



Federal Space Agency  
Joint Stock Company  
«Academician M.F. Reshetnev « INFORMATION SATELLITE SYSTEMS»



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# GLONASS Evolution and Performance Improvement

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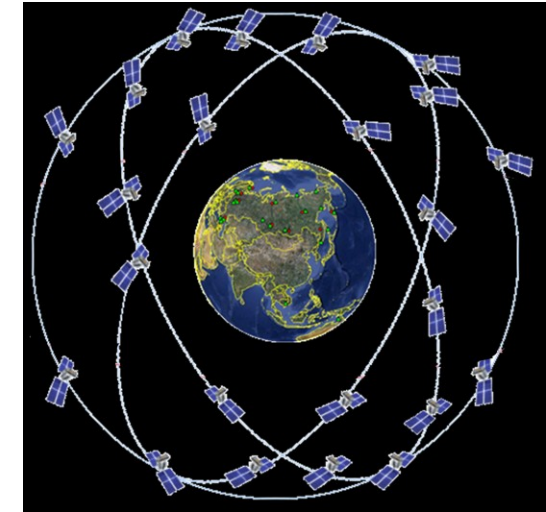
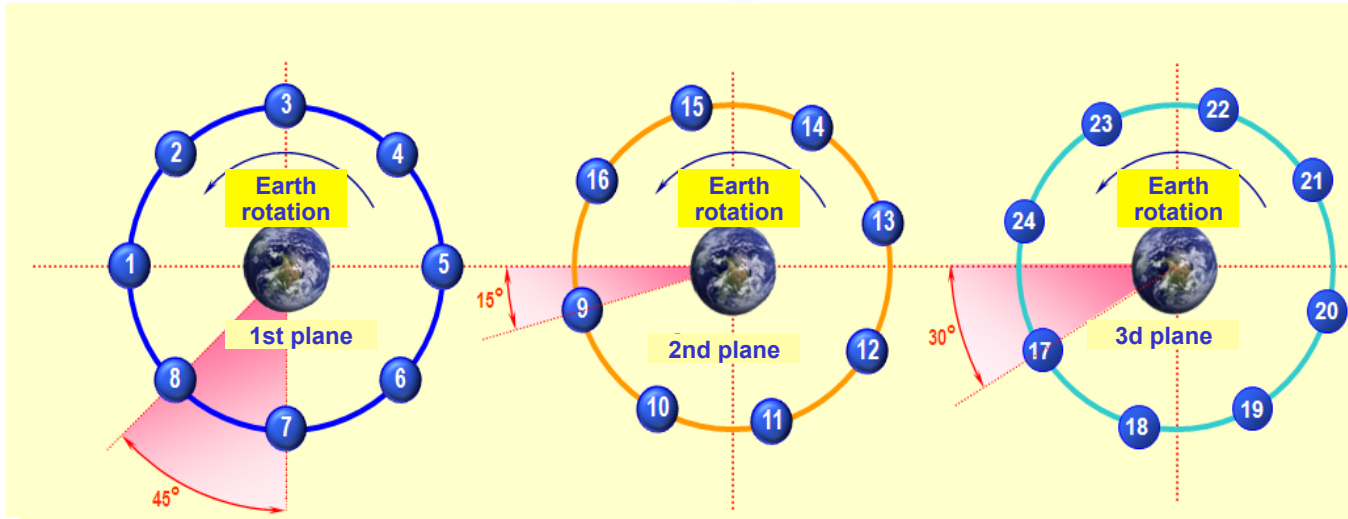
November 9—14, 2014  
Prague, Czech Republic

# Orbital Crystal

## GLONASS Nominal Constellation



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### Constellation:

24 S/Cs (3 planes, 8 satellites per a plane)

### Orbit type:

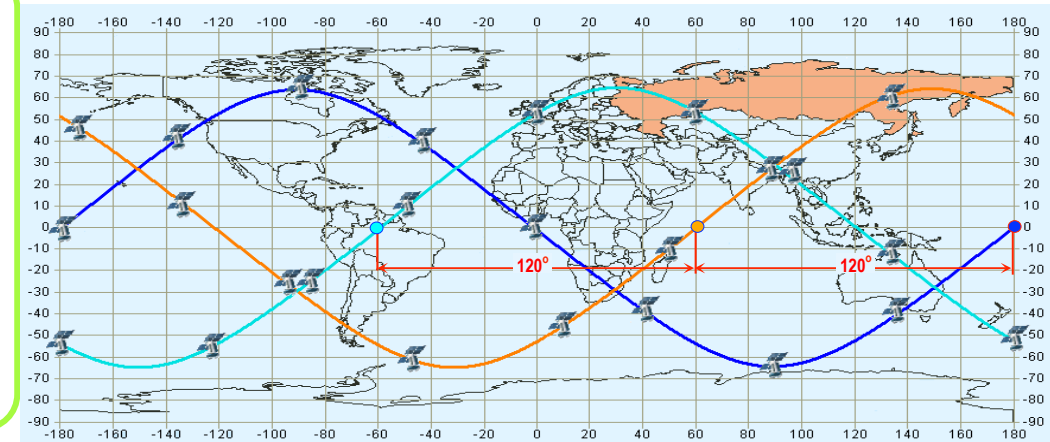
circular,  
altitude -  $H = 19\,100$  km,  
inclination -  $i = 64.8^\circ$

### Orbital period:

11 h 15 min 44 sec

Orbital planes: spaced by  $120^\circ$  along equator  
Service area: global, up to altitude of 2000 km

