



OSGeo's Global Conference for Open
Source Geospatial Software
Nottingham 17 - 21 September 2013

Web-based Participatory GIS with data collection on the field: a prototype architecture

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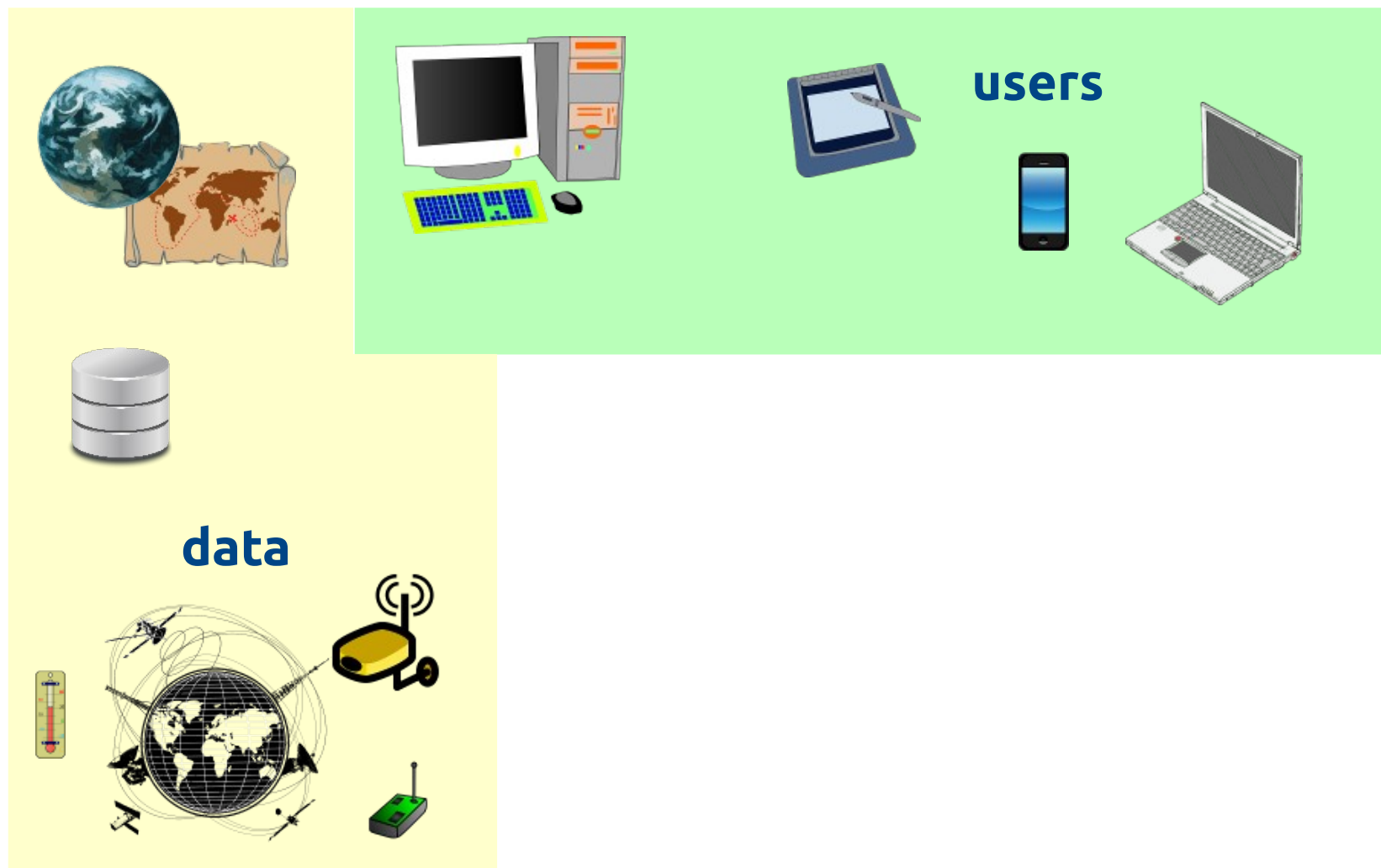
Politecnico di Milano, DICA - Geomatics Laboratory at Como Campus



