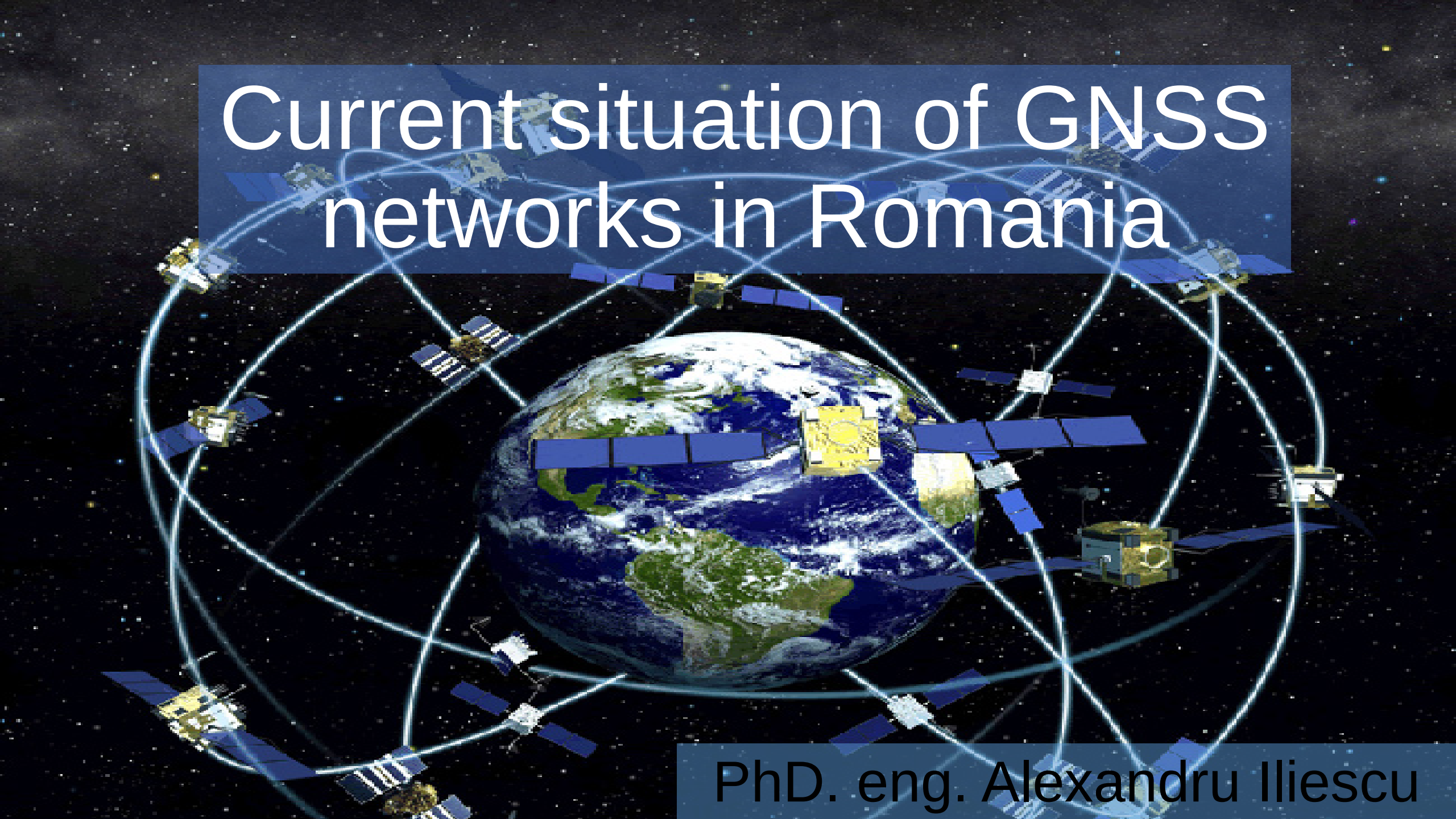
Current situation of GNSS networks in Romania



PhD. eng. Alexandru Iliescu

Geodetic Network

Type of network	Precision of the network level	Aplication	Precission of the network	Network information
National Geodetic network – First grade	A level (CORS stations)	Regional and local geodynamics, deformation projects, topographic engineering	+/-1.0 cm	74 GNSS stations – ROMPOS stations
Second grade	B level	topographic engineering	+/-2.0 cm	303 points
Third grade	C level	Topographic engineering and cadastre	+/-3 cm	1171 points
Fourth grade	D level	Topographic engineering, cadastre, GIS application	+/-5 cm	957 points

