Republic Geodetic Authority of Serbia
Active Geodetic Reference Network of Serbia-AGROS-

United Nations/Turkey/European Space Agency Workshop on “Space Technology Applications for Socio-Economic Benefits”
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General information on the Republic of Serbia

- Surface of the Republic of Serbia is 88,361 km²
- Republic of Serbia has 10,086,800 citizens (data from 2001)
- Belgrade is the capital, with 2,136,786 citizens (data from 2006)
- 23 cities (special territorial units)
- 189 political municipalities
- 4,522 cadastral municipalities
- 18,823,336 cadastral parcels
- 4,230,942 real estate sheets
Development of the Republic Geodetic Authority

Republic Geodetic Authority (RGA) was established in 1992. under this name, through the integration of:

1. Republic geodetic administration;
2. Geodetic authority;
3. Agency for photogrammetry (staff members were also taken over);
4. Municipal geodetic administration (cadastres);
5. City geodetic authority for the City of Belgrade.

The Law on state survey and cadastre and real estate rights registrations (1992.), stipulates competences of the newly-formed RGA (the Law is not in force since 11th September 2009.)
Competence on RGA

GOVERNMENT OF REPUBLIC OF SERBIA

MINISTRIES

MINISTRY FOR THE ENVIRONMENT AND SPATIAL PLANNING

SPECIAL ORGANIZATIONS

REPUBLIC GEODETIC AUTHORITY
Legal framework

Law on state survey and cadastre
- *In force since 11th September 2009.*
RGA’s scope of works...

RGA’s scope of works includes geodetic and other public administration activities, concerning:

1. Basic geodetic works (Active Geodetic Reference Network of Serbia-AGROS);
2. Cadastral survey and land consolidation;
3. Establishment, renewal and maintenance of the Real Estate Cadastre;
4. Line (utilities) cadastre, establishment and maintenance;
5. Professional control over geodetic works;
6. Issuing and revoking licenses for geodetic organization;
7. Supervision of works performed by geodetic organizations;
8. Issuing and revoking licenses for aerial surveys over Republic of Serbia’s territory, for state survey maintenance purposes;
RGA’s scope of works...

9. Address registry;
10. Maintenance of the Spatial units registry;
11. State border survey;
12. Determination of cadastral class and land fertility levels;
13. Cadastral revenue determination;
14. Real estate valuation and maintenance of real estate value registers;
15. **Remote sensing, topographic survey and mapping**;
16. Issuing cartographic and other types of publications; approving cartographic product publication;
RGA’s scope of works...

17. Managing cartographic name registers;
18. Establishment, maintenance and utilization of geodetic & cadastral information system;
19. Managing archives relating to state survey, Real Estate Cadastre, Utilities cadastre and topographic & mapping activities;
20. Establishing and maintaining National spatial data infrastructure (NSDI);
21. Validation of geodetic bases in engineering & technical fields;
22. Offering its consultancy to the Authority in the field of international cooperation.
Article 32

Spatial reference system for Republic of Serbia is terrestrially three dimensional coordinate system that under the definition of coordinate beginning, orientation of coordinate axis, ratio, length unit and time evolution, coincides with European terrestrial reference system – European Terrestrial Reference System 1989, (further on as: ETRS89).

For the first time AGROS was also defined explicitly by a Law act together with introducing of a new system. In the section of Law defining the concepts AGROS is defined as follows: “AGROS” presents the Network of permanent stations of global positioning system for the territory of Republic of Serbia.

Article 38, paragraph 2

While in the section of Law defining the realization of the new Spatial reference system AGROS is introduced through the article 38, paragraph 2 that says: Spatial and horizontal reference systems in paragraph 1 of this article are defined by the Reference network of Republic of Serbia – SREF and by the Network of permanent stations of Republic of Serbia – AGROS.
Aktivna Geodetska Referentna Osnova Srbije

(Active Geodetic Reference Network of Serbia)

AGROS - Active Geodetic Reference Network of Serbia (AGROS) is a permanent GNSS service of accurate satellite positioning on the Republic of Serbia’s territory.
Project and establishment...

• Activities relating to AGROS establishment began in December 2001, when necessary technical documentation was produced;

• In February 2002, cooperation was established with the European Academy of the Urban Environment regarding the establishment of a permanent GNSS station network for 16 countries in Central and Eastern Europe, called EUPOS (European Position Determination System);

• On that occasion, it was decided that – by harmonizing technical standards – the existing AGROS project should become sub-project of a EUPOS system.

AGROS=EUPOS
Republic Geodetic Authority (RGA) in June 2003 began implementation of permanent GNSS station network Project for the Serbian territory – AGROS.

AGROS is designed as a central system, comprised of three interlinked components:
1. permanent station component,
2. communication component and
3. user component.
Permanent station component

Basic founding principles of AGROS have been devised strictly according to EUPOS rules (Standard Summary – June 2003):

- Permanent stations must be mainly evenly distributed, covering the whole of Serbian territory (34 GNSS permanent stations);
- The average distance between stations is 70 km;
- Receiver’s antenna must be placed on stable terrain, not in the vicinity of devices that represent sources of electromagnetic radiation (active or passive);
- Elevation mask must be 15 degrees and the area above the elevation mask must be such as to provide undisturbed reception of satellite signals.

