POLITECNICO DI MILANO
GEO Laboratory

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Overview of Free and Open Source Software for Geoinformation (FOSS4G)

Maria Antonia Brovelli

Politecnico di Milano, DICA – GEO Laboratory

Short intro: GEO Lab @ PoliMI

Research fields

- GIS
- Global Gravity Models
- GNSS
- SAR

http://geolab.como.polimi.it/

GEOLaB
Geomatics and Earth Observation lab

GIS Magic Team: collaborative work

Topics

- WebMapping (virtual globes, multiframe,etc)
- Global Land Coverage
- Open Data Quality
- Migration from proprietary to OS Solutions
- Citizen Science and Geocrowdsourcing

Geo for All

UN OPENGIS

GROUP ON EARTH OBSERVATIONS

UN-GGIM
UNITED NATIONS INITIATIVE ON GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

UN OpenGIS

Capacity Building
with G4A

The Geospatial Information Section (UNGIS) and Information and Communications Technology Division (ICTD) of the United Nations Department of Field Support (DFS) gave birth to the UN OpenGIS Experiment

Geoinformatics Engineering MSc at PoliMI

- The Master of Science in Geoinformatics Engineering is a two years international master course taught in English for Italian and foreign students.
- Students with academic background in environmental science will find an introductory course in computer science, while those with a computer oriented first level degree will follow a basic course on geomatics and environmental issues.
- The mandatory courses cover topics such as Geospatial Data Analysis, Geographical Information Systems (GIS), Positioning and location based services, Pollution measurement and management on the Geomatics / Environmental side as well as Databases, Software engineering, Computer Infrastructures, Formal languages in the Computer Science area.
- Eligible courses will allow students to deepen their expertise either in computer programming and computer systems design or in geomatics and environmental issues .

- http://www.geoinformatics.polimi.it/

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Overview

- The context: Future Earth and Digital Earth
- FOSS4G/OSGeo/GeoForAll
- Applications

The Future Earth

- Future Earth (FE) is a 10-year international research initiative that emerged in 2011 to create a global environmental change research platform to provide more useful and accessible knowledge for decision-makers, and to support the acceleration of the transformation to a sustainable world (Future Earth Norway Secretariat 2015; Future Earth Secretariat 2013).

- FE focuses on three main research themes:
  - Dynamic Planet;
  - Global Sustainable Development;
  - Transformations Towards Sustainability (Future Earth Secretariat 2014).

The Future Earth

- It is designed to provide a fundamental, holistic understanding of the interconnections between natural and human drivers of change, the resulting environmental changes, and their implications for human well-being (Future Earth Secretariat 2013).

- While FE is conceived as a global research platform for co-creating and co-developing knowledge, Digital Earth is the technological framework and infrastructure to realize the FE vision and goals.

The Digital Earth

- The Digital Earth (DE) was introduced in 1998 by Al Gore, as a tri-dimensional and multi-resolution model of the planet which make it possible to visually put in place the huge amount of geo-referenced information about the physical and social environment.

- This system allows the user to navigate not only in space but also in time, by having access to historical data sets and to future prevision based on social and environmental models.

- Gore, A., 1998 The Digital Earth: underdstanding our planet in the 21st century,
- http://portal.opengeospatial.org/files/?artifact_id=6210.

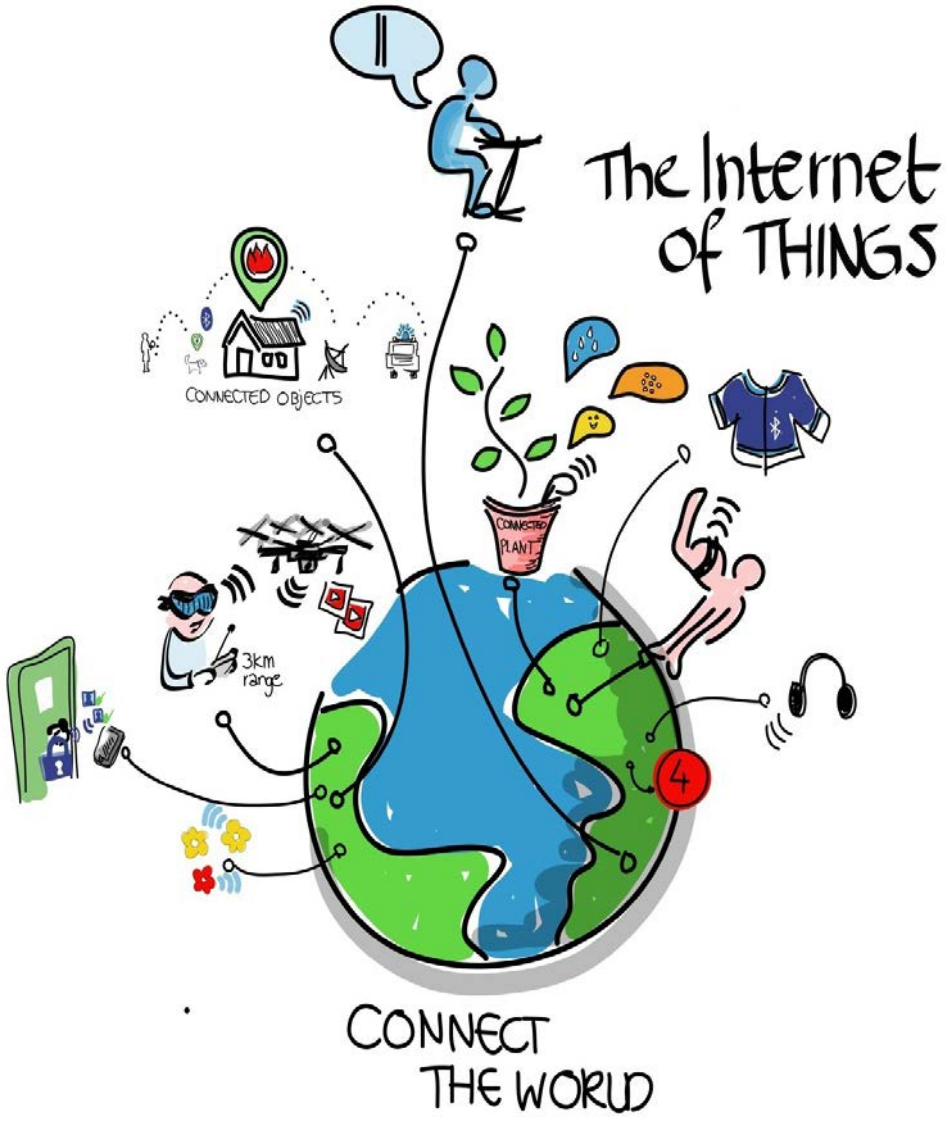
The Digital Earth

- There isn't a single Digital Earth.
- The Digital Earth is a mix of shared, multi-thematic, multi-resolution and multi-perspective archives of geo-referenced knowledge, which meet the requirements of different parties, like scientist, decision makers, cummunity and citizens.
- All these archives, which are updated in real-time thanks to sensor observations and information, are interconnected.
- The Digital Earth is based on open access and on the users participation through multiple technological platforms.

