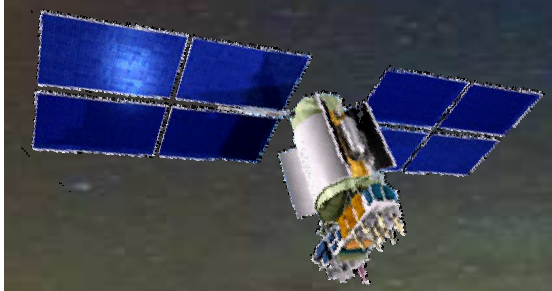
The Eighth Meeting of the International Committee on Global Navigation Satellite Systems, November 9 – 14, 2013, Dubai

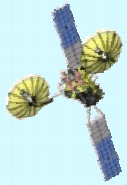


SDCM present status and future. GLONASS signals development.

Prof. Grigory Stupak, Dr. of Science
Deputy Director General –
First Deputy Designer General
JSC «Russian Space Systems»,

System of Differential Correction and Monitoring (SDCM)

Data downlinks



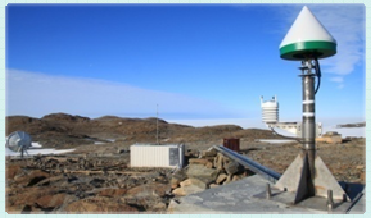
✓ *3 GEO relay satellites*

✓ *SiSnet server*

Reference stations network (RS)

✓ *19 RS in Russia*

✓ *4 RS abroad*



SDCM data processing center

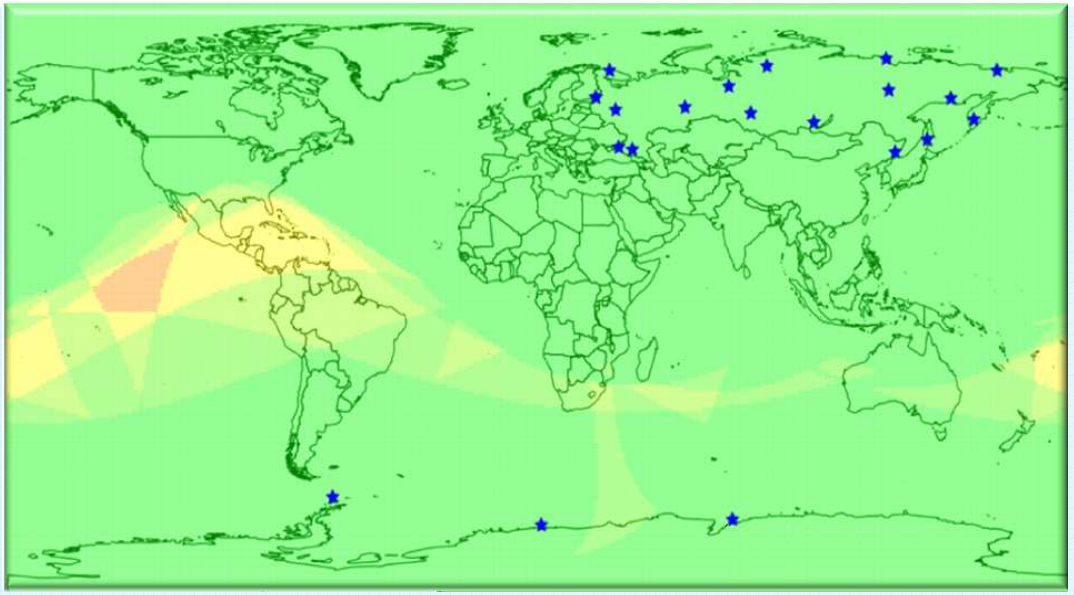
SDCM reference stations network

19 reference stations in the territory of the RF:

Pulkovo and Svetloe (Leningrad region), Mendeleevo, Moscow, Gelendzhik, Kislovodsk, Novosibirsk, Irkutsk, Petropavlovsk-Kamchatski, Tiksi, Vladivostok, Magadan, Yuzhno-Sakhalinsk, Lovozero (Murmansk region),Yekaterinburg, Norilsk, Bilibino (Chukchi Peninsula), Noyabrsk (Tyumen region

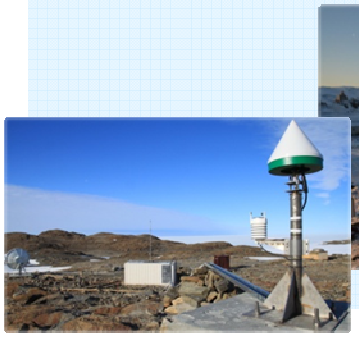
4 reference stations abroad:

