GLONASS System Development and Use

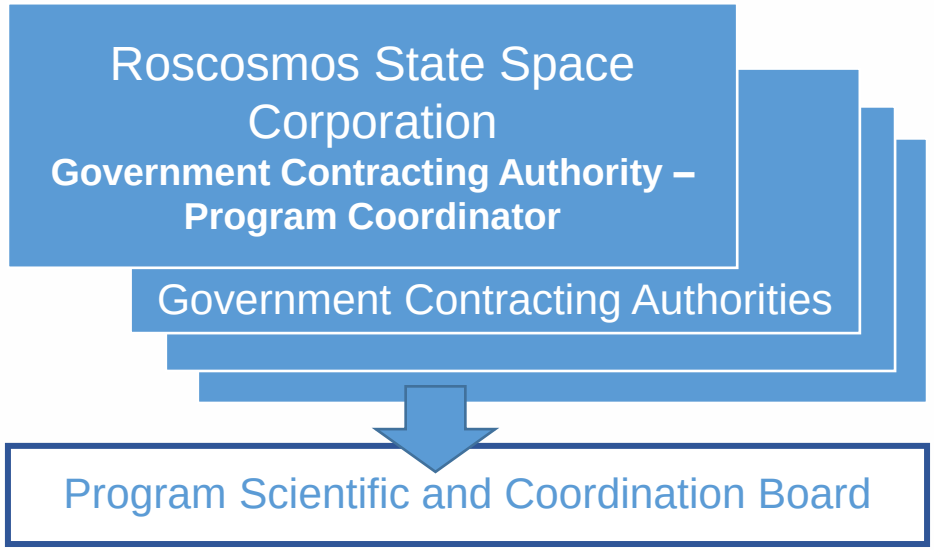
United Nations/Argentina Workshop on the applications of global navigation satellite systems
19 - 23 March 2018, Falda Del Carmen, Argentina

ROSCOSMOS
State Space Corporation

ROSCOSMOS

- Presidential Decree of May 17, 2007 No. 638 On Use of GLONASS (Global Navigation Satellite System) for the Benefit of Social and Economic Development of the Russian Federation
- Federal Program on GLONASS Sustainment, Development and Use for 2012-2020 – planning and budgeting instrument for GLONASS development and use
- Budget planning for the forthcoming decade – up to 2030

GLONASS Program governance:



GLONASS Program Goals:

- Improving GLONASS performance – its accuracy and integrity
- Ensuring positioning, navigation and timing solutions in restricted visibility of satellites, interference and jamming conditions
- Enhancing current application efficiency and broadening application domains

Accuracy Improvement *by means of:*

- Ground Segment modernization
- introduction of new onboard atomic frequency standards with enhanced performance
- introduction of advanced satellite control and command, orbit and clock determination technologies based on intersatellite crosslinks in RF and optical bands
- transition to PZ-90.11 Geodetic System aligned to the ITRF with mm error level
- synchronization of GLONASS Time Scale with UTC(SU) at less than 2 ns

