Development of the Ukrainian GNSS-based positioning-timing-navigation system (UAPOS)

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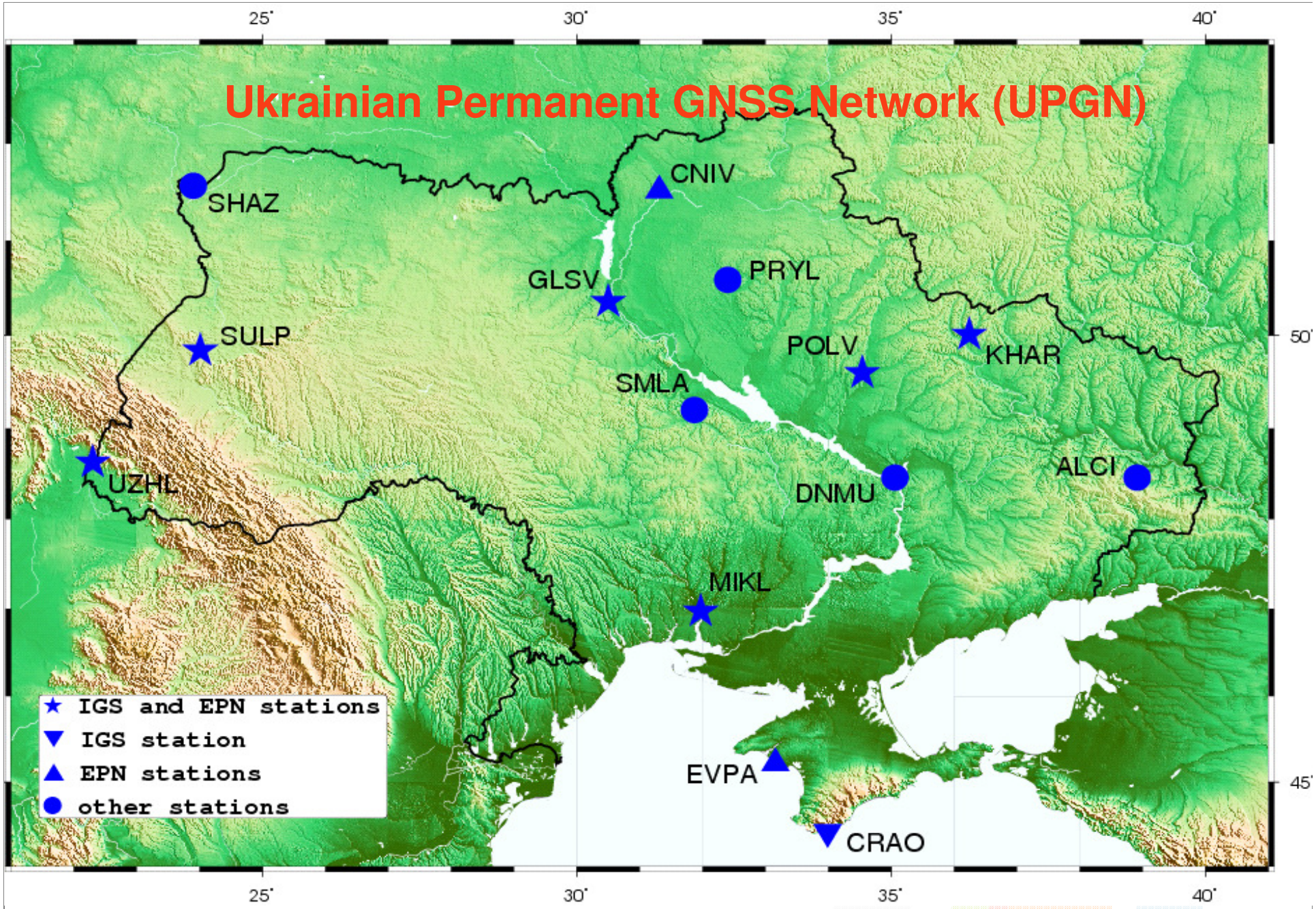
United Nations/Moldova/United States of America Workshop on the applications of Global Navigation Satellite Systems, 17 - 21 May 2010, Chisinau, Moldova


sqare=603,700km², population=46 mln.
UKRAINE
RUSSIA
BELARUS
POLAND
LITHUANIA
LAT.
SLOVAKIA
HUNGARY
ROMANIA
BULGARIA
YUGOSLAVIA
CZECH REPUBLIC
BOS.
MACE.
ALB.
GR.
TURKEY
GEORGIA
BALTIC SEA
BLACK SEA
SEA OF AZOV
ADRIATIC SEA
CAUCASUS
CARPATHIAN MOUNTAINS
KØBENHAVN (Copenhagen)
MOSKVA (Moscow)
Vilnius
MINSK
BERLIN
WARSZAWA (Warsaw)
PRAHA (Prague)
WIEN (Vienna)
Bratislava
BUDAPEST
Ljubljana
Zagreb
Sarajevo
BEOGRAD (Belgrade)
BUCUREŞTI (Bucharest)
Chişinău
SOFIJA (Sofia)
Skopje
Tirane
Nagy-Milic 2940 ft
Vârful Bihor 6066 ft
Goljam Perelik 7188 ft
gora Fišt 9406 ft
gora Ageputa 10699 ft
gora El'brus 18510 ft
Kackar Daxı 12900 ft
DOGU KARADENIZ


Ukrainian Permanent GNSS Network (UPGN)
25°
30°
35°
40°
50°
45°
SHAZ
CNIV
GLSV
PRYL
SULP
POLV
KHAR
SMLA
UZHL
DNMU
ALCI
MIKL
EVPA
CRAO
IGS and EPN stations
IGS station
EPN stations
other stations

USK-2000:Genesis, Realization and Status

- State geodetic referent system of coordinates for Ukraine was created from ITRS/ITRF2000 on epoch 2005.0 and fixed for Ukraine region by points of State Surveying Network.

- Realization: the center is matched with the center of reference ellipsoid, axes are parallel to axes of ITRS/ITRF2000 and the scale coefficient of USK-2000=scale coefficient ITRS/ITRF2000. RMS of differences between USK-2000 and ITRF2000 (2005.0) ~ 0.01-0.02m.