«Bellingshausen» (Antarctica)
«Novolazarevskaya» (Antarctica)
«Progress» (Antarctica)
Brazilia (Brazil)



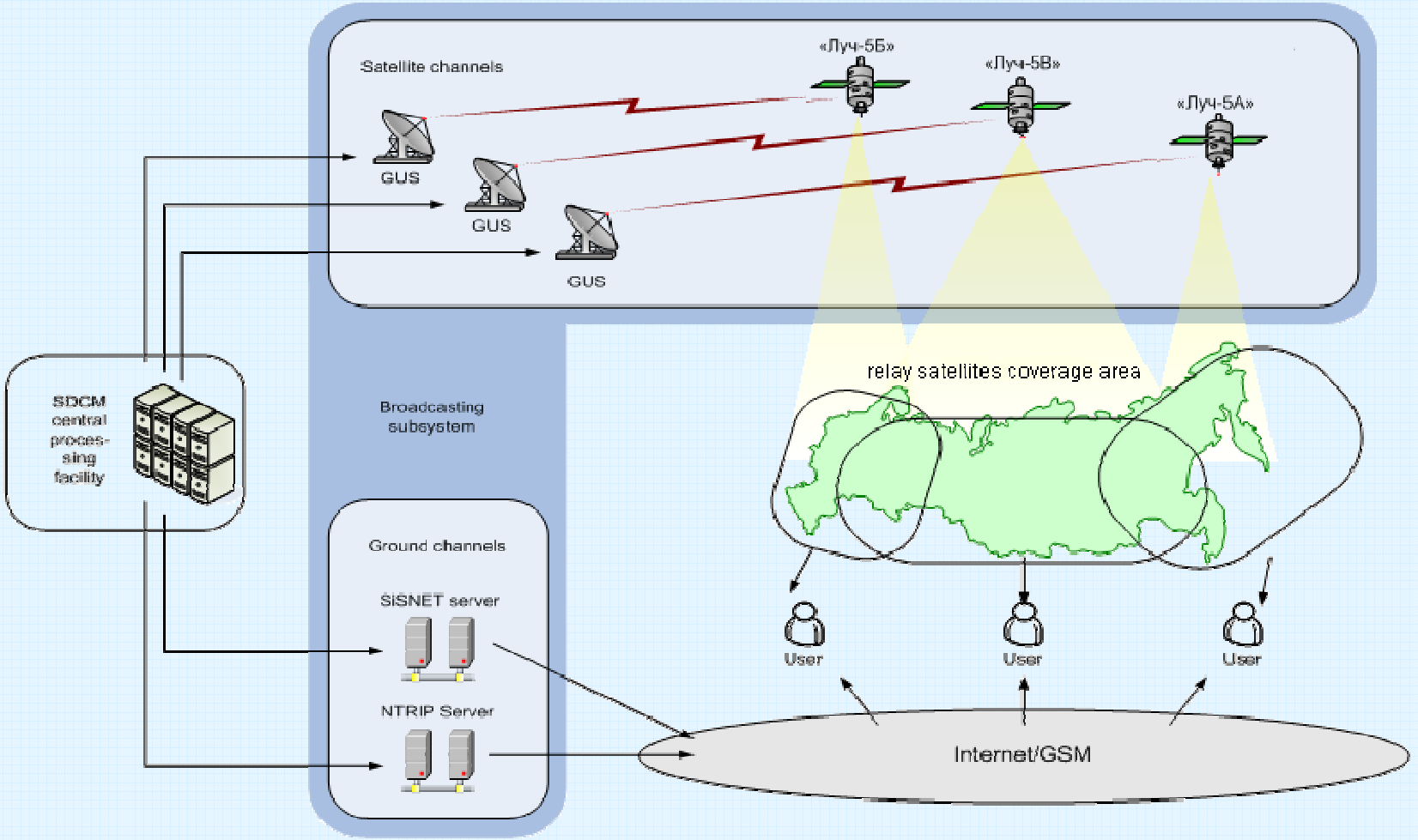
Several stations simultaneously track one satellite