Geo Big Data

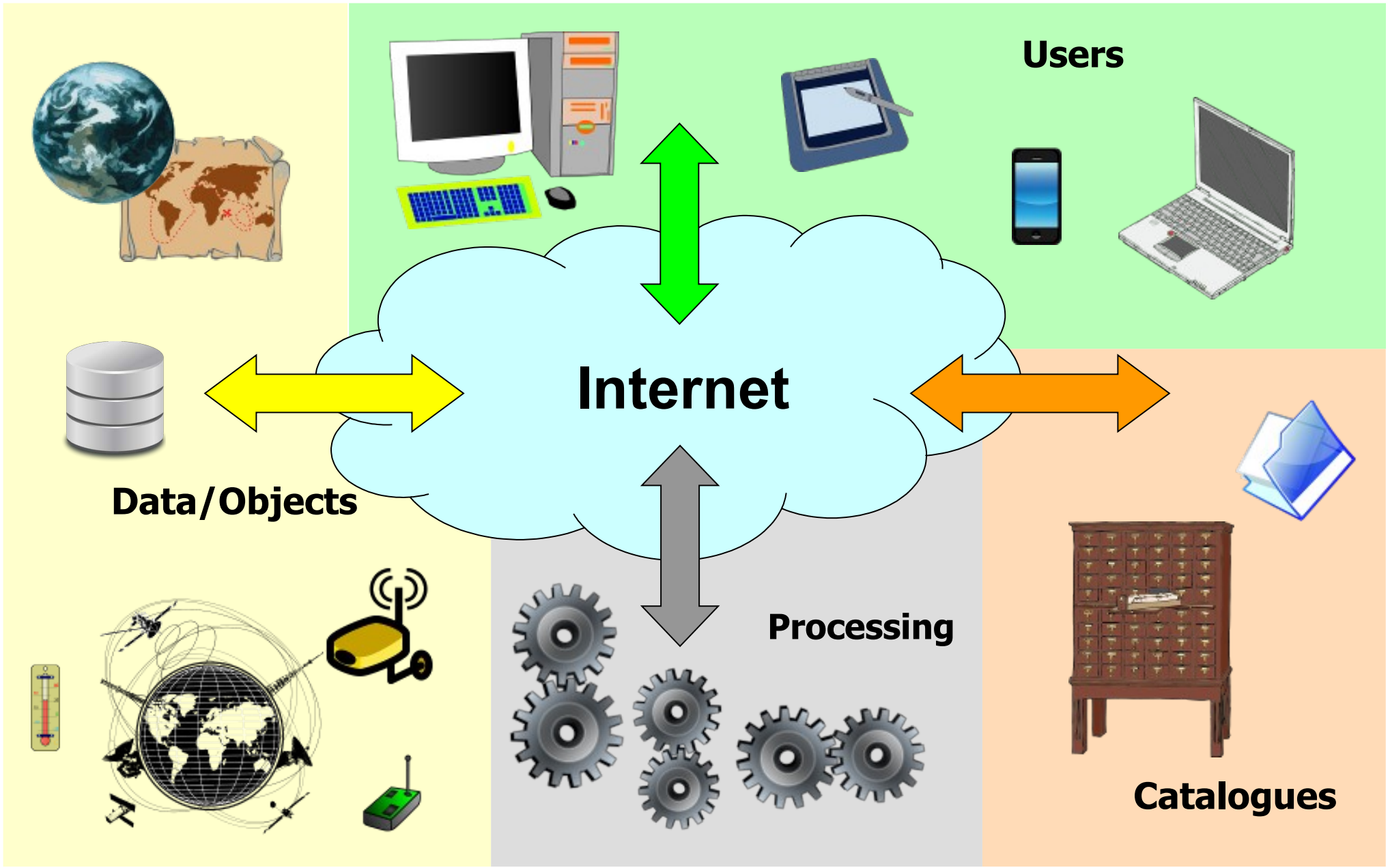
- Every day we create 2.5 trillion (10^{18}) bytes of data. 80 % of these are already georeferenced or can be.
- It's a huge dataset, equal to a DVD tower that goes from the Earth to the Moon every day.

Internet of Things (IoT)

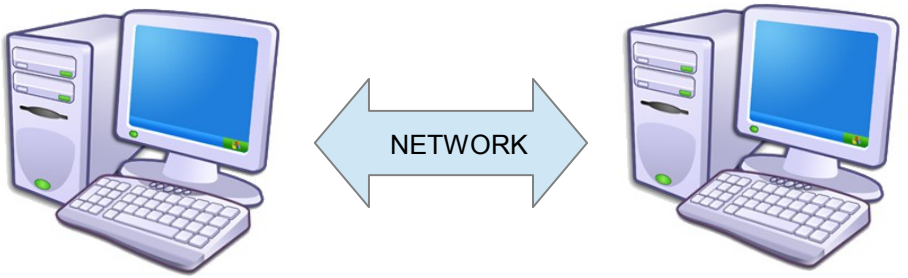


- By 2020 there will be 26 billions of connected devices.
- The Internet of things is a possible evolution of the use of the Internet.
- The objects become recognisable thanks to the ability to communicate data about themselves and to access information provided by others.

Geospatial Web

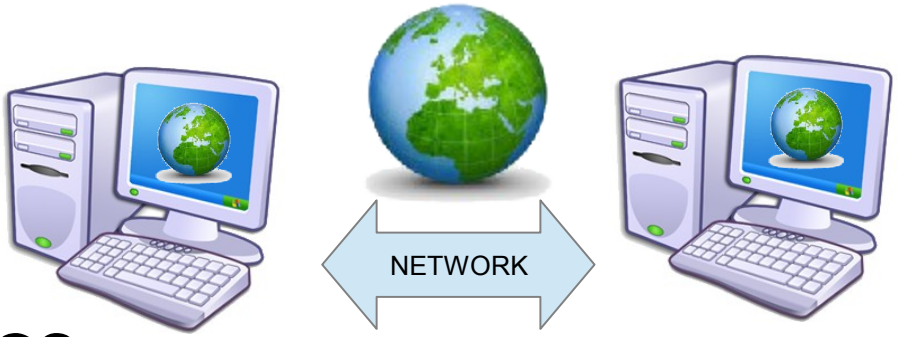


Web Geospatial Services



Web Service

"... a software system designed to support the interoperability between network machines "



Web Geospatial Service

"...specific web services for geospatial data and information"

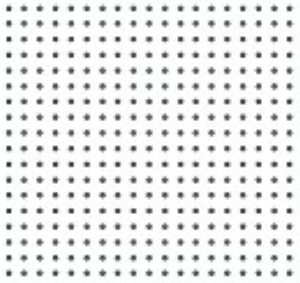
Geo Services Types

Data

RASTER DATA

•

VECTOR DATA

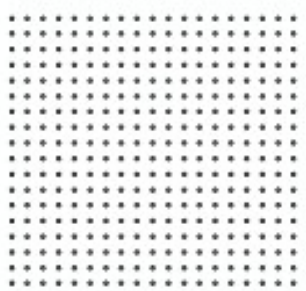


GRID DATA

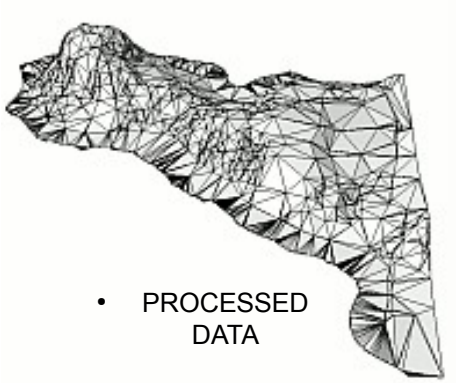
Other geospatial data (e.g. sensors)

