Developments of the Glonass system and Glonass Service

10th Anniversary of the International GPS Service
IGS Work Shop and Symposium
Berne, Switzerland
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Presented by Sergey Revnivykh
Mission Control Center
Russian Aviation and Space Agency
Member of Executive Secretariat of Interagency GLONASS Coordination Board
sergey.revnivykh@mcc.rsa.ru

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GLONASS Policy

❑ **THE DECREE OF THE GOVERNMENT OF THE RUSSIAN FEDERATION (March 7, 1995 No 237)**

➢ **GLONASS system is opened for civil use**

➢ **ICD available for users and user equipment development**

➢ **Civil GLONASS signal is available for free**

❑ **THE DECREE OF THE PRESIDENT OF THE RUSSIAN FEDERATION (February 18, 1999 No. 38-rp)**

➢ **GLONASS is a dual use system**

❑ **DECLARATION OF THE GOVERNMENT OF THE RUSSIAN FEDERATION (29 March 1999)**

➢ **GLONASS is opened for international cooperation**

❑ **THE DECREE OF THE GOVERNMENT OF THE RUSSIAN FEDERATION (August 20, 2001 No 587)**

➢ **Federal GLONASS Program has been approved for 2002 - 2011**

Federal GLONASS Program

**Approved by the Russian Government in August, 2001 for 10 years.
Coordinated by Russian Aviation and Space Agency**

Program Directions:

Ä **Sustainment and development of GLONASS system:**

  ➢ **Minimal operation capability (18 satellites) by 2007**

  ➢ **Full operation capability (24 satellites) by 2010**

Ä **Development and production preparation of the GNSS user equipment for civil and special users**

  ➢ **Combined GNSS receivers**

  ➢ **Integrated systems based on SatNav techniques**

  ➢ **Components manufacture**

Ä **Navigation technology introduction in the transport infrastructure**

Ä **Geodesy system modernization**

GLONASS Program Managing

Ministry of Defence (MOD) –
Security Issues Coordinator

Russian Aviation and
Space Agency
(Rosaviakosmos) –
General Program
Coordinator

Agency on Control
Systems (RACS)

Interagency GLONASS Coordination Board

Ministry of Transport
(MOT)

Mapping Agency
(Roskartographia)

Ministry of Science,
Industry and
Technologies (MSIT)

Research Institute
Support Team

Executive Secretariat
of IGCB

Research Institute
Support Team

GLONASS Architecture

Orbital constellation:
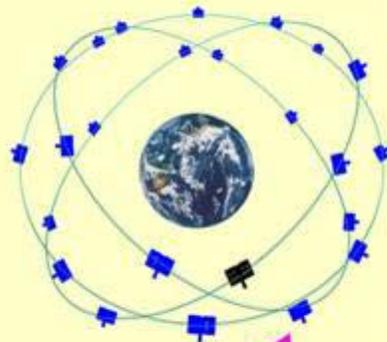24 satellites (8 satellites in each of 3 planes)
Orbit type:
circular, H = 19 100 km, i = 64.8°
Orbit period: 11 hours 15 minutes
Angular spacing between orbits is 120°

Data for position
determination and
time synchronization

USERS

Position determination
Definition of velocity correction
Definition of time correction

ground   air   nautical   space

Orbital constellation
deployment and
maintenance

Satellite control.
Status monitoring

ROCKET-SPACE COMPLEX

"PROTON-K" Launcher
("PROTON-M")
"BREEZE-M" Booster

"SOYUZ-2" Launcher
"FREGAT" Booster

Technical facilities for:
- satellite
- launcher
- booster

Technical facilities for:
- satellite
- launcher
- booster

BAIKONUR cosmodrome   PLESETSK cosmodrome

GROUND SEGMENT FOR SATELLITE CONTROL AND ORBIT DETERMINATION & TIME SYNCHRONIZATION

TT&C   TT&C

SCC   TT&C

TT&C

TT&C

SCC - System Control Center
TT&C - Telemetry, Tracking & Control

GLONASS Status

Guarantied lifetime - 36 month
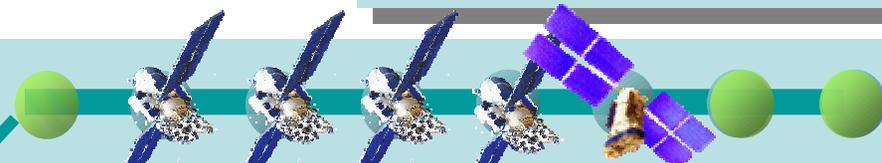
Mean actual lifetime 54.7 months