Geospatial Web



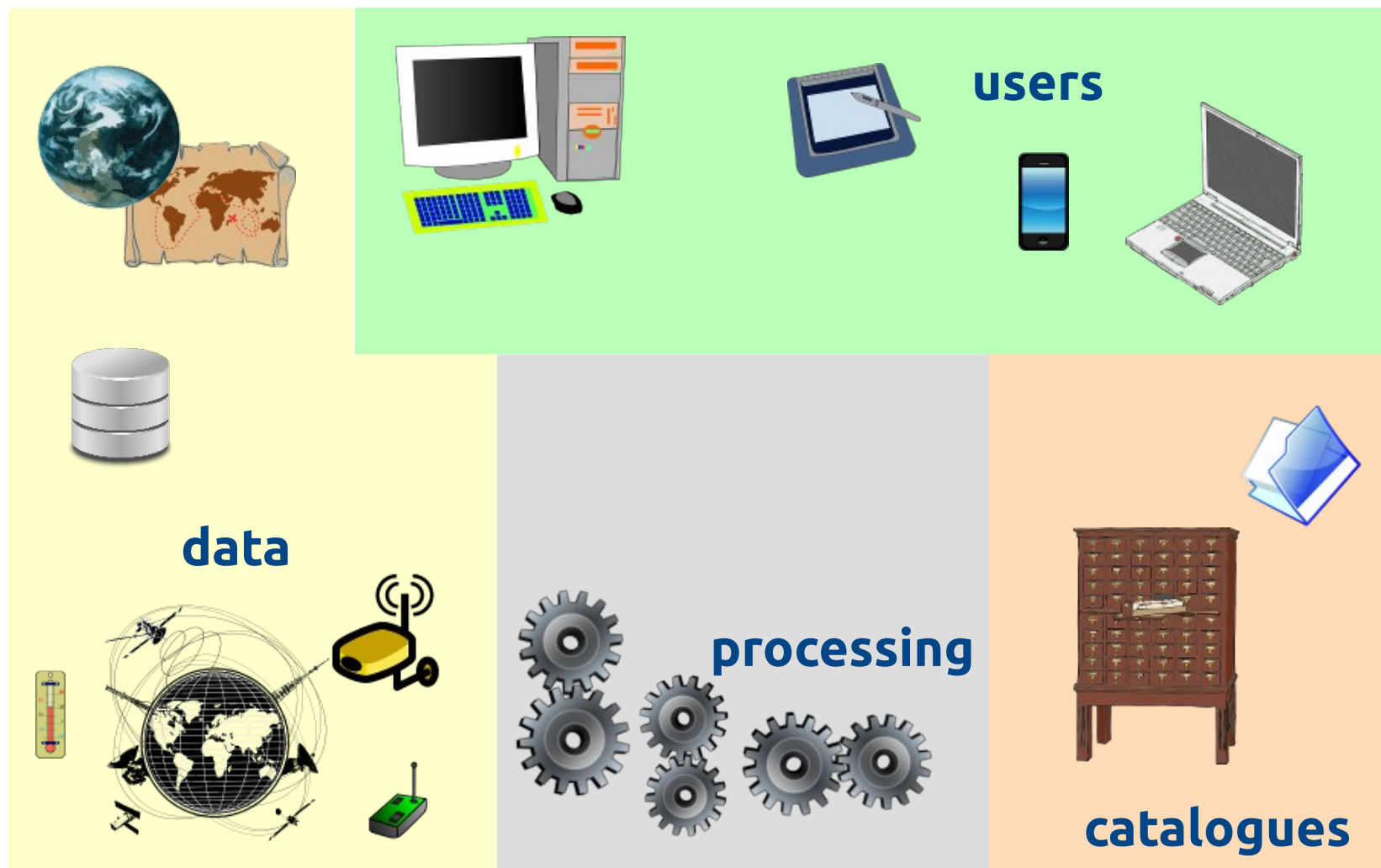
Geospatial Web



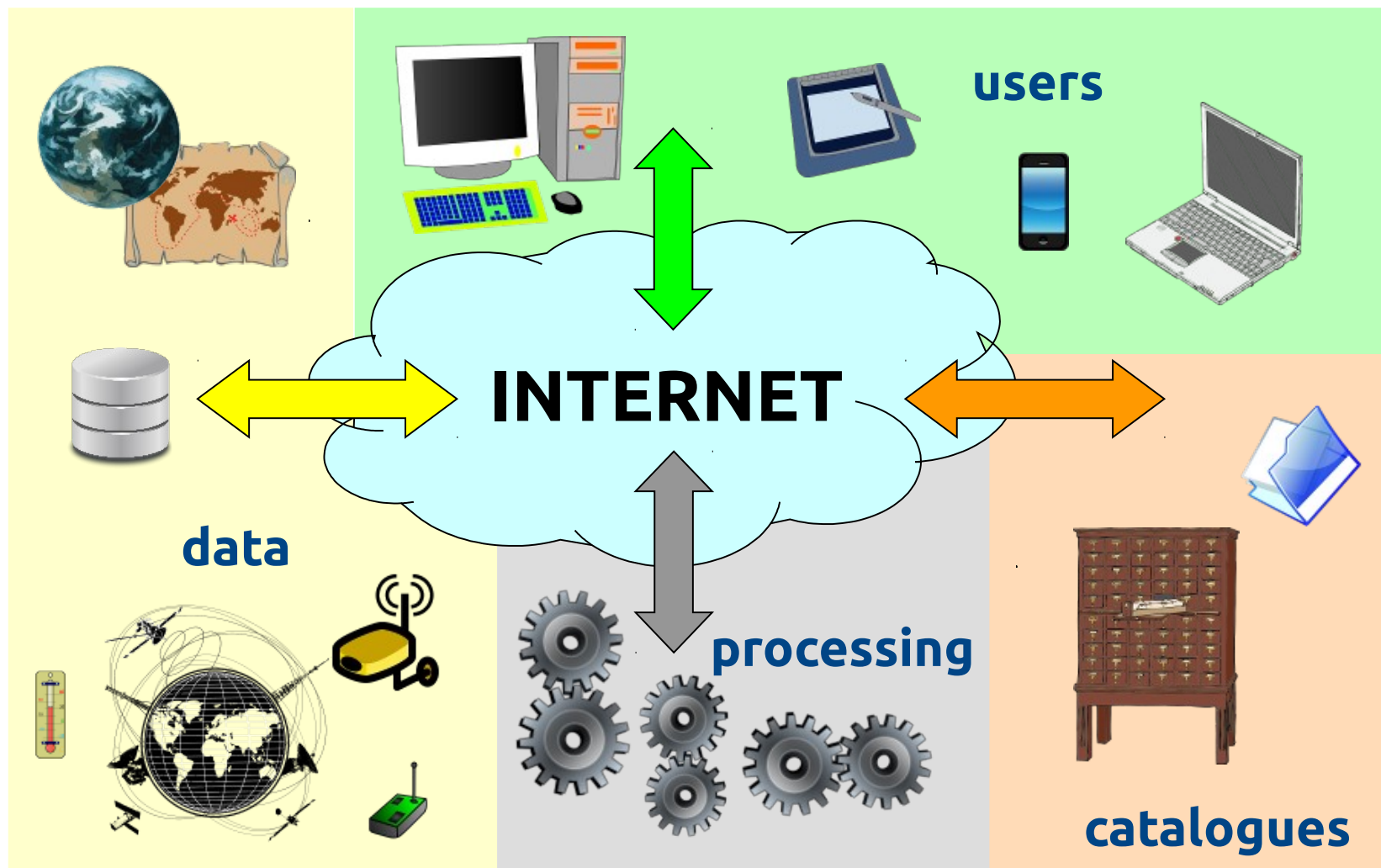
Geospatial Web



Geospatial Web



Geospatial Web



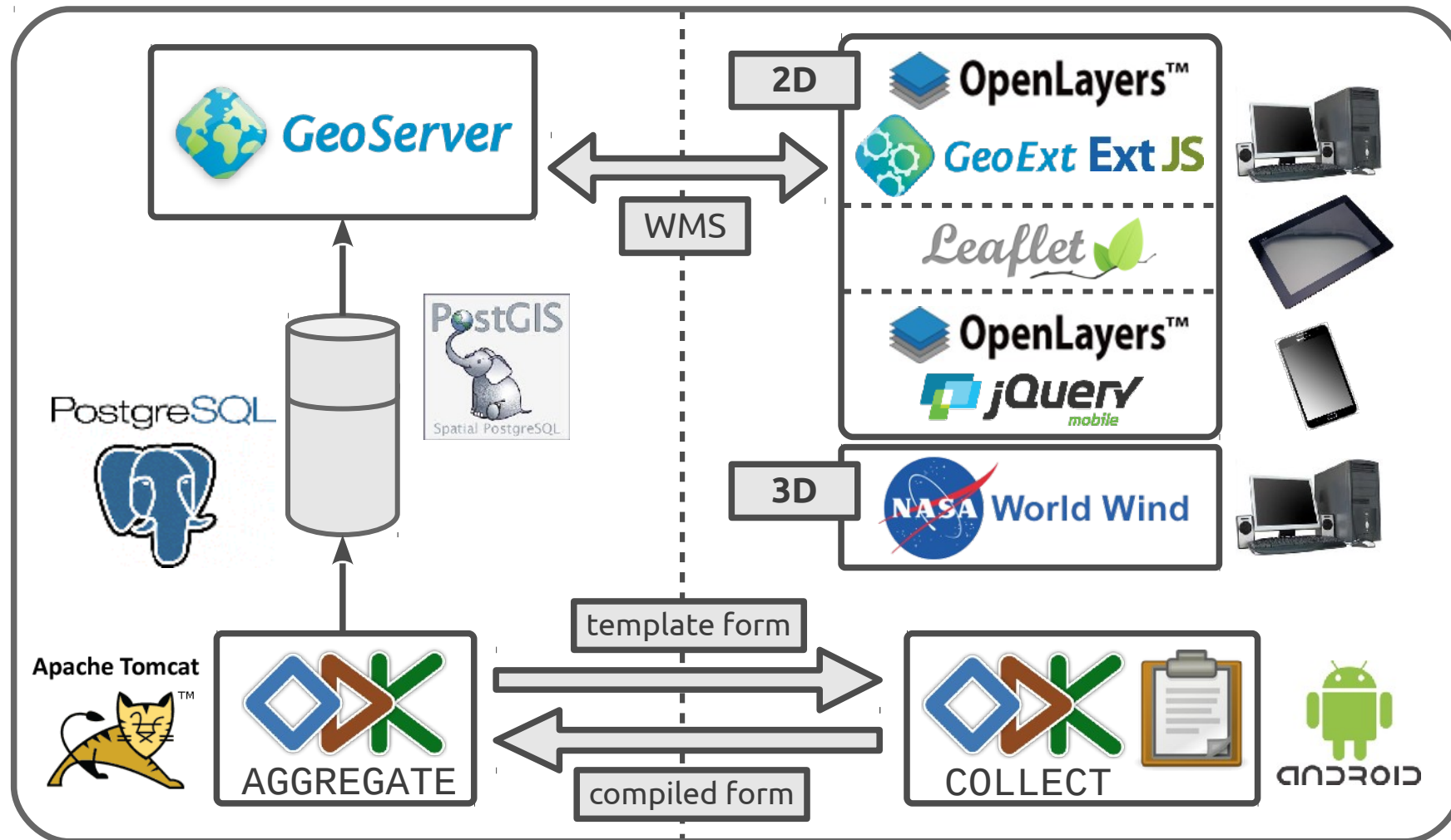
- ❖ Web 2.0
 - online applications allowing rich user **interaction**
 - **dynamic Web** as opposed to static (1.0) Web
 - Web 2.0 in five keywords: **sharing**, **participation**, **collaboration**, **user-generated** information, virtual **community**
- ❖ GeoWeb 2.0 (Web Mapping 2.0)
 - interactive tools allowing user participation in spatial data management
 - **neogeography**: Web tools allow (non-expert) users to create their own maps
 - **Volunteered Geographic Information (VGI)**: the idea of humans behaving like sensors able to register geospatial contents
- ❖ Proliferation of **mobile devices** equipped with sensors (GPS, camera, etc.)
 - users can easily perform real-time collection of georeferenced data
- ❖ Participatory GIS (PGIS)
 - GIS as a tool for promoting **citizens' intervention** in decision-making processes
 - Web-based applications allowing maps mash-ups, content upload and editing

PGIS - requirements

- ❖ Data description
 - information should be described with a **standard language** comprehensible to everyone (e.g. GML, KML, NetCDF, CityGML, WaterML)
- ❖ Data sharing
 - information should be made available through **standard protocols** in order to be widely accessed from different client applications (e.g. WMS, WFS, WCS)
- ❖ User administration
 - systems should manage multiple **user profiles** and their related privileges
- ❖ Mash-up
 - maps coming from different sources should be directly overlapped in order to automatically **integrate multiple information** referred to the same context
- ❖ Data editing
 - users should be able to **manipulate** (e.g. insert, update, delete) geographical features through standard common interfaces (such as WFS-T)

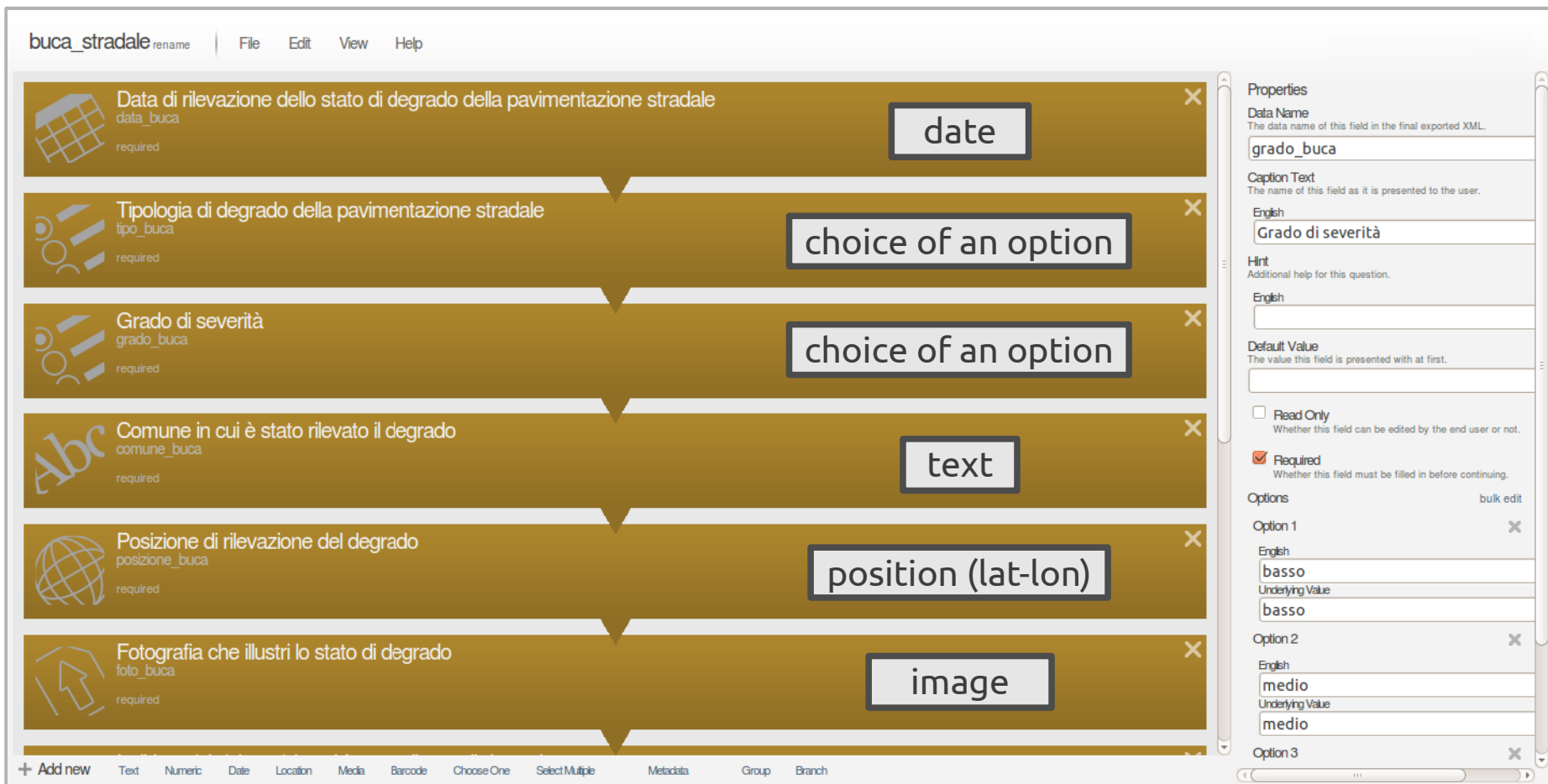
SERVER

CLIENT



- ❖ Suite providing a set of tools for managing **mobile data collection**
 - <http://opendatakit.org>
 - free and **open source** under Apache2 license
 - developed from University of Washington – Department of Computer Science & Engineering
- ❖ Composed of 3 modules
 - form authoring tools:
 - ✗ **ODK Build**: graphical drag-and-drop tool for creating simple forms
 - ✗ **XLSForm**: form design via Excel spreadsheet
 - **ODK Collect**:
 - ✗ Android app for filling forms (which can contain multimedia and locations)
 - **ODK Aggregate**:
 - ✗ repository of the data sent by ODK Collect
 - ✗ can run in the cloud, on a virtual machine or on a private server (i.e. a Tomcat server backed with a PostgreSQL database)

- ❖ **ODK Build**: graphical drag-and-drop tool for creating simple forms



The screenshot shows the ODK Build interface for creating a form titled "buca_stradale". The form consists of six sections, each with a specific data type and a required field:

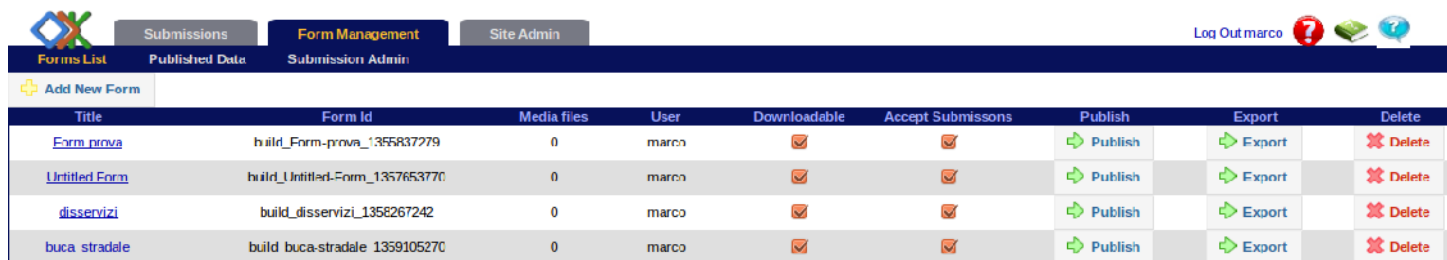
- Data di rilevazione dello stato di degrado della pavimentazione stradale** (data_buca): date
- Tipologia di degrado della pavimentazione stradale** (tipo_buca): choice of an option
- Grado di severità** (grado_buca): choice of an option
- Comune in cui è stato rilevato il degrado** (comune_buca): text
- Posizione di rilevazione del degrado** (posizione_buca): position (lat-lon)
- Fotografia che illustri lo stato di degrado** (foto_buca): image

The right sidebar shows the **Properties** panel for the selected field, including fields for Data Name, Caption Text, English, Hint, Default Value, Read Only, Required, and Options.

