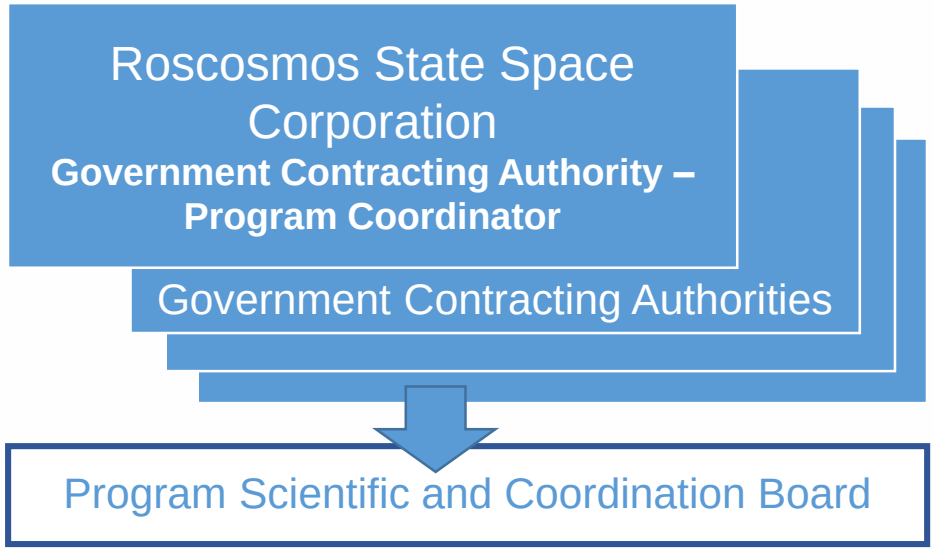
GLONASS system development and use

ROSCOSMOS
State Space Corporation

December 2-7, 2017
Kyoto, Japan

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 – Global Navigation System – 2030
- Program governance:



- Program Goals:
  - Improving system performance in terms of accuracy and integrity
  - Ensuring guaranteed positioning, navigation and timing solutions in restricted visibility of satellites, interference and jamming conditions
  - Enhancing current application efficiency and broadening application domains

❑ Four-fold 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 27.11.2017)

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
2 System Control Centers
8 One-way Reference Stations
3 One-way Reference Information Processing Systems
5 Uplink Stations
3 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

- 2016 - 2 Glonass-M satellites launched (07 Feb 16 and May 29)
- 22.09.2017 – 1 Glonass-M

Glonass-K

- 2 Glonass-K in orbit:

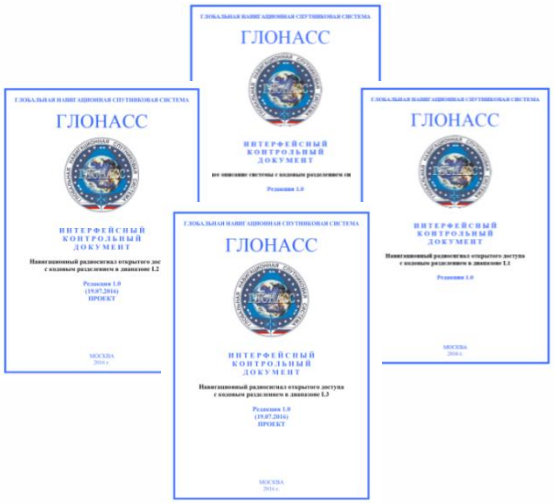
  1 undergoing flight testing

  1 commissioned in Feb 2016, operational

Glonass-M Launch on September 22, 2017

4 GLONASS REFEENCE DOCUMENTS RELEASED

- 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”