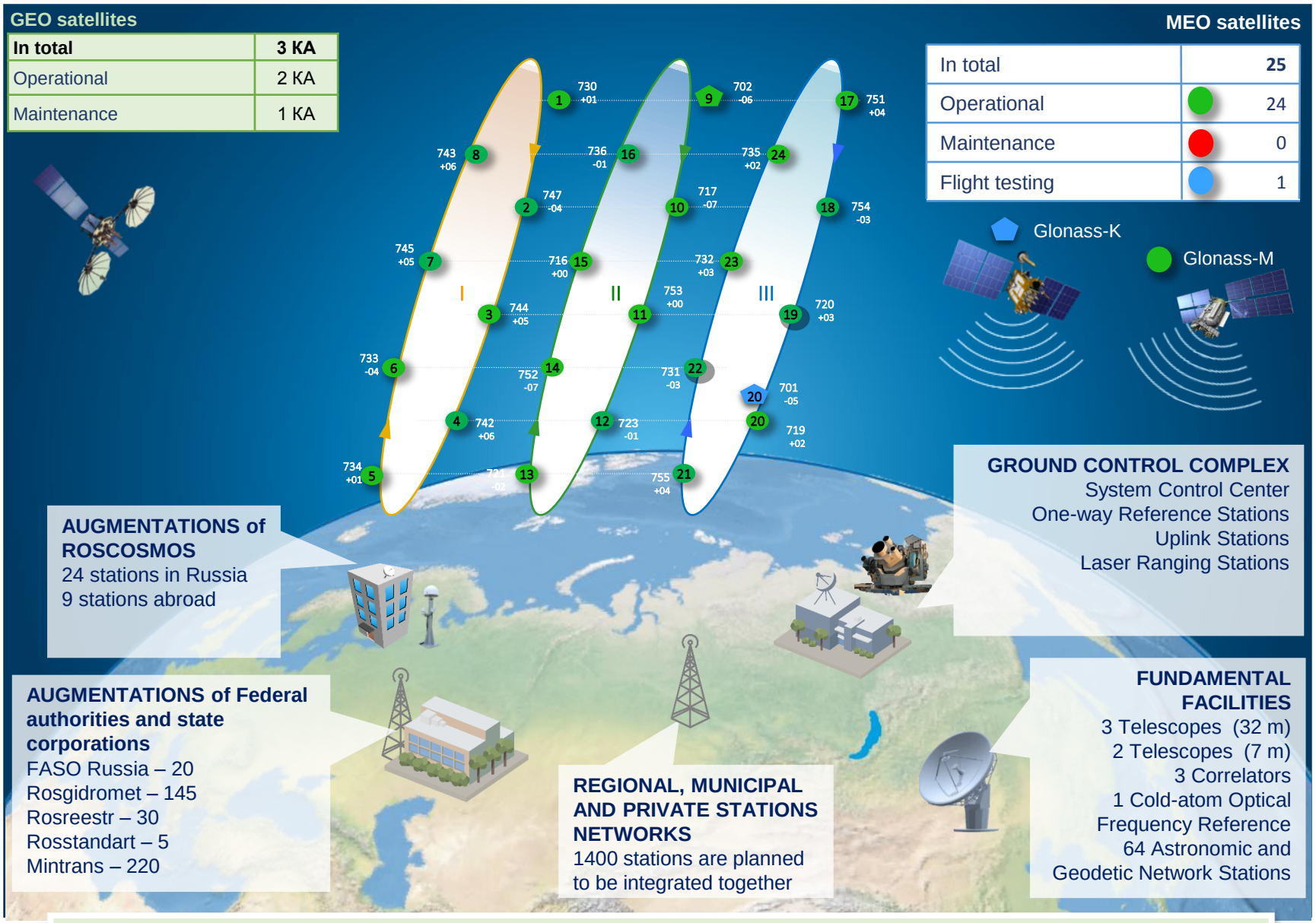
GLONASS STATUS (as of 19.03.2018)

GEO satellites

In total	3 KA
Operational	2 KA
Maintenance	1 KA

MEO satellites

In total	25
Operational	24
Maintenance	0
Flight testing	1



AUGMENTATIONS of ROSCOSMOS
24 stations in Russia
9 stations abroad

GROUND CONTROL COMPLEX
System Control Center
One-way Reference Stations
Uplink Stations
Laser Ranging Stations

AUGMENTATIONS of Federal authorities and state corporations
FASO Russia – 20
Rosgidromet – 145
Rosreestr – 30
Rosstandart – 5
Mintrans – 220

REGIONAL, MUNICIPAL AND PRIVATE STATIONS NETWORKS
1400 stations are planned to be integrated together

FUNDAMENTAL FACILITIES
3 Telescopes (32 m)
2 Telescopes (7 m)
3 Correlators
1 Cold-atom Optical Frequency Reference
64 Astronomic and Geodetic Network Stations