❖ XLSForm: form design via Excel spreadsheet

	A	B	C	D	E	
1	list_name	name	label::Italiano	label::English	label::Español	tip
2	tipologia_utente	tourist from Italy	turista italiano	tourist from Italy	turista italiano	
3	tipologia_utente	tourist from abroad	turista straniero	tourist from abroad	turista internacional	
4	tipologia_utente	Italian citizen	cittadino locale	Italian citizen	ciudadano italiano	
5						
6	tipologia_POI	point with panoramic view	punto panoramico	point with panoramic view	punto panorámico	
7	tipologia_POI	monument	monumento	monument	monumento	
8	tipologia_POI	historical/monumental building	edificio storico/monumentale	historical/monumental building	edificio histórico/monumental	
9	tipologia_POI	place of worship	luogo di culto	place of worship	lugar de culto	
10	tipologia_POI	place of artistic/cultural activities	sede di attività artistico/culturali	place of artistic/cultural activities	sede de actividad artística/cultural	
11	tipologia_POI	sports facility	impianto sportivo	sports facility	centro deportivo	
12	tipologia_POI	transport station	stazione di trasporto	transport station	estación de transporte	
13	tipologia_POI	event	evento	event	evento	
14	tipologia_POI_2	point of naturalistic/landscape interest	punto di interesse naturalistico/paesaggio	point of naturalistic/landscape interest	punto de interés natural/paisaje	point with panoramic view
15	tipologia_POI_2	point of architectural interest	punto di interesse architettonico	point of architectural interest	punto de interés arquitectónico	point with panoramic view
16	tipologia_POI_2	statue/sculpture	statua/scultura	statue/sculpture	estatua/escultura	monument
17	tipologia_POI_2	fountain	fontana	fountain	fuelle	monument
18	tipologia_POI_2	historical monument	monumento storico	historical monument	monumento histórico	monument
19	tipologia_POI_2	castle	castello	castle	castillo	historical/monument
20	tipologia_POI_2	villa	villa	villa	villa	historical/monument
21	tipologia_POI_2	palace	palazzo	palace	edificio	historical/monument
22	tipologia_POI_2	lighthouse	faro	lighthouse	faro	historical/monument
23	tipologia_POI_2	bell tower	campanile	bell tower	campanario	historical/monument
24	tipologia_POI_2	tower	torre	tower	torre	historical/monument
25	tipologia_POI_2	church/basilica	chiesa/basilica	church/basilica	iglesia/basilica	place of worship
26	tipologia_POI_2	baptistery	battistero	baptistery	baptisterio	place of worship
27	tipologia_POI_2	convent	convento	convent	convento	place of worship
28	tipologia_POI_2	cemetery	cimitero	cemetery	cementerio	place of worship

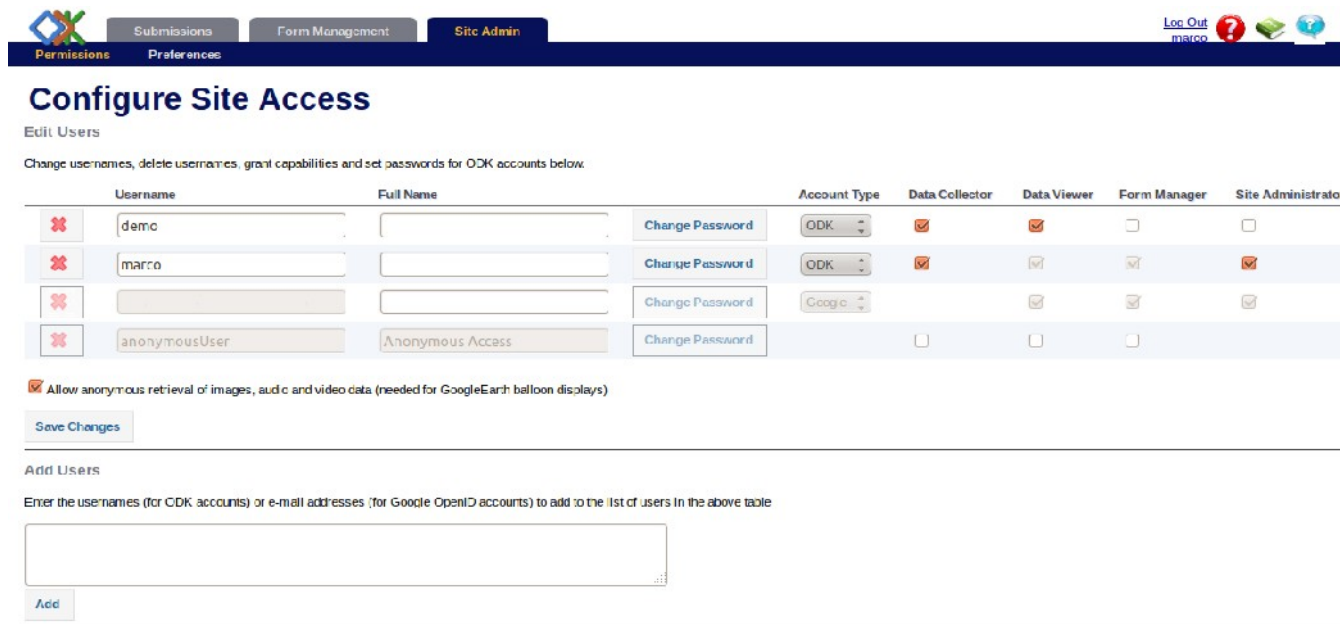
- ❖ Form templates upload, option management and submitted forms export



The screenshot shows the 'Form Management' tab with a table of forms. The table has columns for Title, Form Id, Media files, User, Downloadable, Accept Submissions, Publish, Export, and Delete. There are four rows of forms listed.

Title	Form Id	Media files	User	Downloadable	Accept Submissions	Publish	Export	Delete
Form prova	build_Form-prova_1355837779	0	marco	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Publish	Export	Delete
Untitled Form	build_Untitled-Form_1357653770	0	marco	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Publish	Export	Delete
disservizi	build_disservizi_1358267242	0	marco	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Publish	Export	Delete
buca stradale	build_buca-stradale_1359105270	0	marco	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Publish	Export	Delete

- ❖ User administration and assignment of privileges



The screenshot shows the 'Configure Site Access' page under the 'Site Admin' tab. It includes a table for managing users with columns for Username, Full Name, Account Type, Data Collector, Data Viewer, Form Manager, and Site Administrator. There are also checkboxes for permissions and a 'Save Changes' button.

Configure Site Access
Edit Users
Change usernames, delete usernames, grant capabilities and set passwords for ODK accounts below:

Username	Full Name	Account Type	Data Collector	Data Viewer	Form Manager	Site Administrator
demo		ODK	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
marco		ODK	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
anonymousUser	Anonymous Access	Google	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☒ Allow anonymous retrieval of images, audio and video data (needed for GoogleEarth balloon displays)

[Save Changes](#)

Add Users
Enter the usernames (for ODK accounts) or e-mail addresses (for Google OpenID accounts) to add to the list of users in the above table

[Add](#)

❖ Application main menu



❖ Application main menu

ODK Collect > Main Menu

ODK Collect 1.3 (1030)
Data collection made easier...

Fill Blank Form

Edit Saved Form

Send Finalized Form

Get Blank Form

Delete Saved Form

10:22

❖ Download of form template

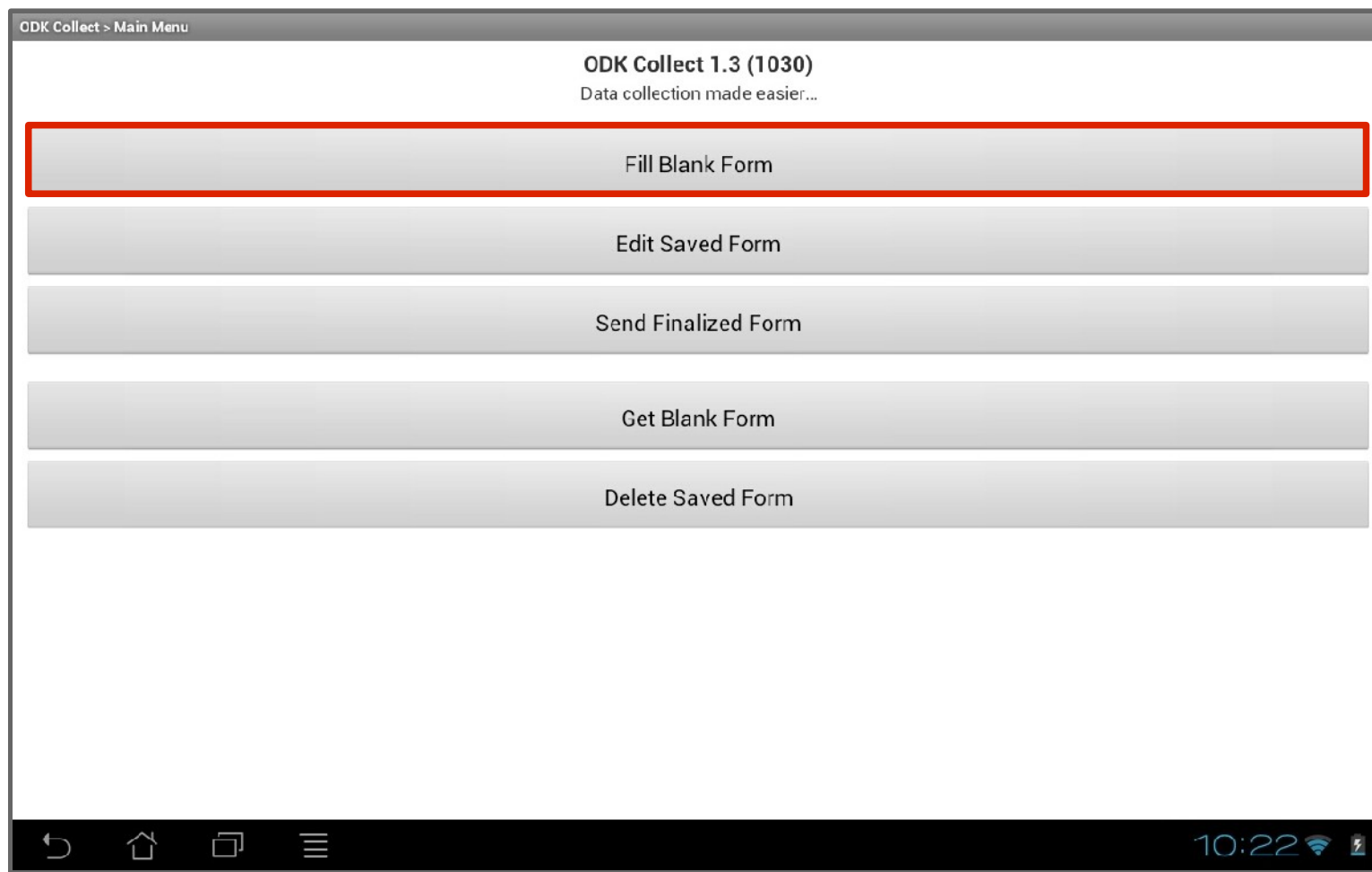
ODK Collect > Get Blank Form

Percorsi ID: build_Percorsi_1369901447	<input type="checkbox"/>
Point Of Interest ID: PointofInterest	<input checked="" type="checkbox"/>
Rampe ID: build_Rampe_1369901495	<input type="checkbox"/>
Scale ID: build_Scale_1369901422	<input type="checkbox"/>
adbpo ID: build_adbpo_1364564556	<input type="checkbox"/>
buca_stradale ID: build_buca-stradale_1359105270	<input type="checkbox"/>