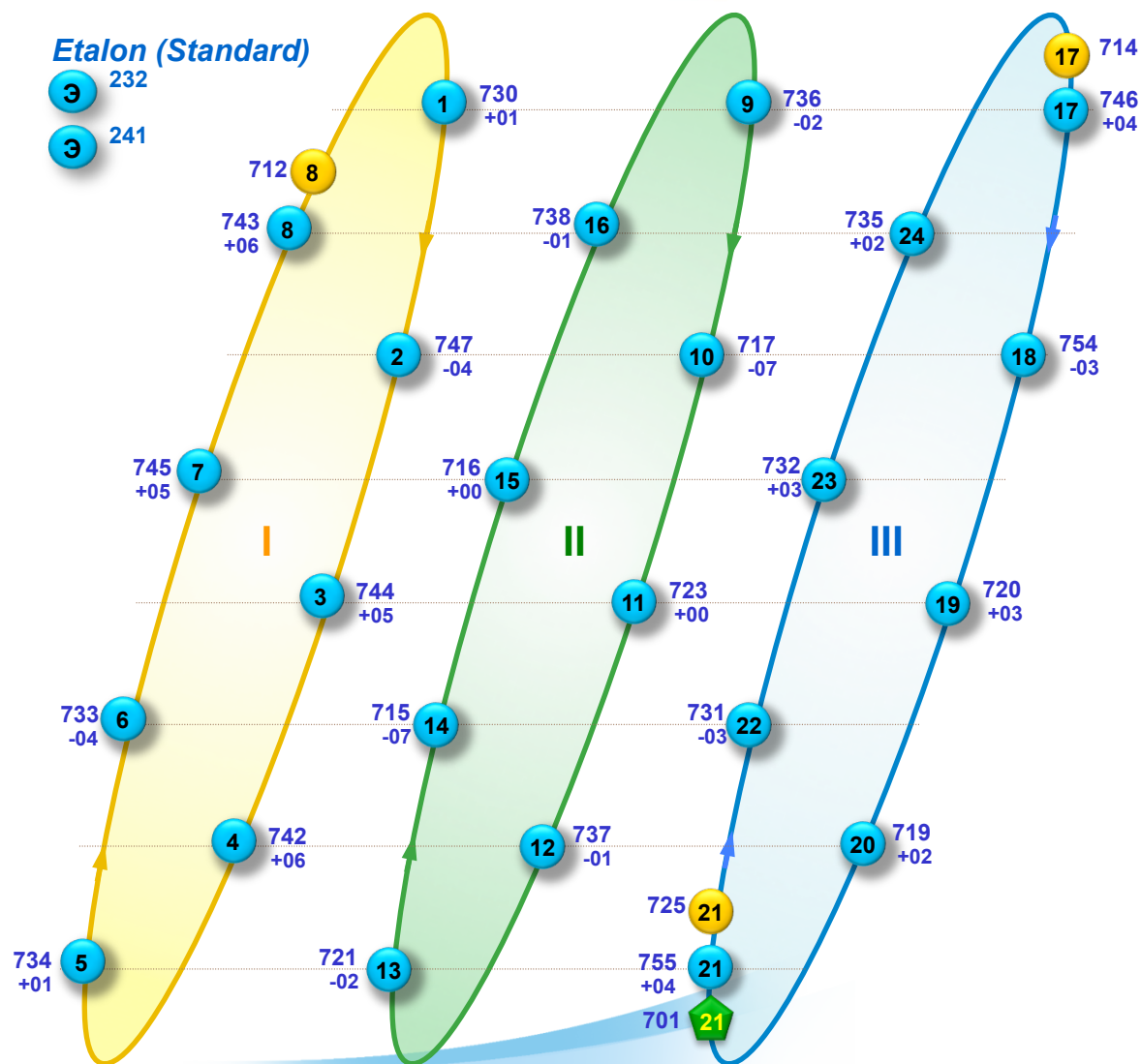
### Ground traces of GLONASS satellites



Orbital parameters allow high stability of GLONASS constellation over the entire satellite operational life time without additional maintenance costs & propellant 2



# GLONASS Constellation



Status as of November 10, 2014	
<b>Total</b>	<b>28 S/C</b>
<b>Operational</b>	<b>24 S/C</b>
<b>Orbital spare</b>	<b>2 S/C</b>
<b>Under flight test</b>	<b>1 S/C</b>
<b>Under Investigation</b>	<b>1 S/C</b>



The launch is scheduled in December  
Block K2s – «Glonass-K1» No.12

# Glonass-M



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- ❑ Mission life 7 years
- ❑ Mass 1415 kg
- ❑ Power consumption 1450 W
- ❑ Navigation payload:
  - Mass 250 kg
  - Power consumption 580 W
  - L3OC (starting with #55, 2014)

**Glonass-M is the 2nd generation of Glonass family**

**First launch was in 2003**

Navigation antenna

Laser retroreflectors





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# Глонасс-K1



Laser retroreflectors

Navigation antenna

- Mission life 10 years
- Mass 995 kg
- Power consumption 1460 W
- Navigation payload
  - Mass 260 kg
  - Power consumption 750 W
- Navigation signals
  - L1OF, L1SF, L2OF, L2SF
  - L3OC