≥3	2	1



1. IP telephone
2. VPN module
3. Controller
4. Computer
5. GLONASS/GPS receiver
6. Hydrogen Mazer
7. UPS module

SDCM data dissemination system

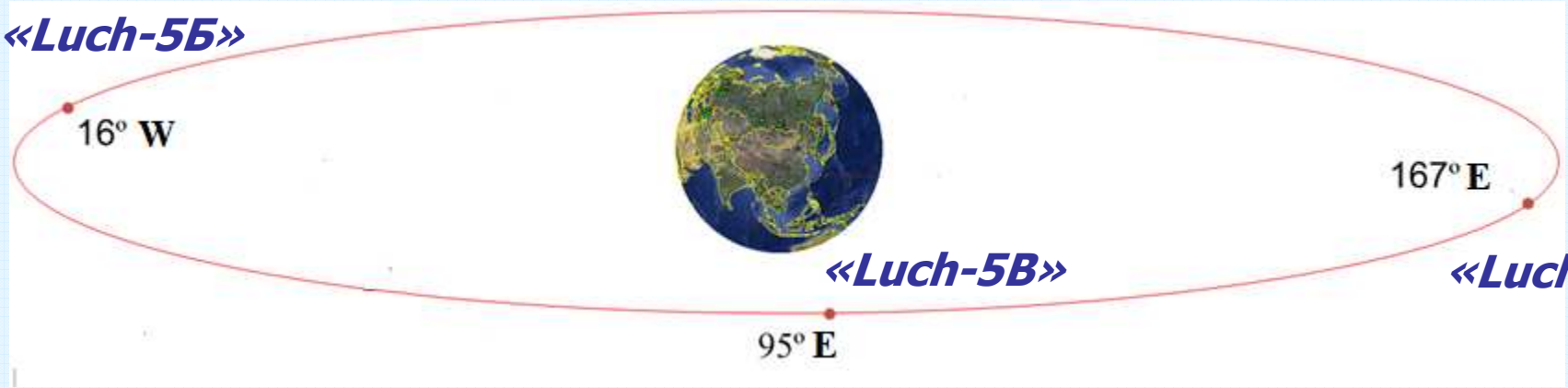


IP: 79.104.19.214 port: 5555

SDCM constellation expansion

On the 11th of December, 2011 the «Luch-5A» satellite was successfully put into geostationary orbit

On the 3rd of November 2012, the «Luch-5Б» was successfully put into orbit



The «Luch-5B» satellite is scheduled for launch in Q1 of 2014

Main objectives of SDCM development

- **SBAS L1 seamless coverage of the Russian territory**
- **SBAS L1 dual coverage of the central part of Russia by 2018**
- **Precise positioning services by SBAS L1/L5 and precise point positioning services by L1/L3 in the GLONASS band by 2018**
- **SDCM certification for LPV-200 requirements**
- **Plan to use SDCM as a basis for future precise point positioning service**
- **Verification of SBAS+ technology**

SDCM capabilities with employment of SBAS+ technology

Civil aviation

- ICAO category approach
- Airfield flights

Agriculture

- Controlling the vehicle's steering automatically for cultivation of small-seeded crops and field mapping
- Accurate and quick connection of fields and controlling the vehicle's steering automatically for cultivation of large-seeded crops

ROAD BUSINESS

- Checking the state of a pre-lane road
- Accurate and quick connection of construction sites in the system of absolute coordinates

RIVER TRANSPORT

- Navigation in coastal zone
- Accurate and quick location of navigation signs

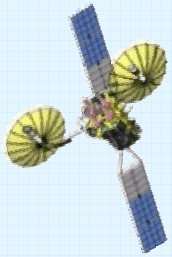
RAILWAY TRANSPORT SAFETY

- Tracking trains on adjacent railroad tracks.
- Optimization of the engine's steering

GEODESY and MAPPING

- Updating mapping data databases
- Building maps of pipelines and cable routings
- Natural resources mapping
- Mapping real estate properties and construction sites

Development of SDCM



Broadcasting satellites

- ✓ *3 L1 GEO*
- ✓ *1 L1/L3/L5 GEO*
- ✓ *SiSnet server*

Unified reference stations network

- ✓ *46 are located in Russia*
- ✓ *up to 50 abroad, 8 of which are located along the Russian boarder*