The constellation provides global continuous navigation

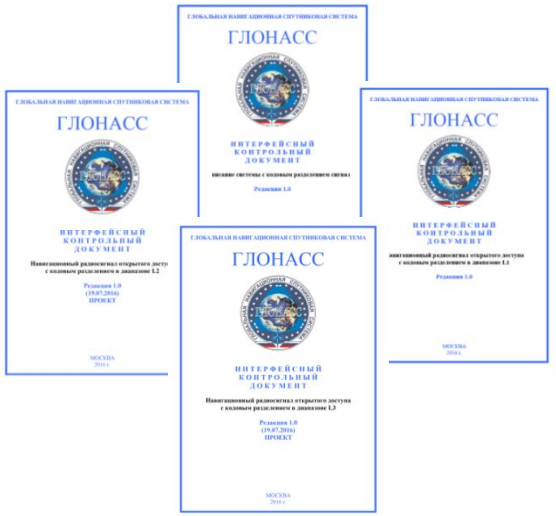
Glonass-M satellites launches

- 2 Glonass-M satellites were launched in 2016 (February 7th and May 29th)
- 1 Glonass-M satellite was launched in 2017(September 22nd)

Glonass-M Launch
on September 22nd, 2017

GLONASS INTERFACE CONTROL DOCUMENTS

Released at http://russianspacesystems.ru



- Interface Control Document “General Description of the GLObal NAvigation Satellite System with the Code Division Multiple Access Signals”
- Interface Control Document “GLONASS L1 Open Service Code Division Multiple Access Signal”
- Interface Control Document “GLONASS L2 Open Service Code Division Multiple Access Signal”
- Interface Control Document “GLONASS L3 Open Service Code Division Multiple Access Signal”

Type of difference	FDMA signal reference documents	CDMA signal reference documents
Variable number of SVs	0 to 24	0 to 63
Message structure	Fixed structure “superframe/frame/string”	Continuous sequence of strings, non-fixed length, variable composition depending on the number of operational SVs, types of strings can be added, backward compatibility with receivers currently in use
Time stamp length	30 bits	12 bits
Value of LSB	0.4 m	0.001 m
Signal health status periodicity	1 per 4 sec	1 per 2 sec for L1 and L2 1 per 3 sec for L3

- All types of augmentations to support all types of high accuracy services developed and continue to expand