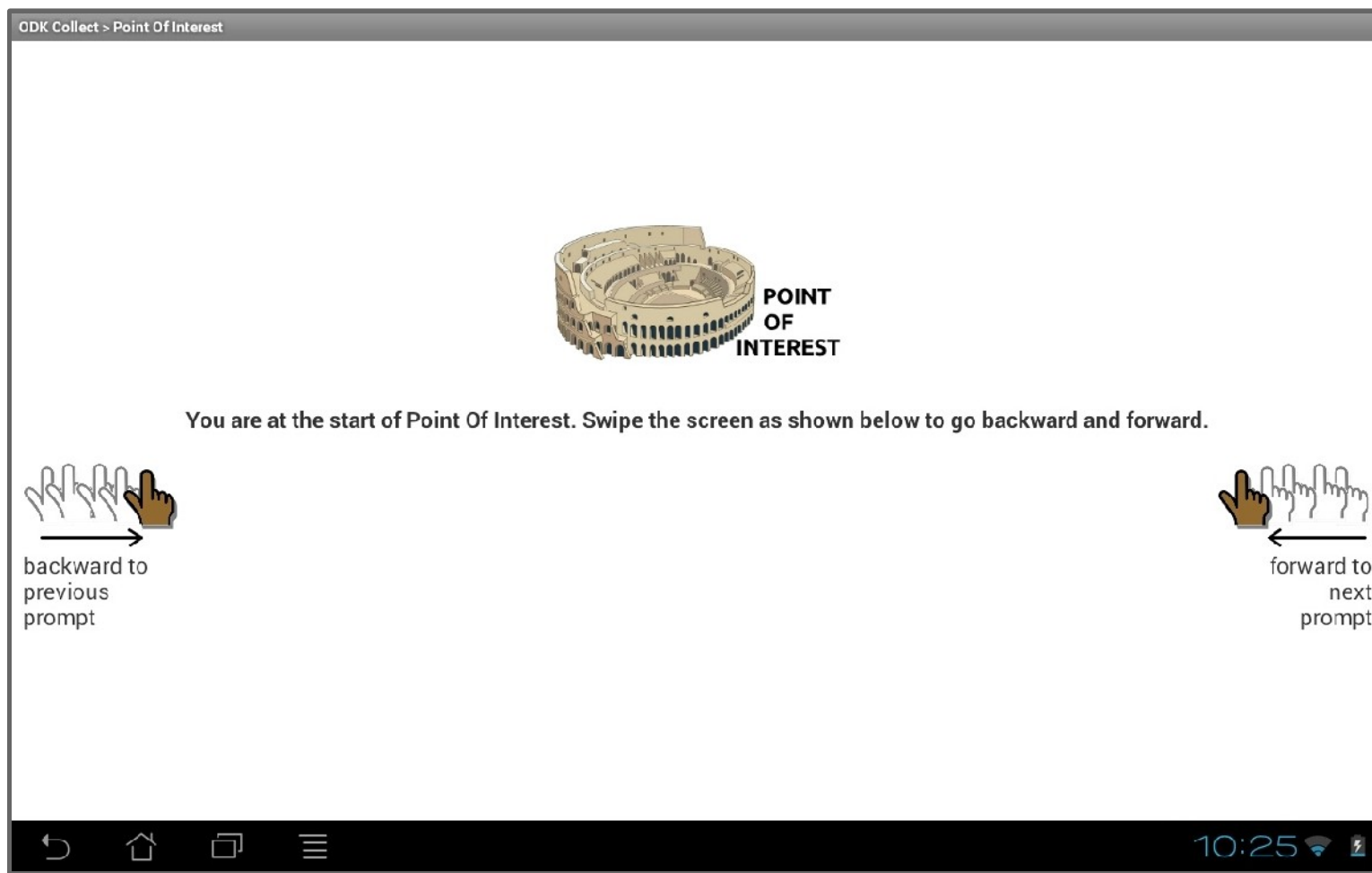
Toggle All Refresh **Get Selected**

10:24

❖ Application main menu



❖ Guided form compilation



❖ Guided form compilation

ODK Collect > Point Of Interest

Date of report of the point of interest
Insert the current date or the date the report is referred to.

+	+	+
13	Jun	2013
-	-	-


10:25

❖ Guided form compilation


ODK Collect > Point Of Interest

Type of point of interest
Specify which kind of point of interest you wish to report by choosing one of the following options.


☐ point with panoramic view



☐ monument



☒ historical/monumental building



☐ place of worship


10:36

❖ Guided form compilation


ODK Collect > Point Of Interest

Classification of the point of interest
Classify the point of interest you wish to report by choosing one of the following options.


☐ castle



☒ villa



☐ palace



☐ lighthouse


10:36

❖ Guided form compilation

ODK Collect > Point Of Interest

Name of the point of interest
Type the name of the point of interest you wish to report.

Villa Olmo



10:37

❖ Guided form compilation

ODK Collect > Point Of Interest

Position of the point of interest

Be sure to be outdoors and check that the device GPS is on. Alternatively, you can also determine the position by connecting to a wi-fi network.

Replace Location

Latitude: N 45°48'6"
Longitude: E 9°5'43"
Altitude: 0m
Accuracy: 5m

Navigation icons: back, home, recent apps, menu, camera, gallery, files, settings, battery, 10:40, signal, Wi-Fi, battery


❖ Guided form compilation

ODK Collect > Point Of Interest

Picture showing the point of interest
Take a picture of the point of interest using the device camera or upload a picture available on the device.

Take Picture

Choose Image



10:45

❖ Guided form compilation

ODK Collect > Point Of Interest

You are at the end of Point Of Interest.

Name this form

Point Of Interest

☒ Mark form as finalized

Save Form and Exit

10:46

❖ Application main menu

ODK Collect > Main Menu

ODK Collect 1.3 (1030)
Data collection made easier...

Fill Blank Form

Edit Saved Form

Send Finalized Form

Get Blank Form

Delete Saved Form

10:22

❖ Application main menu

ODK Collect > Main Menu

ODK Collect 1.3 (1030)
Data collection made easier...

Fill Blank Form

Edit Saved Form

Send Finalized Form

Get Blank Form

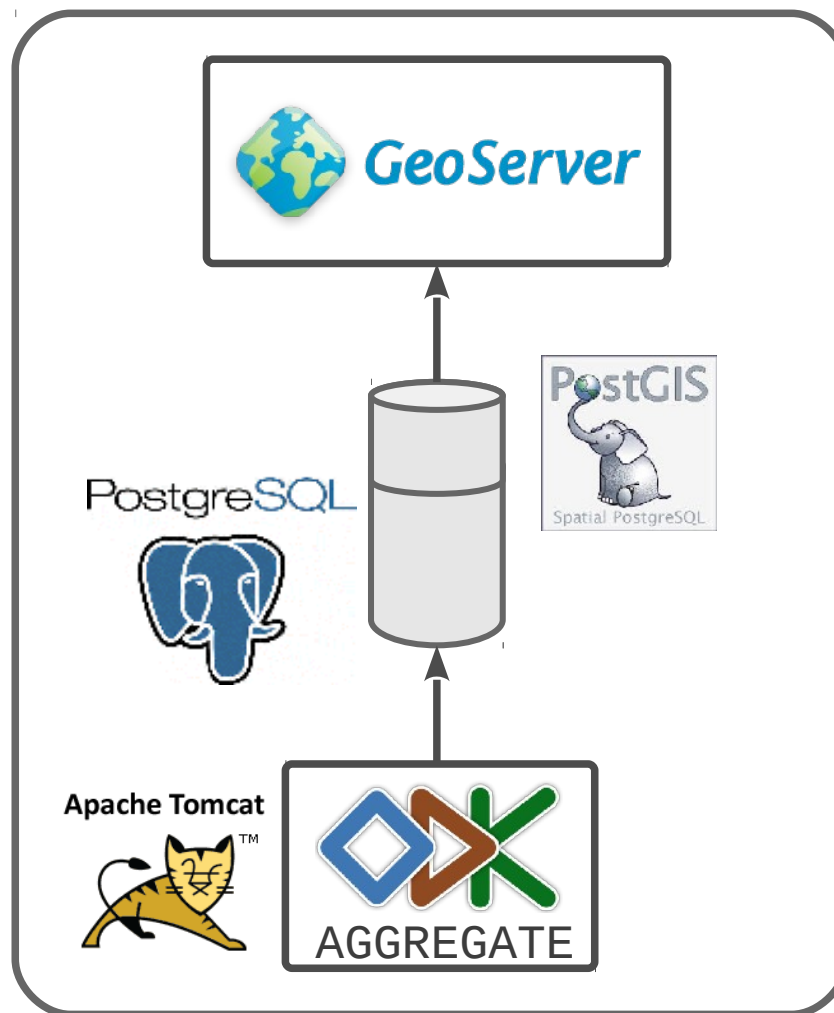
Delete Saved Form

10:22

Storage and publication



SERVER



2D view - computers

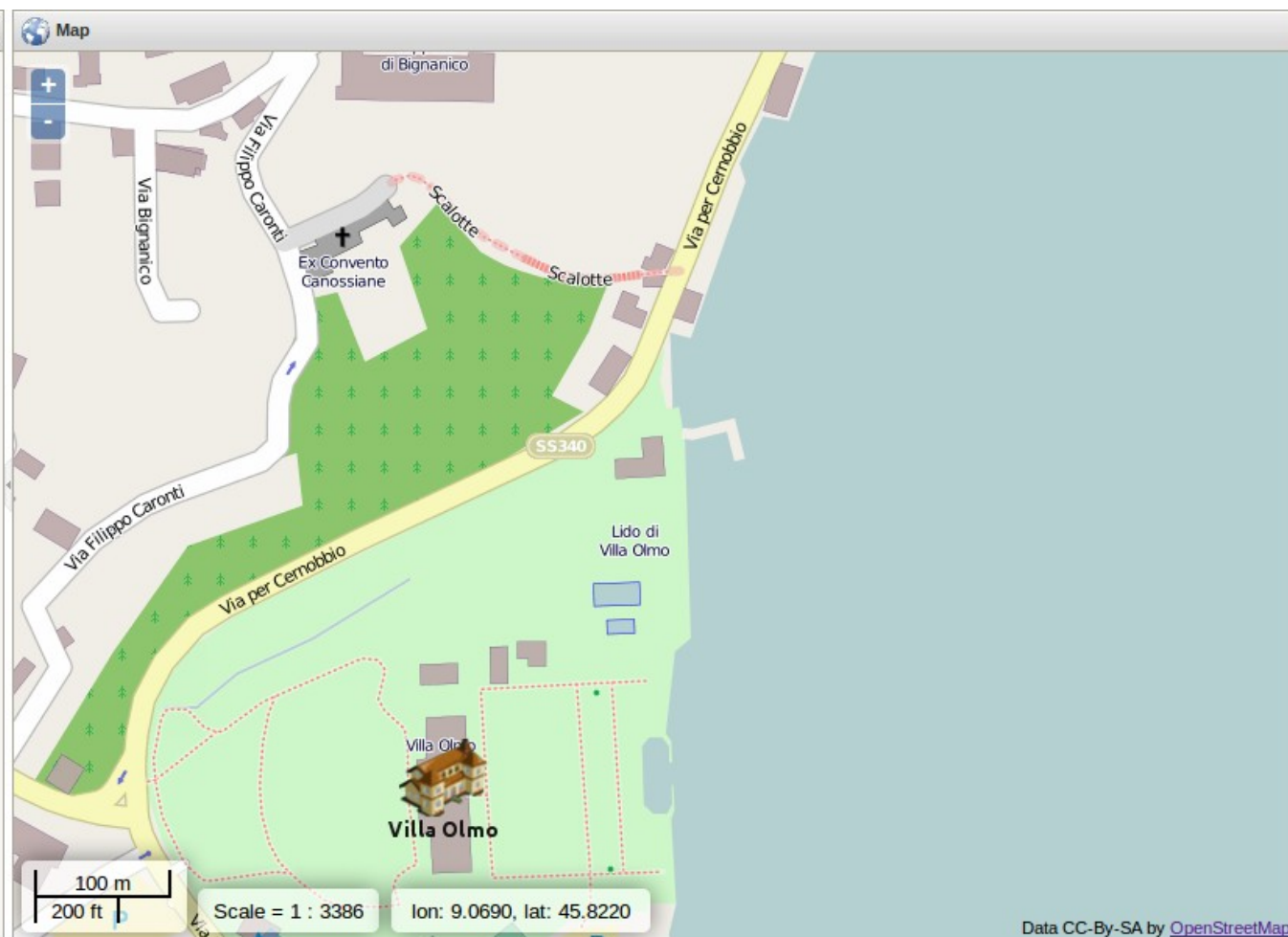


GeoExt ExtJS

Layer menu

- Base maps
 - ☒ OpenStreetMap
 - ☐ Mapquest OpenStreetMap
 - ☐ Google Streets
 - ☐ Google Hybrid
 - ☐ Google Satellite
 - ☐ Bing Road
 - ☐ Bing Aerial
 - ☐ Bing Aerial with Labels
 - ☐ Ortofoto Portale Cartografico Nazionale
- Points of interest
 - ☒ Points with panoramic view
 - ☐ point of naturalistic/landscape interest
 - ☐ point of architectural interest
- Monuments
 - ☒ statue/sculpture
 - ☐ fountain
 - ☐ historical monument
- Historical/monumental buildings
 - ☒ castle
 - ☐ villa
 - ☐ palace
 - ☐ lighthouse
 - ☐ bell tower
 - ☐ tower
- Places of worship
 - ☒ Places of worship
- Places of artistic/cultural activities
 - ☒ Places of artistic/cultural activities
- Sports facilities
 - ☒ Sports facilities
- Transport stations
 - ☒ Transport stations
- Events
 - ☒ Events

