




 POLITECNICO DI MILANO  
GEO Laboratory



**→ EARTH OBSERVATION  
SUMMER SCHOOL**

Earth System Monitoring & Modelling

**seom**  
scientific exploitation  
of operational missions

1-12 August 2016 | ESA-ESRIN | Frascati (Rome), Italy



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

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Politecnico di Milano, DICA – GEO Laboratory





## Research fields

- GIS
- Global Gravity Models
- GNSS
- SAR

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



## GIS Magic Team: collaborative work





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



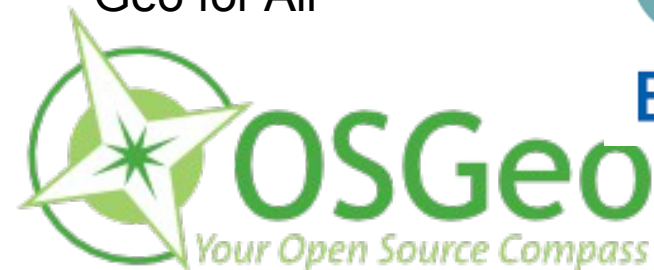
Geo for All



UN OPENGIS



UN-GGIM  
UNITED NATIONS INITIATIVE ON  
GLOBAL GEOSPATIAL  
INFORMATION MANAGEMENT







**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<sup>5</sup>

- ✓ 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/>



POLITECNICO  
MILANO 1863





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



- ✓ 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).





- ✓ 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 (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: understanding our planet in the 21<sup>st</sup> century,
- ✓ [http://portal.opengeospatial.org/files/?artifact\\_id=6210](http://portal.opengeospatial.org/files/?artifact_id=6210).





- ✓ 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, community 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.





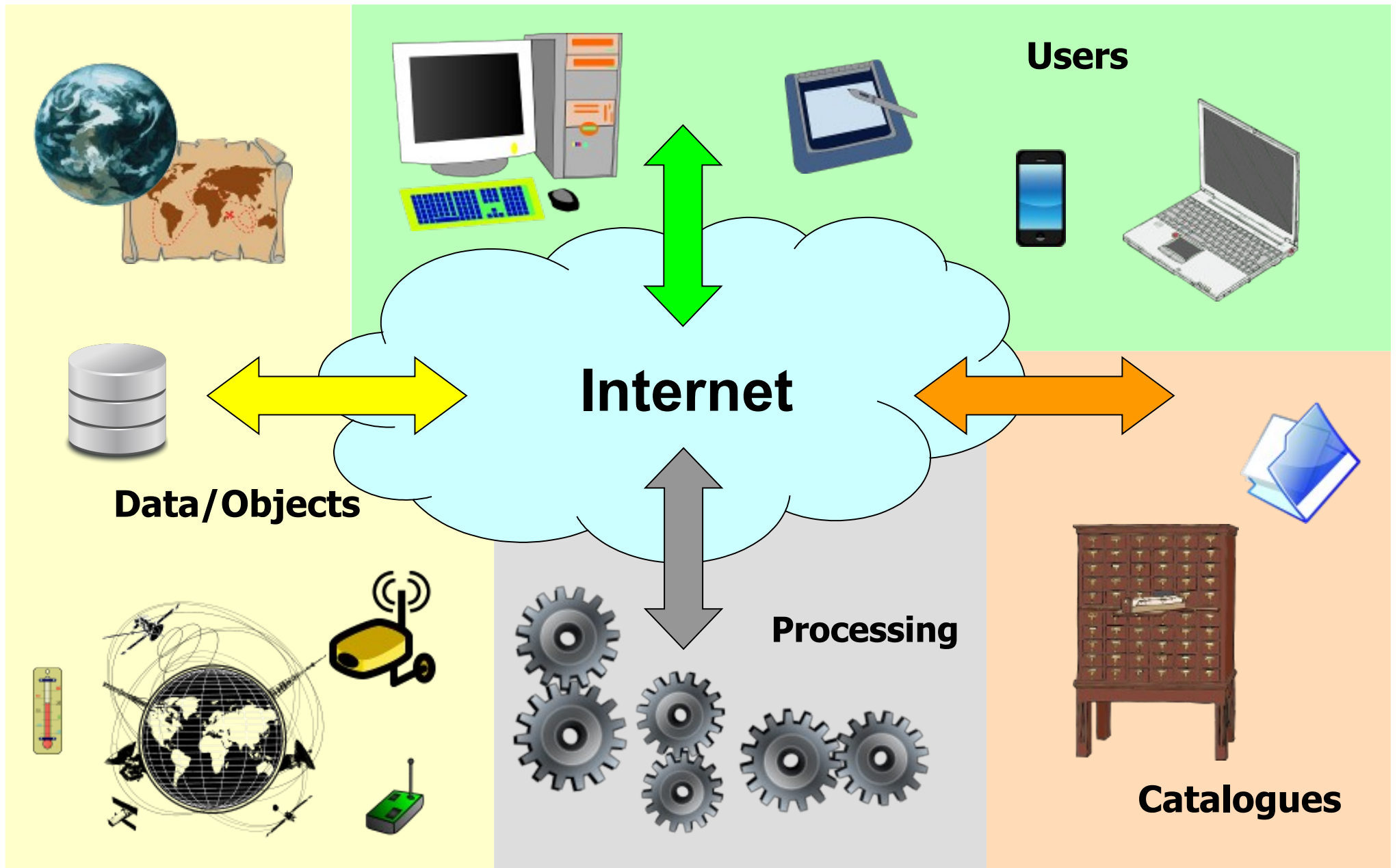
- ✓ Every day we create 2.5 trillion ( $10^{18}$ ) bytes of data. 80 % of these are already georeferenced or can be.
- ✓ It's a huge dataset, equal to a DVD tower that goes from the Earth to the Moon every day.