Block 33. Launch in 2004

Glonass № 96
Life-time 3 years

Glonass № 97
Life-time 3 years

Glonass-М № 12Л
Life-time 7 years

Glonass
№ 95
Launch
10.12.03
LT 3 yrs

Glonass
№ 89
Launch
01.12.01
LT 3 yrs

Glonass
№ 94
Launch
10.12.03
LT 3 yrs

Glonass
№ 11Л
Launch
01.12.01
LT 5 yrs

Glonass-M
№ 11Л
Launch
10.12.03
LT 7 yrs

Glonass
№ 87
Launch
13.10.00
LT 3 yrs

Glonass
№ 83
Launch
13.10.00
LT 3 yrs

Glonass
№ 92
Launch
25.12.02
LT 3 yrs

Glonass
№ 91
Launch
25.12.02
LT 3 yrs

Glonass
№ 93
Launch
25.12.02
LT 3 yrs

Glonass
№ 88
Launch
13.10.00
LT 3 yrs

GLONASS Modernization Goals

⇗ For Users

- ➤ **More robust navigation against interference, compensation of ionosphere delays due to new civil signals**
- ➤ **Higher accuracy, availability, integrity, reliability**
- ➤ **Supplementary functions (SAR, integrity and differential correction broadcasting)**

⇗ For Customers

- ➤ **Operational cost reduction due to enhanced life-time of new satellites and ground control segment modernization**
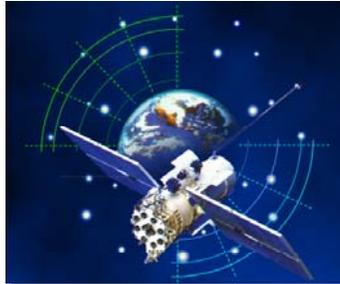
⇗ For International Cooperation

- ➤ **Compatibility and interoperability of GLONASS, GPS, GALILEO and augmentations**

GLONASS Modernization

GLONASS 1982-2007	GLONASS-M 2003-2013	GLONASS-K 2007-2022	GLONASS-KM 2015-…

Developer NPO PM
Producer PO "Polyot"
Total launched 79 SV
Ordered 3 SV
In orbit 10 SV
Clock 3-5·10^{-13}
Life-time 4.5 yrs

Developer NPO PM
Flight Test phase
Ordered 3 SV
In orbit 1 SV
To be ordered 9
Clock 1·10^{-13}
Life-time 7 years
2nd civil signal

Developer NPO PM
D&D phase
To be ordered up to 27 SV
Life-time more 10 ys
3rd civil signal

Requirement definition since 2002 г.