Map



di Bignanico

Via Filippo Caronti

Ex Convento Canossiane

Scalotte

Via per Cernobbio

SS340

Lido di Villa Olmo

Villa Olmo

Scale = 1 : 3386

lon: 9.0690, lat: 45.8220

Data CC-BY-SA by [OpenStreetMap](#)

2D view - computers



OpenLayers™

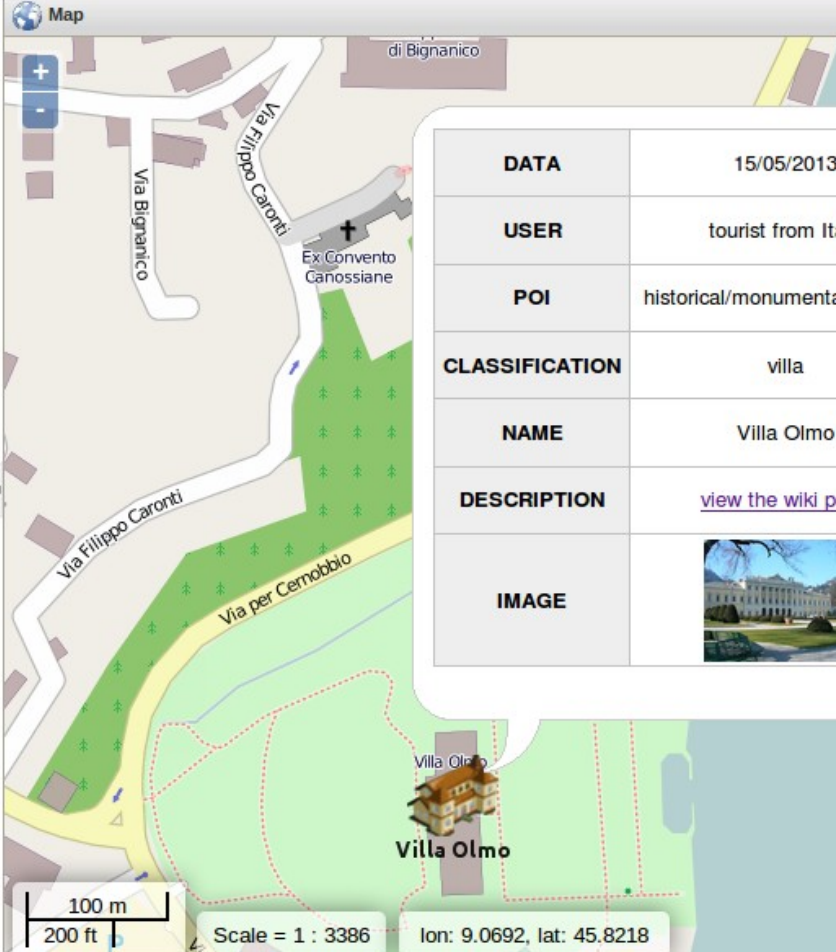



GeoExt ExtJS

Layer menu

- Base maps
 - ☒ OpenStreetMap
 - ☐ Mapquest OpenStreetMap
 - ☐ Google Streets
 - ☐ Google Hybrid
 - ☐ Google Satellite
 - ☐ Bing Road
 - ☐ Bing Aerial
 - ☐ Bing Aerial with Labels
 - ☐ Ortofoto Portale Cartografico Nazionale
- Points of interest
 - ☒ Points with panoramic view
 - ☐ point of naturalistic/landscape interest
 - ☐ point of architectural interest
 - ☒ Monuments
 - statue/sculpture
 - fountain
 - historical monument
 - ☒ Historical/monumental buildings
 - castle
 - villa
 - palace
 - lighthouse
 - bell tower
 - tower
 - ☒ Places of worship
 - ☒ Places of artistic/cultural activities
 - ☒ Sports facilities
 - ☒ Transport stations
 - ☒ Events

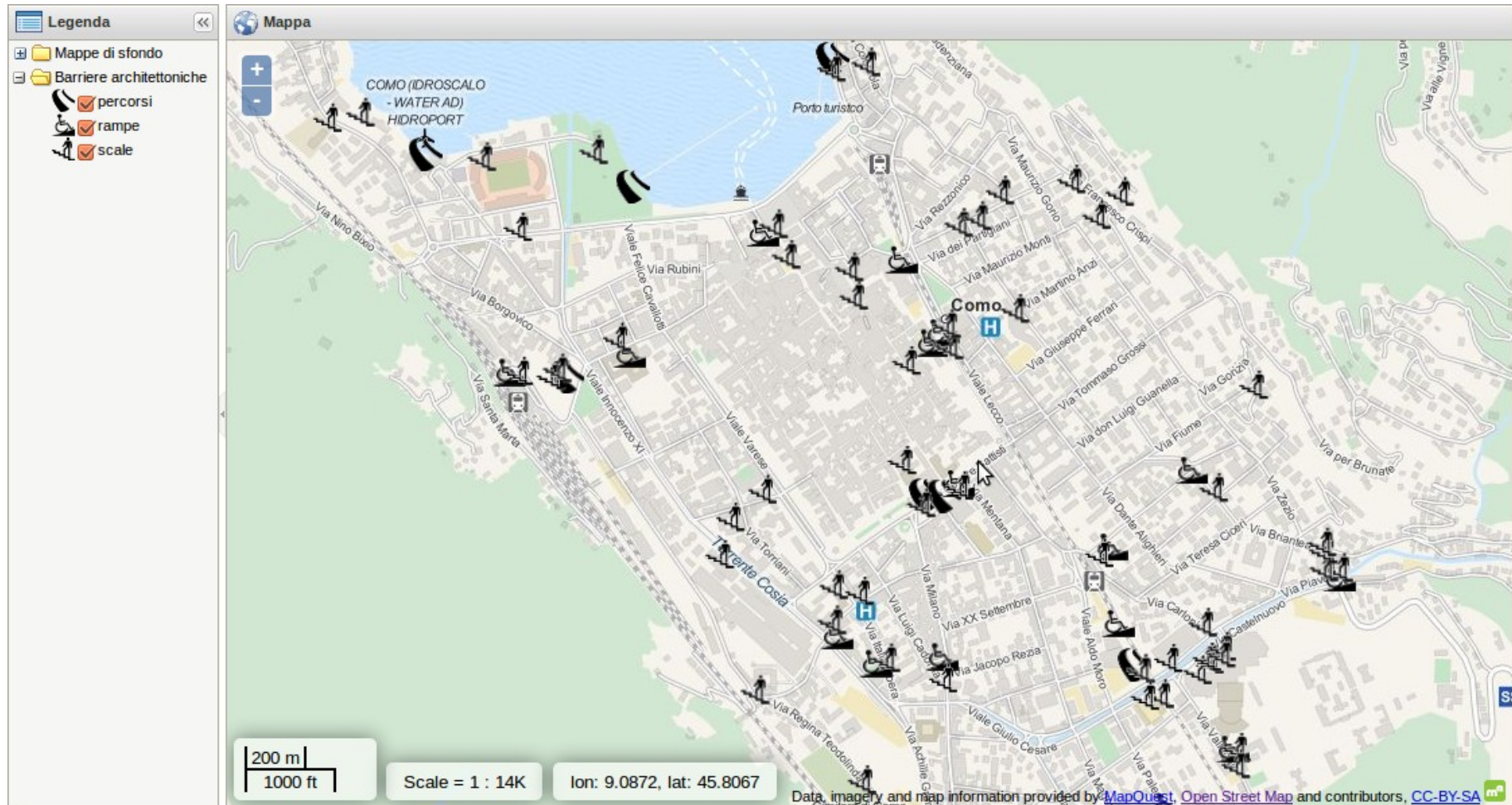
Map



DATA	15/05/2013
USER	tourist from Italy
POI	historical/monumental building
CLASSIFICATION	villa
NAME	Villa Olmo
DESCRIPTION	view the wiki page
IMAGE	

100 m
200 ft
Scale = 1 : 3386
lon: 9.0692, lat: 45.8218

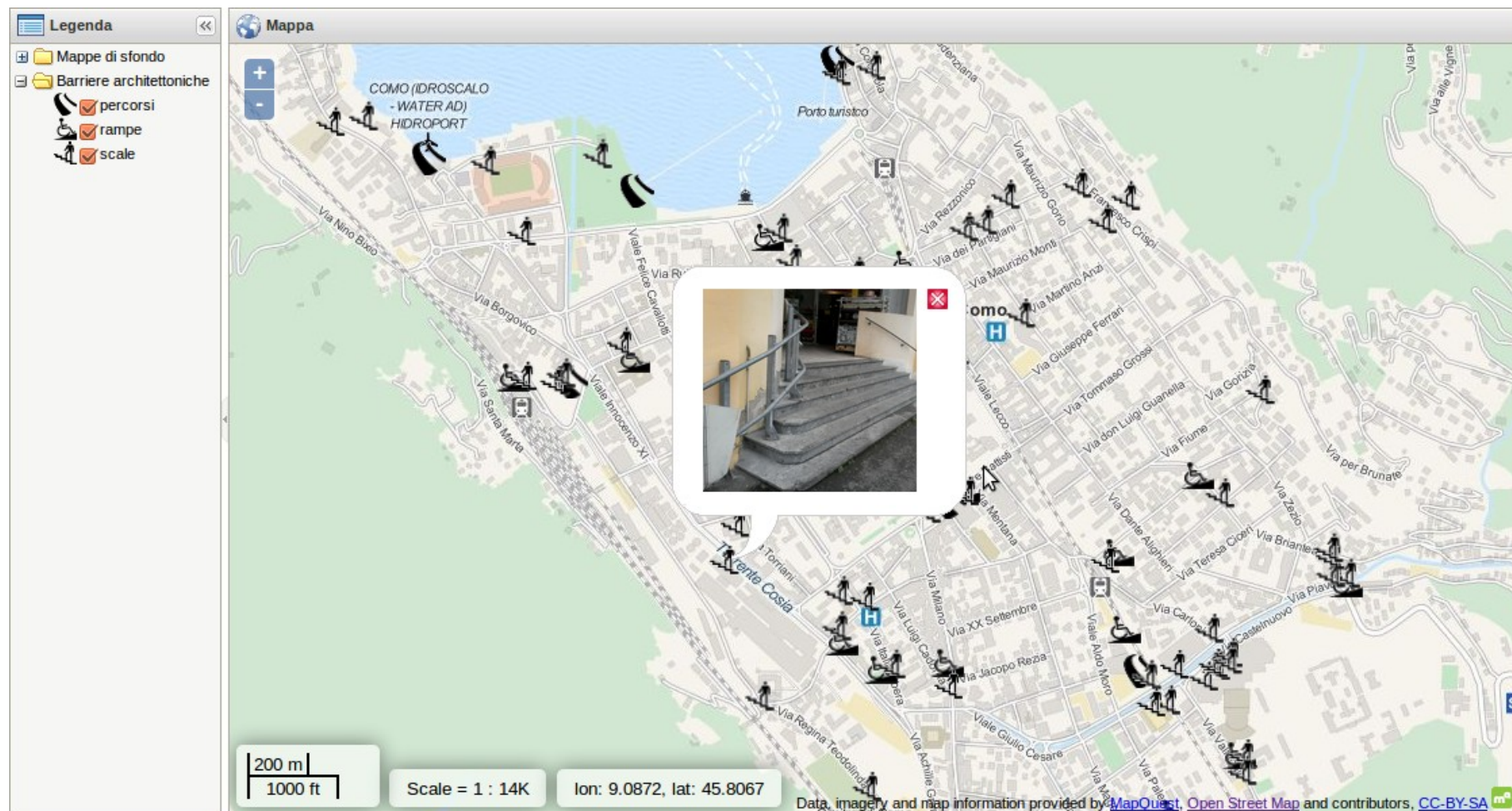
Data CC-BY-SA by [OpenStreetMap](#)