- ✓ 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.



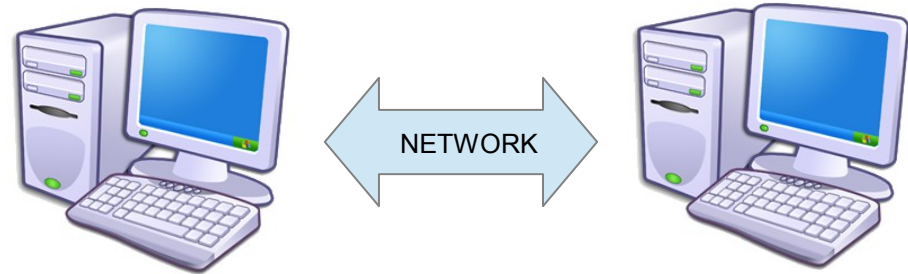






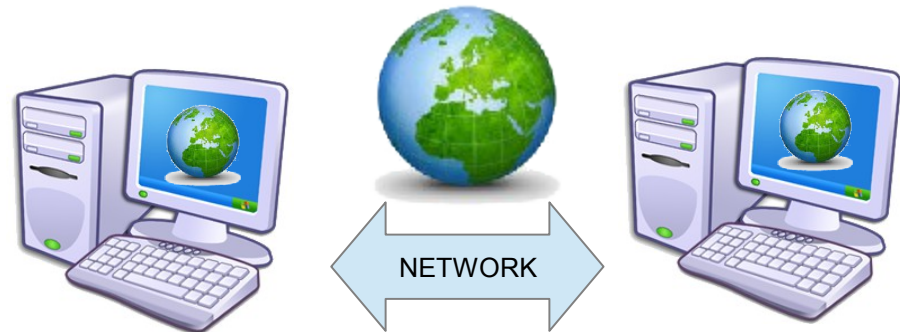
## Web Service

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



## Web Geospatial Service

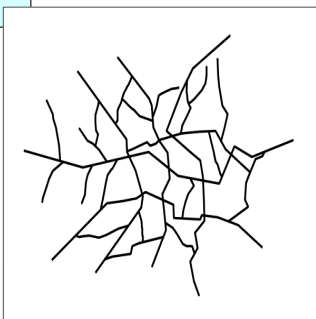
“...specific web services for geospatial data and information”



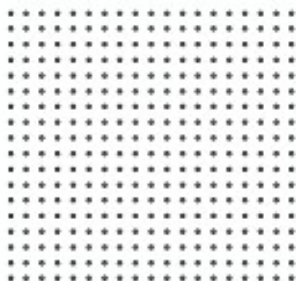
## Data



RASTER DATA



VECTOR DATA



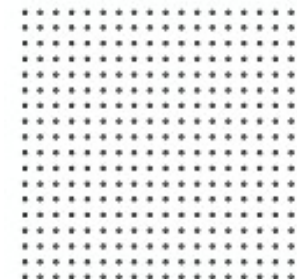
GRID DATA

Other geospatial data  
(e.g. sensors)