- network densification
- space segment modernization
- coverage extension

POCKOCMOC

BROADCASTING FACILITIES

GEO

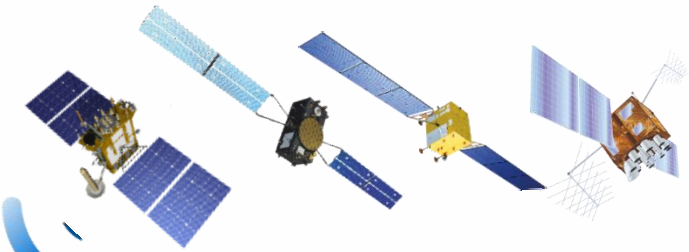
L1/L5 SBAS

L1/L3 GLONASS

INTERNET

NTRIP

GNSS CONSTELLATION

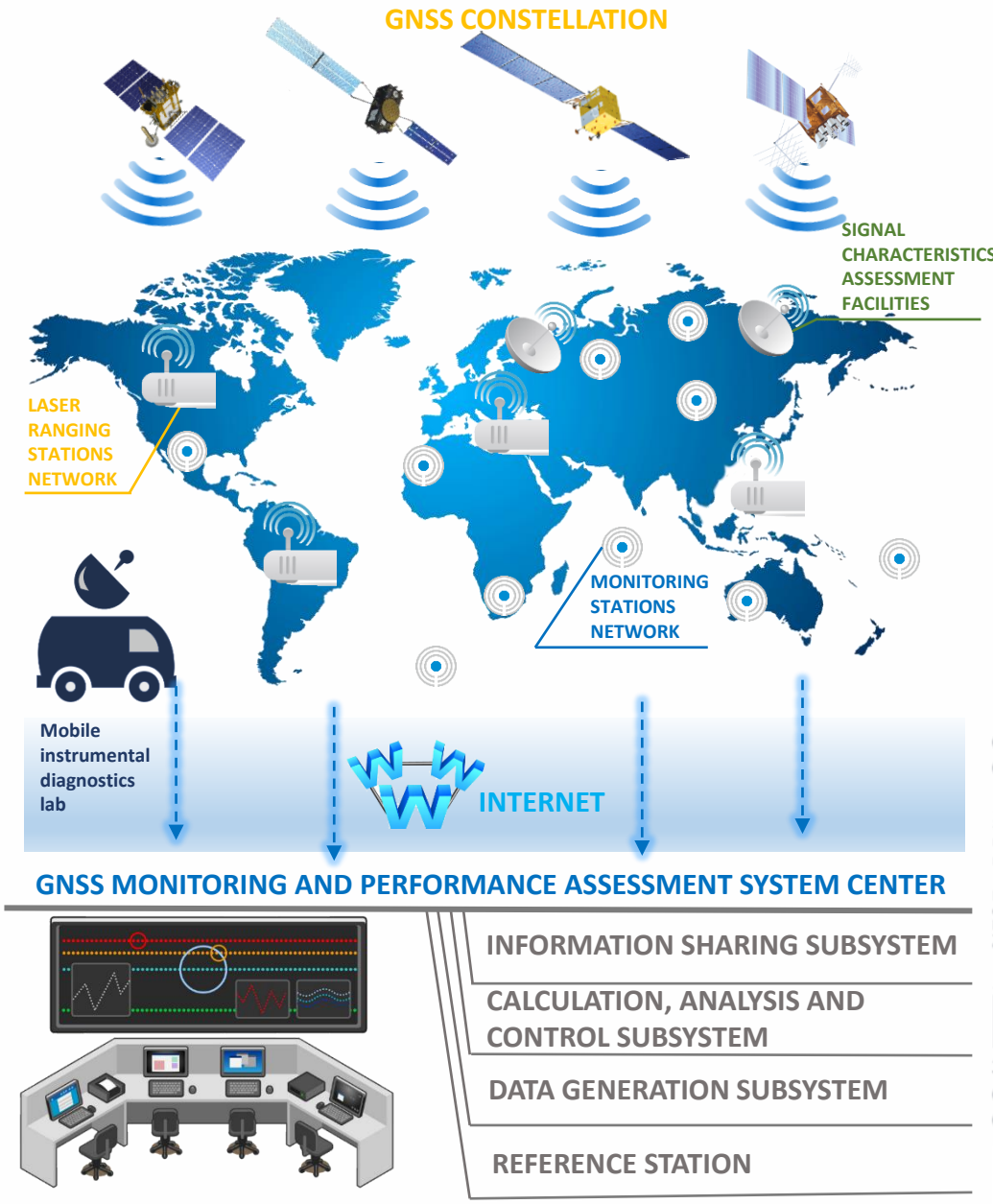


DATA PROCESSING FACILITY

- Master Center
- Back-Up Center

GLOBAL MONITORING NETWORK

- Independent monitoring and verification of performance characteristics against system requirements
- Generating input data to assess GLONASS Program KPIs
- Measuring user level GLONASS performance



GLONASS CIVIL SERVICES

Name	Users	Current value	Means
1 BASIC OPEN SERVICE Navigation in absolute regime using open CDMA signals		2 m	**SPACE SEGMENT**
2 SERVICE OF IMPROVED RELIABILITY AND ACCURACY Navigation in absolute regime using CDMA signals and augmentations from regional and local augmentation systems		1 m	SYSTEM FOR DIFFERENTIAL CORRECTION AND MONITORING
3 RELATIVE NAVIGATION SERVICE Navigation in relative regime using phase measurements and a reference receiver (reference station)		0,03 m	NATIONAL SYSTEM FOR HIGH-ACCURACY POSTIONING
4 HIGH-PRECISION SERVICE Navigation in absolute regime using phase measurements (PPP) on a commercial basis		0,1 m	HIGH-PRECISION SYSTEM FOR OBTAINING THE NAVIGATION AND EPHEMERIS-AND-TIME INFORMATION

