GLONASS Status and Modernization Plans

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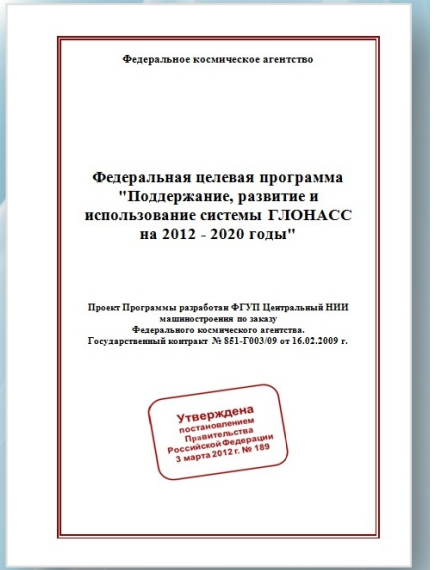
Government Policy

The Presidential Decree № 638 of May, 17, 2007

"On Use of GLONASS (Global Navigation Satellite System) for the Benefit of Social and Economic Development of the Russian Federation"

- GLONASS is the core element of the national PNT infrastructure ensuring national security and economic development
- PNT infrastructure sustainment and development are Government's function
- GLONASS civil services are free and unlimited globally
- Mandatory use of GLONASS for government applications and critical industries
- GLONASS Federal Program is the instrument for implementing national policy in PNT
- GLONASS Federal Program 2012-2020
  - Budget for 9 years secured
  - Most contracts awarded


Федеральное космическое агентство

Федеральная целевая программа "Поддержание, развитие и использование системы ГЛОНАСС на 2012 - 2020 годы"

Проект Программы разработан ФГУП Центральный НИИ машиностроения по заказу Федерального космического агентства. Государственный контракт № 851-Г003/09 от 16.02.2009 г.

Утверждена постановлением Правительства Российской Федерации 3 марта 2012 г. № 189

Federal GLONASS Program is a basis for Russian Policy in PNT

GLONASS Federal Program Goals

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

Key Quality Indicator of Program – guaranteed provision of announced GLONASS performance characteristics

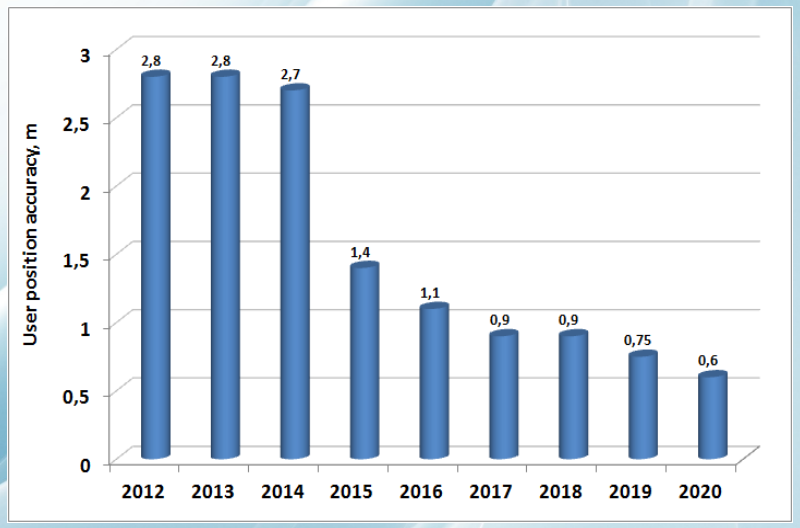
Performance Improvement Plan

❖ Four-fold accuracy improvement

by means of

- ground control segment modernization
- introduction of new onboard atomic frequency standards (2 CAFs + 2 RAFs)
- introduction of advanced satellite control and command, orbit and clock determination technologies based on crosslinks in RF and optical bands
- transition to PZ-90.11 Geodetic System aligned to ITRF with mm level
- synchronization of GLONASS Time Scale with UTC(SU) at less than 2ns while keeping UTC(SU) long-term stability at 10^{-17}