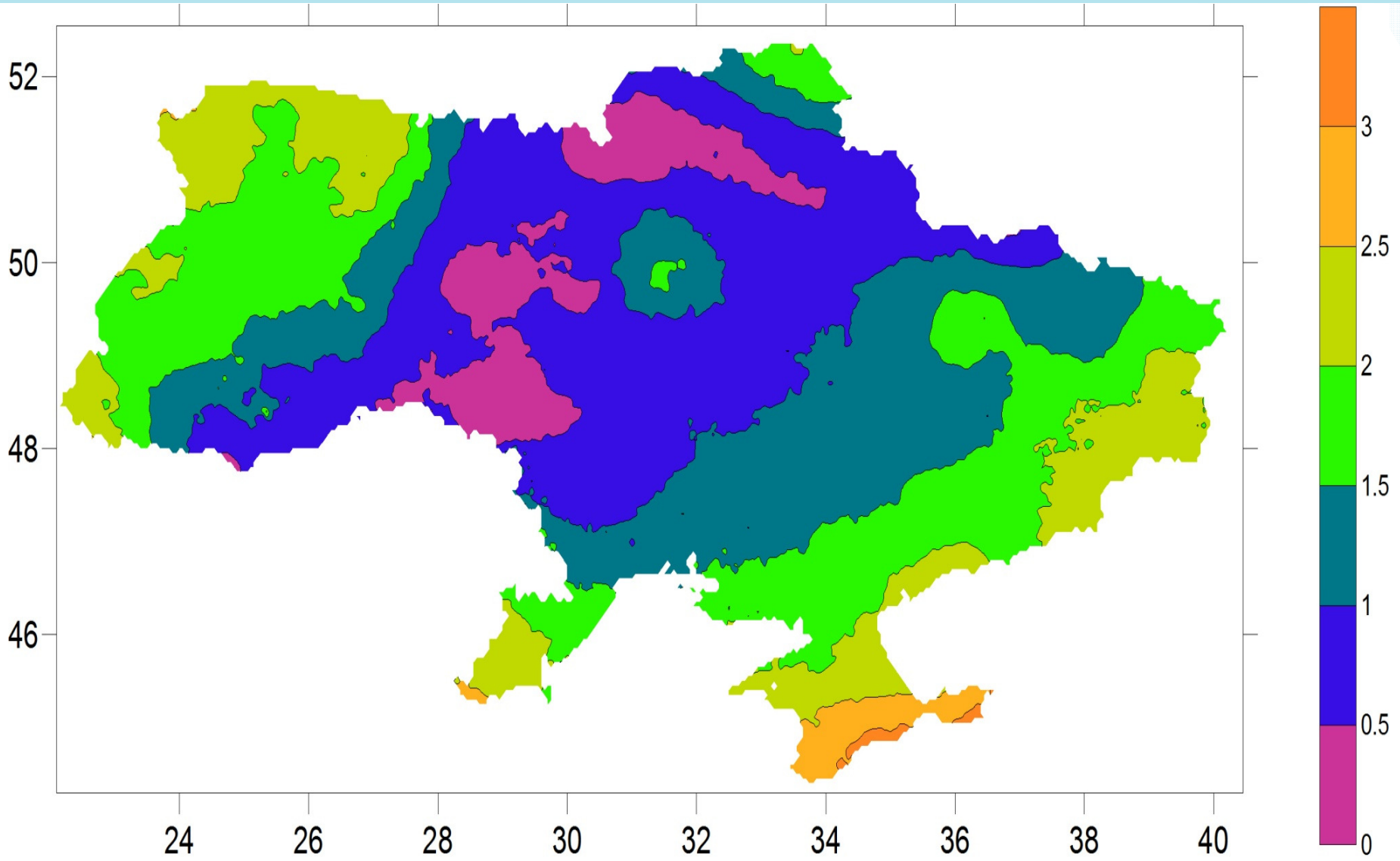
- USK-2000 is mandatory for all surveying and mapping works in Ukraine in according to the Regulation of Cabinet Ministers of 22-Sep-2004 №1259.

Distribution of RMS for points of SSN of Ukraine

Classes of points	1	2	3	4	Total
Number of points	813	5586	10084	8174	24657
Min	0.001	0.001	0.001	0.003	0.001
Max	0.026	0.112	0.099	0.143	0.143
Mean	0.003	0.020	0.032	0.032	0.028
RMS	0.002	0.007	0.013	0.009	0.012

Classes of points	1	2	3	4	
RMS for point 0..1 см	803	316	841	7	1967
1..2 cm	8	2738	622	658	4026
2..3 cm	2	2219	3119	3074	8414
3..4 cm	0	189	3143	2883	6215
4..5 cm	0	80	1722	1256	3058
5..6 cm	0	30	493	236	759
6..10 cm	0	13	144	58	215
>10 cm	0	1	0	2	3

Distribution of differences between SK-42 and USK-2000



Results of USK-2000 implementation

Successes in creating of USK-2000 allowed NSAU to start the works on designing and deploying of the Ukrainian GNSS-based Positioning-Timing-Navigation System to meet needs of users from different areas of science, technologies and economy of Ukraine

Main tasks of the Ukrainian GNSS-based Positioning-Timing-Navigation System (UAPOS) :

•conducting of the permanent monitoring of navigation fields, that are formed by GNSS GPS (USA), GLONASS (Russia), GALILEO (EU) and others;

•forming and dissemination of differential corrections for GNSS to users;

•forming information about integrity of UAPOS

UAPOS must consist of :