GNSS situation

	GPS	Glonass	Galileo	Compass
Orbital plan	6	3	3	3
Altitude	20160 km	19100 km	23222 km	21500 km
Orbital plane tilting (°)	55	65	56	55
Precision (95%)	5-10 meters	10-15 meters	4 meters	10 meters
Datum	WGS-84	PZ-90.11	GTRF	CGS2000

SATELLITE SYSTEM	YEAR OF FIRST SATELLITE LAUNCH	NO. OF SATELLITE/ NO. OF SATELLITE PROPOSED	ORBITAL	BAND	LEVEL OF COVERING
NavStar-GPS	1978	31/32	6 orbital plane	L1, L2, L5	Global
Glonass	1982	24	3 orbital plane	L1,L2,L3OC	Global
Galileo	2011	20/30	3 orbital plane		Global
Compass	2011	25/35	6 orbital plane	E1, E2, E5B si E6	Global
QZSS	2010	4/4	orbital plane - 45 degrees	L1,L2C, L5,E6	Regional
IRNSS	2013	7/7	Geostationary	L5, S	Regional

1.ROMPOS CORS Network

- ROMPOS CORS Network contains a total of 74 permanent stations in Romania, distributed over an area of 2375000 kmp
- Stations are integrated in the EUPOS system.
- The average distance between the stations is 70km.
- the network is managed by CNC (National Centre of Cartography)
- 5 station are integrated in EUREF-EPN (European Reference Frame – European Permanent Network):

BUCU (Bucharest), BACA (Bacău), BAIA (Baia Mare), COST (Constanţa) şi DEVA (Deva).

- the network is developed with Leica equipment
- There are mounted on public building

ROMPOS CORS Network

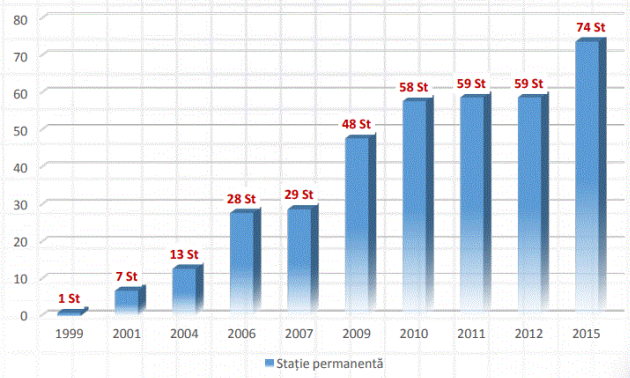
LEGENDA

- Municipiu resedinta de judet
- Limita de judet
- Granita de stat
- BACA Statie GNSS Permanenta
- Statie GNSS Permanenta proiectata
- Statie GNSS Permanenta instalata
- Statie GNSS Permanenta EUREF-EPN
- Statie GNSS Permanenta IGS
- Zona de acoperire (raza 35 km)

Agenția Națională de Cadastru și Publicitate Imobiliară
Centrul Național de Cartografie

3. Rețeaua de stații GNSS permanente de clasă A

3.1. Evoluție



ROMPOS CORS Network

- GNSS stations with Galileo signal receiver

ROMPOS CORS Network

Types of products:

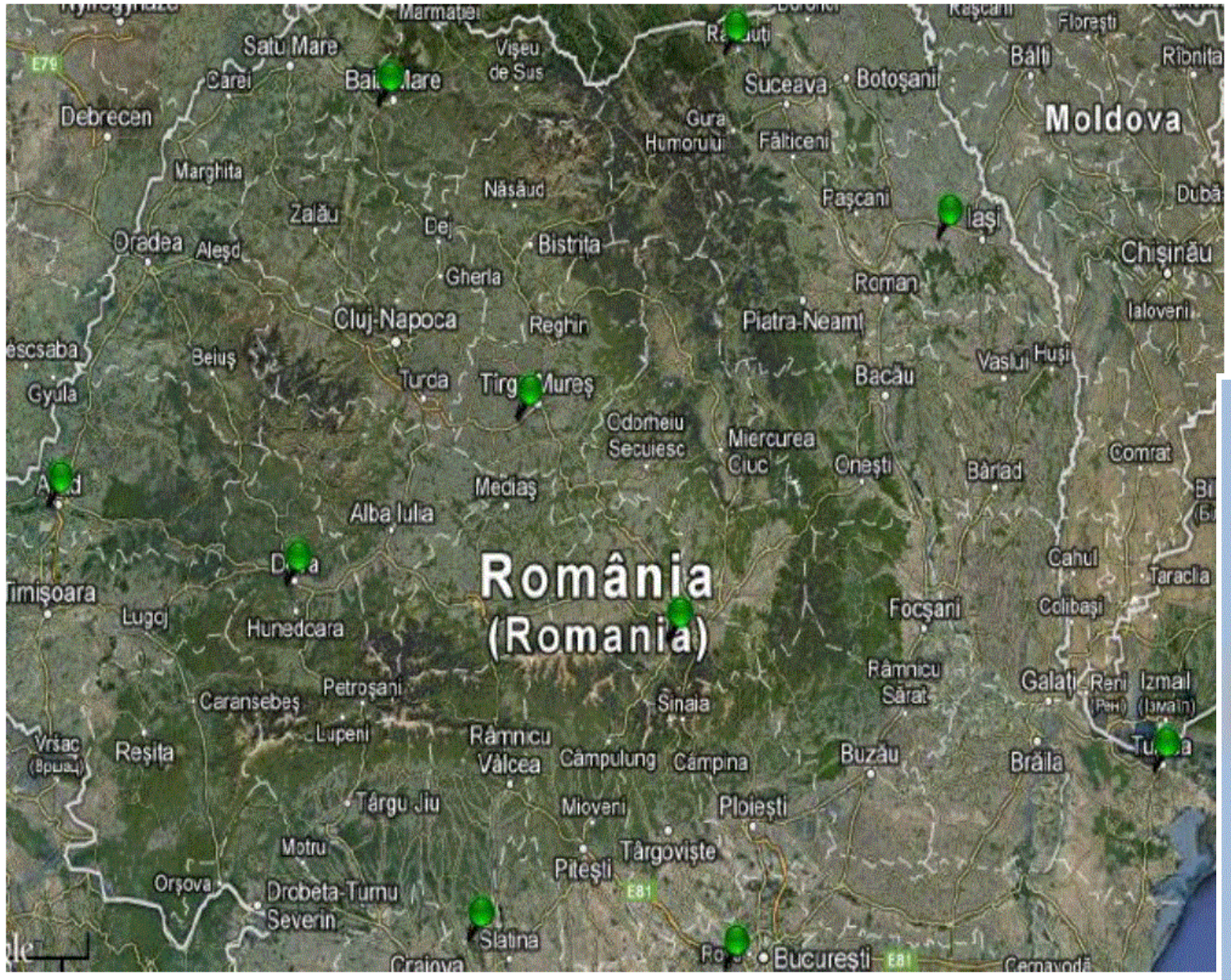
- **„network" products** (generated using the principles of calculating differential corrections based on the network of permanent GNSS stations: VRS (Virtual Reference Station), FKP (Flachen Korrektur Parameter, MAX - Master Auxiliary Concept);
- **"nearest" products (single base) -** (generated using the principles of calculating differential corrections based on a single permanent GNSS station)
- RINEX products

RT Product name	RT Product type	Cells/Sites/Rov...	Message Type	Connection Settings	Ntrip Mount point	Check max. di...	RTCM Version	Coord Rate	Re-check i...	Max. dist...	Iono & Geomet...	Re-check nearest si...
RO_MAX_3.1	Automatic cells	-	MAX RTCM 3.x (Extended,1015,1016)	ROMPOS-Proxy:2101	RO_MAX_3.1	On	3.x	10s	1000	100	5s	On
RO_VRS_3.1	Automatic cells	-	Virtual RS RTCM 3.x (Extended)	ROMPOS-Proxy:2101	RO_VRS_3.1	On	3.x	10s	1000	100	-	On
RO_iMAX_3.1	Automatic cells	-	i-MAX RTCM 3.x (Extended)	ROMPOS-Proxy:2101	RO_iMAX_3.1	On	3.x	10s	200	100	-	On
Nearest_3.1	Nearest site	-	RTCM 3.x (Extended)	ROMPOS-Proxy:2101	Nearest_3.1	On	3.x	5s	200	50	-	On
Nearest_2.3	Nearest site	-	RTCM 2.x (Type 1,2,18,19)	ROMPOS-Proxy:2101	Nearest_2.3	On	2.3	-	200	50	-	On
RO_FKP_3.1	Automatic cells	-	FKP RTCM 3.x (Extended, 1034, 1035)	ROMPOS-Proxy:2101	RO_FKP_3.1	On	3.x	5s	200	100	-	On
RO_i_MAX_2.3	Automatic cells	-	i-MAX RTCM 2.x (Type 1,2,18,19)	ROMPOS-Proxy:2101	RO_i_MAX_2.3	On	2.3	-	1000	100	-	On
RO_FKP_2.3	Automatic cells	-	FKP RTCM 2.x (Type 18,19)	ROMPOS-Proxy:2101	RO_FKP_2.3	On	2.3	-	200	100	-	On