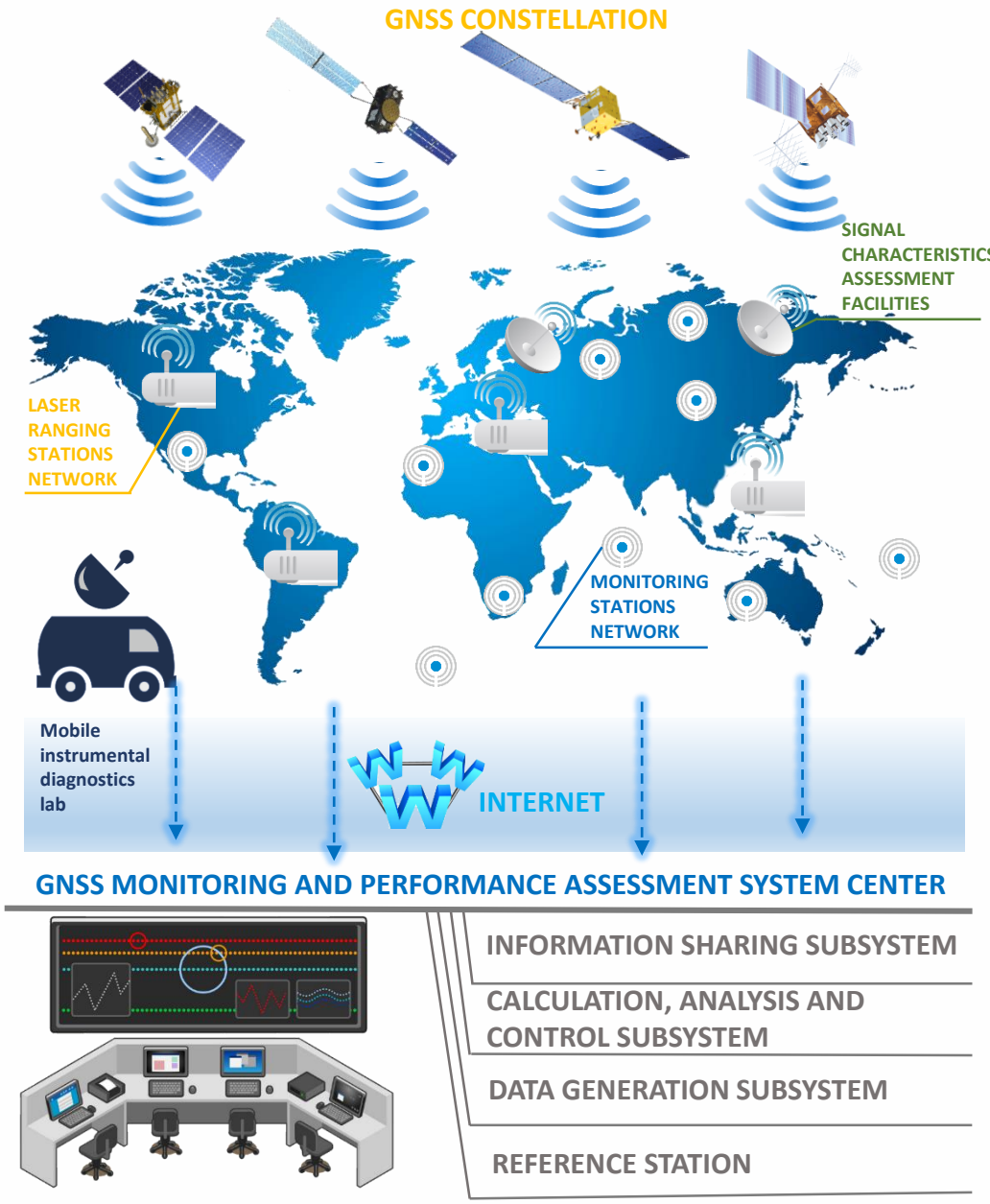


Type of difference	FDMA signal reference documents	CDMA signal reference documents
Variable number of SVs	0 to 24	0 to 63
Message structure	Fixed structure “superframe/frame/string”	Continuous sequence of strings, non-fixed length, variable composition depending on the number of operational SVs, types 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

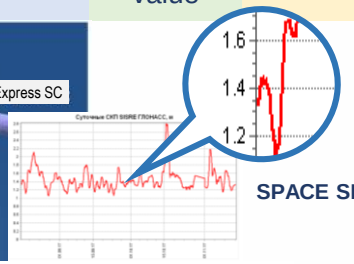
- All types of augmentations to support all types of high accuracy services developed and continue to expand

- network densification
- space segment modernization
- coverage extension

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



GLONASS CIVIL SERVICES

Name	Users	Current value	Means
1 BASIC OPEN SERVICE Navigation in absolute regime using open CDMA signals		 Daily RMS SISRE, m www.glonass-iac.ru	**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

PROVIDING USERS WITH GLONASS-BASED SERVICES

ORBITAL CONSTELLATION

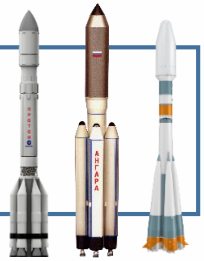
ROSCOSMOS

SATELLITES DESIGN AND MANUFACTURING

LAUNCHERS

ROSCOSMOS

LAUNCHERS DESIGN AND MANUFACTURING
LAUNCH SERVICES



GROUND CONTROL COMPLEX

ROSCOSMOS

DESIGN, MANUFACTURING, MAINTENANCE

OPERATION

SERVICES

GLONASS UNION

JSC GLONASS

+ PRIVATE COMPANIES

ROSCOSMOS

Rostec

Almaz – Antey Air and Space Defence Corporation»

+ PRIVATE COMPANIES

USER NAVIGATION EQUIPMENT

USERS

Transport

Precise agriculture

Energy

Geodesy, mapping

Construction

Recreation

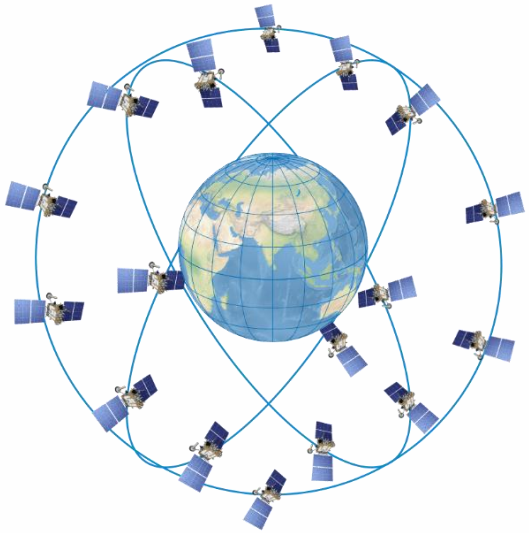
KEY GLONASS APPLICATION PROJECTS DURING GLONASS FEDERAL PROGRAMS REALIZATION IN 2002-2017

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



ROCKET & 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;
- Bars-M SC and others.

