - GeoRest (WFS)

## My impression:

- web map server **outperform** proprietary products,
- in particular strong MapServer & GeoServer

# SDI Web GIS Server Projects



Server Software



Web GIS Server

processing spatial data remotely:

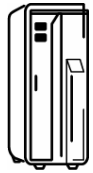
- OGC WPS
- ISO 19119



Proprietary equivalents:

- ESRI ArcServer(?)
- PCI Geomatics?

# SDI Web GIS Server Projects



Server Software

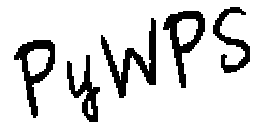
Web GIS Server

## 52° North WPS



license: GPL  
web: [52north.org](http://52north.org)  
OGC: WPS, ...

## PyWPS



license: GPL  
web: [pywps.wald.intevation.org](http://pywps.wald.intevation.org)  
OGC: WPS

## deegree 3



license: LGPL  
web: [wiki.deegree.org](http://wiki.deegree.org)  
OGC: WMS, WFS, WFS-(T &G), WCS, WMC, SLD, GML, WPS,

## My impression:

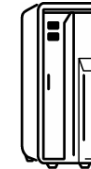
FOSS and proprietary solutions **tie**, since WPS is a new thing – however, I assume proprietary products are better documented (what you pay for...)

# FOSS for SDI



## Client Software

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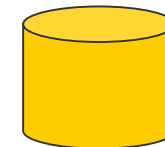
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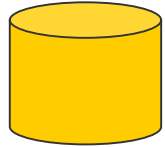
## Catalogue/Registry Metadata



## Spatial Database Management Syst.



# SDI Spatial DBMS



## Spatial Database Management Systems

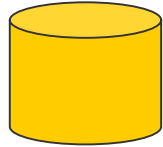
Storing spatial data; sometimes also processing

- OGC SFS
- usually realized as spatial extender to existing DBMS, adding spatial data types, spatial joins, query types, spatial indexing, etc.

Proprietary equivalents:

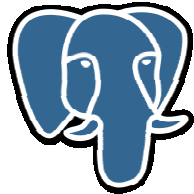
- Oracle Spatial
- ESRI ArcSDE
- DB2 Spatial Extender

# SDI Spatial DBMS



## Spatial Database Management Systems

### PostGIS



For: PostgreSQL

License: PostgreSQL lic.

web: [refractions.net](http://refractions.net)

### MySQL Spatial



For: MySQL

license: GPL

web: [mysql.com](http://mysql.com)

**Bad: queries only with bounding rectangles**

### SpatialLite



For: SQLite

license: public domain(?)

web: [gaia-gis.it/spatiallite](http://gaia-gis.it/spatiallite)

### Others:

- Spatial support under development: Hibernate, H2, INGRES
- experiments with NoSQL DBs: CouchDB, MongoDB

### My impression:

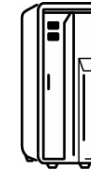
PostGIS (and SpatialLite) **tie(s)** with proprietary solutions, others still need lots of work. However, looking at the price....

# FOSS for SDI



## Client Software

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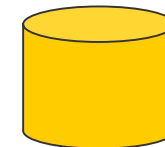
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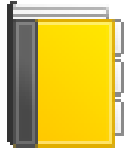
## Catalogue/Registry Metadata



## Spatial Database Management Syst.



# SDI Catalogue Projects



## Catalogue/Registry & Metadata

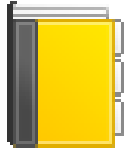
storing metadata on services and geodata  
⇒ allowing to discover, browse and query

- ISO 19115: Metadata
- ISO 19119: Geographic Services

Proprietary equivalents:

- ???

# SDI Catalogue Projects



## Catalogue/Registry & Metadata

### GeoNetwork OS



License: GPL

web: [refractions.net](http://refractions.net)

standards: ISO19115,  
ISO19119, ISO19139,  
FGDC, Dublin Core

### MDweb



license: LGPL

web: [mdweb-project.org](http://mdweb-project.org)

standards: ISO19115,  
OGC CSW, Dublin Core

### deegree



license: LGPL

web: [wiki.deegree.org](http://wiki.deegree.org)