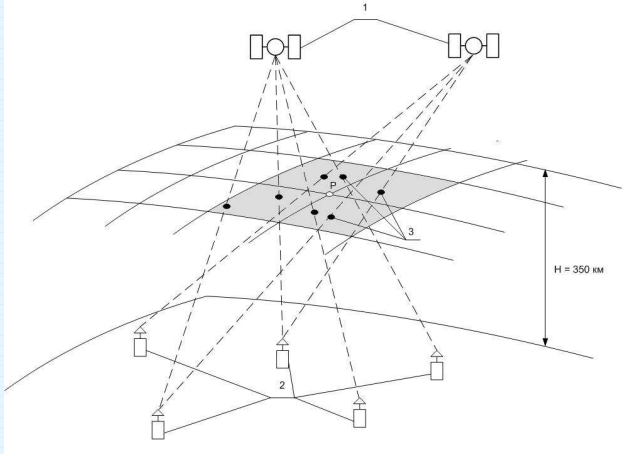
SDCM center

- ✓ *Master (Moscow, RSS)*

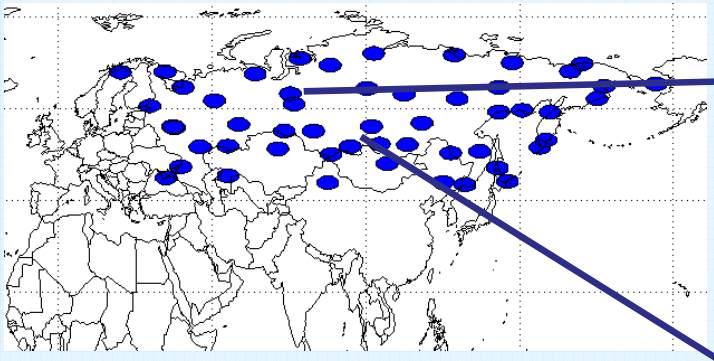
- ✓ *2 regional*

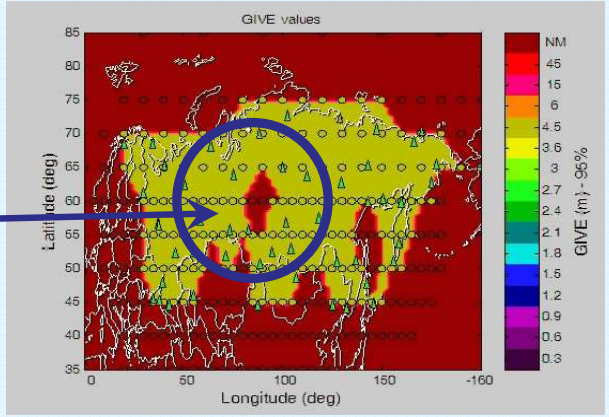
Unified reference stations (URS) network to assess ionospheric delay