2D view - computers



GeoExt ExtJS

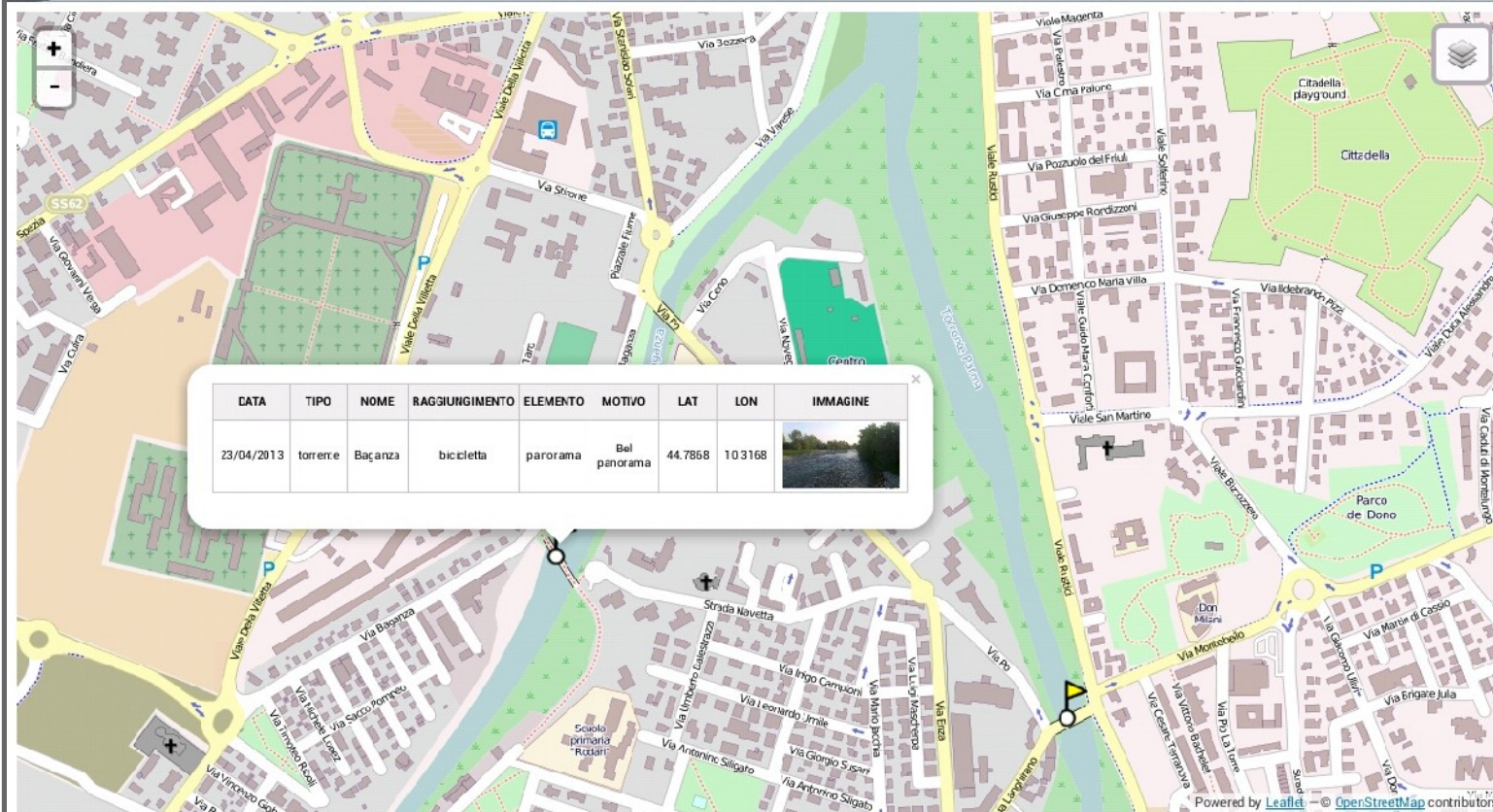



2D view - tablets



Leaflet

1. Segnalazioni ADBPO - tablet

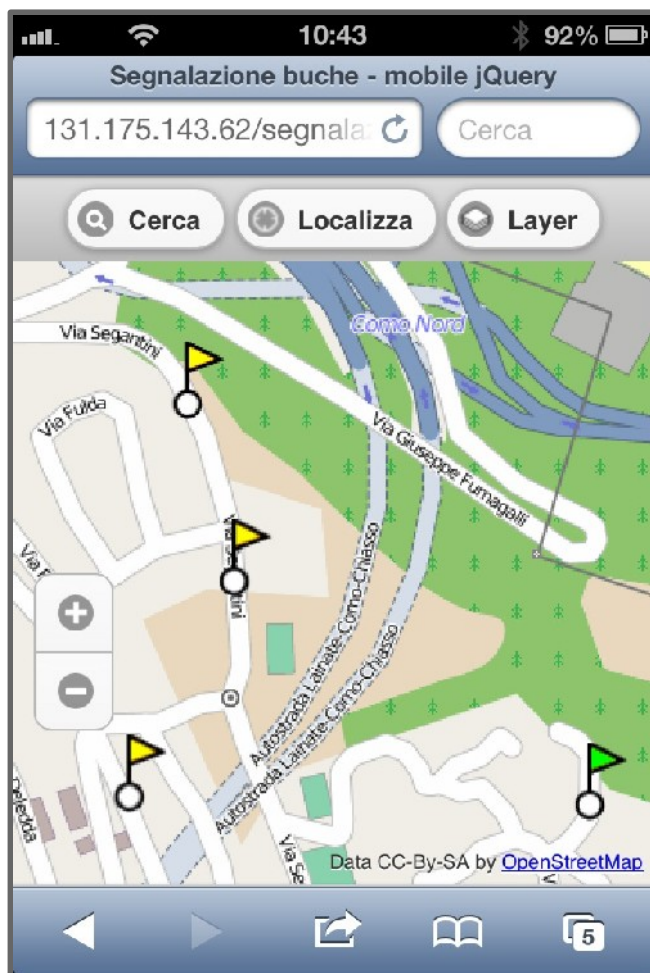


DATA	TIPO	NOME	RAGGIUNGIMENTO	ELEMENTO	MOTIVO	LAT	LON	IMMAGINE
23/04/2013	torr.re	Bačanza	bicicletta	parorama	Bel panorama	44.7858	10.3168	

Powered by Leaflet - OpenStreetMap contributors

17:08

2D view - smartphone



- ❖ PoliCrowd is a Web-based 3D Participatory GIS platform
 - <http://geomobile.como.polimi.it/policrowd>
 - born to promote **tourism and cultural heritage**
 - interaction with user **mobile devices** for uploading Points Of interest (POIs)
 - POIs **three-dimensional visualization** on World Wind virtual globe
 - user **collaborative contribution** in POIs characterization
 - creating, saving and sharing **customized maps** with the community



❖ NASA's virtual globe

- <http://goworldwind.org>
- free and **open source** under the NASA Open Source Agreement (NOSA) license
- Java Software Development Kit (**SDK**)
- multi-platform (Java: "Write once, run anywhere")
- JOGL (Java OpenGL 3D – Engine)
- 3D Web visualization as Java Application, Java Applet or Java Web Start Application
- based on open standards, accommodates any desired data format

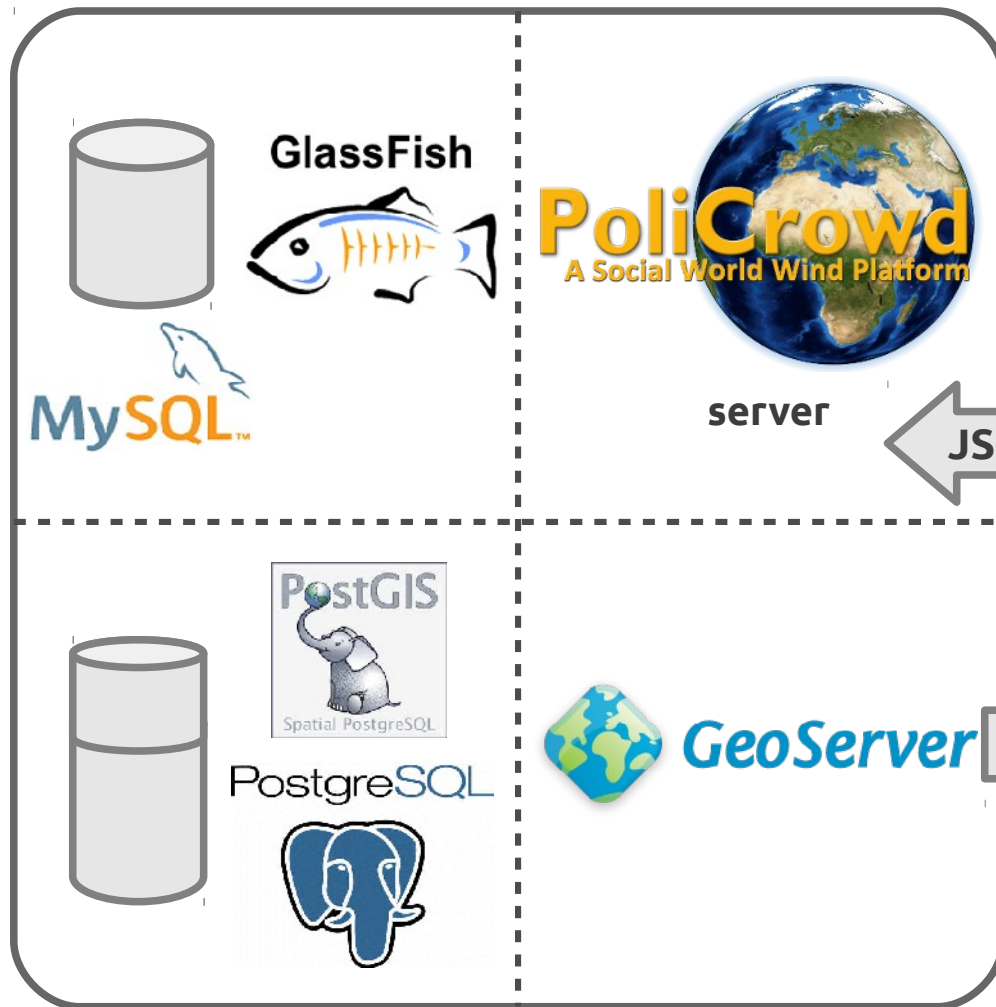
❖ Main features

- quality/accuracy control of horizontal (texture) and vertical (DTM) components
- upload layers from OGC-compliant WMS servers
- default WMS layers (i.e. satellite imagery and DTMs) from NASA and USGS
- 2D objects (e.g. lines, polygons, markers) and 3D objects (e.g. parallelepipeds, spheres, extruded polygons) can be placed on the globe or in its surroundings