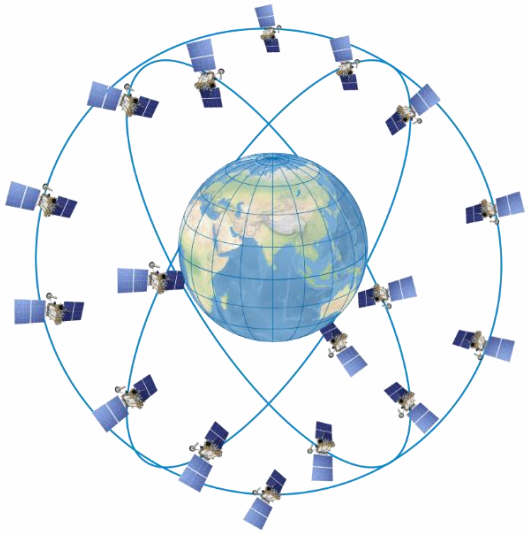
GLONASS APPLICATION PROJECTS

GROUND ROAD TRANSPORT

- ~2.1 million of cars is GNSS-equipped
- 52 regional navigation-informational systems
- ERA-GLONASS – plan for 100% coverage of car fleet in Russia:
  up to 42 million onboard GNSS-terminals;
- Platon – all cargo trucks exceeding 12 tons of gross vehicle weight:
  up to 2 million onboard GNSS-terminals;

RAILROAD TRANSPORT

- 14 thousand of rolling stock is GNSS-equipped
- 49 ground local reference stations for differential correction to support high-precision coordinate systems and shunting



SPACE

GLONASS-based technologies have become primary navigation tool for put-into-orbit operations of:

- Progress-MS cargo SC;
- Soyuz-MS manned SC;
- Resurs Earth Remote Sensing SC;
- Kanopus Earth Remote Sensing SC.

GLONASS technologies are used at:

- Kondor-E SC;
- Meteor-M SC and others.

MARINE TRANSPORT

- Over 40 control and correction stations at the sea and river ports

AGRICULTURE

- 3 thousand of agriculture machinery is GNSS-equipped

AIR TRANSPORT

- 94 civil airports equipped with GLONASS ground-based augmentations systems (GBAS)

ЭРА-ГЛОНАСС

РОСКОСМОС

- In operation since January 1, 2016, nation-wide
- All domestically manufactured or imported vehicles are to be equipped with ERA-GLONASS since January 1, 2017
- 30% reduction of time emergency services respond to an accident
- 347 thousand calls processed, 854 thousand vehicles equipped since start of operation
- Social-and-economic effect: saving more than 4 thousand people annually

(an estimation provided that 100% of the Russian vehicle fleet is equipped)