Catalogues

Processing

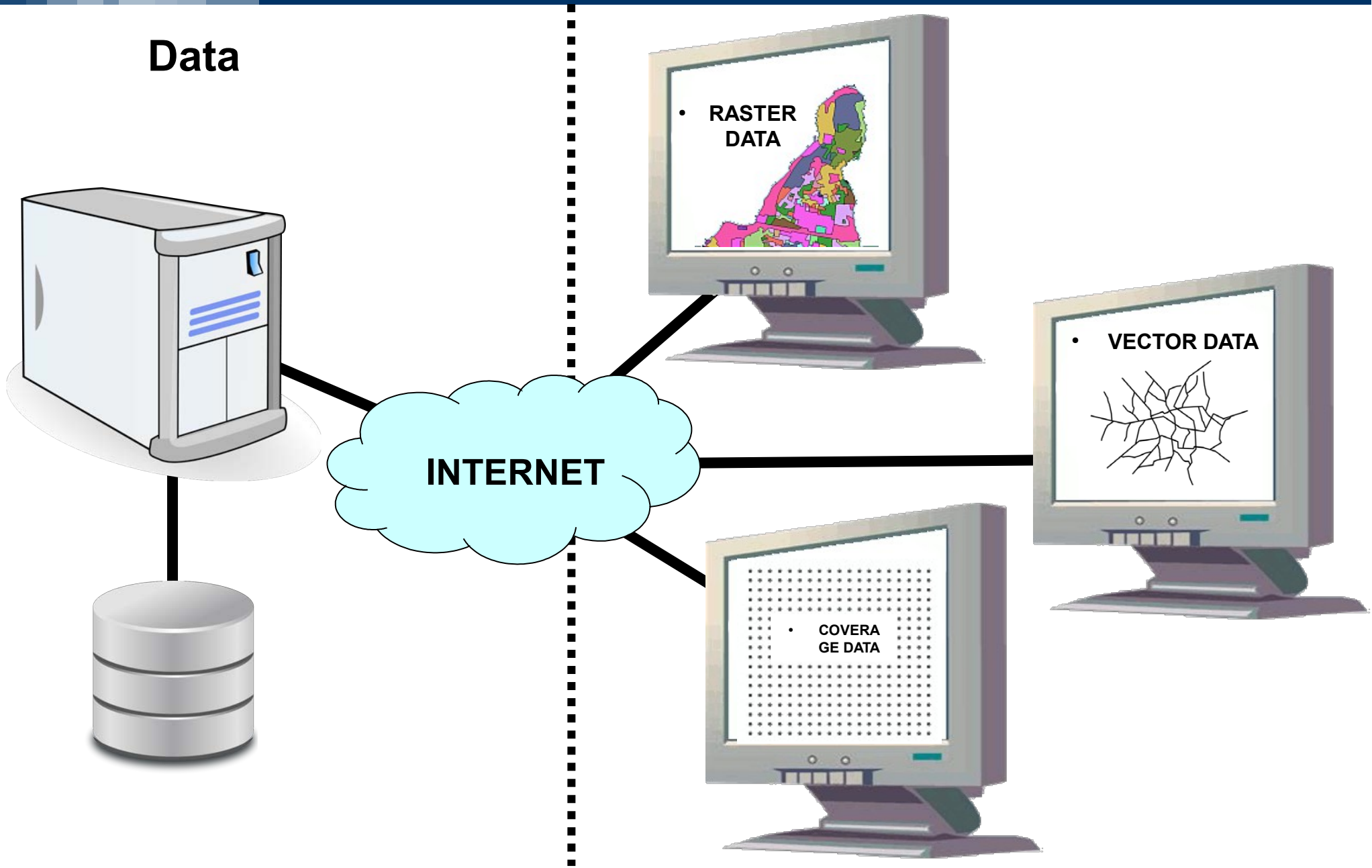


INPUT data

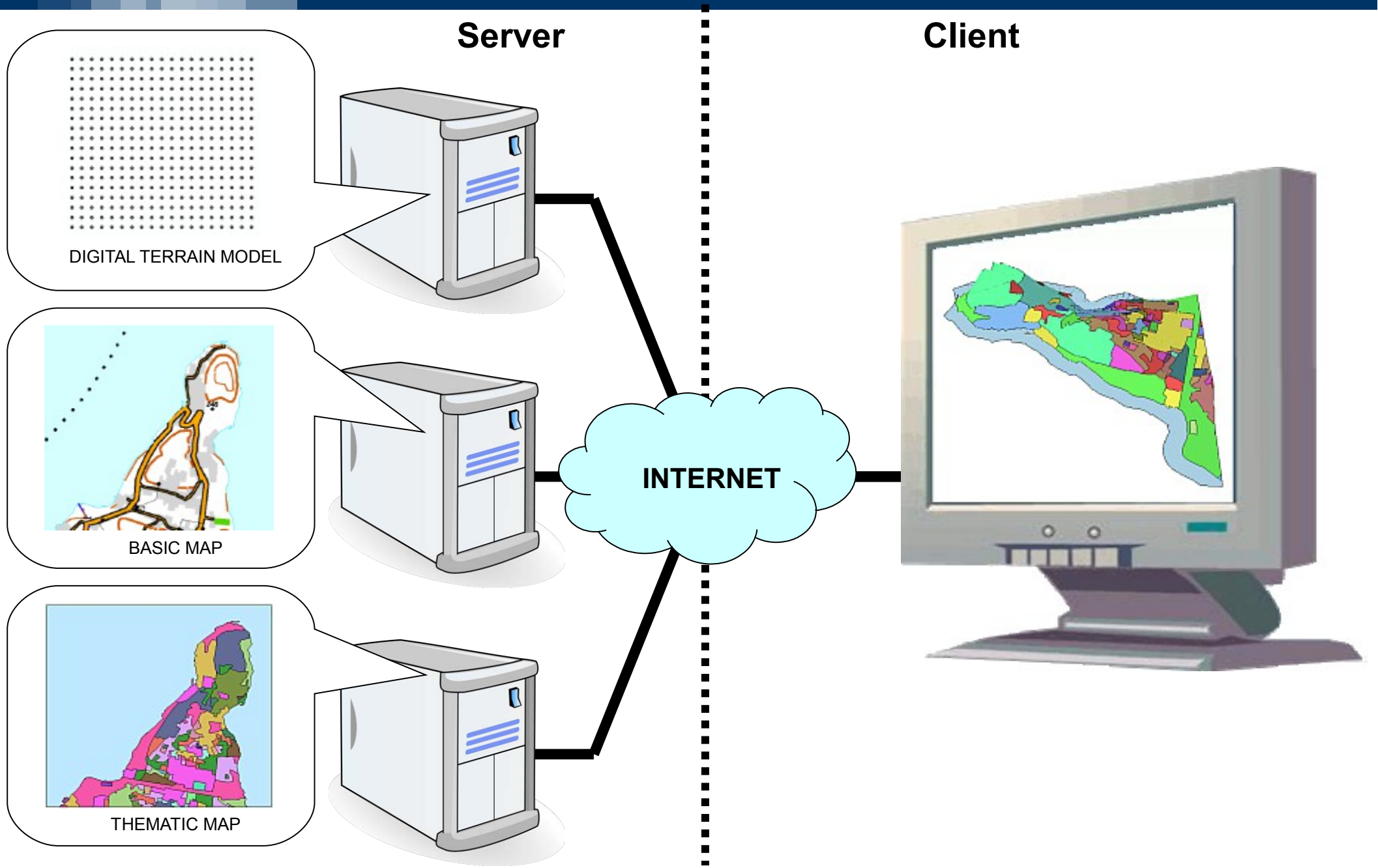


• PROCESSED DATA

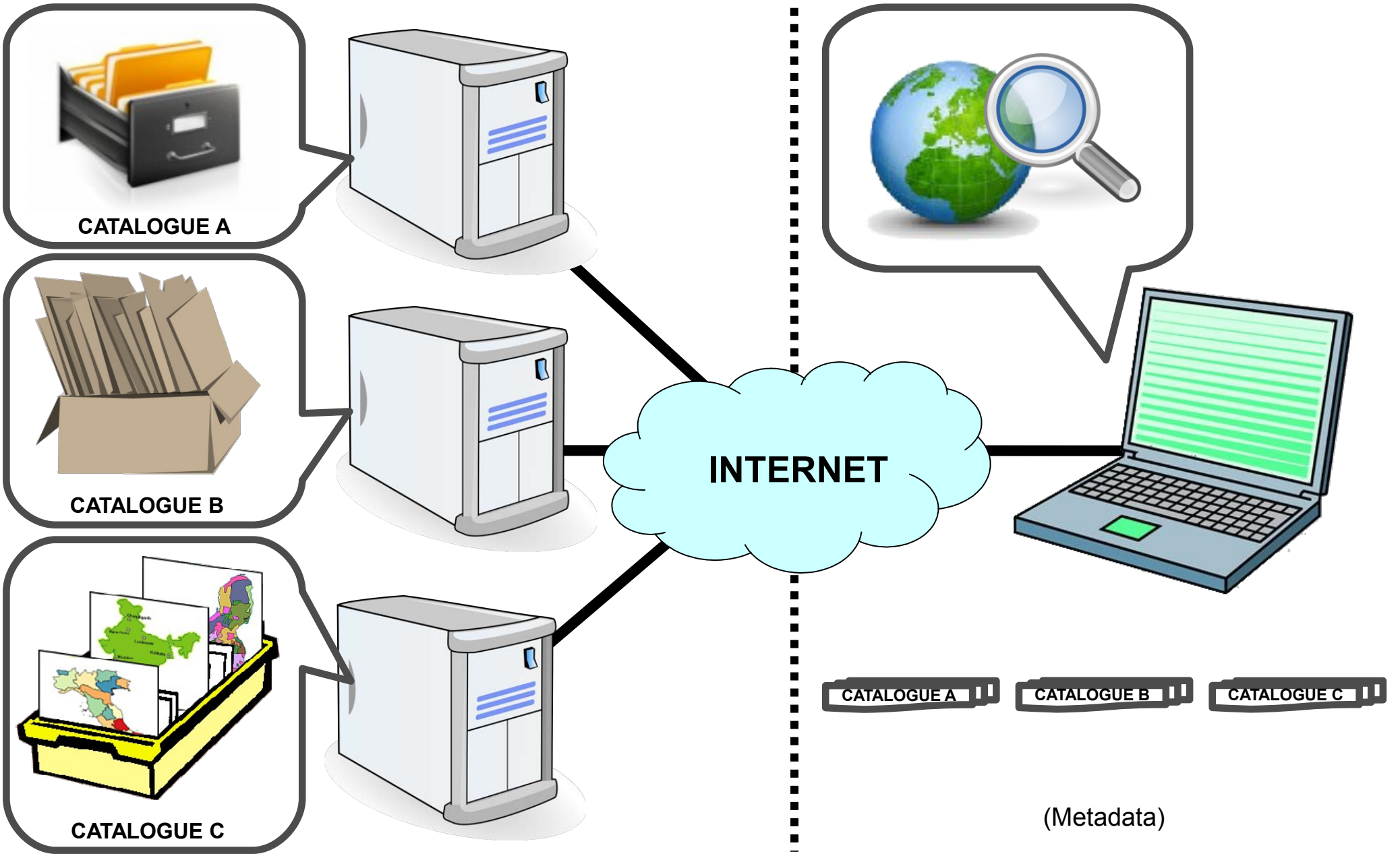
Geodata Services



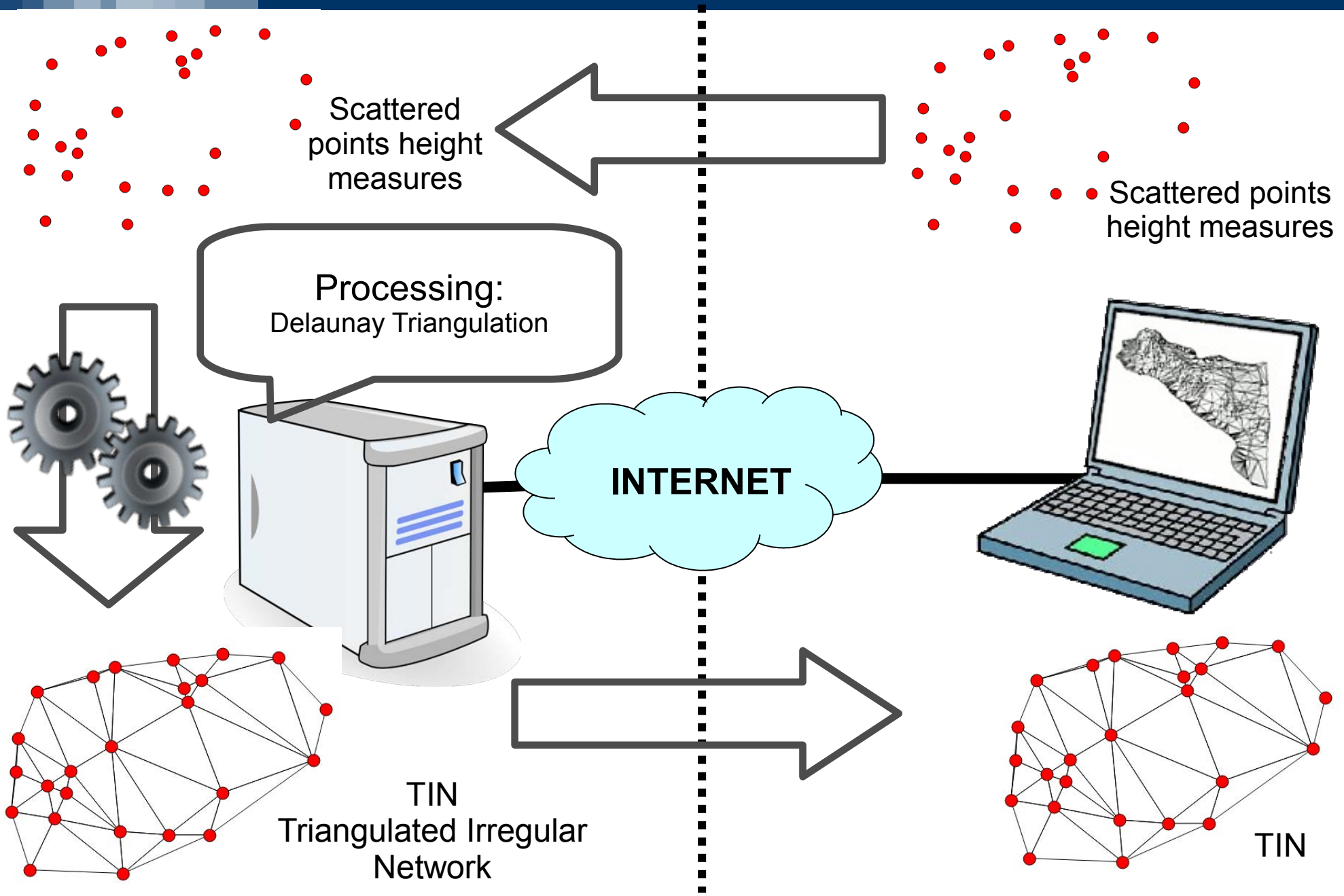
Cartographic Mashup



Geo-Catalogue Service

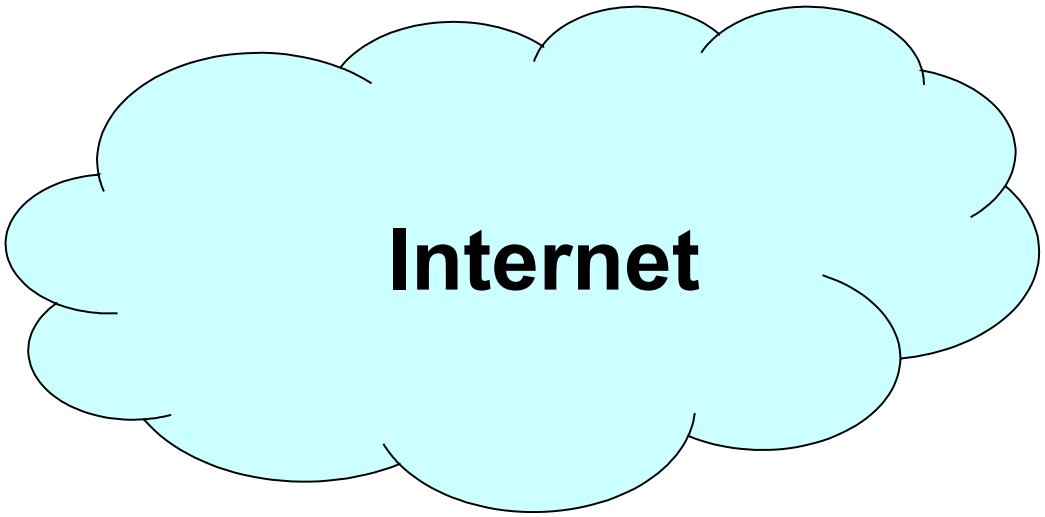


Processing Service



Desktop GIS and Browser Facing GIS

- General GIS viewing, editing, and analysis on the desktop



- General GIS viewing, editing and analysis in the browser

FOSS4G

- FOSS4G (Free and Open Source Software for Geospatial Applications) are software that provides the user the freedom to run the program for any purpose, access the source code to study how it works and change it, redistribute copies, and redistribute copies of modified versions of the software (GNU Project 1996).