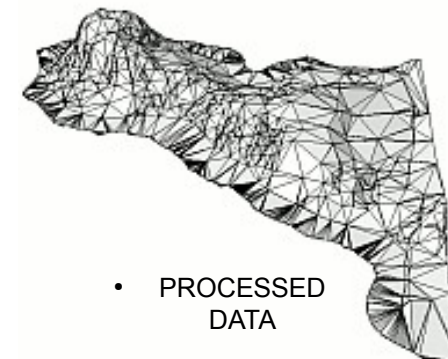
## Catalogues



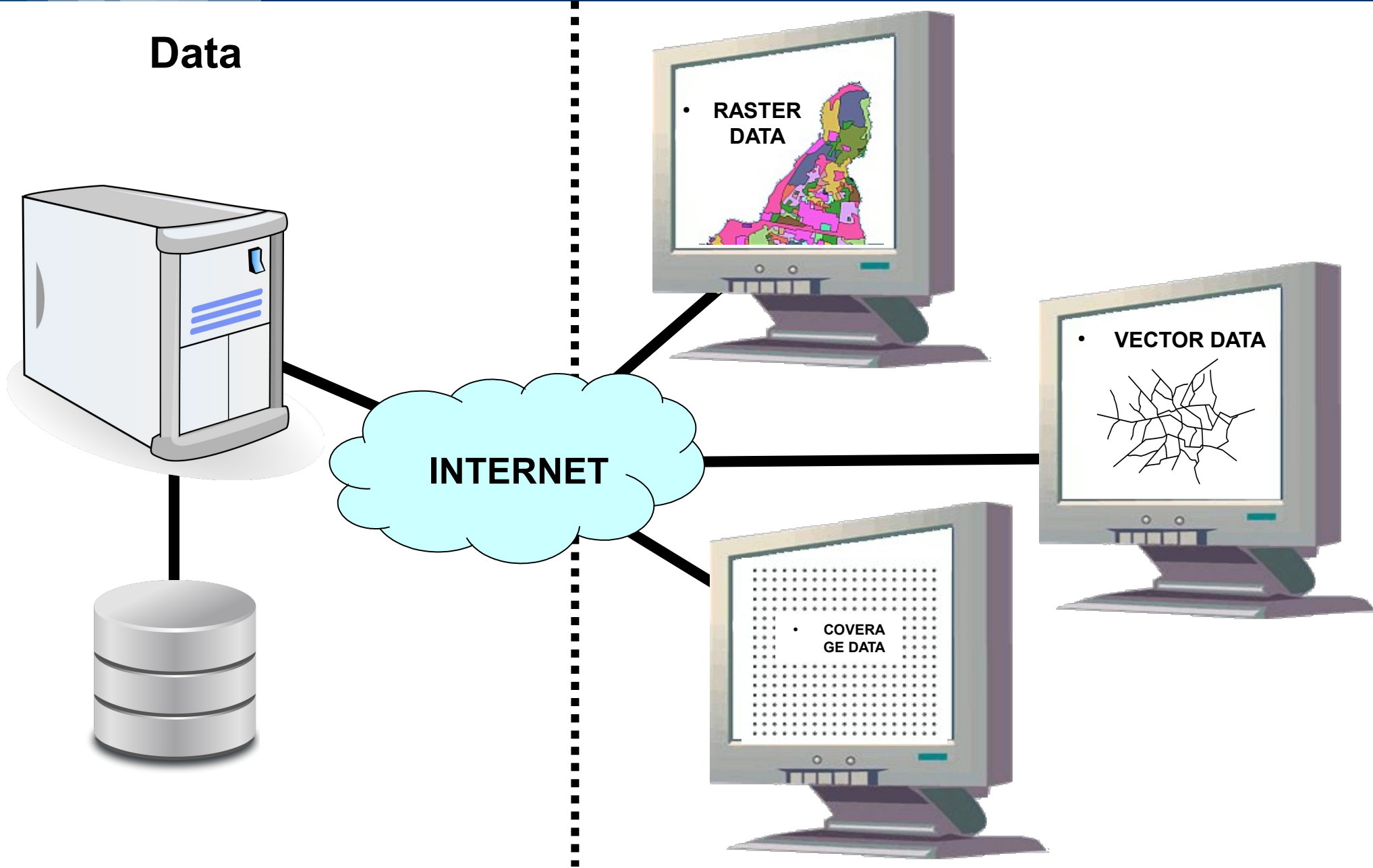
## Processing



INPUT data

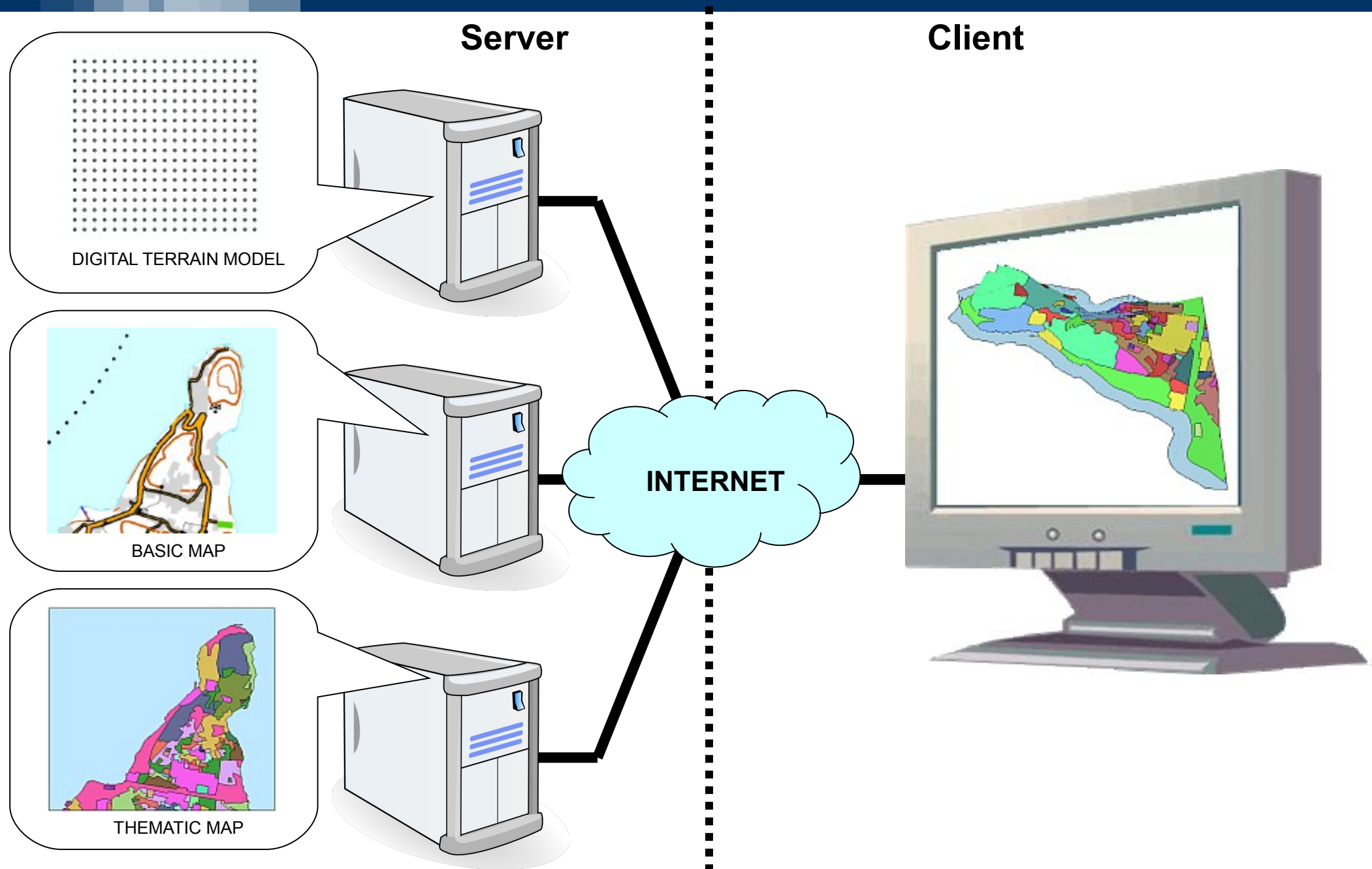


PROCESSED DATA

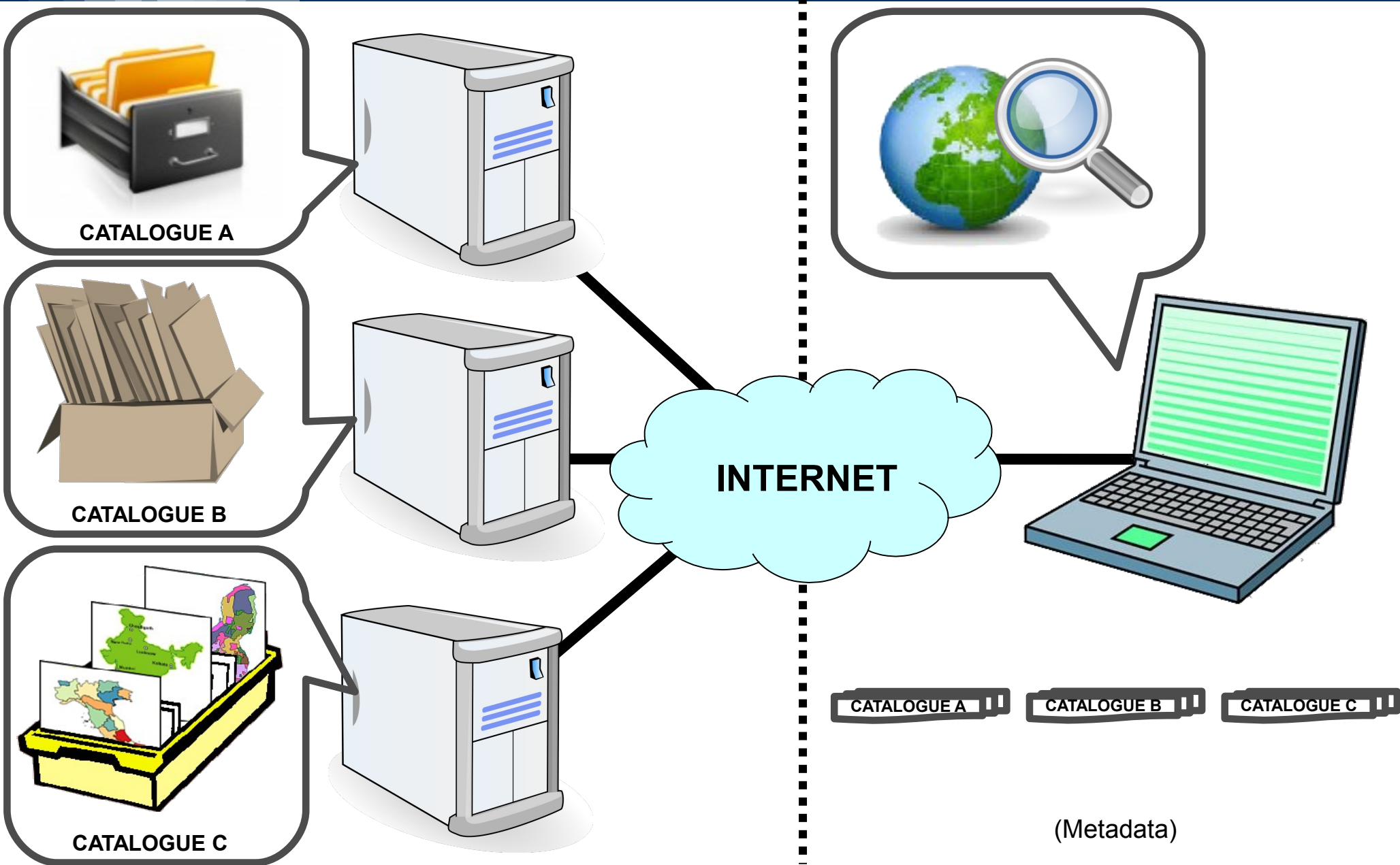




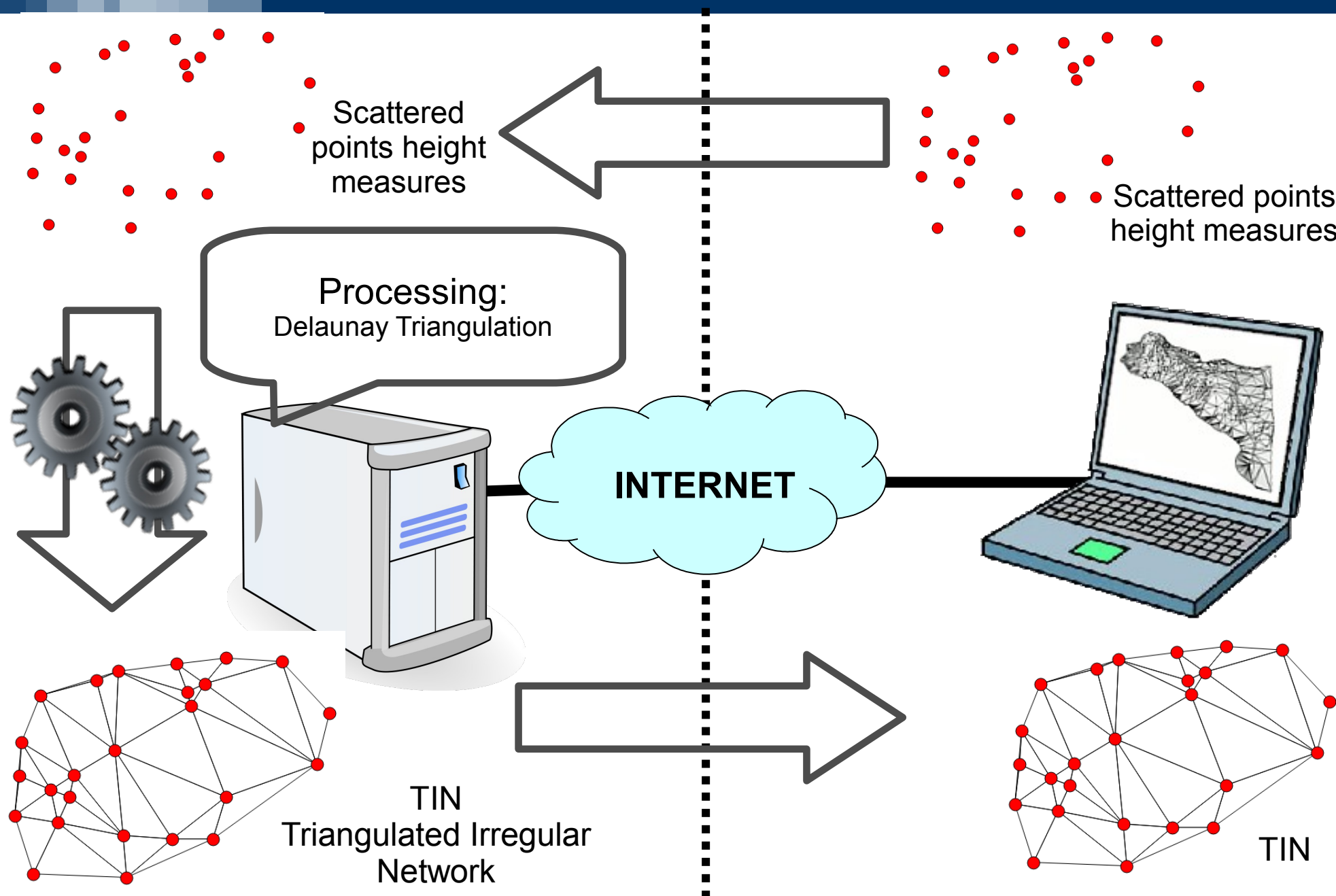