MARINE TRANSPORT

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

AIR TRANSPORT

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

AGRICULTURE

- 3 thousand of agriculture machinery is GNSS-equipped

R&D

- 6 research and development works aimed at GLONASS-based soft-, hardware and complex systems development in transport industry

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)

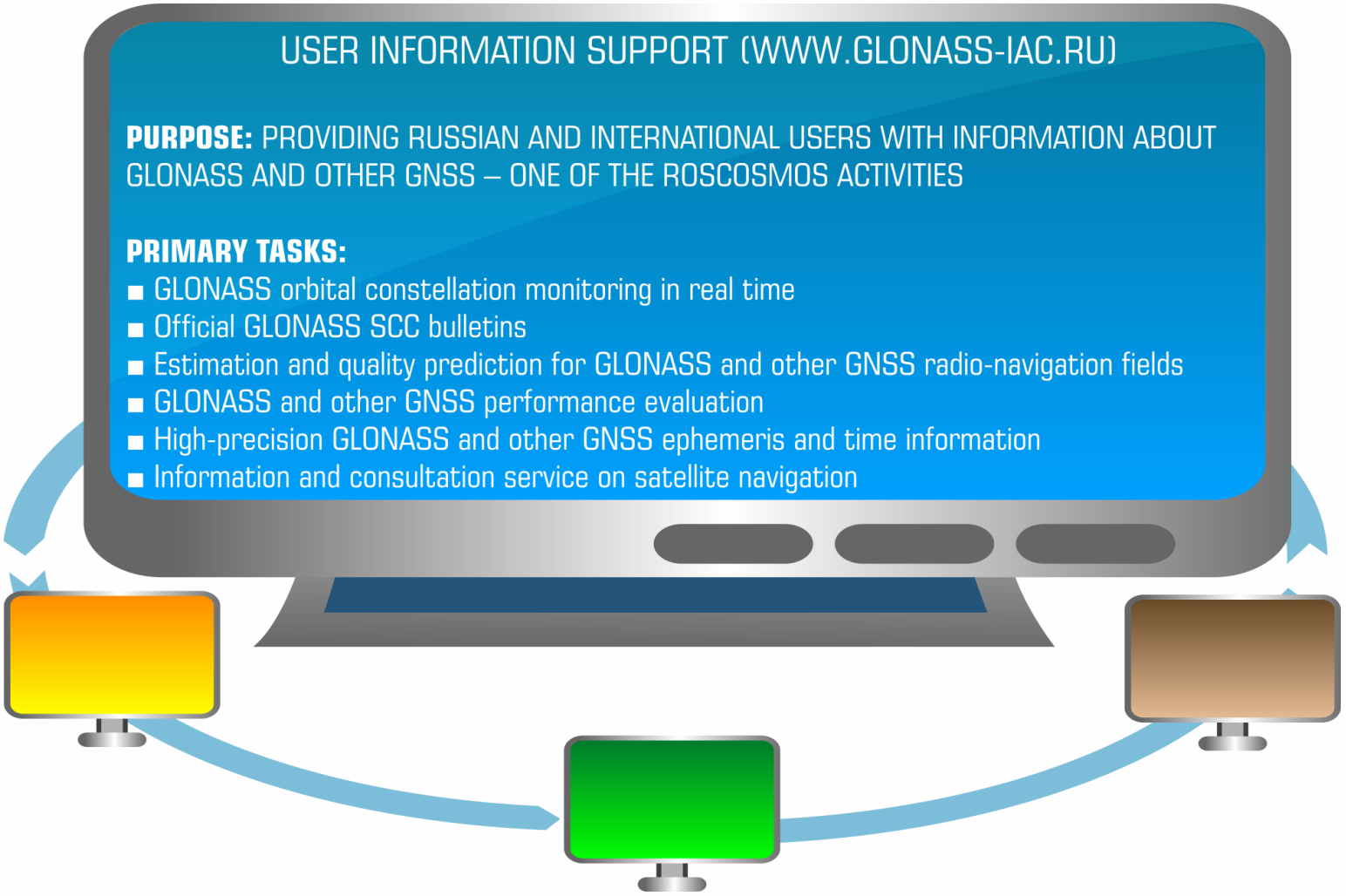
- Emergency call is free of charge
- Commercial application potential: smart insurance, property and crime protection, traffic monitoring, toll collection, distant diagnostics and etc.

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 attention!