Ground control segment modernization
Navigation (OD$TS) system modernization
Integrity monitoring segment implementation
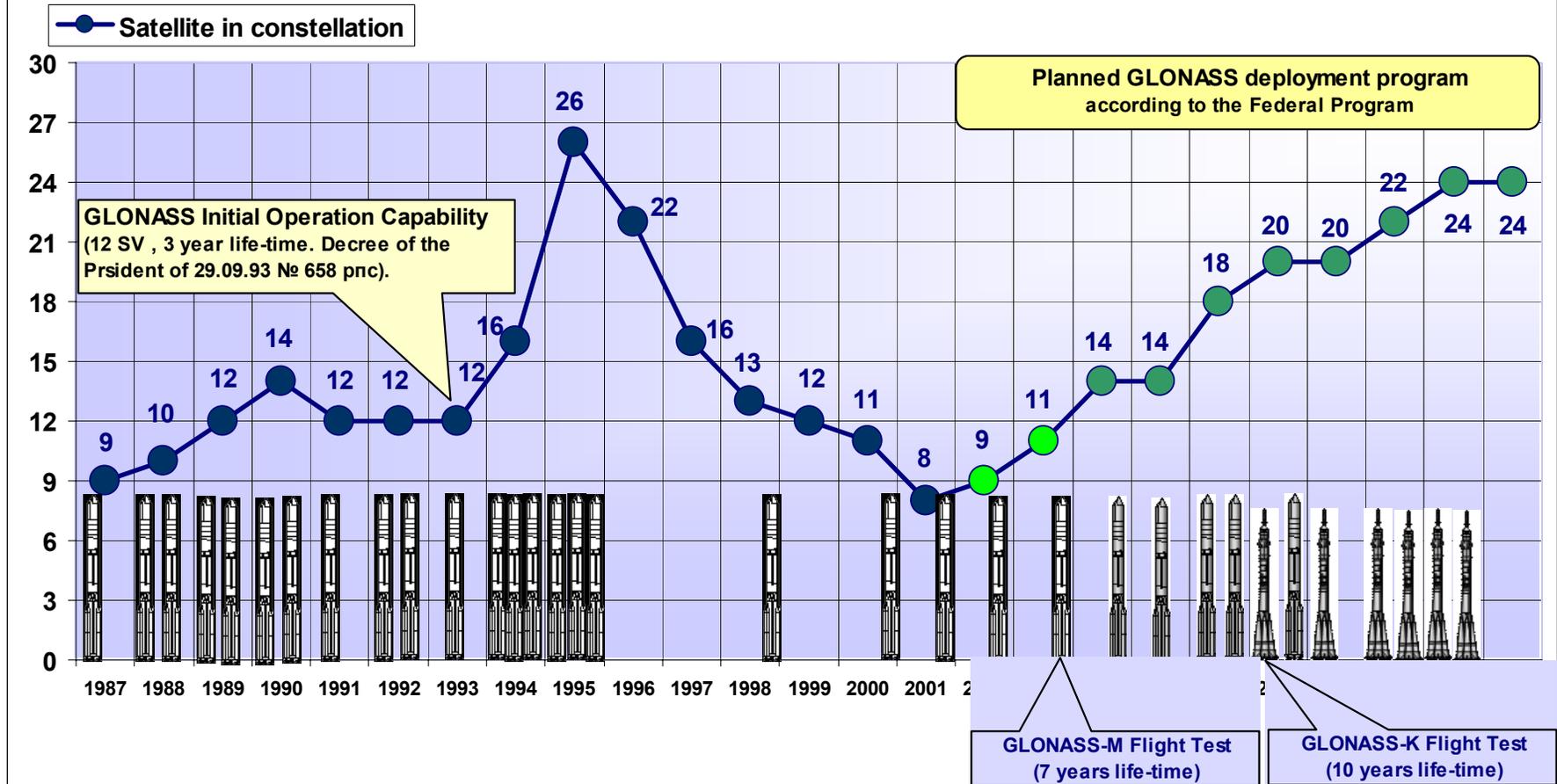**System certification for safety of life applications**

Nuclear tests agreements monitoring
Search and Rescue service implementation
Supplementary functions (TBD)

GLONASS Launch Program
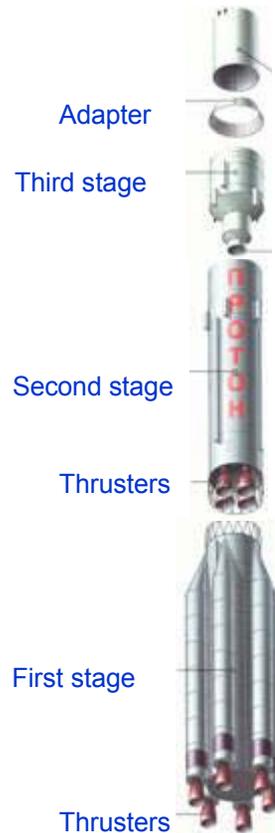
GLONASS Deployment Program. History and Progress.

