# SELCUK ONLINE PROCESSING SYSTEM WITH CASE STUDY IN IGNSS STATIONS

Süleyman Sırrı MARAŞ,
İsmail ŞANLIOĞLU
and Bahadır AKTUĞ
Turkey
sanlioglu@selcuk.edu.tr

## CONTENTS OF PRESENTATION

- ❑ INTRODUCTION
- ❑ DESIGN OF THE PROCESSING SERVICE
- ❑ EXECUTION OF THE PROCESSING SERVICE
- ❑ APLICATION WITH IGNSS STATIONS
- ❑ CONCLUSION

## INTRODUCTION

- ❑ The state of art in GNSS

- ❑ Error models, such as global reference frame, satellite orbit, site specific errors, atmospheric greadients and antenna phase center variations.

- ❑ Baseline precision of up to submilimeter

## INTRODUCTION

- ❑ Using research and academical software packages such as GAMIT/GLOBK, BERNESSE, GIPSY, etc for post-processing

- ❑ Because of sophisticated structure, users avoid such software packages at the commercial applications.

3

# INTRODUCTION

❑ Increasing of national CORS (continuously operating reference stations) networks, online processing services

✓ **Online Global GPS Processing Service, CSRS-PPP** in Canada

✓ **Online Positioning User Service, OPUS** in USA

✓ **Online GPS Processing Service, AUSPOS** in Australia

# INTRODUCTION

❑ Selcuk Online Processing since it has been designed at Selçuk (Seljuk) University in Konya, Turkish version
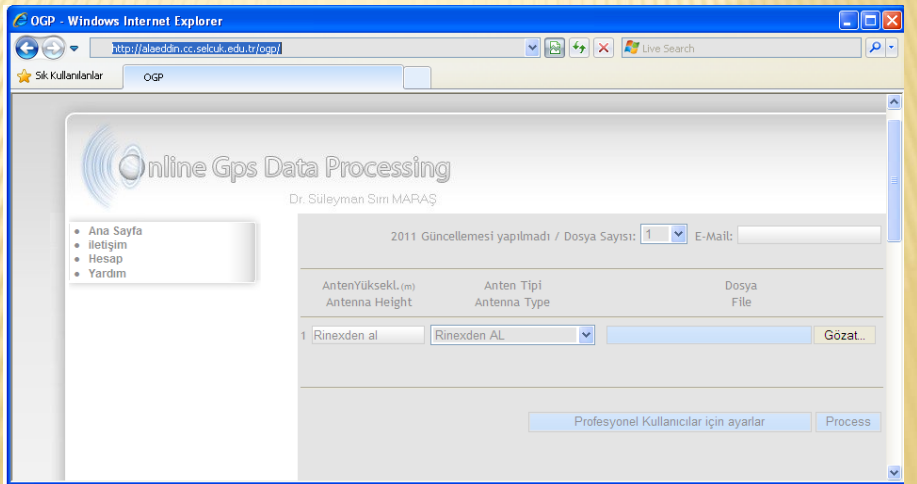
# DESIGN OF THE PROCESSING SERVICE

❑ The interface of the web-based rocessing service was purposely designed in pure HTML

❑ **Workflow and employed Technologies**
  - ✓ Uploading user data and choosing settings and reference stations by web interface.
  - ✓ Checking data integrity and updating default settings.
  - ✓ Processing the data by the engine.
  - ✓ Presenting the results to the user via e-mail in numerical and graphical format

# DESIGN OF THE PROCESSING SERVICE

❑ The employed technologies for various stages of the service

| Modules | Web technology |
|---|---|
| User interface | PHP, HTML, JavaScript |
| System settings | PHP, HTML, JavaScript |
| Data input/output | PHP |
| Data checking/Integrity monitoring | Flash, ShellScript |
| IGS data/products/FTP process | ShellScript, Flash |
| Data processing | ShellScript, Flash, GAMIT |
| Kalman filtering | ShellScript, Flash GLOBK |
| Preliminary results/visualization and mapping | PHP, HTML, JavaScript, Google Maps |
| Coordinate transformations | Perl, C++ |
| E-mail services | ShellScript |

5

# DESIGN OF THE PROCESSING SERVICE

❑ The options offered to the users are as follows:
✓ Solution type
✓ Zenith delay estimation
✓ Atmospheric gradient
✓ Atmospheric loading
✓ Tropospheric constraint
✓ Elevation mask
✓ IGS data provider.
✓ Number of IGS stations in data analysis
✓ Number of IGS stations in network adjustment
✓ Exclude IGS stations
✓ Minimum IGS station distance