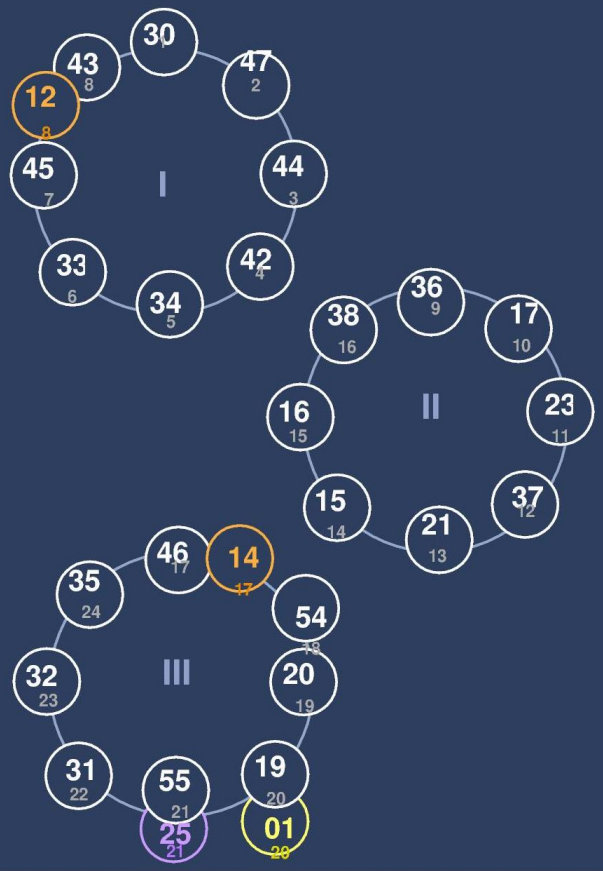
SIS User Positioning Accuracy, m



GLONASS Orbital Constellation Status
(10 November 2014, 00:00)

Orbital Constellation and Satellite Status

In total	28
Glonass-M	27
Glonass-K	1
Used for navigation	24
On maintenance	0
Orbital spares	2
In-orbit flight test	1
In commissioning phase	0
Prime Contractor Check	1

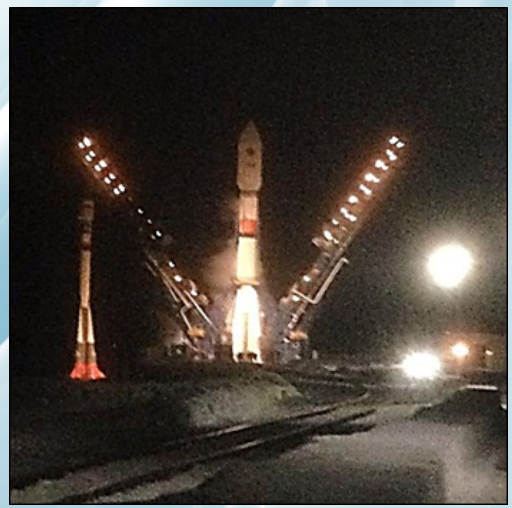


The constellation provides global continuous navigation

Latest Launches and Short-term Sustainment

- 1 Glonass-M (#54) launched March 24, 2014
- 1 Glonass-M (#55) launched June 14, 2014
- 2015-2016 – up to 9 Glonass-M launches
- Further launches by Soyuz or Proton will be determined by operational necessity
  - triple launch planned for the beginning of 2015
- 1 Glonass-K in ground storage to be launched in the end of 2014

Glonass-M # 54 launch



GLONASS Architecture

Space Complex

MEO orbit constellation
Ground control
Launch facilities

Fundamental segment

UTC (SU), Earth Rotation Model and parameters, reference systems

Augmentations

Space-based systems
- High accuracy
- Integrity

Regional and local differential systems for transport and geodesy

User Capabilities

Integrated user equipment (communication, inertial sensors and other sources of navigation information)

Space Segment Modernization

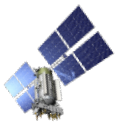
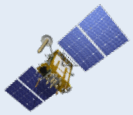
Glonass-M