Legend: ● Satellite in constellation

Planned GLONASS deployment program according to the Federal Program

GLONASS Initial Operation Capability (12 SV , 3 year life-time. Decree of the Prsident of 29.09.93 № 658 рпс).

Data points by year:
- 1987: 9
- 1988: 10
- 1989: 12
- 1990: 14
- 1991: 12
- 1992: 12
- 1993: 12
- 1994: 16
- 1995: 26
- 1996: 22
- 1997: 16
- 1998: 13
- 1999: 12
- 2000: 11
- 2001: 8
- 9
- 11
- 14
- 14
- 18
- 20
- 20
- 22
- 24
- 24

GLONASS-M Flight Test (7 years life-time)

GLONASS-K Flight Test (10 years life-time)

Group Launch of «Glonass»/«Glonass-M» satellites

«PROTON»/«PROTON-M» Launcher

Jettisonable booster adapter

Adapter

Third stage

Thruster
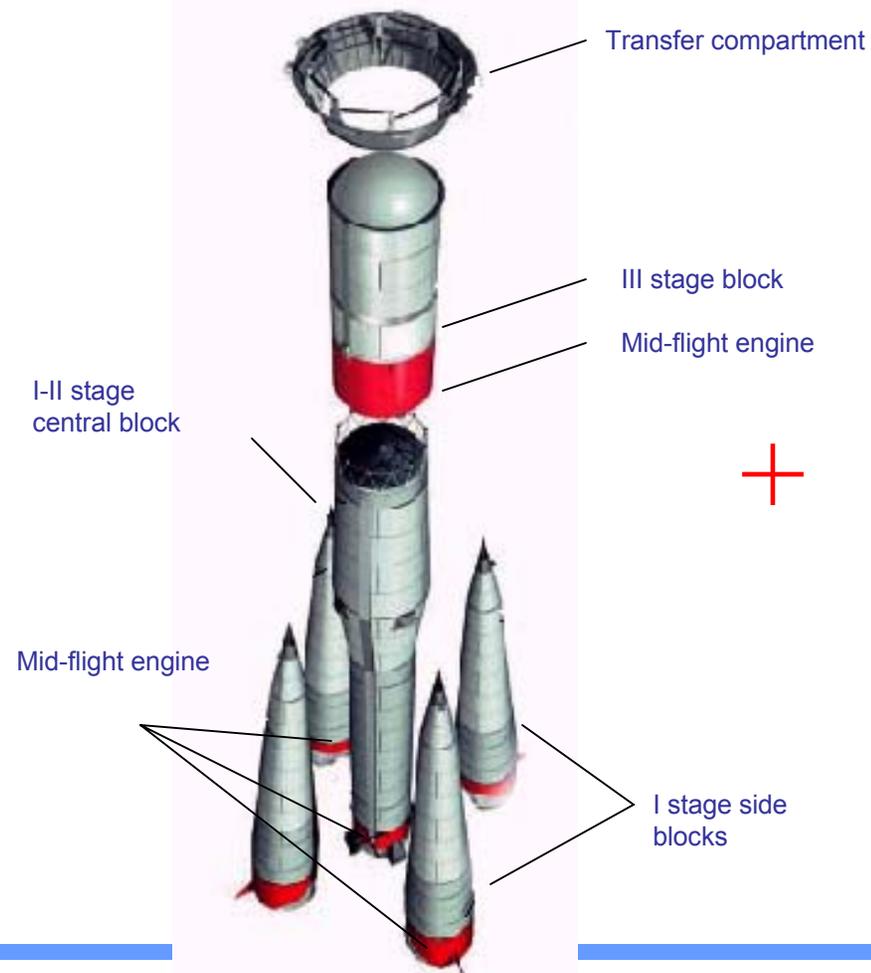
Second stage

Thrusters

First stage

Thrusters

«Breeze-M» Booster

«Glonass-M» S/C

«Glonass-M» S/C
«Glonass» S/C

«Glonass-M» S/C
«Glonass» S/C

Forth stage
«Breeze-M» Booster
with adapter

+

Launcher fairing 14S75 (813.MITS-9)
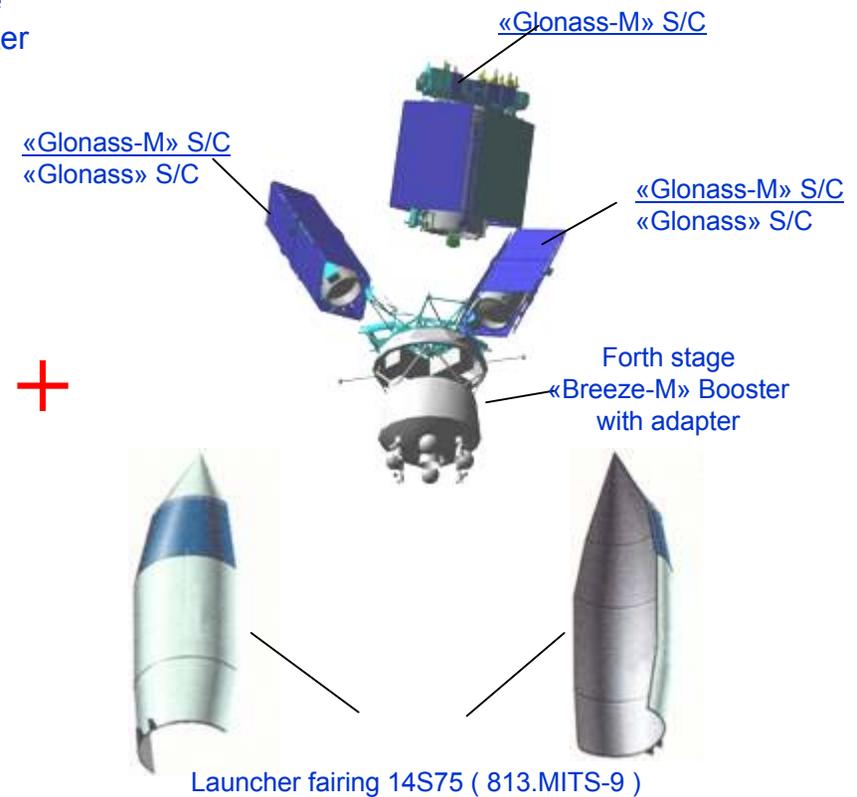
Group Launch of «Glonass-K» satellites