# Cartographic Mashup





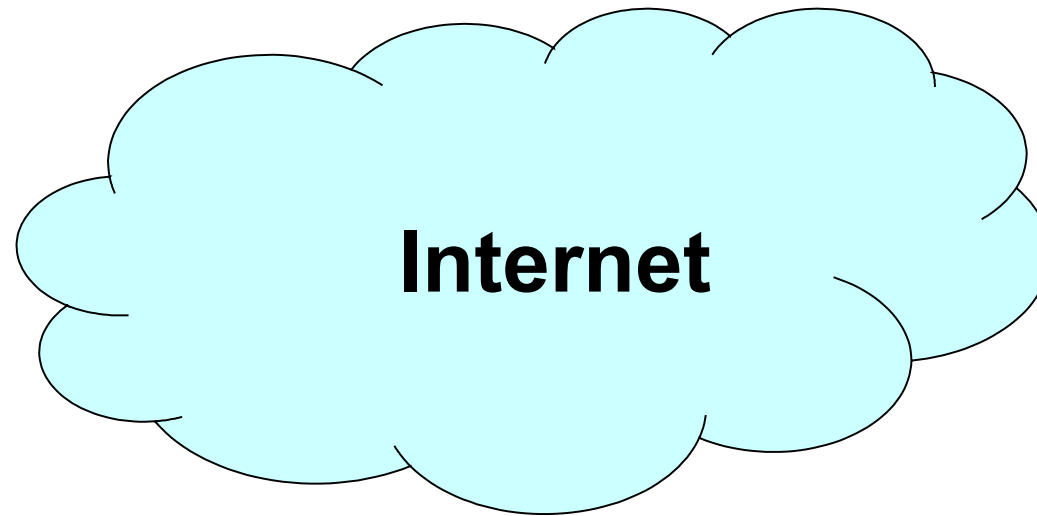








- ✓ General GIS viewing, editing, and analysis on the desktop



- ✓ General GIS viewing, editing and analysis in the browser





- ✓ 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





- ✓ There is at least one mature sophisticated FOSS4G for every geotechnology 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) .





## 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)







- ✓ In 2006 the Open Source Geospatial Foundation (OSGEO), was started. ([www.osgeo.org](http://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.