**Глонасс-K1 is the 3rd generation of Глонасс family**

**It is the interim satellite intended to validate a completely new technology**

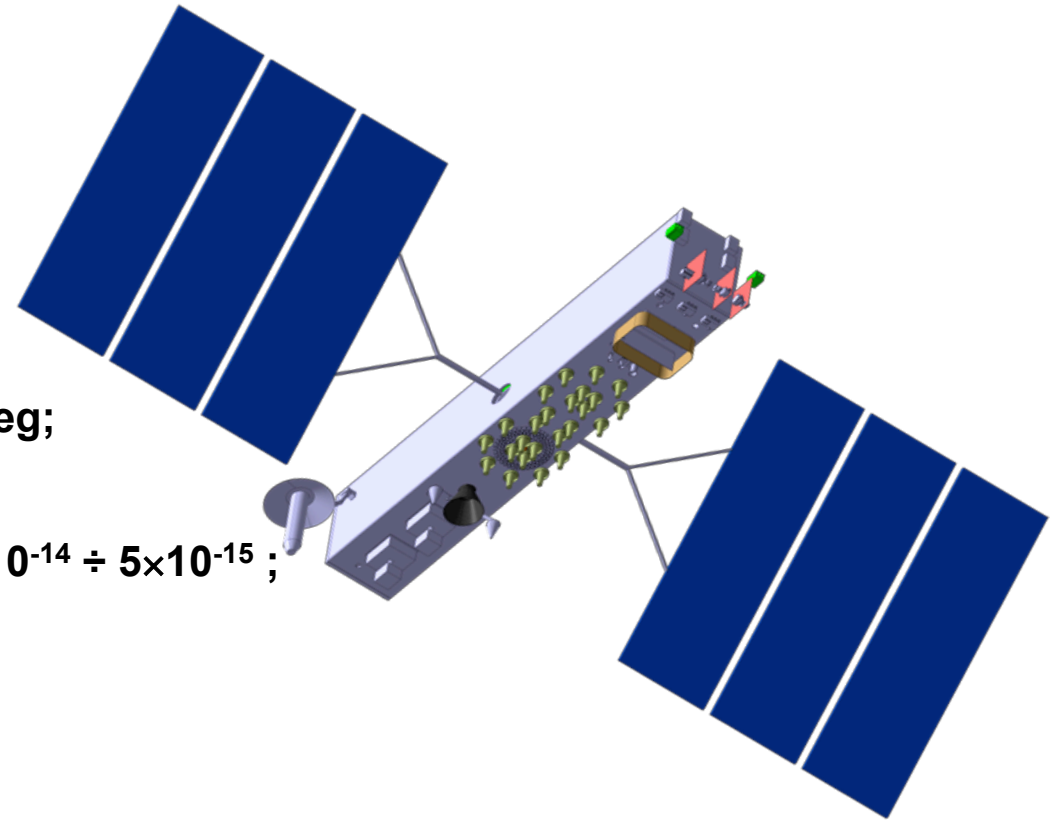
**First launch was in 2012**

# Glonass-K2



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- Design life time - 10 years;
- Mass - 1645 kg;
- Power consumption - 4370 W;
- Navigation payload:
  - Mass - 520 kg;
  - Power consumption - 2618 W;
- Accuracy of S/C attitude control -  $\pm 0.25$  deg;
- Solar arrays area - 33.84 m<sup>2</sup>;
- Stability of onboard frequency generator -  $5 \times 10^{-14} \div 5 \times 10^{-15}$  ;
- S/C availability - 0.99;
- Mission tasks - 6
- Navigation signals:  
L1OF; L2OF; L1SF; L2SF; L1OC; L1SC; L2OC; L2SC; L3OC



**Glonass-K2 is the 3<sup>rd</sup> generation of Glonass family**

**First launch is planned in 2016**

# Navigation Requirements



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## User requirements

- Better accuracy
- Continuous availability
- Interference immunity
- Navigation services ensured by system providers
- Navigation indoor, underwater, underground, in space between the Earth and the Moon

## System Requirements

Parameter	Now	I phase	II phase
<b>No. of satellites in constellation</b>	26	29	30
<b>Positioning accuracy in real-time mode (m)</b>	2.8	1.1	0.6
<b>Timing accuracy (ns)</b>	5	2	1

## Support System Requirements

Parameter	2020
<b>System time scale referenced to UTC(SU) (ns)</b>	1
<b>UTC(SU) referenced to UTC (ns)</b>	1
<b>PZ-90 referenced to ITRS (m)</b>	0.005
<b>Accuracy of Earth Pole determination in real-time mode (m)</b>	0.003