Since such a system depends on several factors and primarily on telecommunication infrastructure, original draft design had to be readjusted, in order to find an optimal solution given the conditions.
Communication and user component

Communication component basically consists of:
- control center,
- telecommunication components that provide links between GNSS permanent stations and the control center, and
- telecommunication components necessary for linking the control center and the user component.

Control center structure must provide data reception from GNSS permanent stations, its processing and user communication.

Based on the requirements mentioned and according to AGROS Project design, the following (minimal) control center configuration has been defined: computer and an adequate application supporting control center’s operation, server dedicated to permanent stations’ data reception and user communication server.
Communication and user component

Permanent stations are planned to communicate with the control center via analogue or digital telephone lines, while the users are planned to communicate via the Internet or using GPRS/GSM technology, through 3 user services:

- RTK - < 2-3cm accuracy (FKP and VRS)
- DGPS - accuracy < 50cm
- Postprocessing
Establishing and exploitation...

- Active Geodetic Reference Network of Serbia – AGROS was established on 1\textsuperscript{st} of December 2005.
- Economic exploitation started on 16\textsuperscript{th} of December 2005.
- Presently, the network consists of 32 GNSS permanent stations (2 GNSS stations receive corrections from GALILEO satellites).
GNSS permanent stations - equipment

GNSS permanent stations are with Trimble’s equipment:

- mainly 5700
- 4 stations – 4400
- 1 station – NetRS
- 2 stations – NetR5

The antennas are Zephyr Geodetic and Choke Ring:

- 2 Choke Ring antennas
- 30 Zephyr Geodetic antennas
GNSS permanent stations…

- The stations are located on the RGA’s local offices buildings (linked via optical cables to the control center);

- The one station is located on the building of Faculty of Civil Engineering – Belgrade (connected via the Internet to the control center).
Control center...

The control center is located in RGA’s Headquarters in Belgrade, where data acquisition is performed.
Control center...

The connection to the control centre is established through optic cables – L2VPN
Communication between users and control center has been established by using Internet or GPRS technology, through 3 user’s services:

- **RTK**
- **DGPS**
- **Postprocessing**

<table>
<thead>
<tr>
<th>Work regime</th>
<th>Service name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRS</td>
<td>VRS_2.3</td>
<td>Service based on RTCM 2.3</td>
</tr>
<tr>
<td></td>
<td>VRS_3.0</td>
<td>Service based on RTCM 3.0</td>
</tr>
<tr>
<td></td>
<td>VRS_DGPS_2.3</td>
<td>DGPS service based on RTCM 2.3</td>
</tr>
<tr>
<td>RTK</td>
<td>RTK_SB_2.3</td>
<td>Service based on RTCM 2.3. All determinations by using of this service are effected by using of only the nearest AGROS station</td>
</tr>
<tr>
<td></td>
<td>DGPS_SB_2.3</td>
<td>Service based on RTCM 2.3. All determinations by using of this service are effected by using of only the nearest AGROS station</td>
</tr>
<tr>
<td>Network service</td>
<td>RTCM3Net</td>
<td>System starts assuming that the receiver is capable of independently applies the network correction, if there are correct RTK messages. They are obtained from the control centre together with relevant data from 6 closest permanent stations Postprocessing by using of one AGROS station</td>
</tr>
<tr>
<td></td>
<td>CORS</td>
<td></td>
</tr>
<tr>
<td>Postprocessing</td>
<td>VRS</td>
<td>Postprocessing by using a virtual AGROS station which is created in a chosen spot in advance, datum, the time of start and end of work.</td>
</tr>
<tr>
<td></td>
<td>Automatically</td>
<td>By e-mail the user sends RINEX data files to control centre, and the data are processed together with the data from at least 5 AGROS permanent stations by Bernese software package. After the processing is done data with a report are sent to the user also by e-mail.</td>
</tr>
<tr>
<td></td>
<td>iGate</td>
<td>Trimble protocol – the user who collected the data in the field is enabled to let the system itself automatically process the data or to prepare the adequate data and send them to the user by connecting the equipment to AGROS</td>
</tr>
</tbody>
</table>
Rover…

The users mainly use VRS – Virtual Referent Stations for field measuring.
Users...

At the moment, there are about 240 users:
- Private companies
- Academic institutions

- 90% of the users utilize the RTI service
- The price of the service is \(~ 0.18 \text{ € / min}\)
- Flat rate
# Prices...

<table>
<thead>
<tr>
<th></th>
<th>AGROS</th>
<th>AGROS RTK</th>
<th>AGROS DGPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Price per started minute</td>
<td>13,6</td>
<td>8,5</td>
</tr>
</tbody>
</table>

**Using per hours**

<table>
<thead>
<tr>
<th></th>
<th>10 hours</th>
<th>8,500,00</th>
<th>5,320,00</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>20</td>
<td>13,600,00</td>
<td>8,500,00</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>21,250,00</td>
<td>13,290,00</td>
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</table>

**Flat Rate**

<table>
<thead>
<tr>
<th></th>
<th>1 months</th>
<th>27,200,00</th>
<th>17,000,00</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6</td>
<td>142,800,00</td>
<td>63,750,00</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>255,000,00</td>
<td>127,500,00</td>
</tr>
</tbody>
</table>

| 9  | AGROS PP (per hour) | 1,020,00 | 595        |

(1 € = 105 RDS)
Coordinates...