## 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

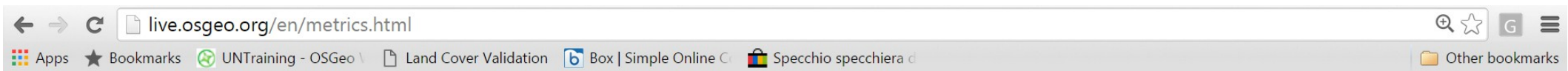
Project fills a gap related to software that OSGeo supports

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





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- Metrics
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- Contact Us

English | Español | Català | Français | Deutsch | Italiano | Polski | Ελληνικά | Русский | 中文 | 한국어 | 日本語

## OSGeo-Live 9.5 Project Metrics

Metrics provided by [OpenHUB](#) which are derived from the projects' code repositories. Note these metrics have known deficiencies (such as caused by repositories moving), and only provide partial indications about the projects' development. Lack of change in smaller, concise packages and libraries may simply reflect a level of maturity and completeness.

Viewing the metrics requires an Internet connection and Javascript to be enabled.



### OSGeo-Live

- Mostly written in JavaScript
- Mature, well-established codebase
- Very large, active development team
- Increasing Y-O-Y development activity
- Average number of code comments
- 56 active contributors

Commit Activity Timeline:



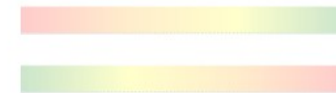
Undated Jul 22 2016

more at [Open HUB](#)



## WebWorldWind

Settings | Report Duplicate



New Project

1

I Use This!

### Project Summary

NASA World Wind in JavaScript for HTML5

Web World Wind is a 3D virtual globe API for HTML5 and JavaScript. Web pages include Web World Wind to provide one or more virtual globes on that page.

#### Tags

mapping virtual nasa earth gis globe visualization

#### Share

Like 0 Tweet G+1 0 Share

Analyzed 29 days ago. based on code collected 29 days ago.

#### Quick Reference

Project Links: [Homepage](#) [Download](#)

Code Locations: [git://github.com/NASAWorldWind/W...](https://github.com/NASAWorldWind/W...)

Licenses: NASA-1.3

Similar Projects: [Worldwind C#](#) [Worldwind Java](#)  
[OpenStreetMap](#) [Marble](#)

Managers: Become the first manager for WebWorldWind

Review Security Info



# Details (WebWorldWind example)

## In a Nutshell, WebWorldWind...

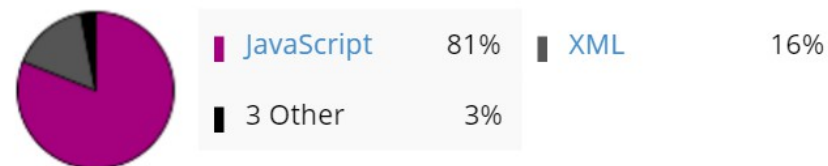
... has had **316 commits** made by **12 contributors** representing **90,794 lines of code**

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

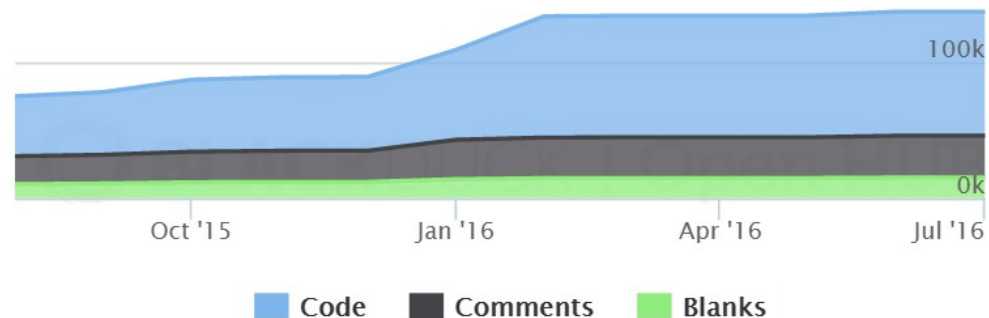
... has a **codebase with a very short history** maintained by a **large development team** with **stable Y-O-Y commits**