**Advenced Settings - Google Chrome**
http://193.255.245.202/

| | |
|---|---|
| Solution Type | LC_AUTCLN |
| Zenith Delay Estimation | Yes |
| Atmospheric Gradients | Yes |
| Atmospheric Loading | No |
| Tropospheric Constraints | No |
| Elevation Mask | 0 |
| Lunar eclipses | Yes |
| IGS Data Provider | sopac |
| Number of IGS Stations in Data Analysis | 3 |
| Number of IGS Stations in Network Adjustment | 3 |
| Exclude IGS stations | Automatic |
| Add IGS stations | Automatic |
| Minimum IGS station distance | 0.1 km. |

Save

L1&L2
L1_ONLY
L2_ONLY
LC_ONLY
L1,L2_INDEPEND.
LC_HELP
LC_AUTCLN

1
2
3
4
5

# DESIGN OF THE PROCESSING SERVICE

❑ Graphical user interface
✓ The introduction page was designed in pure HTML. The introduction page is shown in Figure 2. Since the user is supposed to provide the service with various inputs such as antenna height and antenna type, HTML form objects are formed in run-time through PHP based scripts.

✓ In the second part of the introduction page, the user can upload his/her own RINEX data through the service provided by the online processing system. The upload service supports uploading of up to 7 files simultaneously.

# EXECUTION OF THE PROCESSING SERVICE

❑ The data processing is initiated through the button located on the main page. The processing service will run with the pre-configured default values and will produce an optimal solution. After submitting the files, a concise report is sent to the user verifying the integrity of the observation files and giving a process ID. The processing service appoints a unique process ID for each submission. Another useful property of the processing service is the automatic quality checking of the GPS observations.

❑ After completion of the data, processing engine is started and the progress bar is shown as in web map. The results can be shown online and/or through e-mail.

# EXECUTION OF THE PROCESSING SERVICE



❑ the progress bar

Process may take some time. Please Wait    Processing  % 30    Transaction ID : 12416

```
ANKR IGS Observation file downloads
ZECK IGS Observation file downloads
ISTA IGS Observation file downloads
NSSP IGS Observation file downloads
NICO IGS Observation file downloads
Can get  results online
Results are sending e-mail address.....
```

## APLICATION WITH IGNSS STATIONS

- For this study, four stations, CIHA, AKHR, AKSR, and KAPN were chosen from Continuously Operating Reference Stations of Turkey (CORS-TR) at 02 February 2009.
- The rinex files of these stations were downloaded from CORS-TR. These data were uploaded through the service by the online processing service.
- Following the uploading of the files, antenna type and antenna height information were entered.

## APLICATION WITH IGNSS STATIONS

**Process Points on Map**

You can get a basic information by clicking on markers
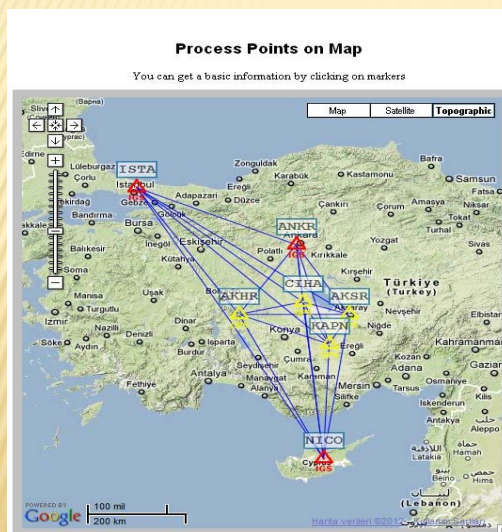
- The display of the baselines and neighboring three reference stations in Google Maps

# APLICATION WITH IGNSS STATIONS

❑ The final evaluation of the results can be done by checking the normalized root-mean-square (NRMS) of the overall data processing. Any discrepancy between the ambiguity-fixed and ambiguity-free solutions can be traced back a problem with the ambiguity fixing procedure.