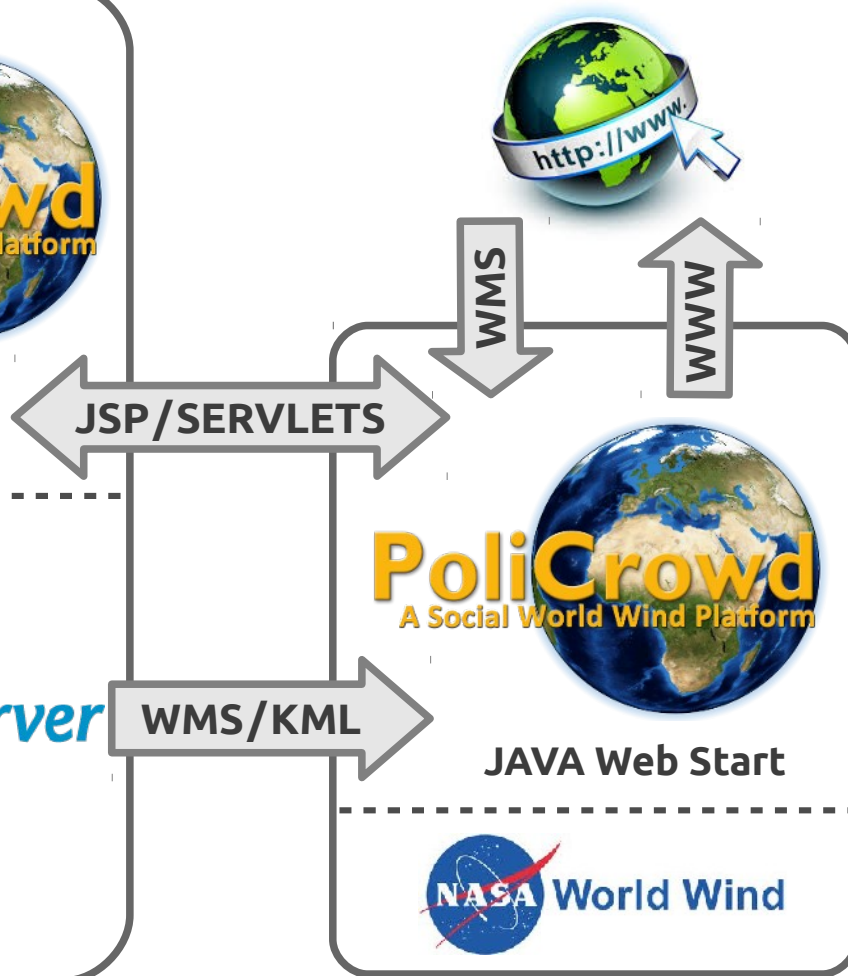
PoliCrowd architecture



SERVER



CLIENT



3D data visualization

- ❖ Points Of Interest (POIs) retrieval from GeoServer
 - parsing of **three KML files** globally representing POIs
- ❖ Points Of Interest (POIs) 3D visualization on top of World Wind
 - access provided to **all PoliCrowd users**
 - POIs rendering through **LOD** (Level Of Detail) technique according to the altitude of the point of view over the globe:
 - ✗ **first LOD**: representation of all the POIs with a **common icon** (i.e. a pin)



3D data visualization

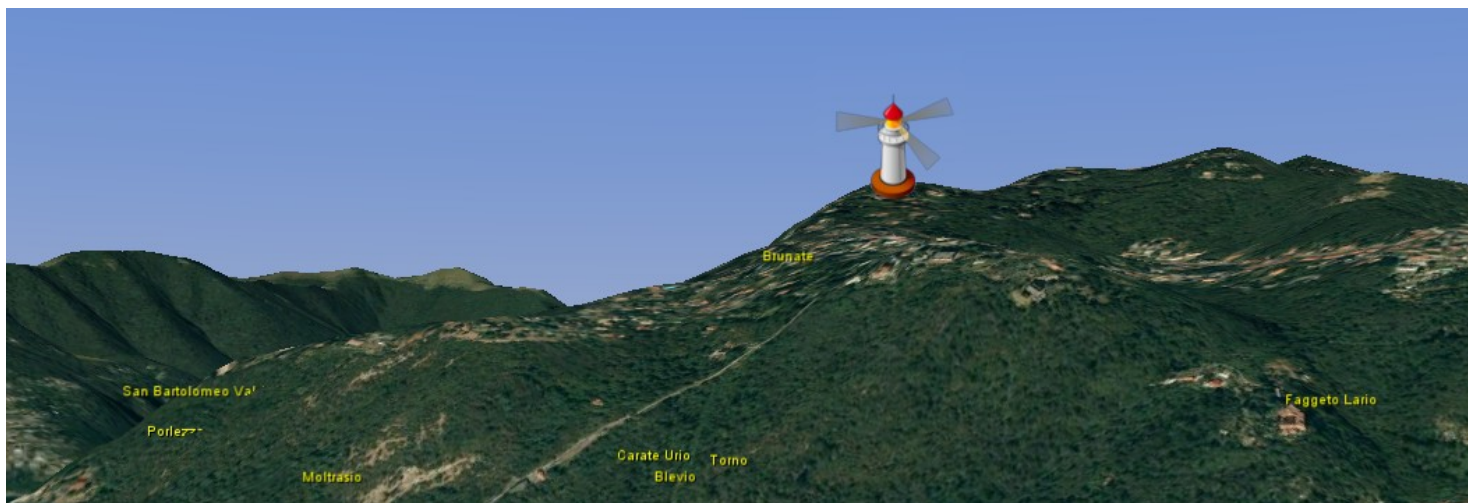


- ❖ Points Of Interest (POIs) retrieval from GeoServer
 - parsing of **three KML files** globally representing POIs
- ❖ Points Of Interest (POIs) 3D visualization on top of World Wind
 - access provided to **all PoliCrowd users**
 - POIs rendering through **LOD** (Level Of Detail) technique according to the altitude of the point of view over the globe:
 - ✗ **second LOD**: representation of POIs with icons showing their **category**



3D data visualization

- ❖ Points Of Interest (POIs) retrieval from GeoServer
 - parsing of **three KML files** globally representing POIs
- ❖ Points Of Interest (POIs) 3D visualization on top of World Wind
 - access provided to **all PoliCrowd users**
 - POIs rendering through **LOD** (Level Of Detail) technique according to the altitude of the point of view over the globe:
 - ✗ **third LOD**: representation of POIs with icons showing their **classification**

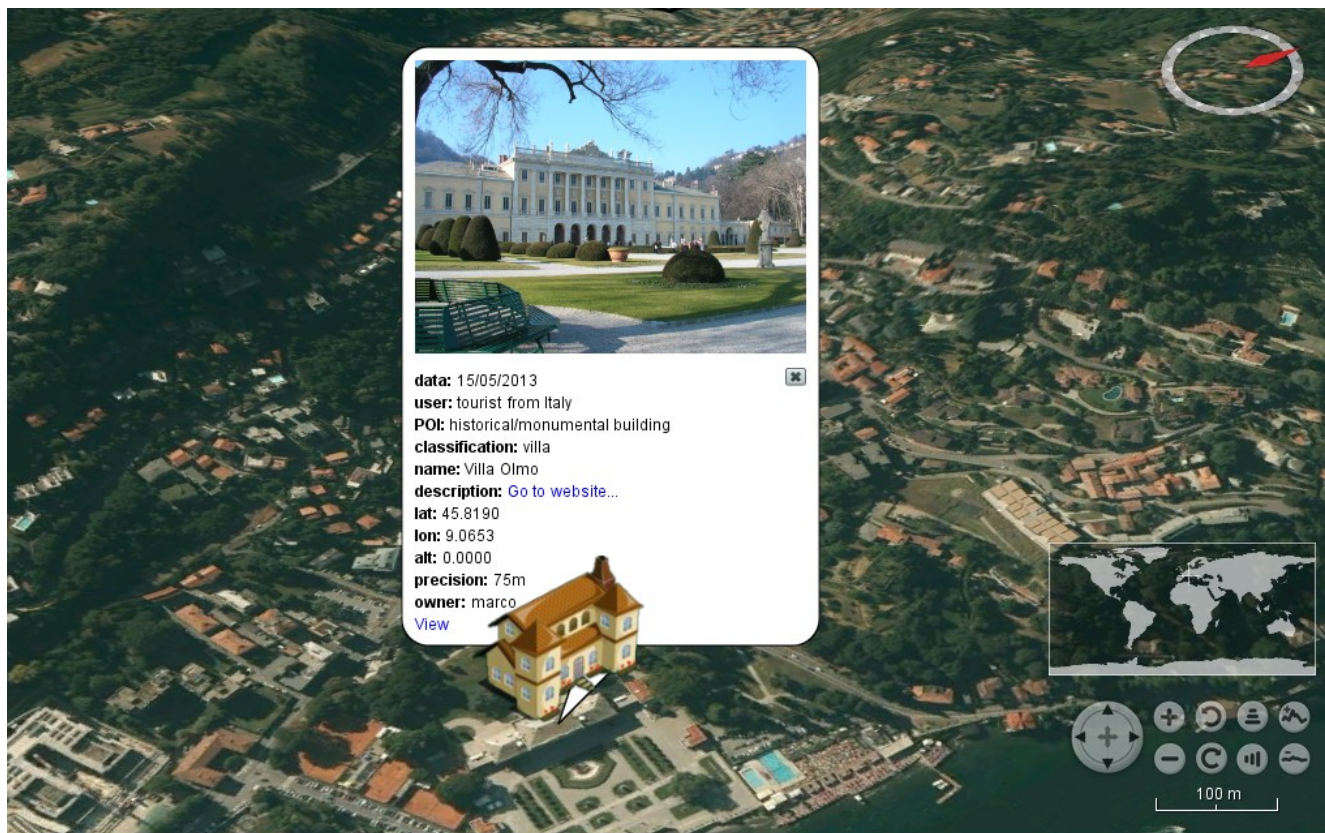


3D data visualization



❖ Querying Points Of Interest

- clickable POIs placemarks
- visualization of Android ODK Collect-reported information in a **balloon**



Interaction with POIs

- ❖ Balloon access to POIs information according to **user privileges**
 - PoliCrowd non registered users provided with a *View* button
 - PoliCrowd registered users provided with a *View/Edit* button



Interaction with POIs

- ❖ Balloon access to POIs information according to **user privileges**
 - PoliCrowd non registered users provided with a *View* button
 - PoliCrowd registered users provided with a *View/Edit* button
- ❖ POIs interaction based on **user privileges**
 - all PoliCrowd users - even if not registered to the platform - can **access** POIs description and view the contents added by registered users
 - PoliCrowd registered users can **contribute** to POIs characterization by adding and manipulating comments and multimedia contents (i.e. images, videos and audios)

- ❖ View page for non-registered users

View Related Media and Comments





Data: 25/05/2013
User: Italian citizen
POI: place of worship
Classification: church/basilica
Name: Basilica di San Fedele
Description: [http://en.wikipedia.org/wiki/Basilica_di_San_Fedele_\(Como\)](http://en.wikipedia.org/wiki/Basilica_di_San_Fedele_(Como))
Lat: 45.8097
Lon: 9.0846
Alt: 0.0000
Precision: 75m
Owner: marco