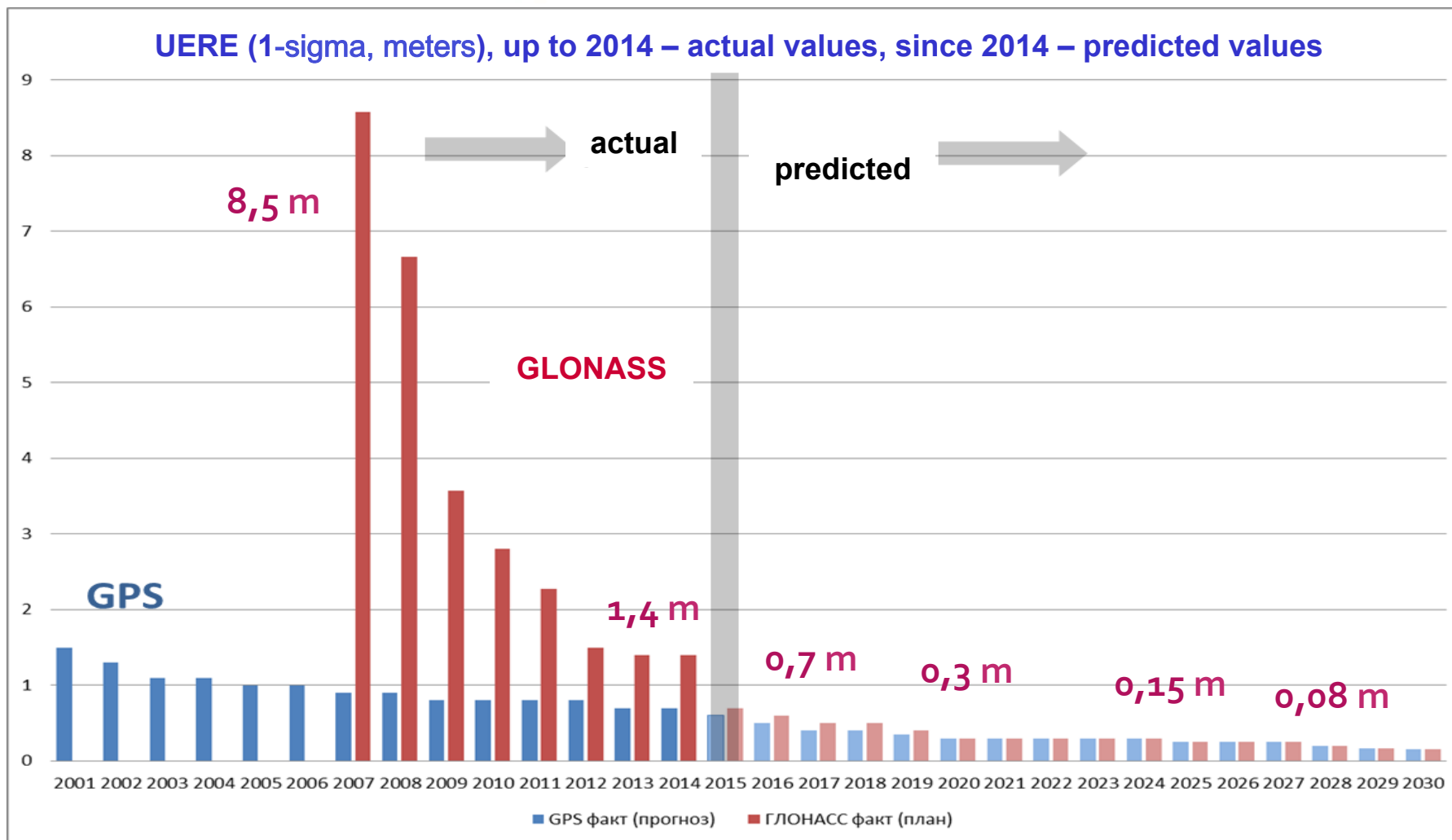


New requirements demand new technologies and new solutions

# Improvement of GLONASS System Accuracy



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Accuracy was improved ten times over the last decade



# Tramlines of GLONASS performance improvement



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- ❑ Constellation renewal with Glonass-K1 and Glonass-K2 satellites
- ❑ Improvement of navigation service accuracy due to:
  - New generation of the Ground Control Segment
  - The global network of one-way measuring stations
  - Crosslink functions for Ephemeris and Clock data provision