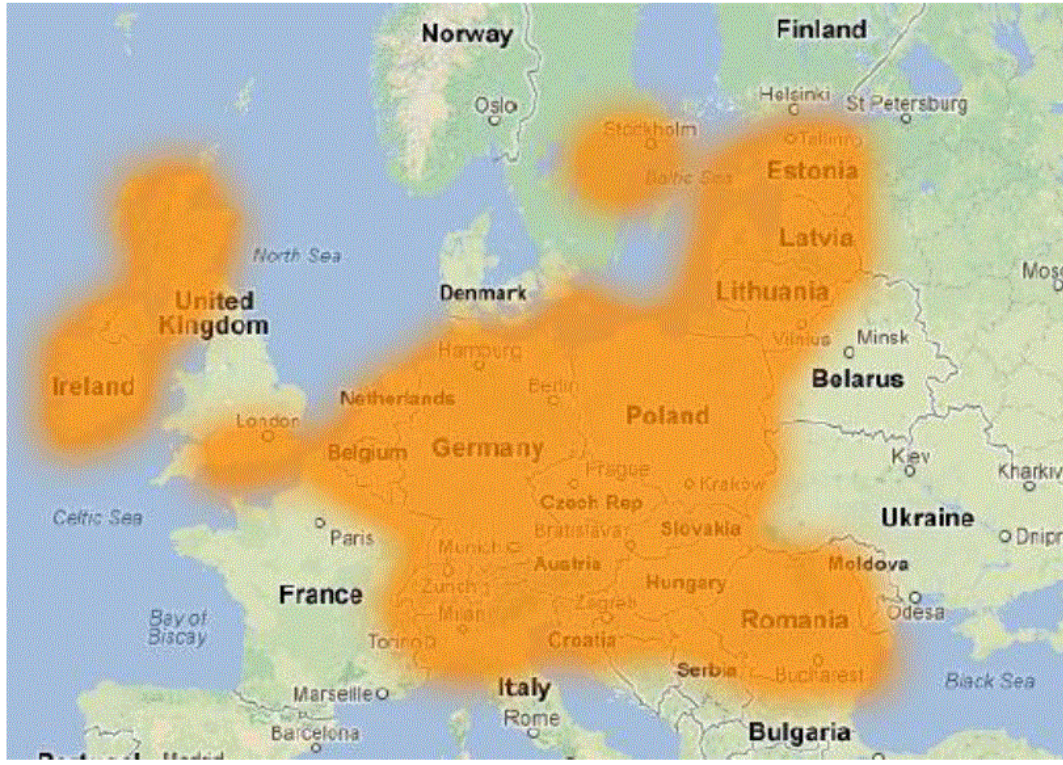
2.GNSSPos network

- The GNSSPos network consists of 50 reference stations located in Romania (35 stations) and in Bulgaria, Serbia, Macedonia and Moldova.
- Offer networks products (RTK) and RINEX products
- you can access the service by paying an annual subscription
- contains Trimble receivers

3. TRIMBLE VRS network



- Network contain 10 GNSS stations
- you can access the service by paying an annual subscription
- Offers RTK network solutions



4. LEICA TGRef network

- Owned and administered by SC Top Geocart SRL.
- consists of 7 stations

TGBV - Brașov
TGGT - Odorheiu Secuiesc
TGRT - Botoșani
TGWA - Suceava

TGGC - Campina
TGTS - Moinești
TOPG - București

- Offers RTK corrections and RINEX products (for free);

5. TOPOCADVEST network

- Topo Cad Vest is a private network of 29 permanent GNSS stations, of which 4 are located in the territory of Bulgaria.
- There will be 9 more permanent stations (with blue in the figure).
- the network is equipped with Hi-Target receivers
- offers RTK corrections and RINEX products
- It is a free service