... 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**

## Languages



## Lines of Code



## Activity

### 30 Day Summary

Jun 1 2016 — Jul 1 2016

**37 Commits**  
**6 Contributors**

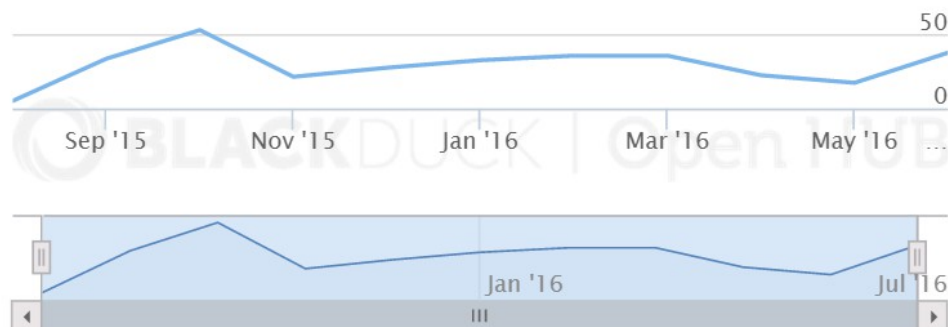
### 12 Month Summary

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.*

## Commits per Month

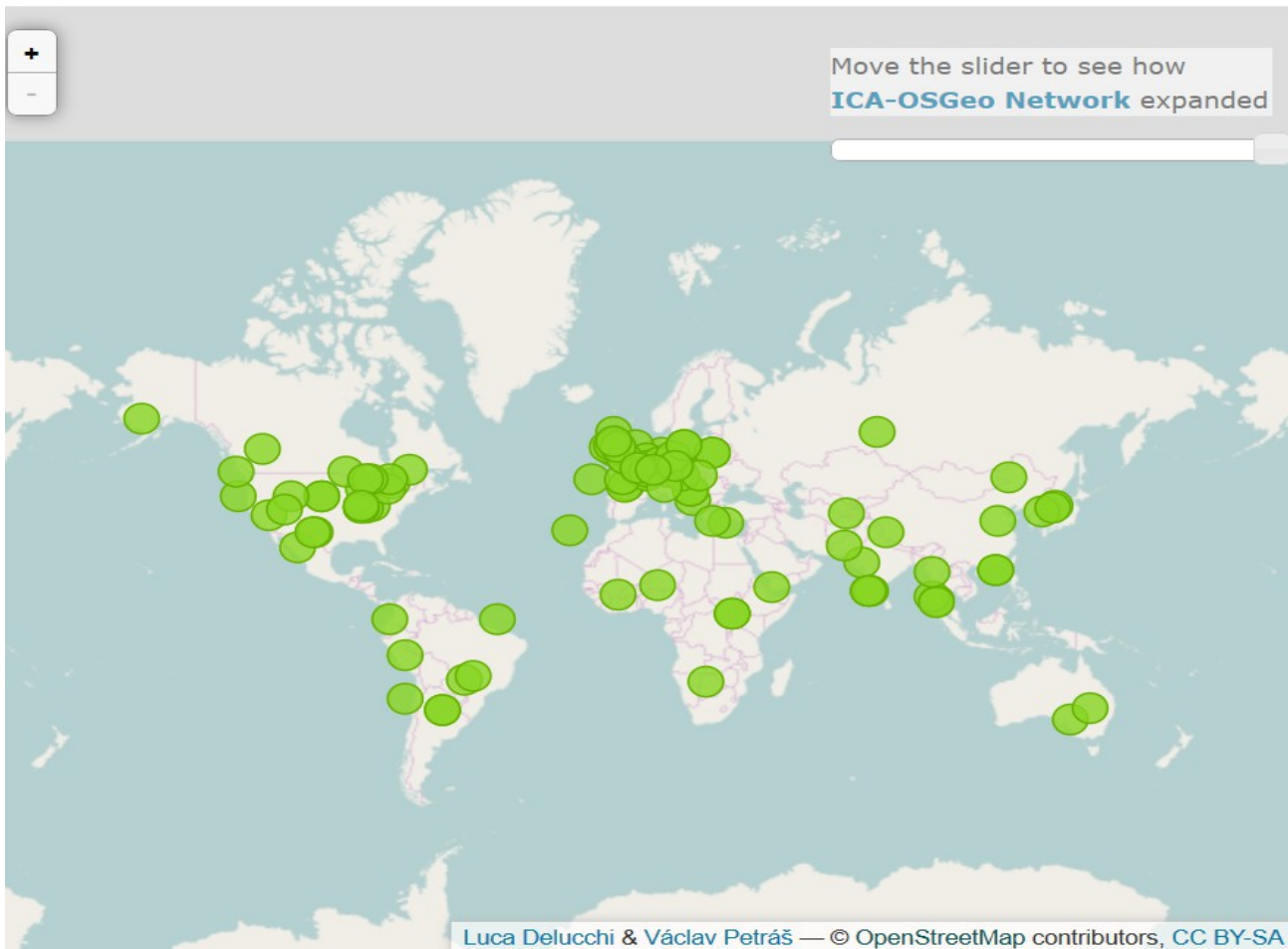
Zoom **All**







# GeoForAll



- ✓ Webinars (monthly)
- ✓ Newsletter (monthly)
  - the lab of the month
  - the geoambassador of the month
  - Events
  - Conferences
  - Webinars
  - Courses
  - ...

110 labs worldwide as of 30th July, 2016







- ✓ OSGeo-Live is a self-contained bootable DVD, USB thumb drive or Virtual Machine based on Ubuntu, 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