❑ In the output mail, the results can be done by checking the normalized root-mean-square (a good solution produces a NRMS of about 0.25)

| | | Biases | Loose Const | reduct. | reduct. |
|---|---|---|---|---|---|
| Free | Normalized rms | 0.185 | 0.187 | 0.181 | 0.183 |
| Fixed | Normalized rms | 0.151 | 0.148 | | |

# APLICATION WITH IGNSS STATIONS

❑ In the output mail, the ellipsoidal coordinates of three reference stations and user points

| | Latitude | | | Longitude | | | Ellipsoidal Height |
|---|---|---|---|---|---|---|---|
| STATION | D | M | S | D | M | S | m |
| AKHR_GPS | 38 | 22 | 09.3801 | 31 | 25 | 47.0736 | 1046.4055 |
| AKSR_GPS | 38 | 22 | 13.4063 | 33 | 59 | 53.3392 | 1005.7963 |
| ANKR_IGS | 39 | 53 | 14.5373 | 32 | 45 | 30.4925 | 976.0121 |
| CIHA_GPS | 38 | 39 | 01.3949 | 32 | 55 | 20.6625 | 1012.7414 |
| ISTA_IGS | 41 | 06 | 16.0123 | 29 | 01 | 09.6303 | 147.2405 |
| KAPN_GPS | 37 | 42 | 52.7959 | 33 | 31 | 36.9392 | 1039.5063 |
| NICO_IGS | 35 | 08 | 27.5525 | 33 | 23 | 47.2090 | 190.0157 |

# APLICATION WITH IGNSS STATIONS

❑ In the output mail, the Cartesian coordinates and sigma of user points determined by Global Kalman Filtering with three reference stations in GLOBK

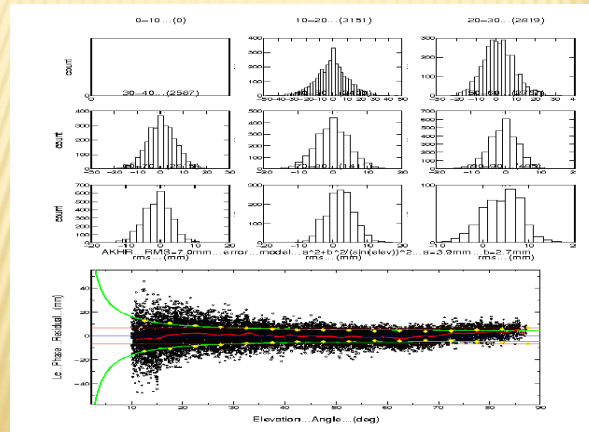| STATION | X<br>m | sigma<br>mm | Y<br>m | sigma<br>mm | Z<br>m | sigma<br>mm |
|---|---|---|---|---|---|---|
| AKHR_GPS | 4273150.852 | ±5.78 | 2611388.100 | ±3.93 | 3938311.894 | ±5.12 |
| AKSR_GPS | 4151745.969 | ±5.63 | 2800192.952 | ±4.10 | 3938384.041 | ±5.15 |
| CIHA_GPS | 4187342.437 | ±5.31 | 2711236.736 | ±3.79 | 3962713.225 | ±4.75 |
| KAPN_GPS | 4212053.469 | ±5.10 | 2790745.047 | ±3.70 | 3881074.845 | ±4.55 |

# APLICATION WITH IGNSS STATIONS

❑ In the output mail, the post-fit one-way residuals for station AKHR were evaluated in GAMIT analysis for every station satellite pair at every mesaurement epoch
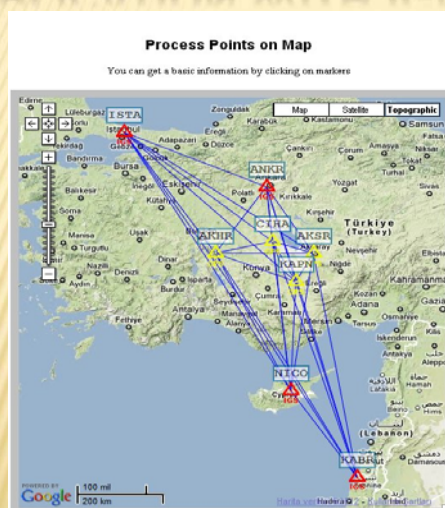