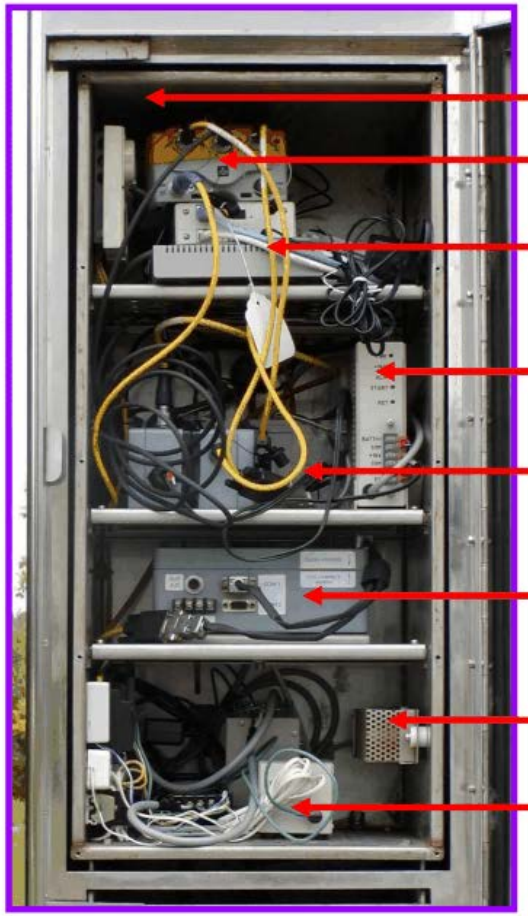
6. INFP GNSS network

- Administrated by National Institute of Earth Physics
- The network consists of 29 GNSS stations
- Developed especially in the eastern part of Romania for monitoring crustal movements and tectonic plate
- Offers RINEX products data for static measurements (for post-processing) for free
- Stations are mounted on the concrete pillars with a depth of 1 meter in the ground
- Leica receivers are used for most stations
- Some stations offer measurements at a frequency of 10 Hz