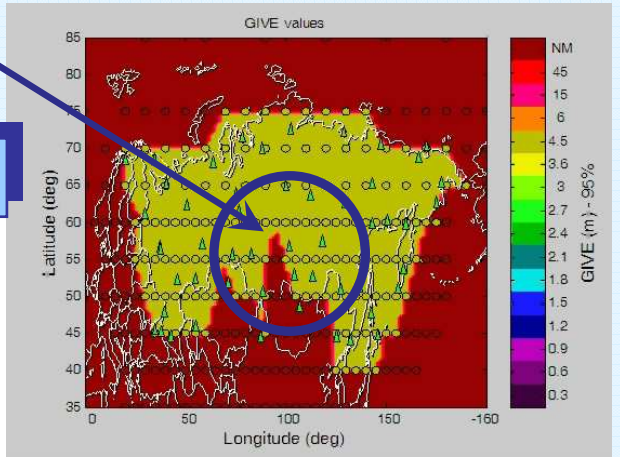
SBAS ionospheric model



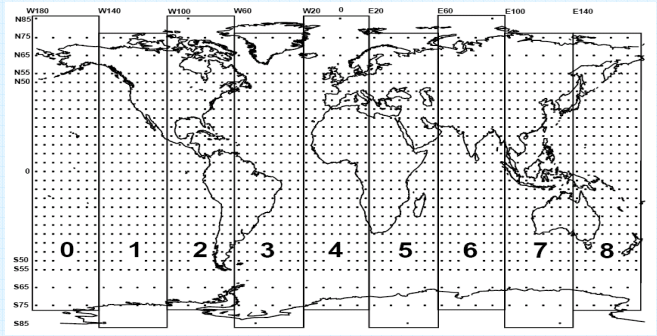
URS network arrangement



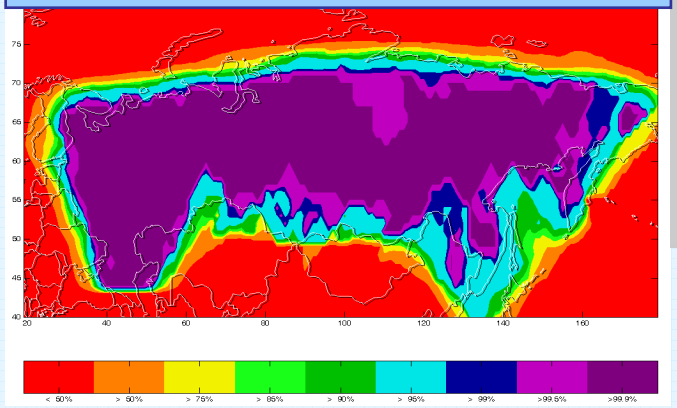




Standard ionosphere grid

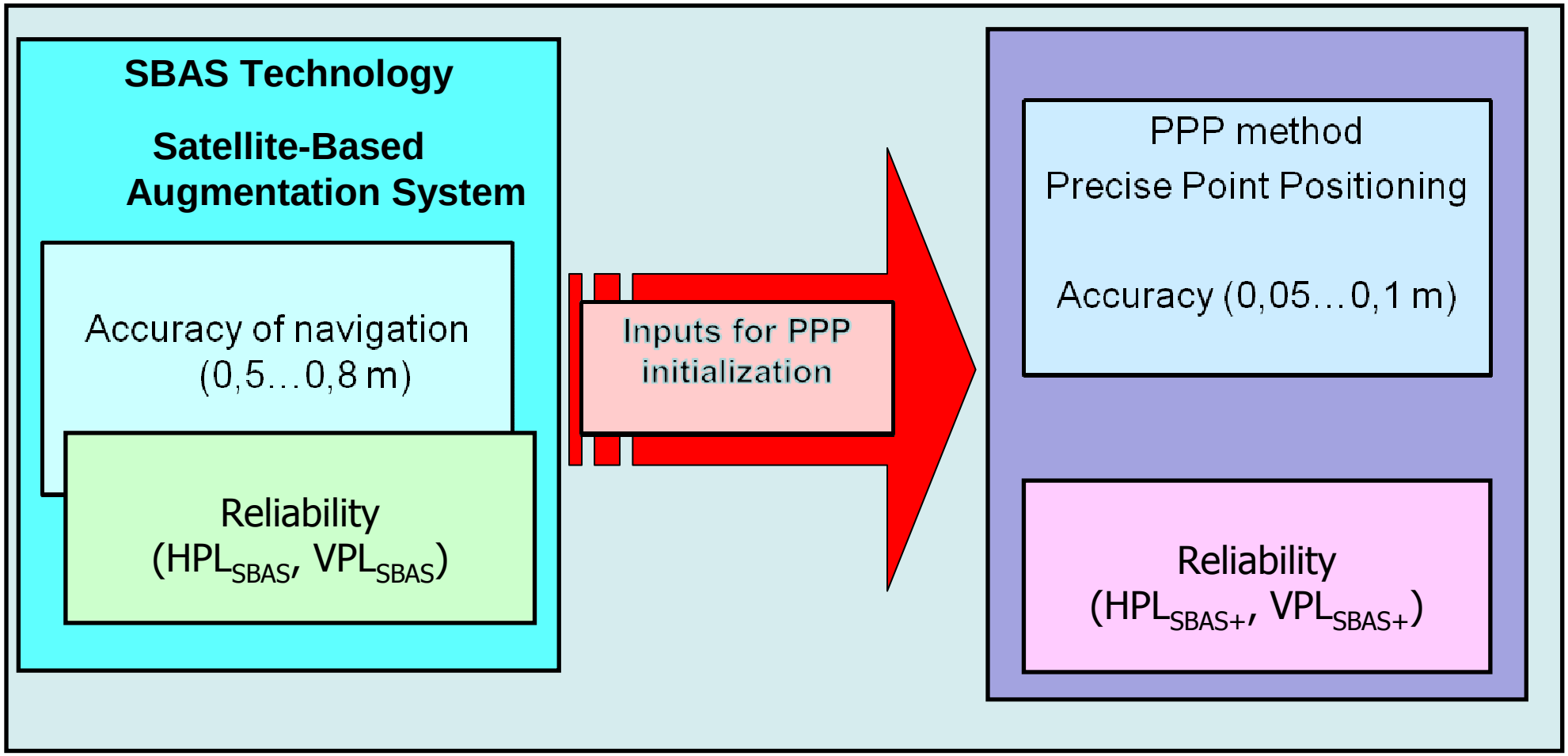


Simulation results



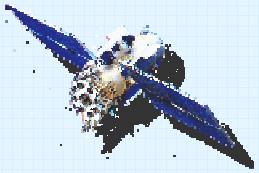
The network comprises:
- 46 URS network in Russia;
- 8 URS network abroad along the Russian boarder.