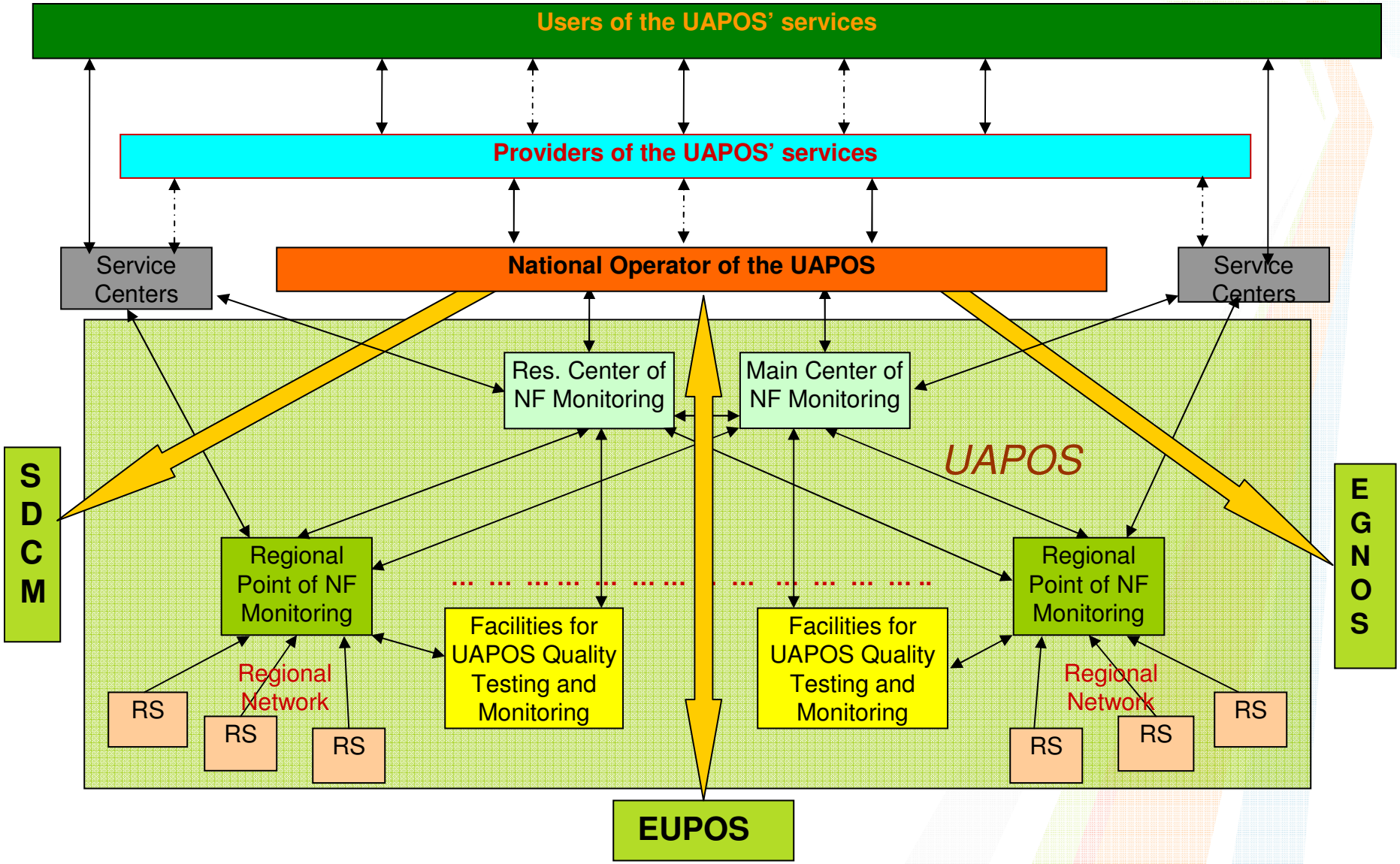
- Subsystem of Wide Area DC (SWADC) in real time, or 'UAPOS DGNSS';

- Subsystem of Precision Post-Processing Estimations (SPPPE) or 'UAPOS Geodetic';

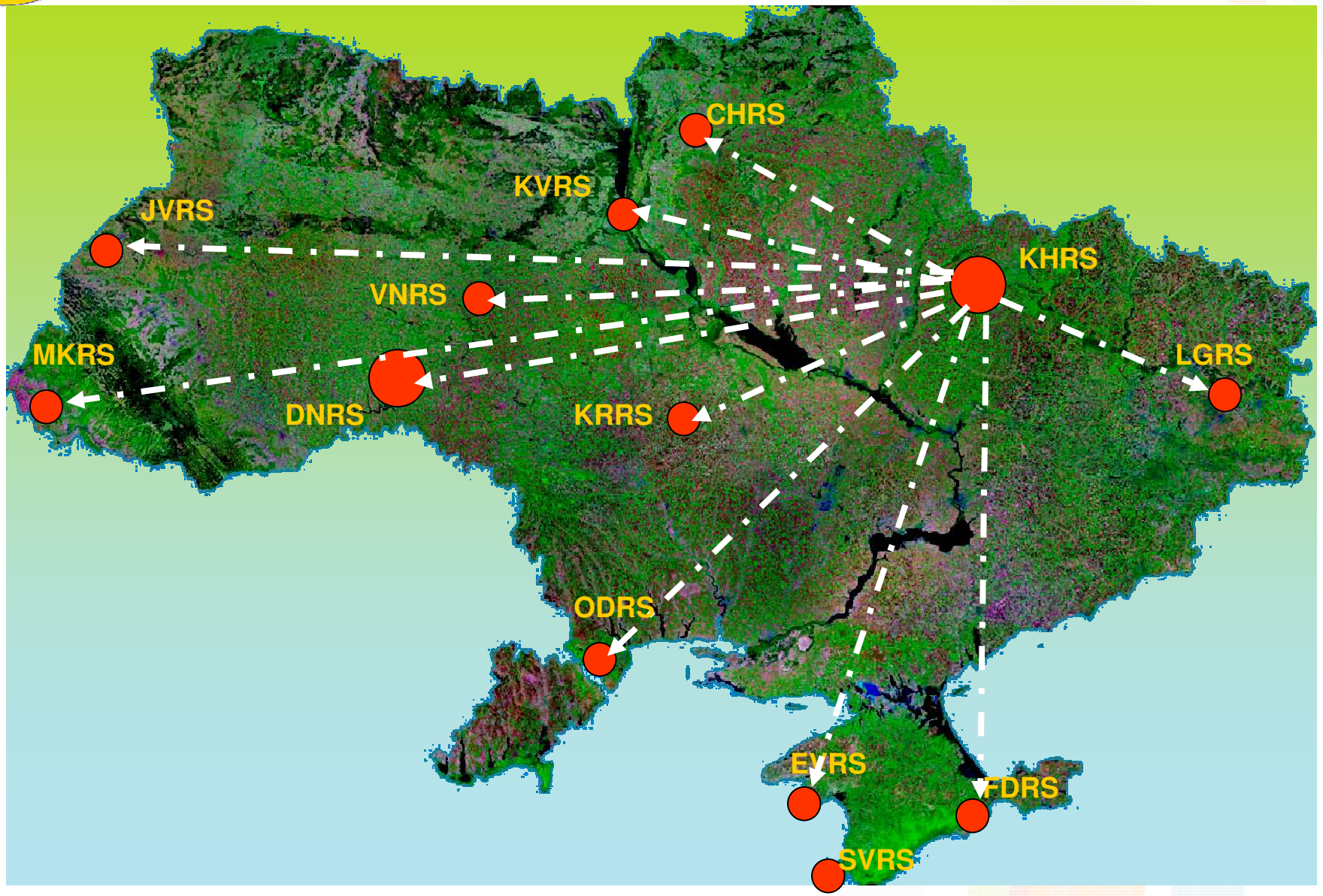
- Subsystem of Regional and Local DC (SRDLC) in real time, or 'UAPOS Network RTK'