- The software must comply with the 10 criteria listed in the Open Source Initiative:

1. Free Redistribution
2. Source Code
3. Derived Works
4. Integrity of The Author's Source Code
5. No Discrimination Against Persons or Groups
6. No Discrimination Against Fields of Endeavor
7. Distribution of License
8. License Must Not Be Specific to a Product
9. License Must Not Restrict Other Software
10. License Must Be Technology-Neutral

FOSS4G

- There is at least one mature sophisticated FOSS4G for every geo-technology area and geospatial information need and application.

- Emerging technologies such as Unmanned Aerial Vehicles (UAV) and Structure from Motion are exceptions where the FOSS4G options do not have yet the maturity or robustness for routine deployment
- However, several efforts exist such as
  - OpenDroneMap http://opendronemap.github.io/odm
  - MicMac http://www.micmac.ign.fr

- Currently there are over 350 FOSS4G projects listed in FreeGIS http://freegis.org and Open Source GIS http://opensourcegis.org.
- Some of these projects have a history that dates back to the early 1980s (e.g. GRASS GIS) while others are more recent and yet have a wide and solid user base (e.g. Geoserver) .

General Software Evaluation Criteria

Characteristics
technical features
reliability
ease of use
documentation
technical support
customizability and extensibility
costs of training
total cost of ownership
support and maintenance and management requirements (e.g. budget, in-house development team expertise, long-term maintainability)