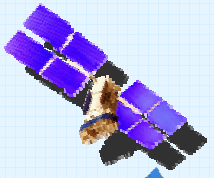
SBAS+ technology under verification

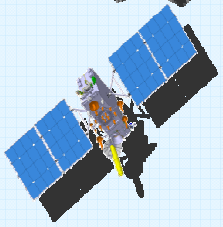


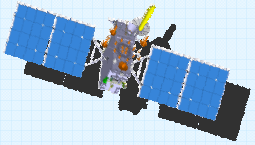
SBAS+ format is an expansion of SBAS standard through broadcasting refined orbits and clocks

Strategy to develop GLONASS open access navigation





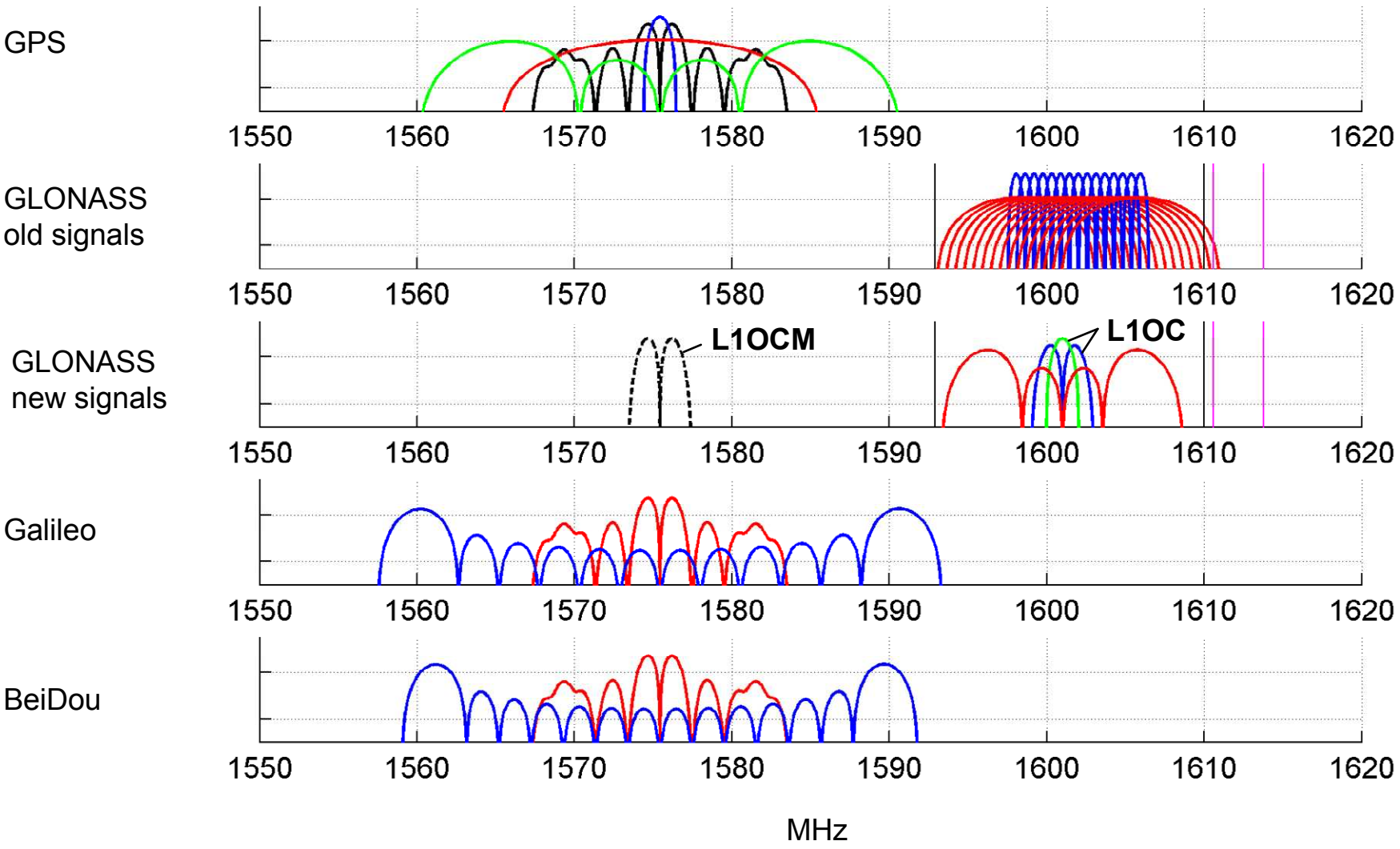