All above subsystems must base on networks that are deployed in Ukraine and in neighboring countries

The UAPOS architecture and interfaces



NSAU WADC (UAPOS DGNSS) Network today

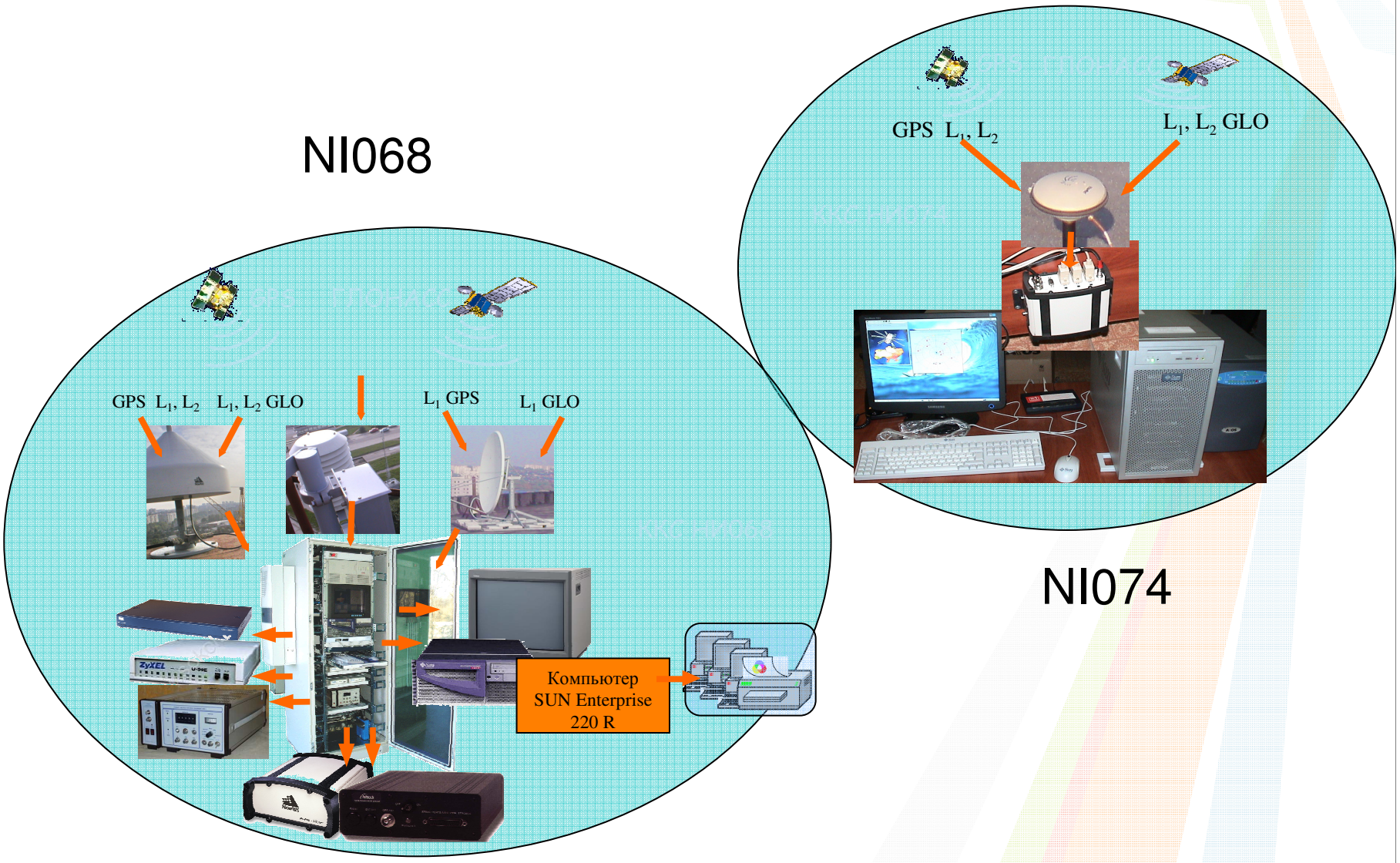


NSAU WADC Network Equipment

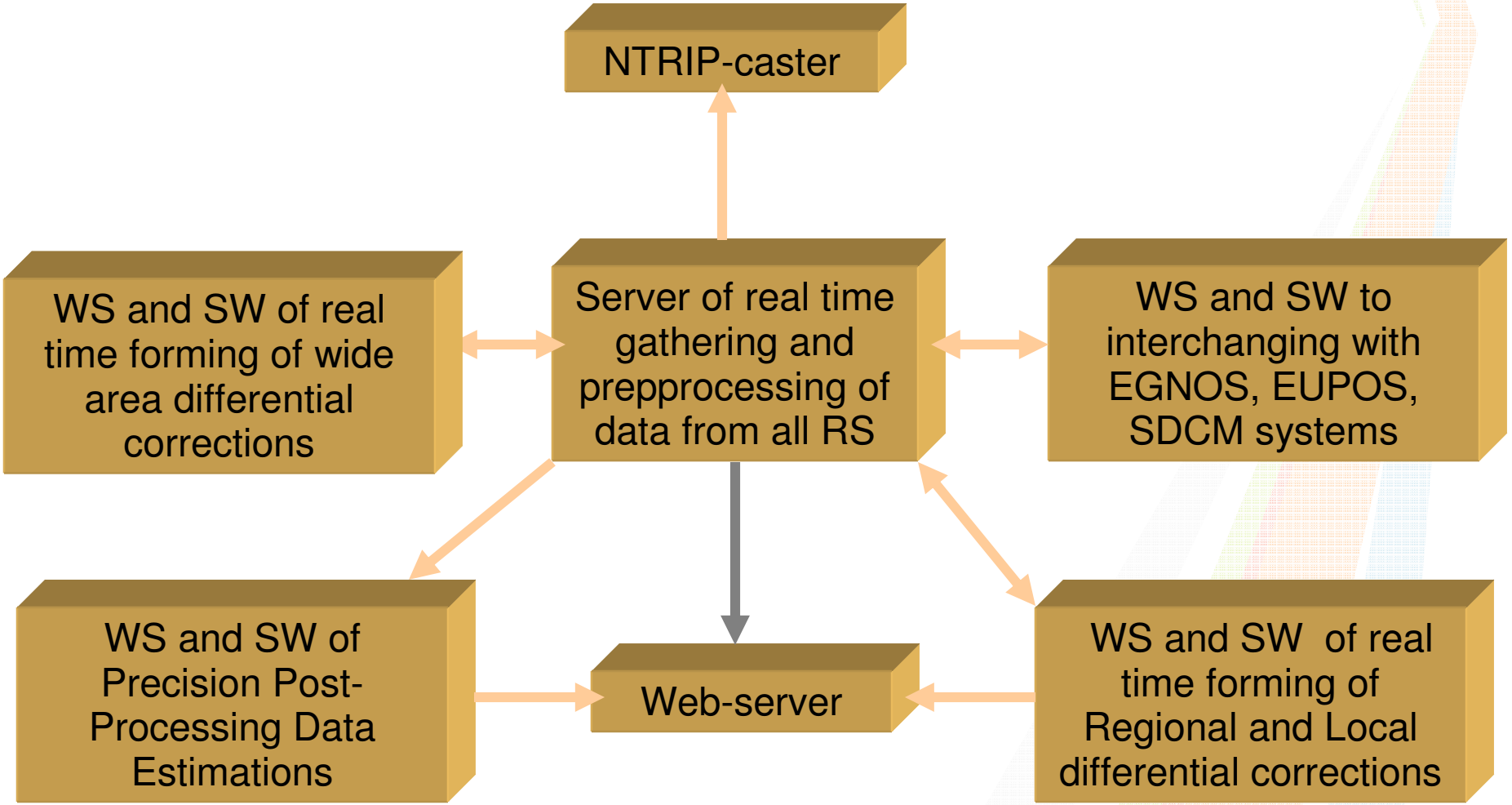
- All the RSs, that are in 'UAPOS DGNSS' are designed and developed by «JSC RIREM» on the base of NovAtel Co (Canada) receivers.
- Supplier – Europromservice Ltd, (Ukraine)

- Two types of RSs are used in UAPOS:
- RIMS-type for the system EGNOS (RIMS NI068)
- RS-type for the system EUPOS (KKS NI074).

Two types of RSs are used in UAPOS



The Navigation Field Monitoring Center's HW and SW Architecture



Currently the Main and Reserve Centers of Navigation Fields Monitoring can provide:

- gathering, archiving and quality control of the information in the real-time and in the post-session mode;
- maintenance of the web-site that contains “raw” and processed data that are received from all the UAPOS stations;
- generation of the FKP differential corrections;
- providing the FKP via Internet with a separate program-technical complex (caster);
- antenna phase center coordinates monitoring for all the RS with the accuracy of binding to EUREF up to 5mm.

Possibilities of 'UAPOS DGNSS' and 'UAPOS Geodetic' subsystems today :

"UAPOS DGNSS" - wide-area differential correction, distributed through the Internet and provides the possibility to precise the position of the single-frequency consumer with the accuracy of 1-1.5m on the all territory of Ukraine)

- Besides that each RS of the network offers to the consumers (non-network mode):
- local differential correction distributed through the Internet for precising the position of the single-frequency consumer with the accuracy of 0.5-1.5m (covered radius of 150km around the RS);
- RTK-correction distributed through the Internet for precising the position of the two-frequencies consumer with the accuracy of 10-20cm (covered redius up to 40km around the working RS).

Possibilities of 'UAPOS Geodetic' subsystems today :

"UAPOS Geodetic" - the information of the RS network (raw and processed information) for solving the tasks of the position determination in the post-session mode with the accuracy of 1-2cm while using the standard programs of processing and measuring of the two-frequencies receiver.

Testing of NSAU WADC Network with m.p. 'Kharov'

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Testing of NSAU WADC Network with m.p. ‘Kirovograd’