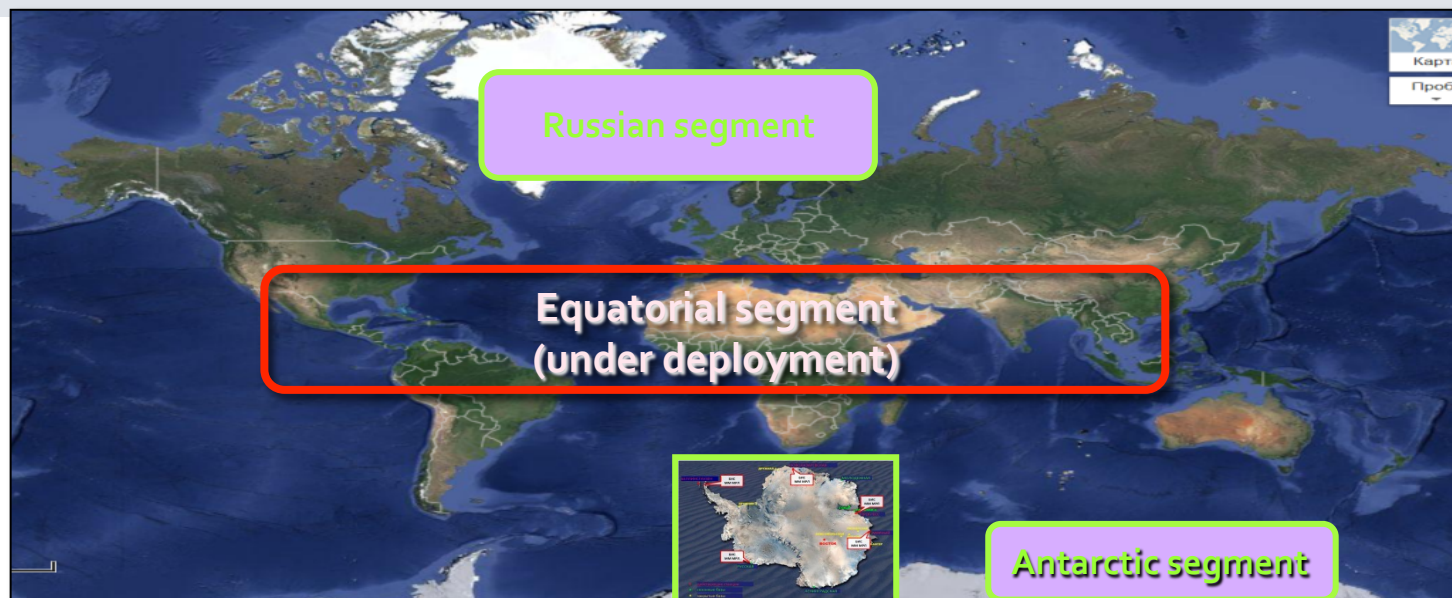
# GLONASS Ground Segment Deployment



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It includes:

- Deployment of measuring station network throughout the Russian territory
- Deployment of measuring station network in Antarctica
- Deployment of uplink station network throughout the Russian territory
- Deployment of global measuring station network outside the Russian territory
- Further use of crosslink functions for Ephemeris and Clock data provision
- Creation of high-stable Time Scale based on distributed frequency standards synchronized versus the state frequency standard.