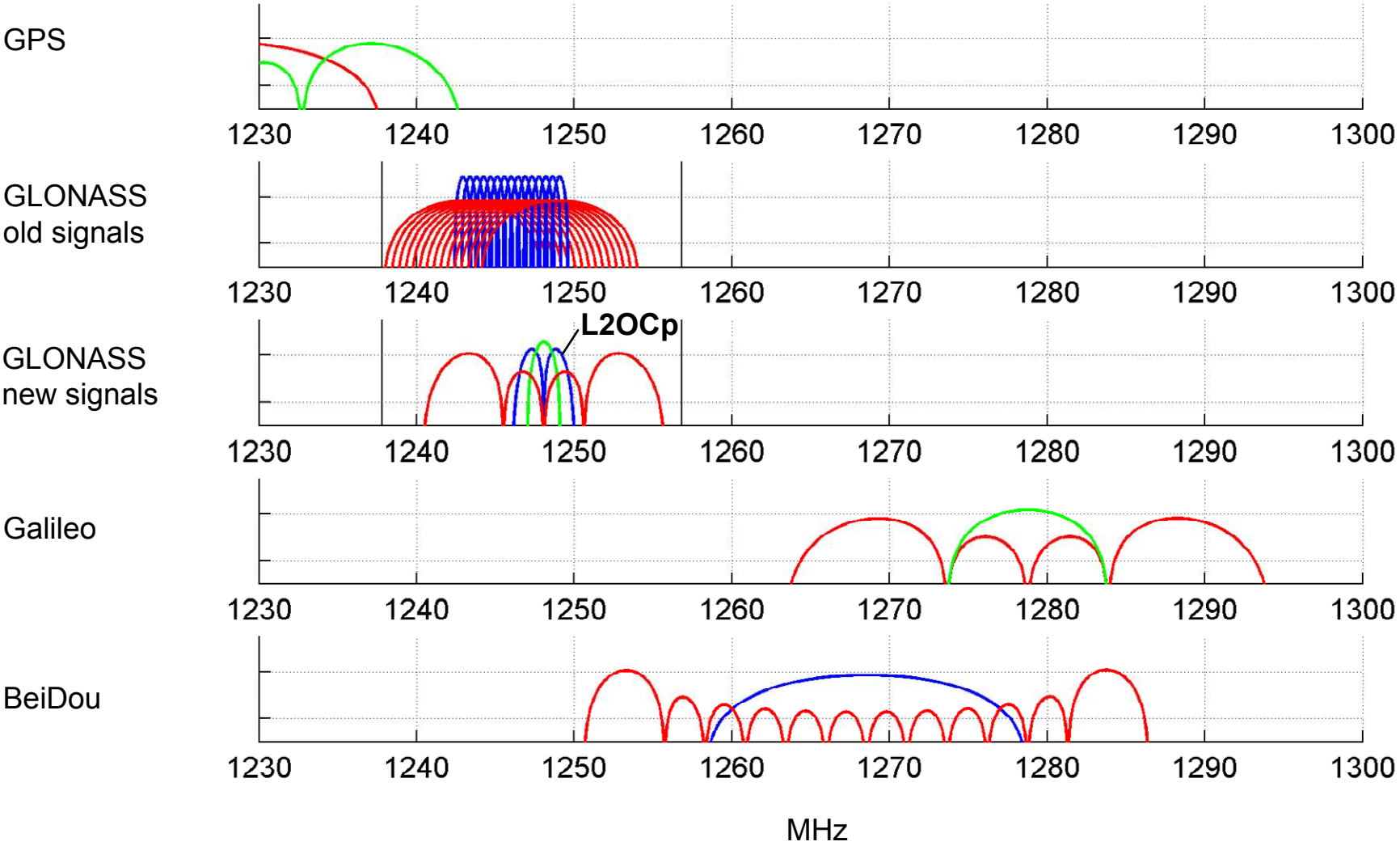
	L1	L2	L3	L1	L2	Future
«GLONASS» satellite	L1OF	L2OF	-		-	
«GLONASS-M» satellite	L1OF	L2OF	L3OC From 2014/ 2015		-	
«GLONASS -K1» satellite	L1OF	L2OF	L3OC test		-	
«GLONASS-K2» satellite	L1OF	L2OF	L3OC L3OC	L1OC L1OC	L2OC	
«GLONASS-KM» satellite	L1OF	L2OF	L3OC L3OC	L1OC L1OC	L2OC	L1OC, L5OC