standards: ISO19115,  
ISO19119, ISO19139, and  
see above

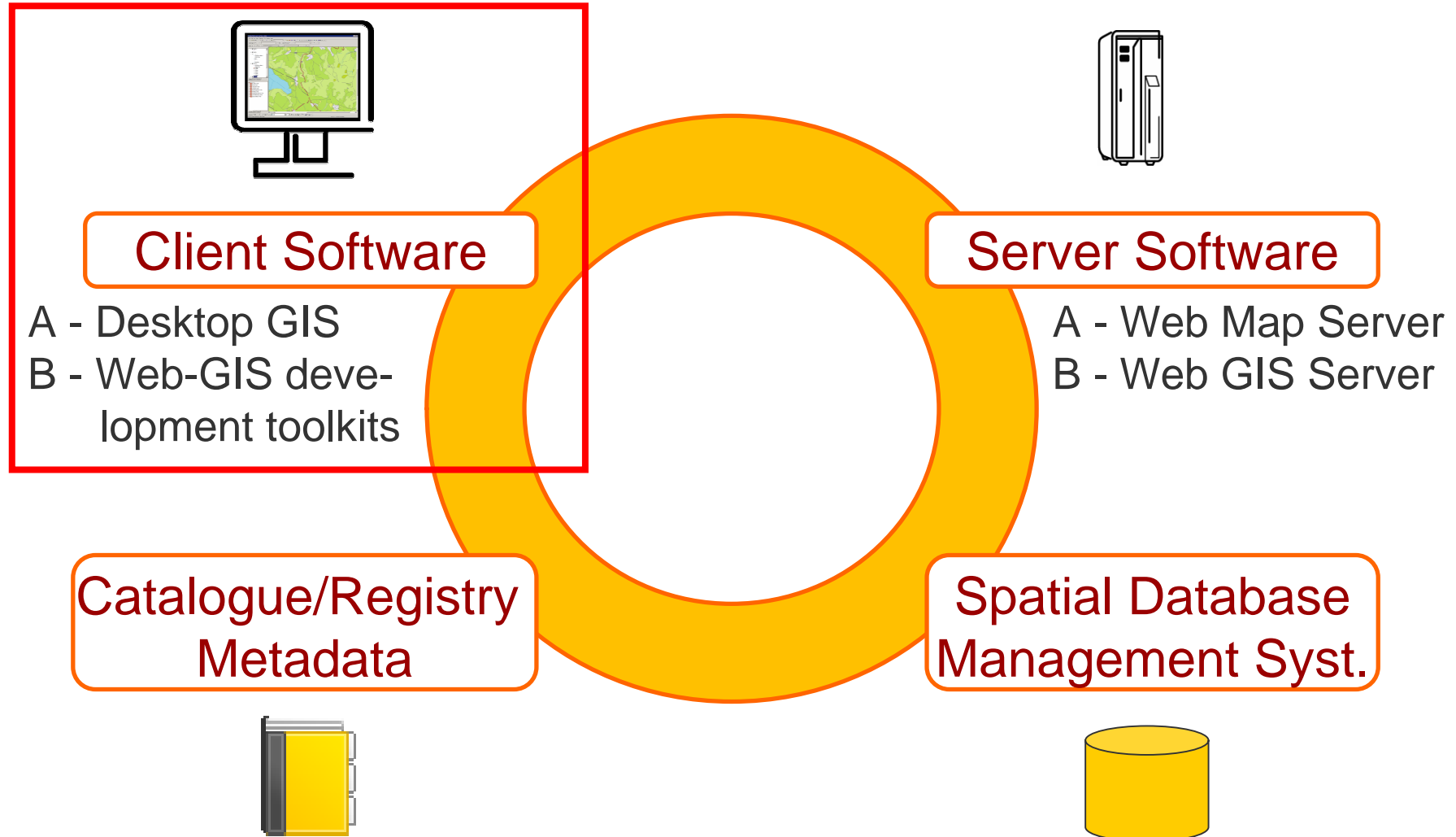
### Others:

- desktop MetaData editor: CatMDEdit (ISO19115, ISO19139,... )

### My impression:

GeoNetwork OpenSource seems to be the most adopted solution,  
though deegree is used in several implementations too.

# FOSS for SDI



# SDI Client Projects



Client Software



Desktop GIS

Viewing, querying, creating, updating, analysing & printing geodata

- at least **OGC WMS**, for viewing maps
- from the *major* projects presented last year, (6+1) have WMS support, some support more standards
- some standards (WFS(-T), KML, WPS) may require a plugin
- Several free-of-cost Desktop GIS exist too (e.g. Spring GIS, Tatuk GIS)

Proprietary equivalents:

- ESRI ArcGIS, ESRI ArcExplorer
- Desktop products from AutoDesk, Pitney Bowes, Intergraph, Bentley, etc.