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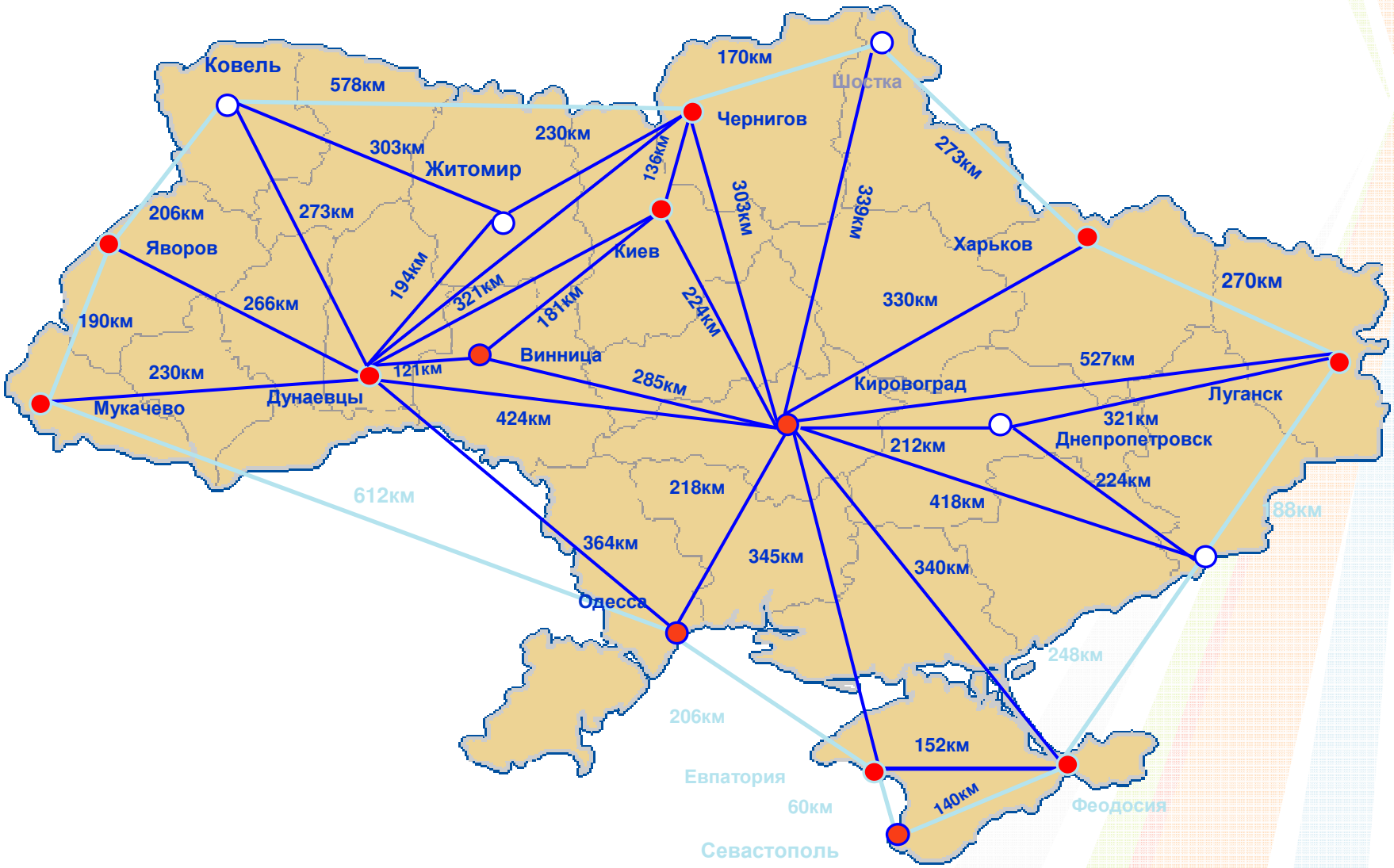
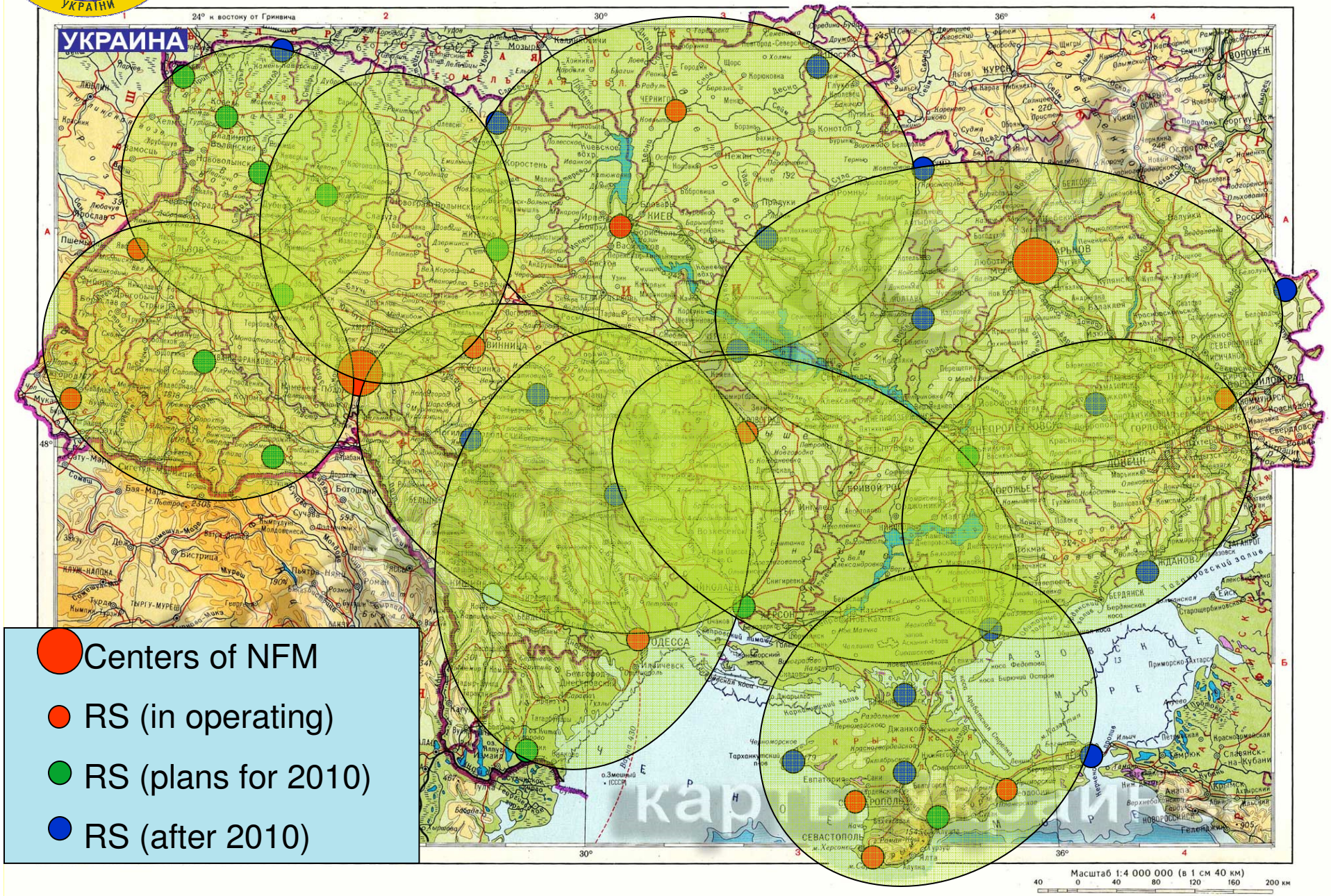
Base-lines in the NSAU WADC Network



Planned configuration of UAPOS to 2012



UAPOS Regional Networks

- **For maintenance of the international transport highways and railroads, which crossing Ukraine**
- In separate important economic regions of Ukraine
- In regions directly bordering with the EUPOS countries