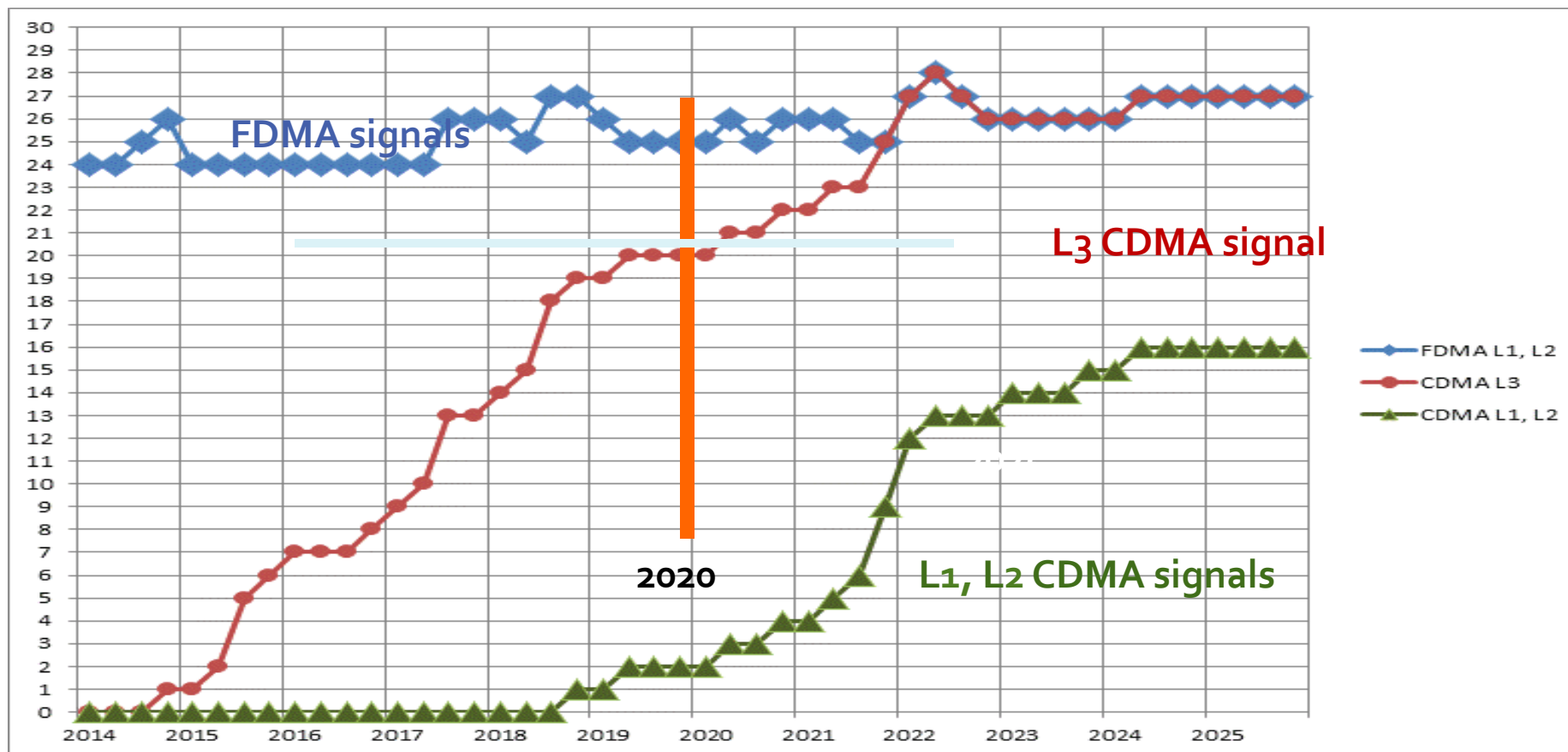
Ground segment deployment ensures significant improvement of GLONASS system accuracy.

# Prediction for launches of satellites with new CDMA signals



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Number of satellites with the specified signals within GLONASS constellation



# Conclusion



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- ❑ The GLONASS system was, is, and will be the foundation of the Russian navigation infrastructure for years.
- ❑ Being a part of the global navigation infrastructure, the GLONASS system is providing the baseline services to all users free of charge.
- ❑ Keeping up with competitors is the basis of mainstream use of GLONASS services worldwide.
- ❑ International GNSS cooperation is aimed to assure mainstream use of GLONASS services worldwide.

## Thank you for attention!