«Soyuz-2» Launcher

«Fregat» Booster

Transfer compartment

III stage block

Mid-flight engine

I-II stage central block

Mid-flight engine

I stage side blocks

+

2 «Glonass-K» S/Cs

«Fregat» Booster

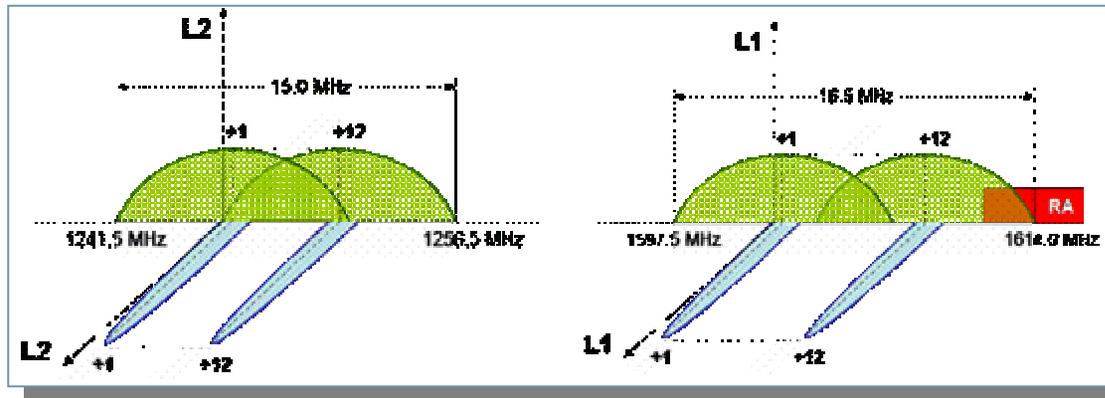Launcher fairing of 11F639M0100-0 type
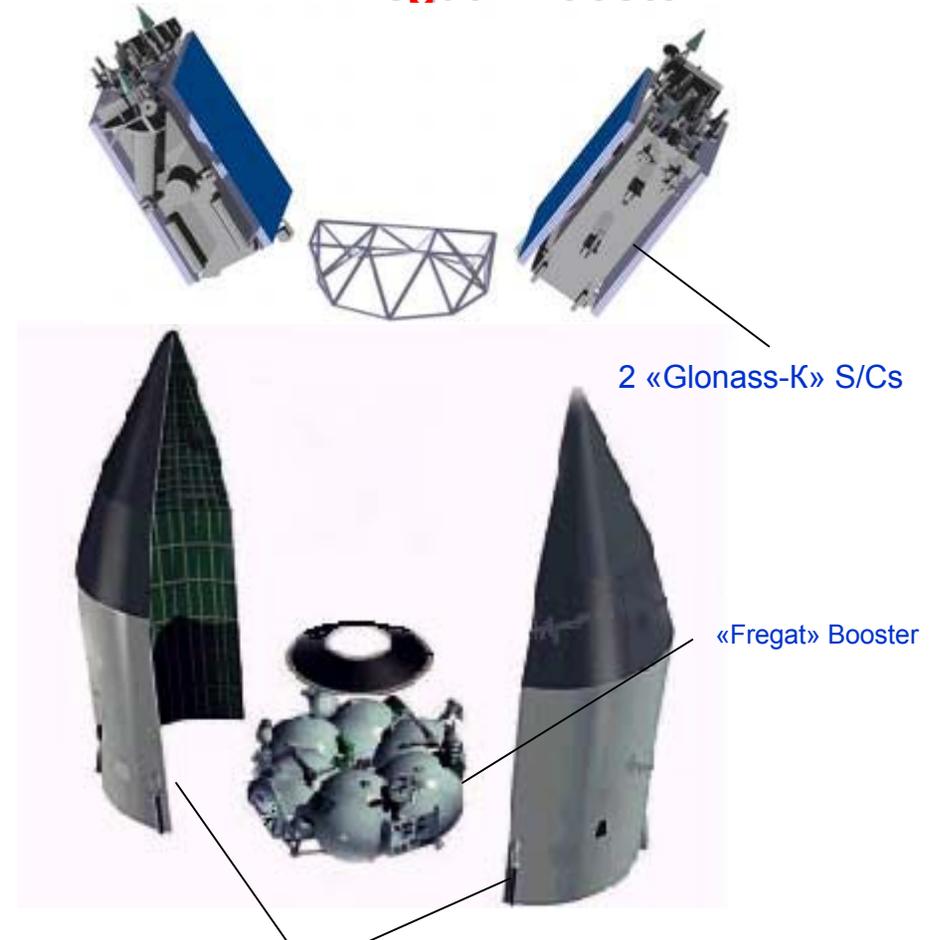
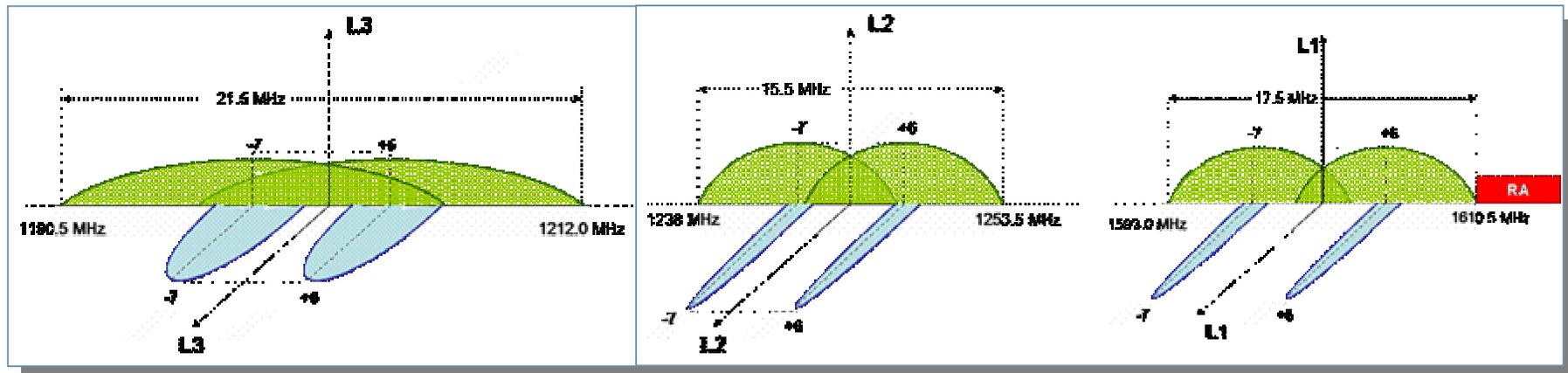# GLONASS Frequency Plan