# SDI Client Projects



Client Software

Desktop GIS

## GRASS



License: GPL

web: [grass.osgeo.org](http://grass.osgeo.org)

OGC: WMS, WFS,  
GML, WPS\*

## gvSIG



license: GPL

web: [gvSIG.org](http://gvSIG.org)

OGC: WMS, WFS(-G),  
WCS, GML, KML, CS-W

## Quantum GIS



license: GPL

web: [qgis.org](http://qgis.org)

OGC: WMS, WFS, SFS,  
GML, KML

## OpenJUMP



License: GPL

web: [openjump.org](http://openjump.org)

OGC: WMS, SFS, KML\*,  
WFS(T)\*, GML, SLD, WPS\*

## MapWindow



license: Mozilla

web: [mapwindow.org](http://mapwindow.org)

OGC: WMS\*, WFS\*

## uDig



license: LGPL

web: [refractions.net](http://refractions.net)

OGC: WMS, WFS(-T),  
SFS, GML, SLD, WPS\*

# SDI Client Projects



Client Software



Desktop GIS

## Others:

- lots of... (not mentioned above was ILWIS)

## My impression:

- Can **replace** proprietary products for a certain range of **tasks** (i.e. replacement depends on task – such as viewing, editing, analysis, etc.)
- However, **creating** real nice **maps** for a GIS *newbie* with FOS Desktop GIS **is (still) hard**
- particular strong seems to be gvSIG as SDI client application (due to the projects focus)

# SDI Client Projects



Client Software



Web Development Toolkits

Viewing maps and querying geodata within a **web browser**

- sometimes also more advanced functions (...editing)
- at least **OGC WMS**, for viewing maps
- from 'simple' map viewer projects to complete web map development toolkits

Proprietary equivalents:

- ESRI ArcGIS Web Mapping APIs (Flex, JS, Silverlight)
- ...

# SDI Client Projects



Client Software

Web Development Toolkits

## Viewers:

- OpenLayers (like Google Maps without data)
- OpenScales (Flex-based)

## Geoportal toolkits:

- MapBender
- Deegree

## Web map development toolkits:

- GeoMajas
- GeoExt
- GeoMoose
- MapFish
- SharpMap



OpenLayers map window

# SDI Client Projects



Client Software



Web Development Toolkits

## Not to forget:

- Google Web Toolkit
- Google Gears

and for (server side) spatial operations & DB connection:

- GeoTools (and SharpMap for C# fans?)

## My impression:

- Lots of FOS toolkits out there, probably way **better** than proprietary toolkits, as it is still a *new* thing
- Drawback may be that it doesn't come from one source

## Summarizing this section




- FOS software in each category
- Particular **competitive** in comparison to proprietary software with respect to functionality, are:
  - GeoServer & MapServer - **Web Map Server**
  - **PostGIS** - DBMS/database
  - GeoNetwork OpenSource – Catalogue/Registry
  - **OpenLayers** – Web Map Viewer
  - Web mapping toolkits
  - For desktop GIS: depends on tasks
- **Price** advantage (especially for DBMS)
- Paid **support** is **available** (support networks emerge)

# Outline

1. What is an SDI?
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3. FOSS Software for SDIs
4. **How to select among FOSS software**
5. Conclusions

## Selecting FOS software

- The previous section listed **lots of projects** for one category  $\Rightarrow$  so we need to **choose...** 
- FOS software can not be selected like proprietary software, since **license, development and distribution models differ** (also: we may have “free-of-cost” support options)
- Recommendable software evaluation process:



# Selecting FOS software



Selection **criteria** should address



- software features (**functionality**, platform, **standards**, reliability/credibility, stability, options for customization)
- **costs** (switching, maintenance, training)
- support (options & costs)
- community (developer & user)  $\Rightarrow$  **longevity**, goals – who has influence on development?, support factor
- **license** type  $\Rightarrow$  extending software & keeping extensions private

# Selecting FOS software

If more than 5 products available, it may be worth while to do an **initial screening** to retrieve a **set of (3) candidates**

**Questions** for such a screening:

- **Functionality:**



- What are my use cases?
- What standards needs the software to support?
- What data do I need to work with? raster vs. vector, files vs. database

- **Platform:**

- Will your users work with Windows, Linux, Mac?

- **Support:**

- What is the language of your users?
- Do you need hotline & emergency support?
- Is it likely that customization is needed?

- **But also: Is it an option to use proprietary software?**

⇒ because we want the *best* tools to fulfill a task

# Outline

1. What is an SDI?
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## My Conclusions

- So, can you implement SDIs with FOSS **successfully**?

- **Yes** you can,



- Since for all software categories needed to implement an SDI, FOSS **software is available!**

- But, **only if:**

- You **know** your **requirements**,
- You have a dedicated technology **person** (... that likes to explore new terrain), and
- you can make an **informed** choice (... learning from others too..)

or even an  
IT department

icons from: <http://www.iconspedia.com>

# Thank you!

[[ssteinig@ucalgary.ca](mailto:ssteinig@ucalgary.ca)]

## more info:

- [www.spatialserver.net/osgis/](http://www.spatialserver.net/osgis/) (⇒ articles on that)
- <http://www.geo.uzh.ch/~sstein/>
- [www.osgeo.org](http://www.osgeo.org)



**OSGeo – Alberta**  
(Calgary) group