- ❖ View/upload page for registered users

View Related Media and Comments



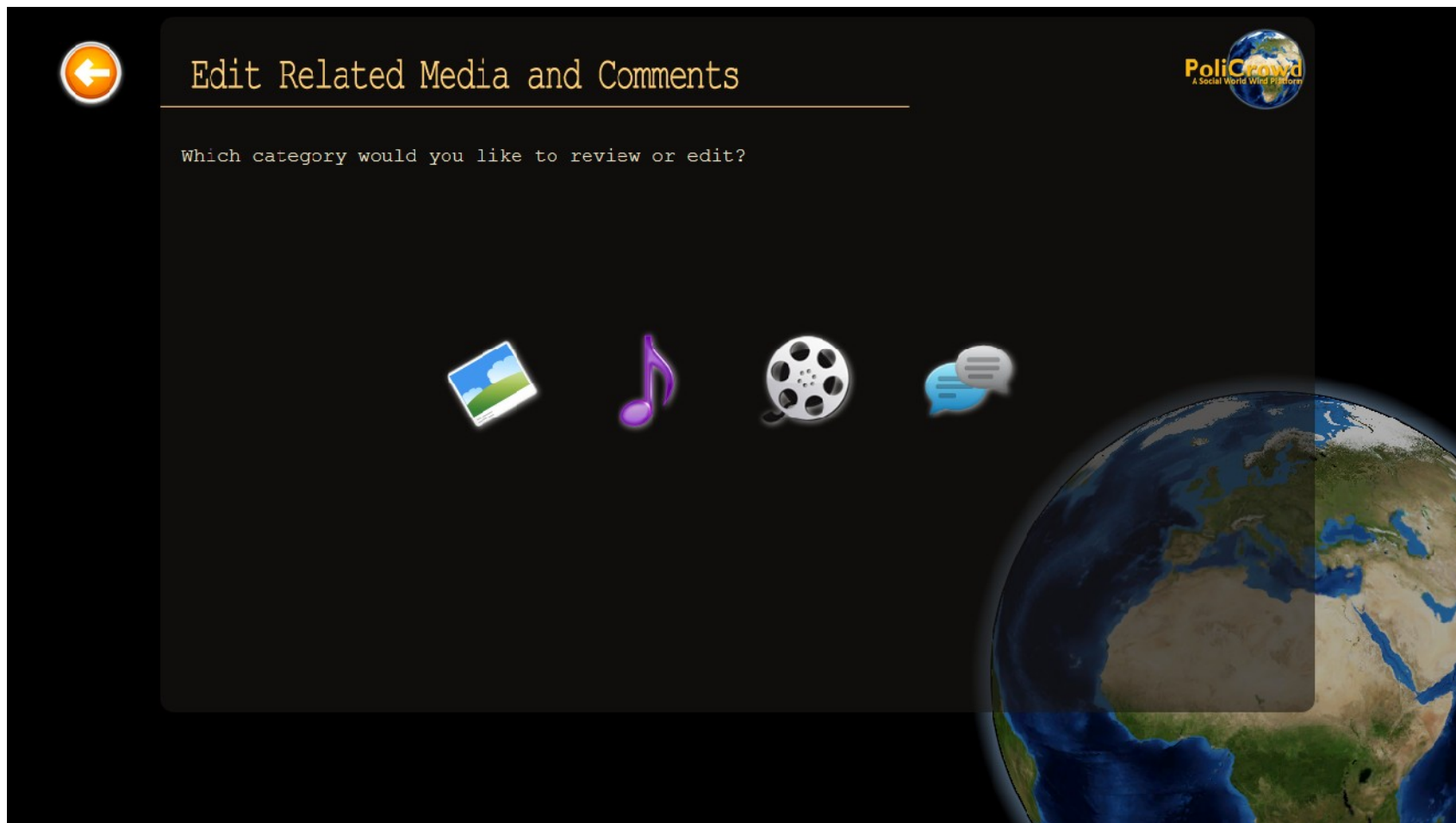
Data: 25/05/2013
User: Italian citizen
POI: place of worship
Classification: church/basilica
Name: Basilica di San Fedele
Description: [http://en.wikipedia.org/wiki/Basilica_di_San_Fedele_\(Como\)](http://en.wikipedia.org/wiki/Basilica_di_San_Fedele_(Como))
Lat: 45.8097
Lon: 9.0846
Alt: 0.0000
Precision: 75m
Owner: marco





PoliCrowd
A Social World Wide Platform

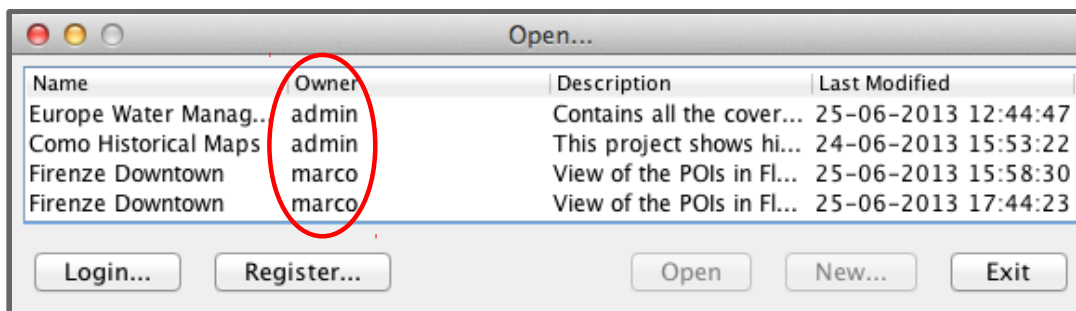
- ❖ Add/edit comments and multimedia contents (registered users only)



Creating/saving projects



- ❖ Creation of a new PoliCrowd project
 - authenticated users can create a new project, entering a name and a description
- ❖ Saving a PoliCrowd project
 - storage of the **current layers**, the **position** (i.e. latitude, longitude and altitude) and the **camera orientation** of the point of view over the globe
- ❖ Visualization of user-created projects
 - all the created project feed a **catalogue** available for the whole community
 - the catalogue keeps trace of the project owner

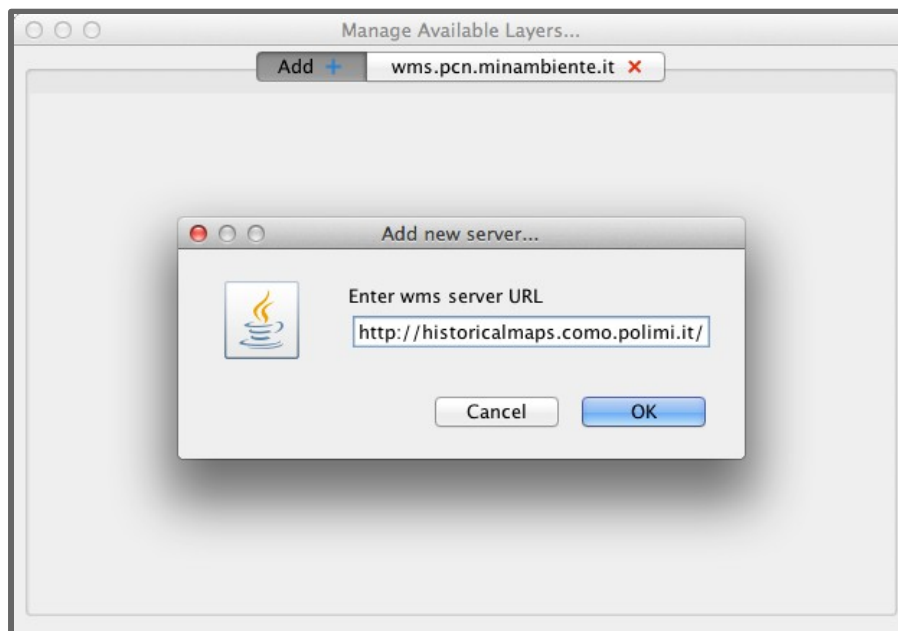


Name	Owner	Description	Last Modified
Europe Water Manag..	admin	Contains all the cover...	25-06-2013 12:44:47
Como Historical Maps	admin	This project shows hi...	24-06-2013 15:53:22
Firenze Downtown	marco	View of the POIs in Fl...	25-06-2013 15:58:30
Firenze Downtown	marco	View of the POIs in Fl...	25-06-2013 17:44:23

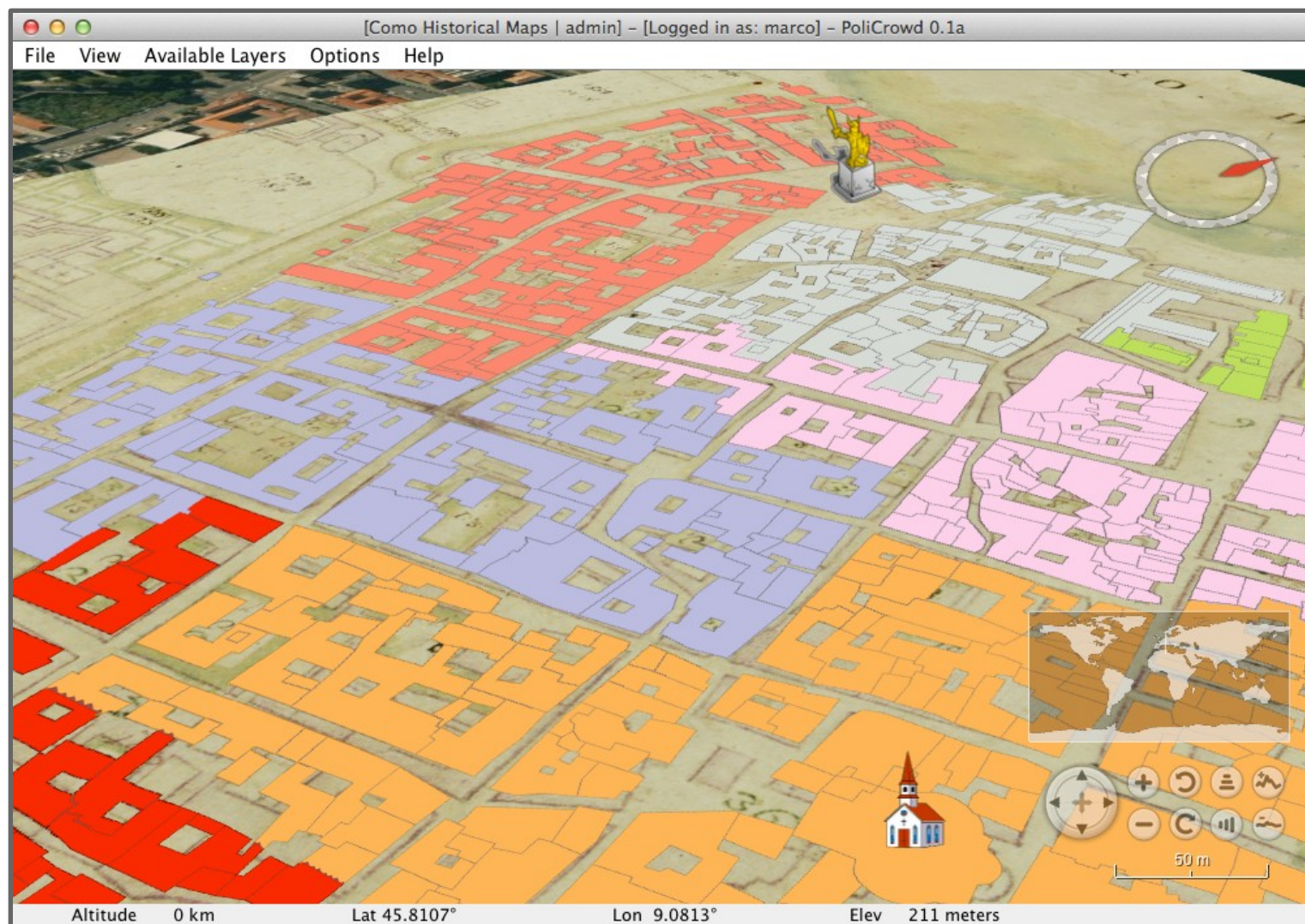
- all users can visualize PoliCrowd projects
- project owners have also **editing options** available

Adding WMS layers

- ❖ Adding layers from available **WMS servers**
 - option available only for registered users
 - users have to enter a valid WMS **server URL** and then select from the list the desired layer(s)
 - all the WMS layers added to a PoliCrowd project feed a **catalogue** available for the whole community



Creating layer mash-ups



PoliCrowd team

- ❖ Winner of the first NASA World Wind Europa Challenge in Florence (<http://eurochallenge.como.polimi.it>)
- ❖ Team composed by
 - a mentor:
 - ✗ Giorgio Zamboni
 - 4 students:
 - ✗ Michele Bianchi
 - ✗ Marco Minghini
 - ✗ Rodi Jolak
 - ✗ Andrés Quiñones



Conclusions

- ❖ FOSS architecture for a Web-based participatory GIS system
 - data collection on the field
 - data Web visualization and sharing
 - 3D fully-participatory platform
- ❖ Future improvements
 - extension of the ODK Collect app to overcome positioning problems (i.e. absence of GPS, poor GPS accuracy, mismatch between the position where the picture is taken and the position of the object being photographed)
 - ✗ positioning refinement through an interactive map
 - ✗ allowing positioning also for non GPS-enabled devices
 - synchronisation of user profiles on ODK toolkit and PoliCrowd platform

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Thanks for your attention!

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