before 2005:

$$f_{k1} = f_{01} + k \cdot \Delta f_1$$

$$f_{k2} = f_{02} + k \cdot \Delta f_2$$

$$f_{01} = 1602 \text{ MHz}; \quad \Delta f_1 = 562{,}5 \text{ kHz}$$

$$f_{02} = 1246 \text{ MHz}; \quad \Delta f_2 = 437{,}5 \text{ kHz}$$

after 2005:

⇘ **Second civil signal at L2 frequency band since GLONASS-M in 2003** for higher accuracy

⇘ **Third civil signal at L3(L5) frequency band since GLONASS-K in 2007** for higher reliability and accuracy, especially for safety-of-life applications

⇘ **GNSS Integrity information in the third civil signal (GLONASS-K) –** reliability of navigation service

⇘ **Global differential ephemeris and time corrections in the third civil signal (GLONASS-K) –** sub meter real time accuracy for mobile users

⇘ **Search and Rescue service (extension of COSPAS/SARSAT service) –** shortening time of precise positioning and rescue for people in distress
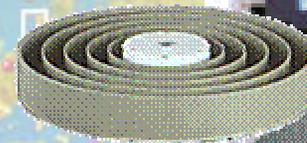
GLONASS/GPS Receiver

Deployment of the GLONASS/GPS receiver network

Russian Research Institute of Space Device Engineering, Moscow GLONASS/GPS receiving station
- two frequencies
- multi-channel
- internal calibration
- hot redundancy

Glonass Service Interface

Ministry of Defense, Russian Federation
Coordination Scientific Information Center
www.glonass-center.ru (Russian and English)

GLONASS operation information

Russian Aviation and Space Agency
Central Research Institute, Mission Control Center
Information Analytical Center
www.mcc.rsa.ru/main_iac.htm (Russian and *English*)

GNSS Performance and Application

Russian Aviation and Space Agency
Russian Research Institute of Space Device Engineering
Multifunctional Navigation Information Center
www.mnic.rniikp.ru

GNSS Application and User Equipment

Russian Aviation and Space Agency
Scientific Industry Corporation of Applied Mechanics
www.npopm.ru (Russian)

GLONASS Satellite

Inter Agency GLONASS Coordination Board
www.?????.ru
(Russian and English)

Conclusions

- GLONASS is still alive and developing
- GLONASS is a dual use system
- Ministry of Defense is responsible for GLONASS operation
- GLONASS development program is under coordination of Russian Aviation and Space Agency
- GLONASS operation and development is funded from State budget directly according to Federal GLONASS Mission Oriented Program
- Modernization program assumes:
  - performance comparable with GPS and future GALILEO
  - second civil signal since GLONASS-M
  - third civil signal since GLONASS-K
  - OD&TS procedure modernization based on the receiver network
  - new services (integrity, global differential corrections)
  - new functions (SAR)
- Modernization program directed to provide compatibility and interoperability with GPS and future GALILEO

Thank you for your attention!!!