FDMA CDMA

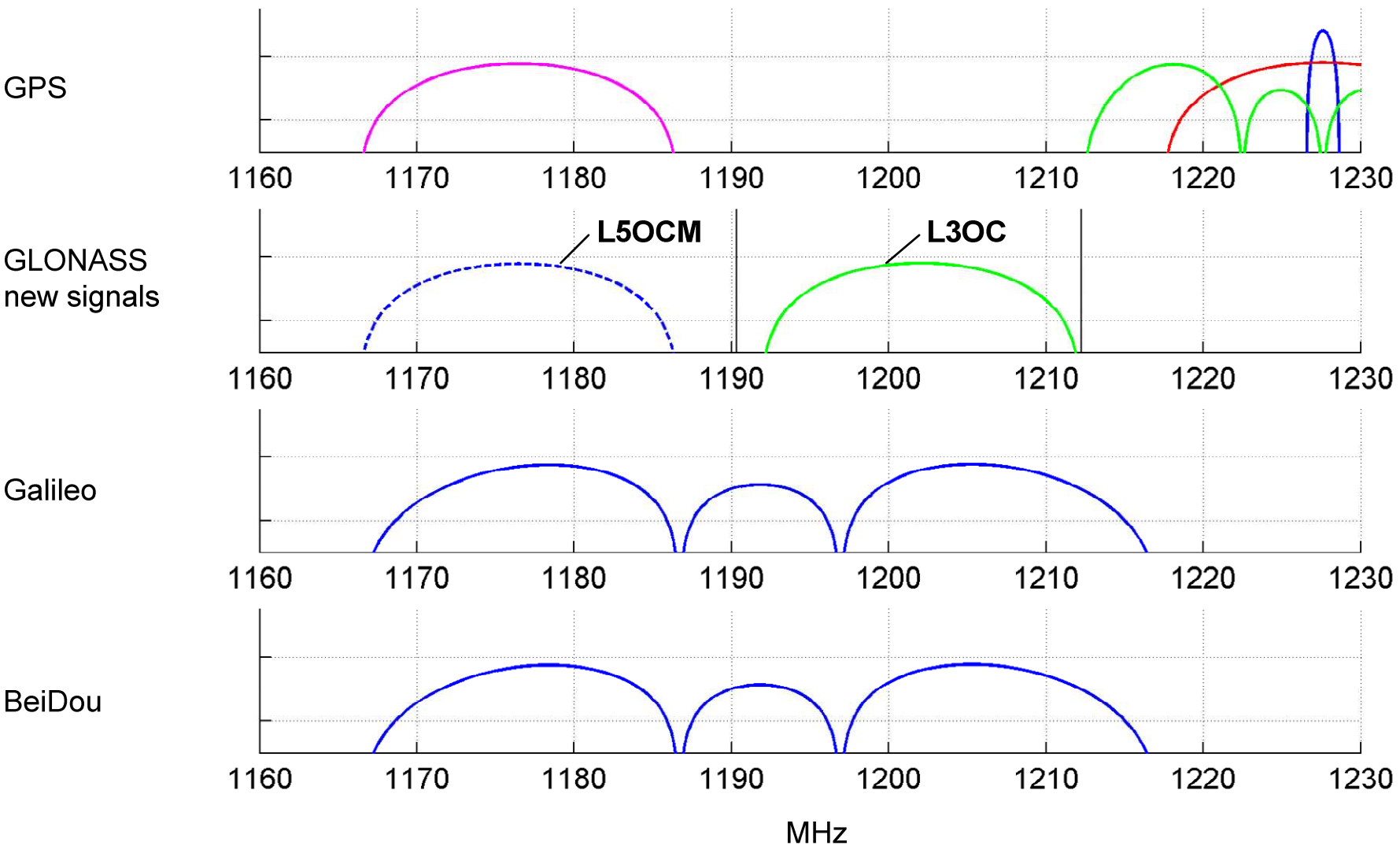
GLONASS signals in L1 band



GLONASS signals in L2 band



GLONASS signals in L3 band



SBAS and ARAIM systems (algorithms)

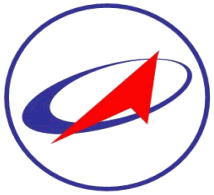
SBAS – wide-band differential system which ensures integrity and better navigation accuracy

ARAIM – algorithm which ensures only integrity

- SBAS adjusts GNSS navigation information in case of a partial access and presence of other interferences
- ARAIM is capable of only identifying and eliminating information sent by "unreliable" satellites from navigation solution
- It is SBAS provider who is responsible for quality of the service
- In case ARAIM is used no responsibility is identified

SBAS - *Satellite-based augmentation system*

ARAIM – *Advanced receiver autonomous integrity monitoring*



SBAS or ARAIM ?

Problem areas of replacing SBAS by ARAIM:

- Inability to improve navigation information as it could be possible if using SBAS corrections
- Problems with combined processing of various GNSS information using ARAIM algorithm (they differ in: systems of coordinates; time scales; accuracy of determining position and clocks corrections; accuracy of navigation solutions; mathematical models of satellites movement;…)
- Identifying who will be responsible for quality of the service and effects of poor solutions (developer of the algorithm - ?; developer of SW - ?; developer or manufacturer of equipment - ?;…) WHO?

SBAS and ARAIM will become interoperable systems in the near future rather than an alternative to each other.

SBAS together with ARAIM !

Summary

It is essential to continue dialogues and multilateral cooperation on compatibility and interoperability of GNSS

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