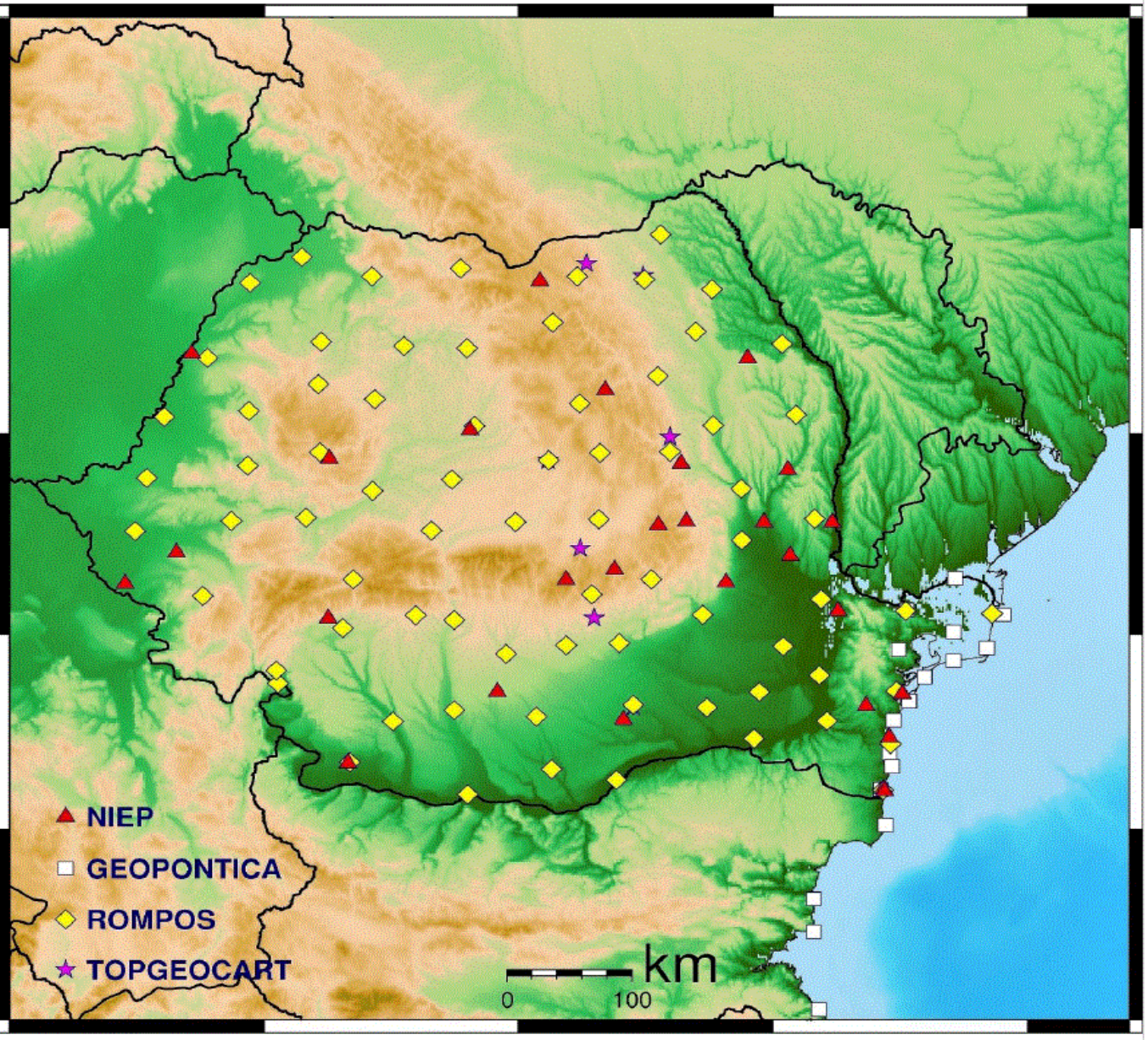
6. INFP GNSS network

- example of a station implemented from the INFP GNSS network

CORS network - JAPAN



7. GEOPONTICA GNSS network



- INCD GeoEcoMar (National Institute of Research and Development for Geology and Marine Geoecology) developed the network through a European project being functional from 2013
- it is composed of 13 GNSS stations located on the coastal area of Romania
- the network is equipped with the GNSS Topcon receiver (reference station) model NET-G3A, GNSS antenna: Topcon, model CR-G5
- designed with the main purpose to allow the highlighting and then monitoring of the movements suffered by the different tectonic blocks that make up the terrestrial crust corresponding to the western continental edge of the Black Sea.
- currently the public does not have access to the network but with the development of the EUPOS project, maybe the data will be available

Network problems

Ntrip streams:

Stream	L..	Country	Lat	Long	Net	Format	Data type	Nmea	Phase info
BAIA		0.00	1	0	0.00	RTCM3.2	1074(1),1084(1),1124(1),1094(1),1...	ZNet...	GPS GLO...
IASI3.1		0.00	0.00	1		RTCM3	1004(1),1012(1),1005/1007(10)	0	2
BAIA2.0		0.00	0.00	1		RTCM2.3	3(10),18(1),19(1)	1	2
BUCU3.1		0.00	0.00	1		RTCM3	1004(1),1012(1),1005/1007(10)	0	2
SATU3.1		0.00	0.00	1		RTCM3	1004(1),1012(1),1005/1007(10)	1	2
PLOI		0.00	1	0	0.00	RTCM3.2	1074(1),1084(1),1124(1),1094(1),1...	ZNet...	GPS GLO...
ROSI		0.00	0.00	1		RTCM3	1004(1),1012(1),1005/1007(10)	1	2
BRAS		0.00	1	0	0.00	RTCM3.2	1074(1),1084(1),1124(1),1094(1),1...	ZNet...	GPS GLO...
IASI		0.00	1	0	0.00	RTCM3.2	1074(1),1084(1),1124(1),1094(1),1...	ZNet...	GPS GLO...
BACA2.3		0.00	0.00	1		RTCM2.3	3(10),18(1),19(1)	1	2
TGMU3.1		0.00	0.00	1		RTCM3	1004(1),1012(1),1005/1007(10)	0	2

- need to implement standards for private networks

CONCLUSIONS

- Now there are 7 networks of permanent stations (3 managed by public institutions and 4 being private networks) that offer various products and are addressed to all types of users, but two networks of permanent stations offer restricted services for a certain segment of users. ;
- The legislation allows the development of permanent networks by anyone who wants this;
- It is necessary to regulate permanent networks, through legislation that requires a standardization of the names, services offered, and how they are implemented;
- Most of the information that reaches the user is not clear and confuses, the type of products offered;
- It is necessary to develop a methodology for processing the new networks implemented and monitoring them;
- There are still problems in the continuous functioning of the networks;
- Different types of receivers are used;
- Some stations offer measurements at a frequency of 10 Hz

- Proposal: implementation of a common integrated system through which the user is redirected to the best station following an analysis by interpreting certain parameters;

Thank you !

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