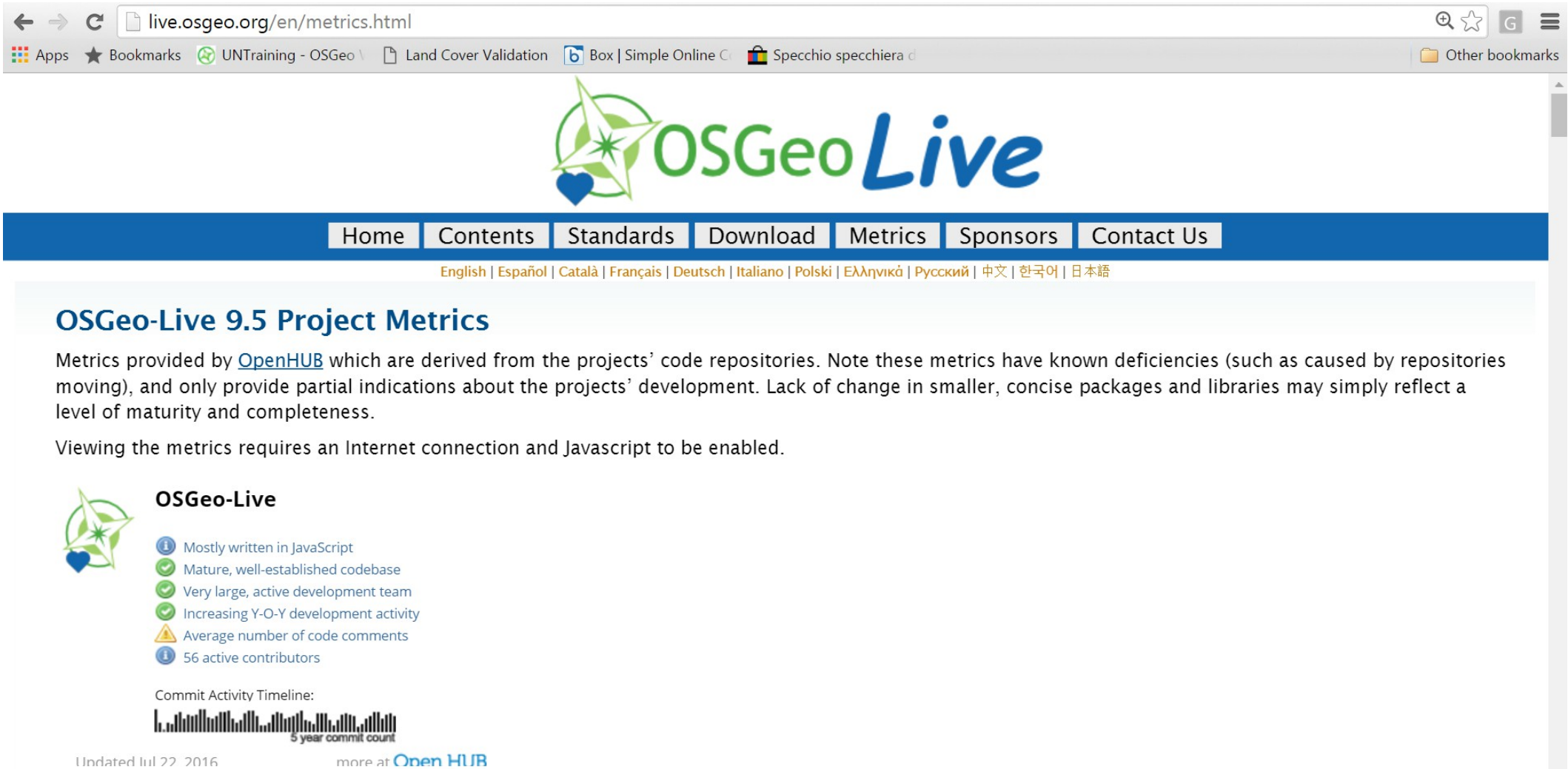
OSGeo

- In 2006 the Open Source Geospatial Foundation (OSGEO), was started. (www.osgeo.org)
- OSGeo is a not-for-profit organization whose mission is to support and promote the collaborative development of open geospatial technologies and data.
- The foundation was formed to provide financial, organizational and legal support to the broader open source geospatial community.
- It serves as an independent legal entity to which community members can contribute code, funding and other resources, secure in the knowledge that their contributions will be maintained for public benefit.

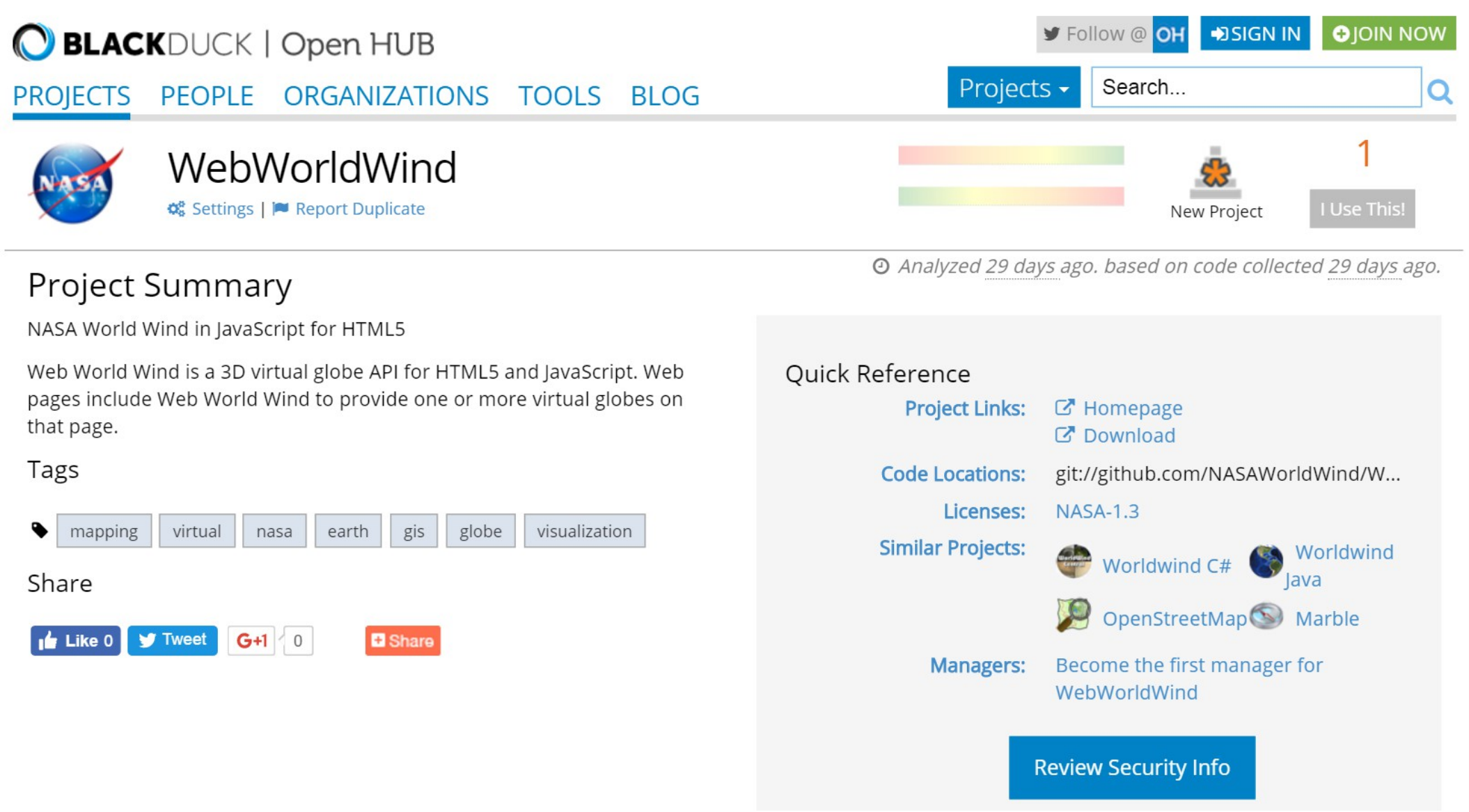
OSGeo Evaluation Criteria

Characteristics
Open source software is already reasonably mature (working quality code)
Project already has a substantial user community
Project already has a substantial and diverse developer community
Project members are aware of, and implement support for, relevant standards (e.g. Open Geospatial Consortium, World Wide Web Consortium, International Organization for Standardization)
Project has linkages with existing OSGeo projects
Project fills a gap related to software that OSGeo supports
Project is prepared to develop in an open and collaborative fashion
Project has contributions and interest from more than just one company/organization (see e.g. OSGeo software metrics)
Project is willing to migrate some or all of its infrastructure (code repository, web site, wiki, mailing list, etc.) to OSGeo support infrastructure, and to adopt a website style consistent with the foundation

OSGeo Metrics



Details (WebWorldWind example)



Details (WebWorldWind example)

In a Nutshell, WebWorldWind...

... has had 316 commits made by 12 contributors representing 90,794 lines of code

... is mostly written in JavaScript with a well-commented source code

... has a codebase with a very short history maintained by a large development team with stable Y-O-Y commits

... took an estimated 23 years of effort (COCOMO model) starting with its first commit in August, 2015 ending with its most recent commit 30 days ago

Activity

30 Day Summary

Jun 1 2016 — Jul 1 2016

37 Commits

6 Contributors

12 Month Summary

Jul 1 2015 — Jul 1 2016

316 Commits

This project is less than 12 months old.