- The network was calculated according to EUREF standards.
- The calculations took 24 hours.
- The network closure is about 1 cm.
- Total control software was used.
- Reference frame ITRF96, epoch 1998.7
Software

• GPS Net

• For data processing Bernese software is used
New software – test phase

Trimble VRS$^3$Net
New software – test phase

Working process control and control of users:
By the end of August a new GPS measurement campaign in 12 points (6 points EUREF, 6 points SREF) is finished.

- For 5 days
- 24 hours a day
- Data processing will be done in Bernese software
- The results will be presented to the ETWG (EUREF Technical Work Group) committee
- The new realization of the system will be ETRS89
- In new referent system realization we will be following EUREF guidelines
Future activities

- Establishment of GLONASS stations in major towns has been planned to be done by the end of this year (purchase three new equipment items - 3 NetR5);
- With existing 2 GNSS stations and 8 GNSS stations with Leica 1200GG+ equipment, almost all territory of Serbia will be covered by GLONASS.
- Establishment of the backup control center.
- Establishment of the alarm systems.
Future activities

Integration within EPN (European Permanent Network of GNSS permanent stations):
- It is planned to connect 2 GNSS permanent stations to the EUREF permanent Network.
International Cooperation

Consortium for Central European GPS Geodynamic Reference Network (CEGRN)

- Participation in international campaigns such as CEGRN.
- Five GNSS permanent stations are taking part in this campaign.
International Cooperation

Currently, the AGROS network is involved in several projects, such as data exchange with the University of Arizona - The project purpose is the research on Earth crust deformation.

Dr. Richard A. Bennett,

University of Arizona Department of Geosciences Tectonic geodesy

Deformation Earth crust

Serbia 2mm per year

http://geodesy.geo.arizona.edu/pages/publications.php
International Cooperation

Cooperation with the Italian Institute for Volcanology and Geophysics—research on seismic movements.

Mr. Giulio Selvaggi
Head of the National Earthquake Center of INGV-Instituto Nazionale di Geofisica e Vulcanologia, AOO Roma

www.ingv.it
International Cooperation

GNSS permanent stations in the Republic of Serbia are being connected or tested to GNSS stations within the neighbouring countries:

- GNSSnet.hu (Republic of Hungary) – connected 2009
- MAKPOS (Republic of Macedonia) – in the test phase
- BULIPOS (Republic of Bulgaria) – in the test phase
- CROPOS (Republic of Croatia) – test phase is finished
- ROMPOS (Republic of Romania) – begining of the test phase
International Cooperation

Cooperation with the neighbouring countries - Institute of Geodesy, Cartography and Remote Sensing - FÖMI, Budapest, Hungary – Republic Hungary GNSS network – GNSSnet.hu

http://www.sgo.fomi.hu
International Cooperation

Cooperation with the neighbouring countries – Republic Macedonia
GNSS network - MAKPOS

MAKPOS
International Cooperation

Cooperation with the neighbouring countries – Republic Bulgaria
GNSS network - BULiPOS
International Cooperation

Cooperation with the neighbouring countries – Republic Croatia
GNSS network - CROPOS
International Cooperation

Cooperation with the neighbouring countries – Republic Romania

GNSS network - ROMPOS
International Cooperation

Cooperation with the neighbouring countries – Republic Montenegro
GNSS network - MONTEPOS

Network expanding

- 4 external stations
  - Croatia, 2 stations
  - Serbia, 2 stations

- Waiting for other neighborhood countries
The network may be accessed via RGA’s official website – [www.rgz.gov.rs](http://www.rgz.gov.rs) and also via the network’s website – [http://agros.rgz.gov.rs](http://agros.rgz.gov.rs).
The network may be accessed via RGA’s official website – www.rgz.gov.rs and also via the network’s website – http://agros.rgz.gov.rs.
www.geosrbija.rs [Map Browser]
NSDI (National Spatial Data Infrastructure) – Initial activities

RGA as provider of fundamental spatial data has the key role in implementation of the infrastructure of spatial data at the national level in accordance with the current European initiatives.

Draft Strategy for Establishment of the NSDI for the period 2010 – 2012

Metadata standard is defined, based on INSPIRE and ISO 19115 standards. Metadata editor was developed for supporting the set metadata standard and to facilitate collection and maintenance of the metadata.

NSDI Council was established by the Serbian Government. RGA is president of NSDI council.

The initial geoportal ‘geoSrbija’ as a tool for viewing and share distributed spatial data and services under the umbrella of the NSDI became operational in November 2009 [www.geosrbija.rs]
Thank you for your attention!

Istanbul 14-17 September, 2010