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GLOBAL NAVIGATION SATELLIT SYSTEM

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GLONASS is a global satellite navigation system that provides real time position and velocity determination for military and civilian users. The satellites are located in the middle circular orbit at 19,100 km altitude with a 64.8 degree inclination and a period of 11 hours and 15 minutes. GLONASS' orbit makes it especially suited for usage in northern latitudes, where getting a GPS signal can be problematic. The constellation operates in three orbital planes, with 8 evenly spaced satellites on each. For complete operational constellation with global coverage 24 satellites are needed.

Global Navigation Satellite System is a part of state policy in the outer space providing national security and economic development in this country. To create, develop and maintain the system is the responsibility of the state. The use of GLONASS is mandatory for state entities and major sectors of economy. GLONASS is used in combination with other global navigation satellite systems (GNSS) and terrestrial radio navigation. Basic civil navigation services are free of direct user fees. Open, free access to GLONASS information is necessary to develop and produce user equipment, to strengthen international cooperation on GNSS compatibility.

GLONASS 2010:

By 2010, GLONASS has achieved 100% coverage of Russia's territory. In February 2011 the constellation consists of 22 operational satellites, 24 satellites are needed to provide continuous global coverage, this is expected to be completed during 2011. In 2001-2011 140.1 billion rubles ($4.7 billion) were spent on the program, making it Roscosmos' largest project and consuming a third of its 2010 budget of 84.5 billion rubles.

The development GLONASS navigation is based on implementation of new satellites. Current research is aimed to modernize signals, to provide better potential accuracy for pseudorange and phase measurements, to ensure better interference and multipath resistance of GLONASS signals and greater interoperability with GPS and GALILEO as well as other GNSS. It is necessary to introduce a continuous global navigation provision plan, Glonass-K flight test (2011), GLONASS accuracy improvement plan and modernization ground control segment and network. It is also topical to cover a time system and orbit improvement, monitoring network outside Russia.

The main concept of GLONASS 2020 is the following:

- Sustention of: performance, state commitments, availability, accuracy, stability of performance;
- Development of: constellation improvement, new signals implementation, accuracy and availability improvement, interference protection improvement, new functions implementation, service area widening;
- Use of: governmental use support, private activity encouraging.

The third generation of GLONASS:

GLONASS-K is a substantial improvement of the previous generation system: it is the first GLONASS satellite with a reduced mass (750 kg versus 1,450 kg of GLONASS-M). It has an operational lifetime of 10 years, compared to the 7-year lifetime of the second generation GLONASS-M. It will transmit 5 navigation signals instead of 2 to improve the

system's accuracy. 4 military signals will be transmitted on the L1 and L2 bands, while the civilian signal will use the L3 band. The GLONASS-K satellites will broadcast additional CDMA signals, two of them GPS/Galileo are compatible navigational signals.

The new satellite's advanced equipment, made solely from Russian components, will allow to increase two folds the accuracy of GLONASS. The first GLONASS-K satellite has been successfully launched on February 26, 2011.

Due to their weight reduction, GLONASS-K spacecrafts can be launched using the low cost Soyuz-2.1b boosters from the Plesetsk Cosmodrome launch site or from the Baikonur Cosmodrome using Proton-K and Briz-M launch vehicles.

Since 2008, new CDMA signals are being researched for use with GLONASS. Two latest Glonass-K1 satellites to be launched in 2010-2011 will introduce an additional SP CDMA signal for testing purposes, located in the L3 band at 1202.025 MHz.

Glonass-K2 satellites, to be launched in 2013-2015, will feature three additional CDMA signals close to the original FDMA frequencies, one obfuscated signal located at 1242 MHz in the L2 band, as well as two signals at 1575.42 MHz in the L1 band. Glonass-KM satellites to be launched after 2015 will feature an open signal in the L5 band at 1176.45 MHz and even more CDMA signals on existing frequencies.

Although the format and modulation of GLONASS CDMA signals are not finalized, preliminary statements from developers indicate the open signal in the L1 band will use BOC(2,2) modulation centered at 1575.42 MHz, the open signal in the L3 band will use QPSK(10) modulation centered at 1202.025 MHz, and the open signal in the L5 band will use BOC(4,4) modulation centered at 1176.45 MHz.

Two of these signals are essentially GPS-format signals placed at the center points of corresponding modernized GPS civilian signals "New Civilian L1" (L1C) and "Safety of Life" (L5), which is close to existing Galileo and Compass signals, and the signal in the L3 band is located just below the modernized GPS' "M-code" signal in the L2 band. Such an arrangement will ensure the easier and cheaper implementation of multi-standard GNSS receivers.

Binary phase-shift keying (BPSK) is used by standard GPS and GLONASS signals, however both BPSK and phase-shift keying (QPSK) can be considered as variations of amplitude modulation (QAM). Binary offset carrier (BOC) is the modulation used by GALILEO, modernized GPS, and COMPASS.

With the introduction of CDMA signals, the constellation will be expanded to 30 active satellites.

Research is in progress to increase the accuracy of GLONASS. By 2011 it should achieve 2.8 m by means of expanding GLONASS's constellation, and improving the ground segment. In particular, the latest satellite design, GLONASS - K has the ability to double the system's accuracy as soon as it is introduced.