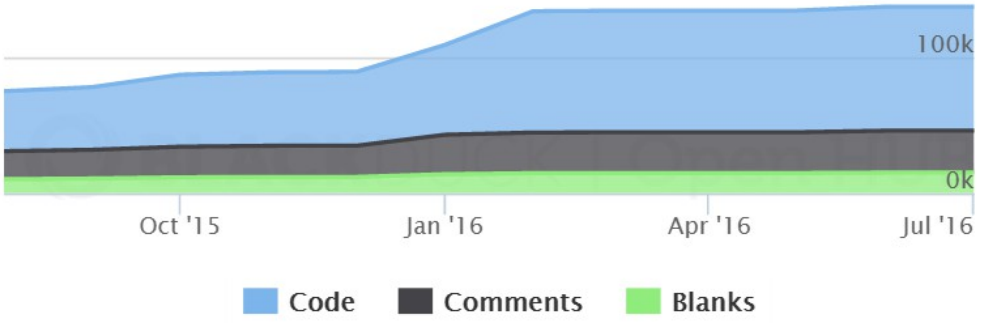
12 Contributors

This project is less than 12 months old.

Languages

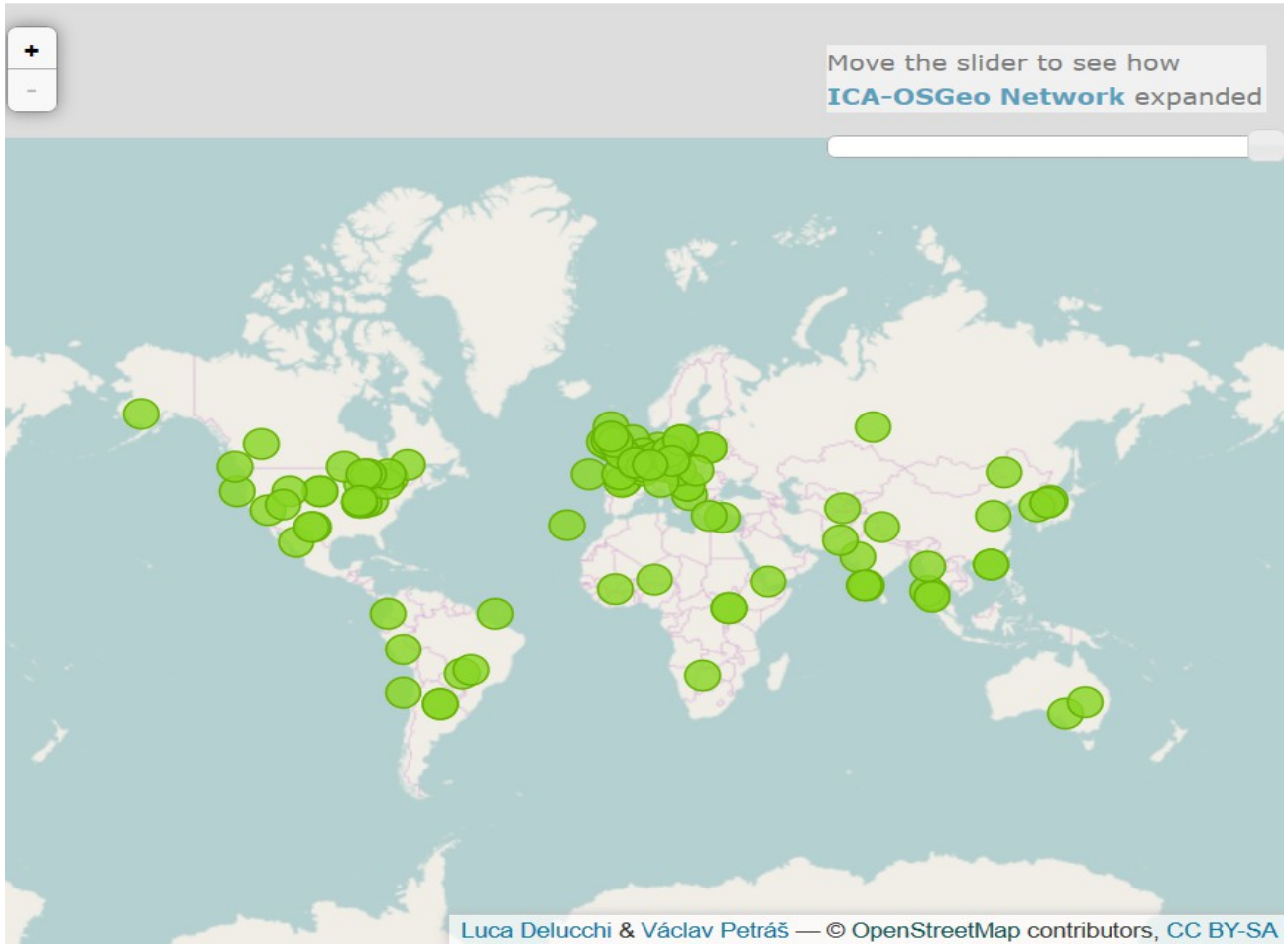
JavaScript	81%	XML	16%
3 Other	3%		

Lines of Code



Commits per Month

GeoForAll



110 labs worldwide as of 30th July, 2016

- ✔ Webinars (monthly)
- ✔ Newsletter (monthly)
  - the lab of the month
  - the geoambassador of the month
  - Events
  - Conferences
  - Webinars
  - Courses
  - …

- OSGeo-Live is a self-contained bootable DVD, USB thumb drive or Virtual Machine based on Lubuntu, that allows users to try a wide variety of open source geospatial software without installing anything. It is composed entirely of free software, allowing it to be freely distributed, duplicated and passed around.
- Many applications are also provided with installers for Apple OSX and Microsoft Windows.
- It contains more than 50 geospatial applications.
- It contains sample datasets

Contents	
Desktop GIS	Spatial Tools
Browser Facing GIS	Domain Specific GIS
Web Services	Data
Data Stores	Geospatial Libraries
Navigation and Maps	

OSGeoLive

An Open Source Geospatial GNU/Linux Distribution

Desktop GIS

General GIS viewing, editing, and analysis on the desktop

QGIS GRASS GIS gvSIG

uDig OpenJUMP SAGA Kosmo

Browser Facing GIS

General GIS viewing, editing and analysis in the browser

OpenLayers3

Leaflet

Cesium

Geomajas

Mapbender3

GeoMOOSE

Cartaro

GeoNode

Web Services

Publishing spatial data to the internet

GeoServer

MapServer

deegree

ncWMS

EOxServer

GeoNetwork

pycsw

MapProxy

QGIS Server

istSOS

52North WPS/SOS

TinyOWS

Zoo Project

Data Stores

Storing spatial data

PostGIS

SpatialLite

rasdaman

pgRouting

Navigation and Maps

GpsDrive

GpsPrune

Marble

Java World Wind

OpenCPN

Open Street Map

Viking

zyGrib

Domain Specific GIS

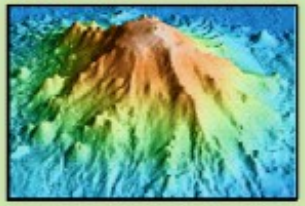
Applications targeted at a specific domain