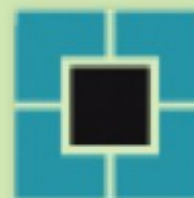
GeoNetwork



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



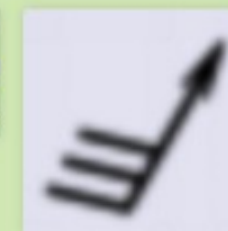
Open Street Map Viking



Viking



zyGrib





# Domain Specific GIS

Applications targeted at a specific domain

Sahana



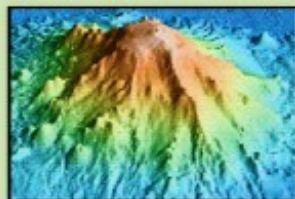
Ushahidi



osgEarth



MB-System



# Spatial Tools

Specific analysis tools

GeoKettle



GMT



Mapnik



TileMill



MapSlicer



OSSIM



ORFEO Toolbox



R







## Geospatial Libraries

GDAL/OGR



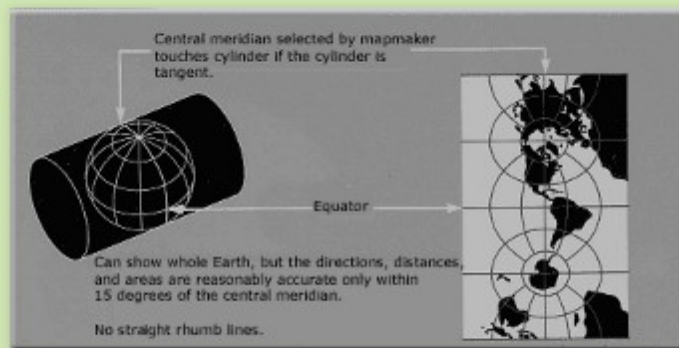
GeoTools



GEOS



MetaCRS Proj4



libLAS



Iris



JTS



## Data Spatial data sets

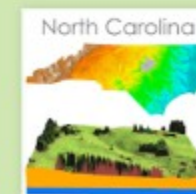
Natural Earth



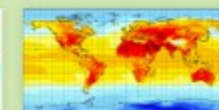
Open Street Map



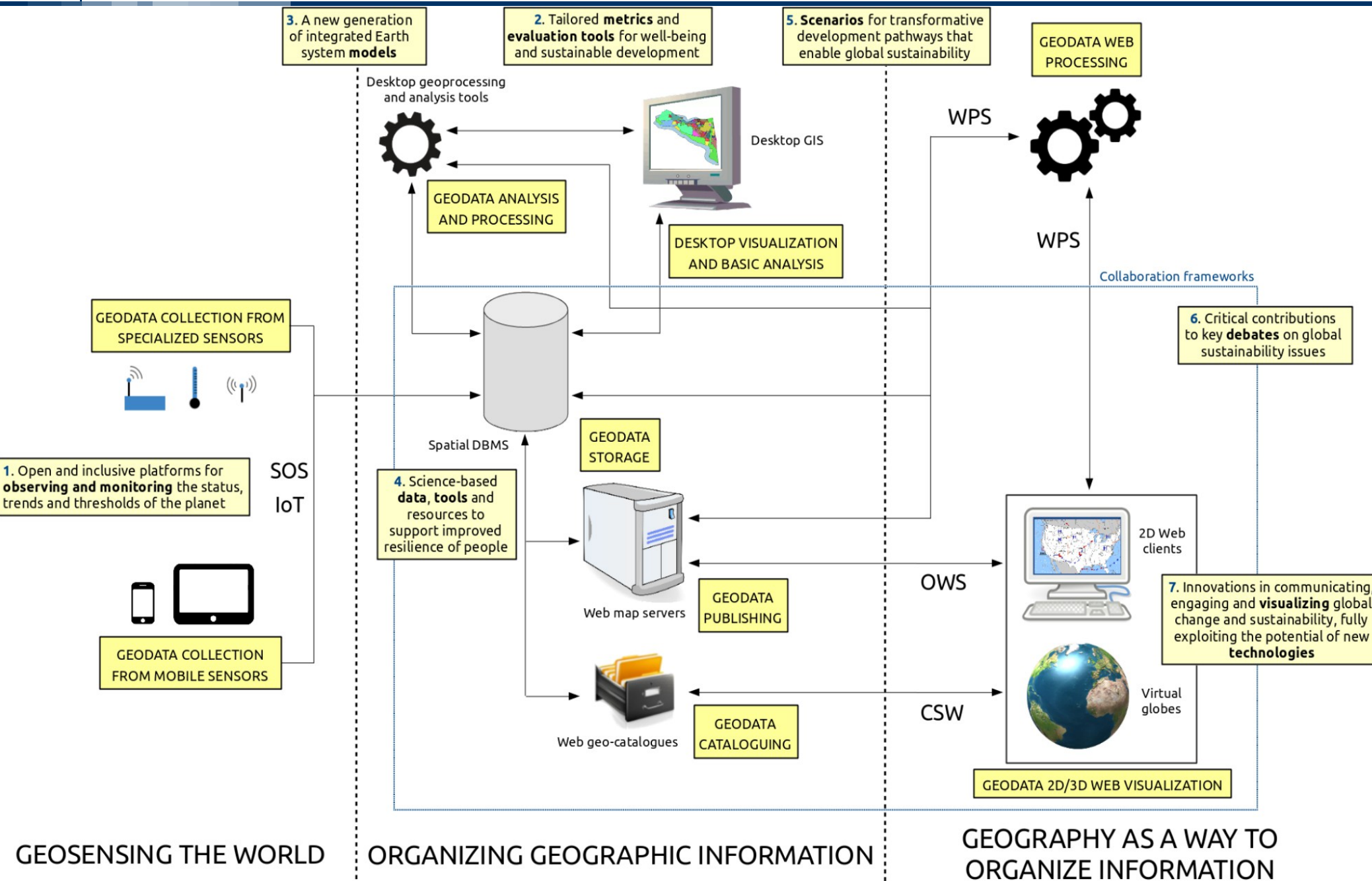
North Carolina



netCDF



# Pillars of FE vision and its seven key focal outputs



GEOSENSING THE WORLD

ORGANIZING GEOGRAPHIC INFORMATION

GEOGRAPHY AS A WAY TO ORGANIZE INFORMATION



Software function	FLOSS4G category	FLOSS4G 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)





Software function	FLOSS4G category	FLOSS4G 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





Software function	FLOSS4G category	FLOSS4G 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





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**Brovelli M.A., Minghini M., Moreno R. and Oliveira R., 2016, Free and Open Source Software for Geospatial Applications (FLOSS4G) to support Future Earth, International Journal of Digital Earth - in print**







# Thanks for your attention!

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

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