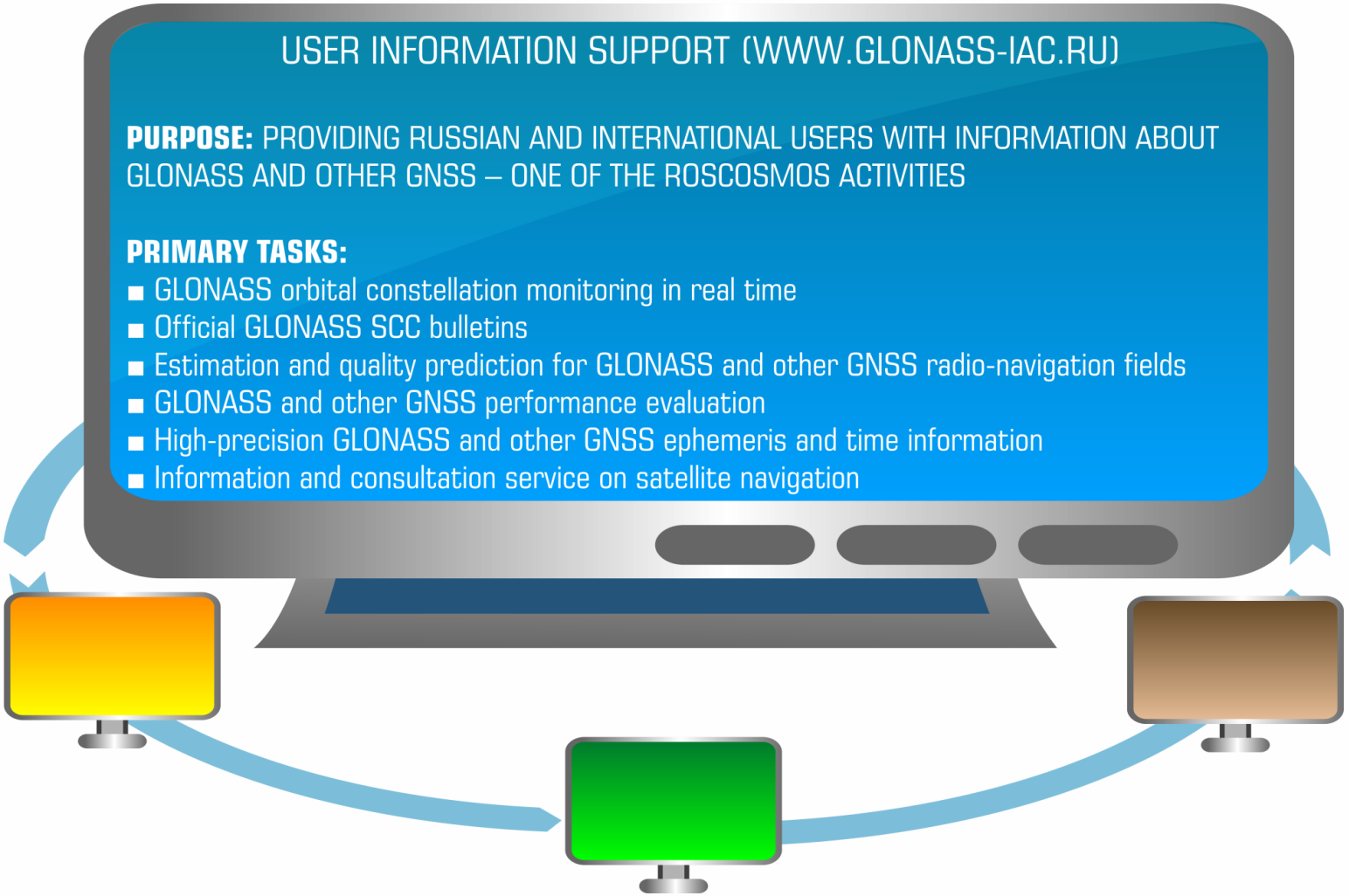
- Emergency call is free of charge
- Commercial application potential: smart insurance, property and crime protection, traffic monitoring, toll collection, distant diagnostics and etc.

ERA-GLONASS – integration of the opportunities provided by telecommunication, navigation, information technologies and microelectronics aimed at people's life and health safety

FEDERAL TOLL COLLECTION SYSTEM FOR COMMERCIAL CARGO TRUCKS – PLATON

- PLATON – nation-wide GLONASS/GPS based automatic toll collection system
- In operation since November 15, 2015
- All trucks over 12 tons
- All Federal-owned highways – 50.774 km in total
- 88% of the total fleet – 330 thousand cargo companies and 900 thousand trucks registered
- 32,9 billion rubles collected for road infrastructure support

РОСКОСМОС



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Thank you for your attention!