Транспортные коридоры Украины
Беларусь
Россия
Польша
Словакия
Венгрия
Румыния
Молдова
Румыния
Гданск Одесса
Европа Азия
ЧЕС
Евроазиатский
КИЕВ
ЛЬВОВ
ТЕРНОПОЛЬ
ЛУЦК
РОВНО
ЖИТОМИР
ВИННИЦА
ЧЕРНОВЦЫ
ЧЕРНИГОВ
СУМЫ
ХАРЬКОВ
ПОЛТАВА
ДНЕПРОПЕТРОВСК
ДОНЕЦК
ЛУГАНСК
ЗАПОРОЖЬЕ
МАРИУПОЛЬ
МЕЛИТОПОЛЬ
ОДЕССА
НИКОЛАЕВ
ХЕРСОН
КРЫВОЙ РОГ
КРЕМЕНЧУГ
АЛЕКСАНДРИЯ
КИРОВОГРАД
ЗНАМЕНКА
УМАНЬ
ХМЕЛЬНИЦКИЙ
ТЕРНОПОЛЬ
ИВАНО-ФРАНКОВСК
МУКАЧЕВО
УЖГОРОД
СТРЫЙ
ЧОП
ДУБНО
КОВЕЛЬ
ГЛУХОВ
БЕЛАЯ ЦЕРКОВЬ
МОГИЛЕВ-ПОДОЛЬСКИЙ
РЕНИ
ДЖАНКОЙ
КЕРЧЬ
СИМФЕРОПОЛЬ
СЕВАСТОПОЛЬ
ЯЛТА
ДЕБАЛЬЦЕВО
АЗОВСКОЕ МОРЕ
ЧЕРНОЕ МОРЕ
Автодороги Украины
Автодороги Украины международного значения (включая Европейские маршруты)
Автодороги Украины национального значения
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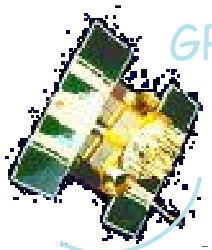


GPS

GLONASS

Regional Navigation-information System

System of high-precision positioning

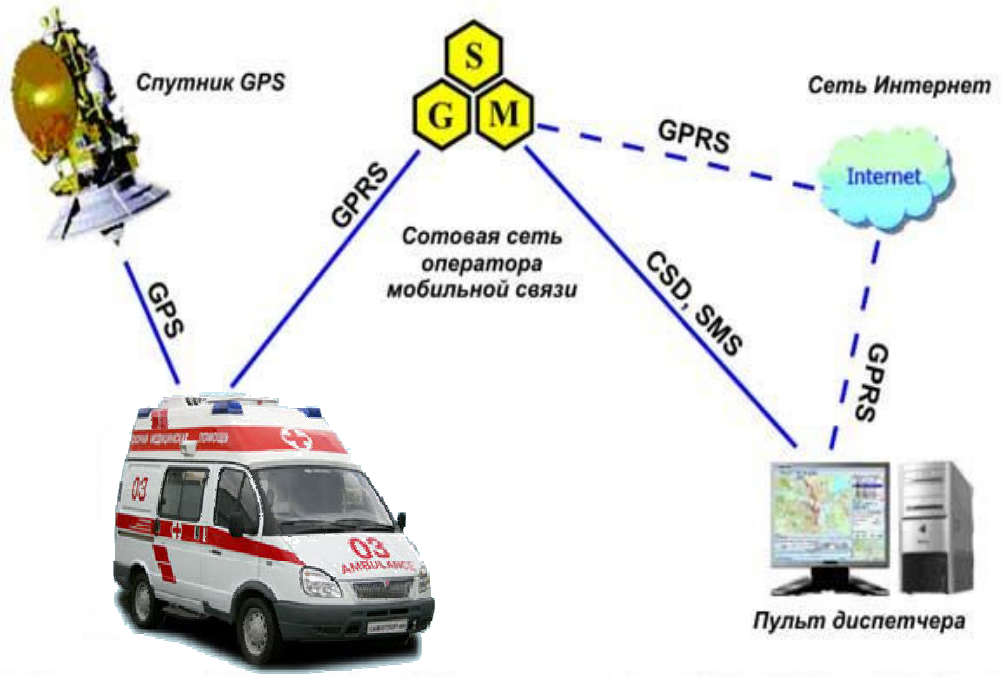
Решение геодезических / кадастровых задач

System of transportation monitoring

AUTOMATED NAVIGATION-DISPATCHING CONTROL SYSTEM of AMBULANCE MOBILE BRIGADES

The purpose of system developing is to raise quality and delivery performance of ambulance service

Improvement of quality and delivery performance is reached by automation of processing of calls, rationalization and automation of decision-making process on a forwarding of ambulance brigade by means of ambulance-CAD, modern means of a radio communication, sensors of



The system from the beginning of 2008 is in trial operation at Kharkov's ambulance station

AUTOMATED NAVIGATION-DISPATCHING CONTROL SYSTEM of AMBULANCE MOBILE BRIGADES

System provides solution of following problems:

- automation of registration of calls which is receiving from the population;
- location of the ambulance car with display it on the electronic map;
- calculation of key parameters of movement of the car;
- automation of a choice of brigades (sorting of calls on priorities, differentiation of brigades on a client specialization and closeness to a concrete call);
- accumulation of the archival information for any period of time