Sahana

Ushahidi

osgEarth

MB-System



Spatial Tools

Specific analysis tools

GeoKettle

GMT

Mapnik

TileMill

MapSlicer

OSSIM

ORFEO Toolbox

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Geospatial Libraries

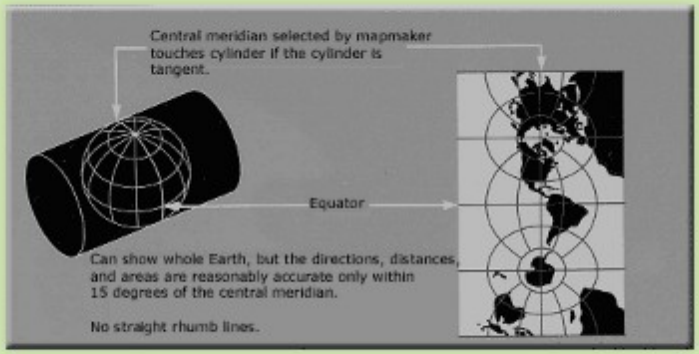
GDAL/OGR

GeoTools

GEOS

GEOS Geometry Engine Open Source

MetaCRS Proj4



libLAS

Iris

JTS

JTS Topology Suite

Data

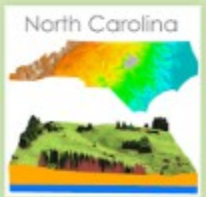
Spatial data sets

Natural Earth

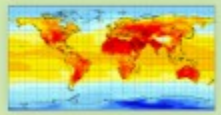
Made with Natural Earth

Open Street Map

North Carolina



netCDF



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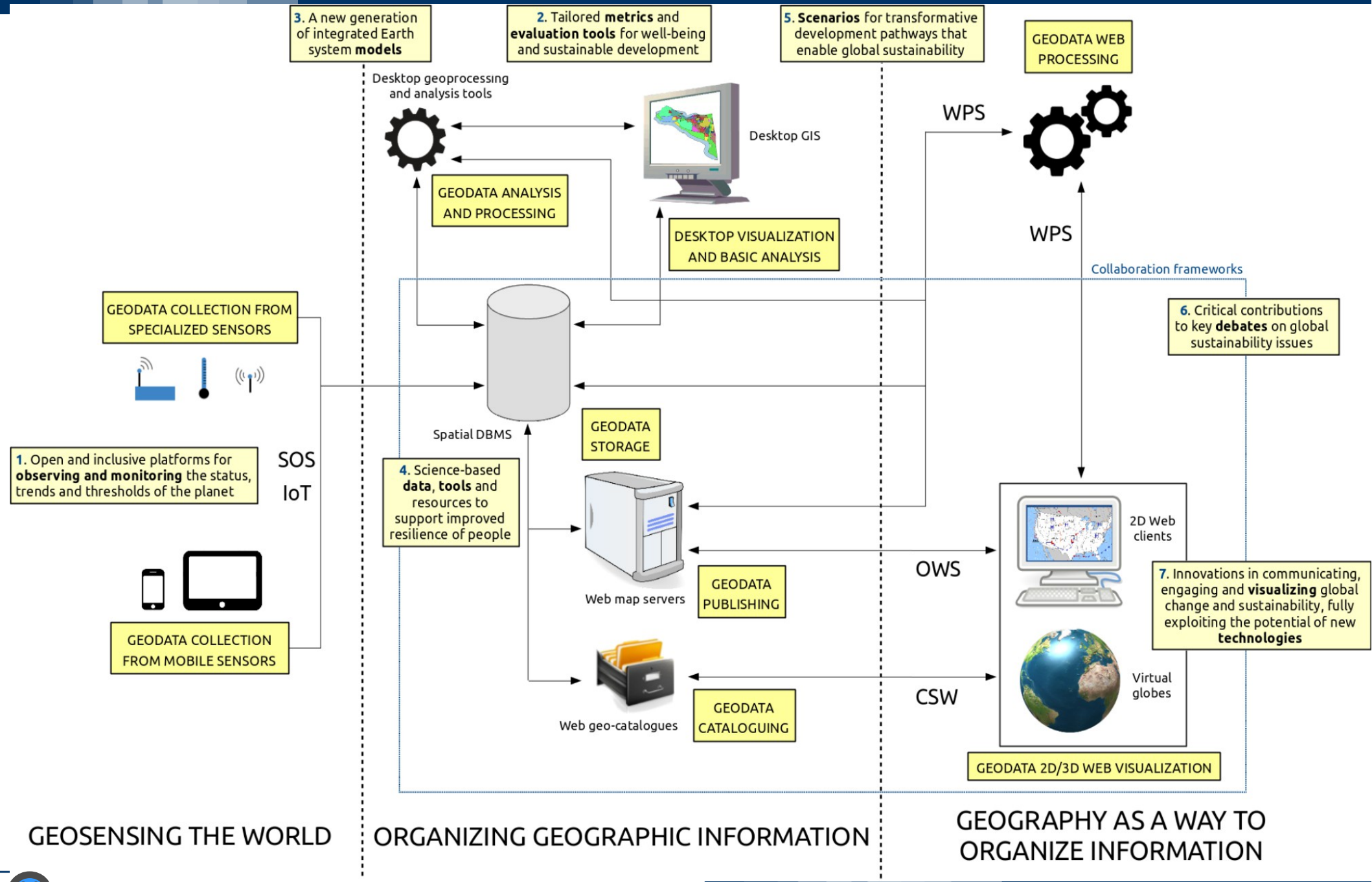
Pillars of FE vision and its seven key focal outputs



Geosensing the World

Software function	FOSS4G category	FOSS4G examples
Geo-referenced data collection from specialized sensors	Integration, processing and distribution of sensor data (e.g OGC Sensor Observation Services SOS)	istSOS, 52°North SOS
Geo-referenced data collection from mobile devices and sensors (including citizen sensors)	Mobile and geo-crowdsourcing tools	Geopaparazzi, Open Data Kit (ODK)

Organizing Geographic Information

Software function	FOSS4G category	FOSS4G examples
Desktop visualization and basic analysis	Desktop GIS	QGIS, gvSIG, uDig, OpenJUMP, SAGA
Geodata storage	Spatial Database Management Systems (DBMS)	PostgreSQL/PostGIS, SQLite/SpatiaLite, MySQL Spatial, MongoDB, CouchDB, Rasdaman
Geodata analysis and processing	Desktop geoprocessing and analysis tools	GRASS GIS, R, CyberGIS Toolkit
Serving geodata over the Web	Web-based GIS (e.g. OGC Web Services OWS)	GeoServer, MapServer, QGIS Server, deegree
Cataloguing geodata	Web-based catalogue services (e.g. OGC Catalog Services for the Web CSW)	GeoNetwork, pyCSW

Geography as a way to organize information

Software function	FOSS4G category	FOSS4G examples
2D Web visualization	2D Web clients	OpenLayers, Leaflet
3D Web visualization	Virtual Globes	NASA World Wind, Cesium, WebGL Earth, OpenWebGlobe
Web-based geoprocessing	Web-based geoprocessing (e.g. OGC Web Processing Services WPS)	pyWPS, ZOO, 52°North WPS, GeoServer, deegree

Geography as a way to organize information

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Brovelli M.A., Minghini M., Moreno R. and Oliveira R., 2016, Free and Open Source Software for Geospatial Applications (FOSS4G) to support Future Earth, International Journal of Digital Earth - in print

Contacts

Thanks for your attention!

Thanks to all people of my team contributing on these topics, especially Marco Minghini and Giorgio Zamboni

Politecnico di Milano
Laboratorio di Geomatica – Polo Territoriale di Como
Via Valleggio 11, 22100 Como (Italy)
maria.brovelli@polimi.it