AKHR Day 033 RMS 7.0 mm
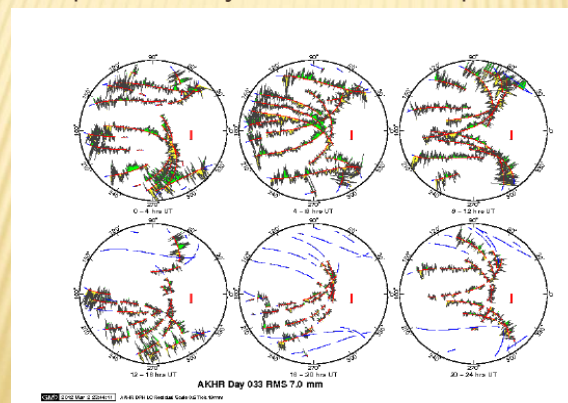
# APLICATION WITH IGNSS STATIONS

❑ In the output mail,  AKHR station  rms dependent on azimuth and elevation angle  and post-fit Lc phase residuals plotted of elevation angle.
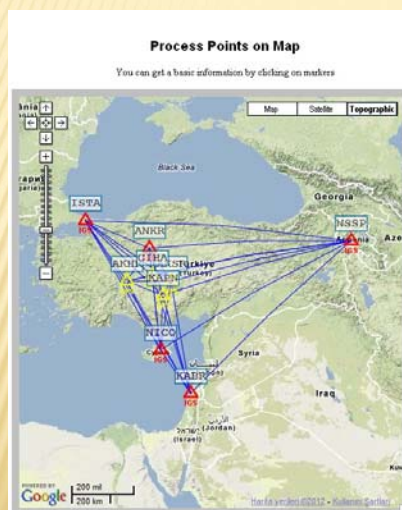


# APLICATION WITH IGNSS STATIONS



❑ The display of the baselines and neighboring
four reference stations
in Google Maps

# APLICATION WITH IGNSS STATIONS

❑ In the output mail, the Cartesian coordinates and sigma of user points determined by Global Kalman Filtering with four reference stations in GLOBK

| STATION | X m | sigma mm | Y m | sigma mm | Z m | sigma mm |
|---|---|---|---|---|---|---|
| AKHR_GPS | 4273150.841 | ±6.05 | 2611388.095 | ±4.15 | 3938311.891 | ±5.39 |
| AKSR_GPS | 4151745.958 | ±5.88 | 2800192.946 | ±4.24 | 3938384.037 | ±5.33 |
| CIHA_GPS | 4187342.425 | ±5.46 | 2711236.729 | ±3.85 | 3962713.220 | ±4.86 |
| KAPN_GPS | 4212053.458 | ±5.25 | 2790745.041 | ±3.77 | 3881074.842 | ±4.65 |

# APLICATION WITH IGNSS STATIONS



❑ The display of the baselines and neighboring five reference stations in Google Maps

## APLICATION WITH IGNSS STATIONS

❑ In the output mail, the Cartesian coordinates and sigma of user points determined by Global Kalman Filtering with five reference stations in GLOBK

| STATION | X<br>m | sigma<br>mm | Y<br>m | sigma<br>mm | Z<br>m | sigma<br>mm |
|---|---|---|---|---|---|---|
| AKHR_GPS | 4273150.840 | ±6.02 | 2611388.094 | ±4.04 | 3938311.893 | ±5.32 |
| AKSR_GPS | 4151745.960 | ±5.81 | 2800192.945 | ±4.22 | 3938384.041 | ±5.32 |
| CIHA_GPS | 4187342.425 | ±5.54 | 2711236.729 | ±3.92 | 3962713.223 | ±4.93 |
| KAPN_GPS | 4212053.460 | ±5.16 | 2790745.040 | ±3.71 | 3881074.845 | ±4.58 |

## CONCLUSION

❑ Web-based online processing services have several advantages: homogenization of the produced coordinate sets, cost-efficiency due to the require minimal hardware, minimizing the training to make use of high-end processing software, instant visualization of the results, correct application of newest error models, detailed reporting , automation.

# CONCLUSION

❑ Minimization of the user interaction together with well configured default settings has the potential of producing high precision coordinates in a very short time. On the other hand, the proposed processing service has also the necessary tools for fine tuning. Many complex modeling such as atmospheric modeling of tropospheric delays, zenith delays, atmospheric loading can be applied with or without any user interaction.

❑ The custom selection of the reference network to be incorporated into the analysis is also found to be very useful. The proposed processing service is designed to be scalable to networks of any dimension. The working principles of the design were deliberately made flexible to enable easy adaptation.

× Thank you for listening