UAPOS Regional Networks

- For maintenance of the international transport highways and railroads, which crossing Ukraine
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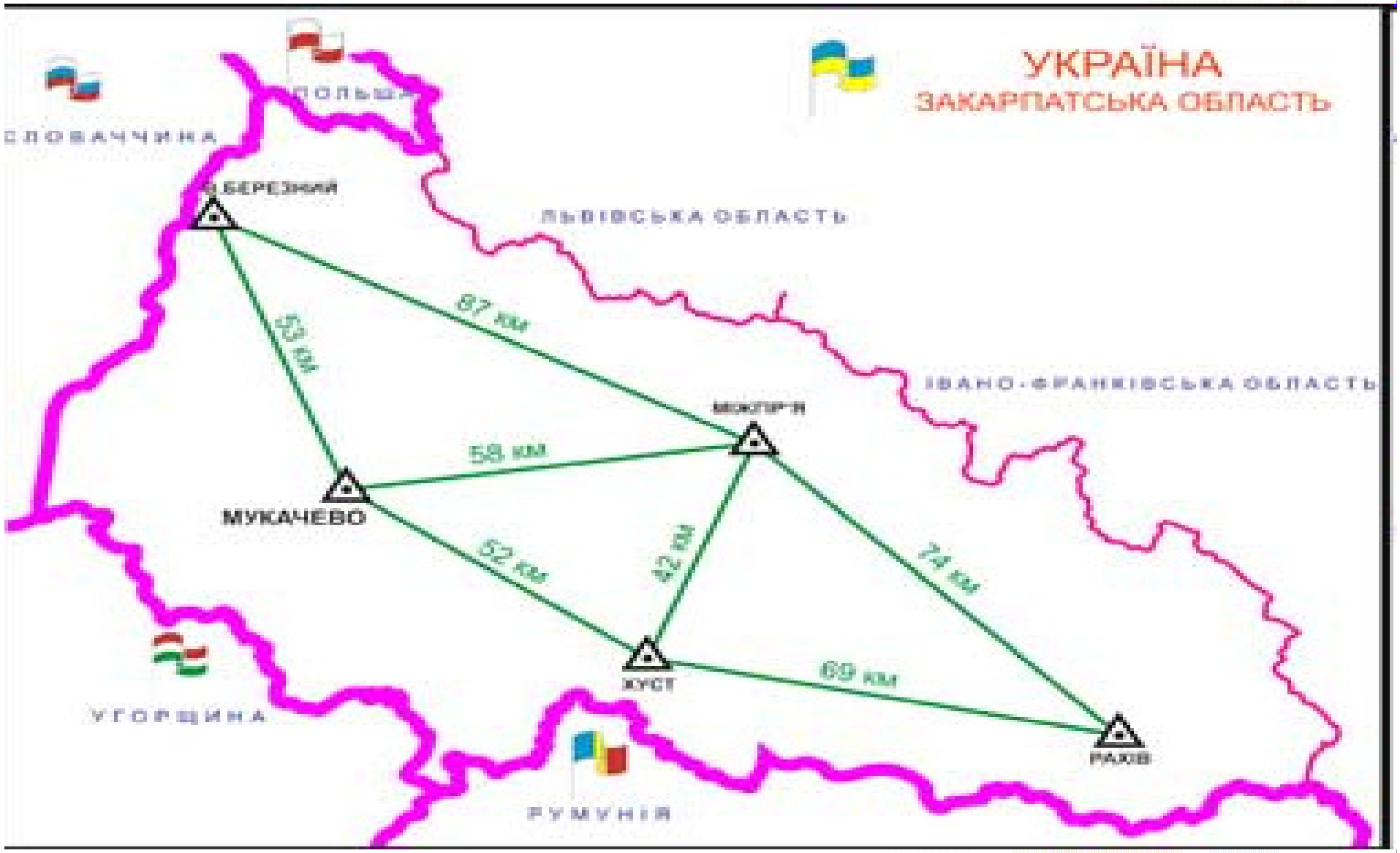
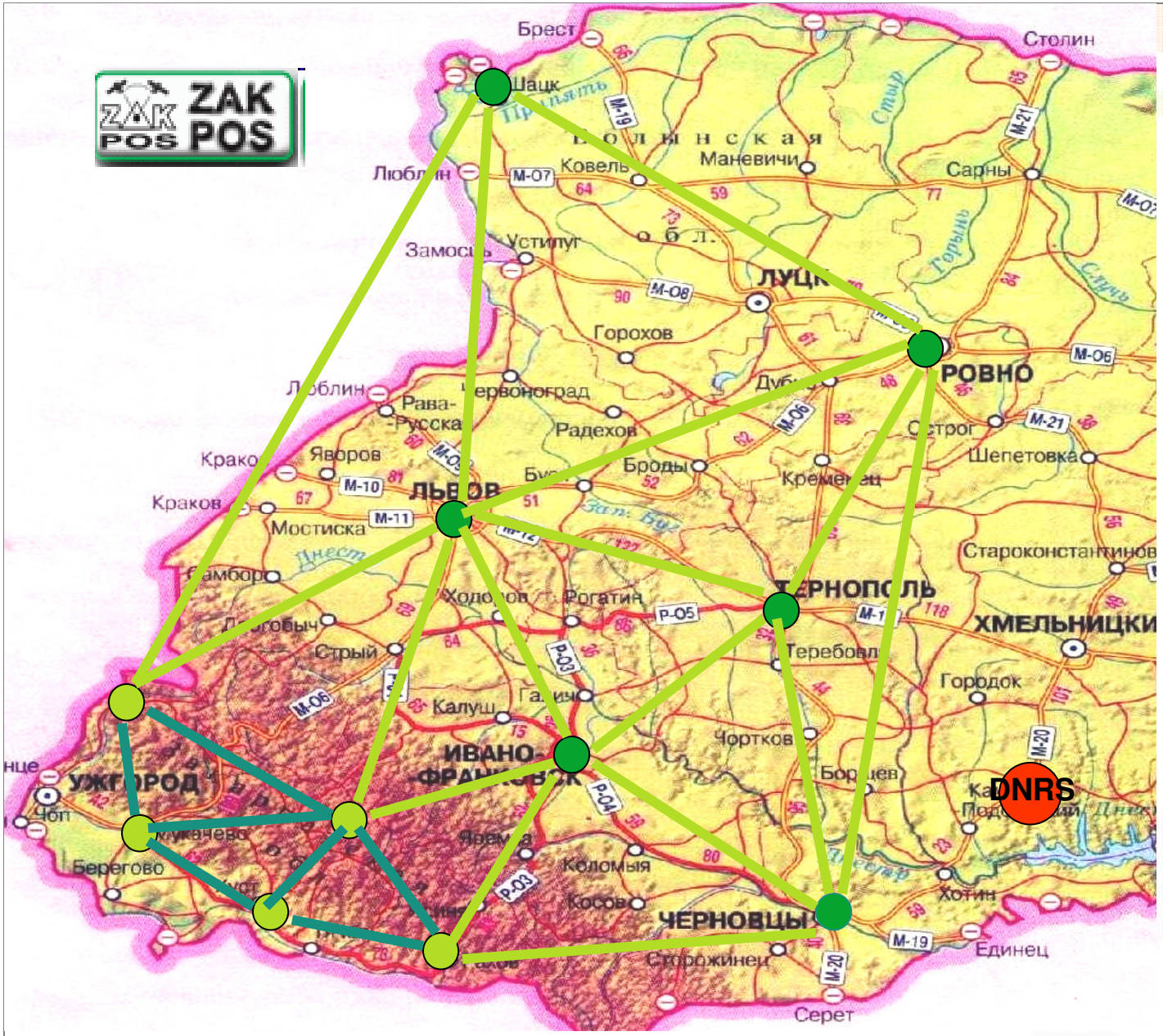
- **In regions directly bordering with the EUPOS countries**

ZAKPOS – first Ukrainian EUPOS Network





ZAKPOS – first Ukrainian EUPOS Network

- 1st step (5 RS)

- 2nd step (+6 RS)

Project of GNSS-network in Volyn' region