Glonass-K

- increase of guaranteed life-time
- evolution of satellite service systems
- more stable on-board clocks
- new control, command and ODTS technologies
- introduction of SAR payload
- new signals

Phased build-up of capabilities

GLONASS Signal Implementation Plan

Satellite	FDMA Signals		CDMA Signals		
	L1	L2	L1	L2	L3
 Glonass-M	L1OF L1SF	L2OF L2SF	-	-	L3OC (2014+) 7 SVs
 Glonass-K	L1OF L1SF	L2OF L2SF			L3OC
Modernized Glonass-K	L1OF L1SF	L2OF L2SF	L1OC L1SC	L2OC L2SC	L3OC

System of Differential Correction and Monitoring (SDCM)

Objectives

- SBAS L1 full coverage over Russian territory by 2016
- SBAS L1 dual coverage and L5 service in the central part of Russia by 2018
- SDCM SBAS service certification by 2019
- Precise point positioning service through signals from GEO in GLONASS bands

System Architecture

Broadcasting channels

✓ *3 L1 GEO*
✓ *1 L1/L5 GEO*
✓ *SiSnet server*

RIMS network

✓ *46 stations in Russia*
✓ *up to 8 stations abroad*

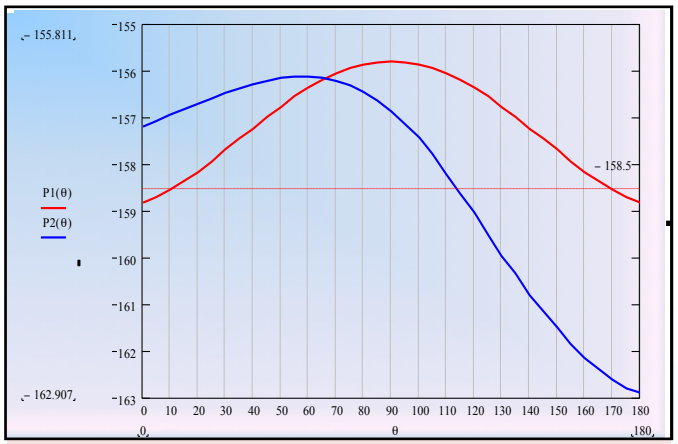
Processing Facilities

✓ *Main (Moscow)*
✓ *2 Regional*

Constellation Status

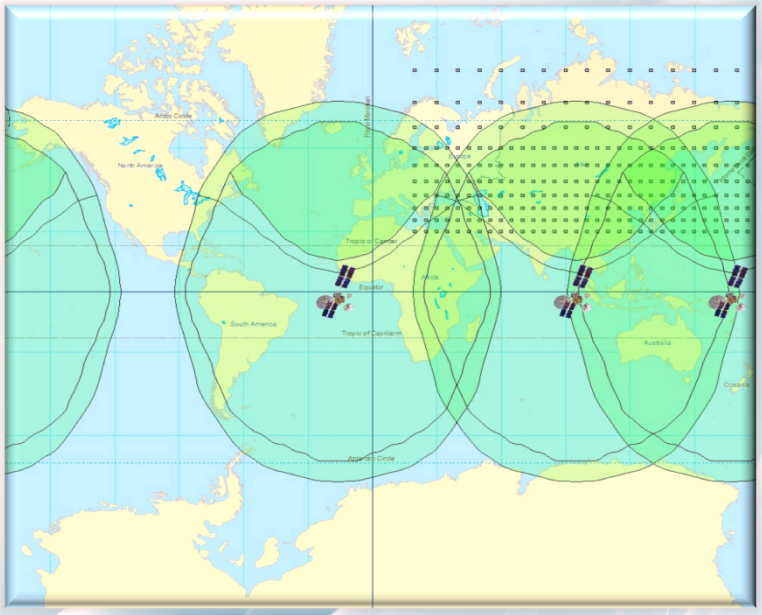
- Luch-5A launched at 16° W on December 11, 2011
- Luch-5B launched at 167° E on November 3, 2012
- Luch-5V launched at 95° E on April 28, 2014

SDCM Performance

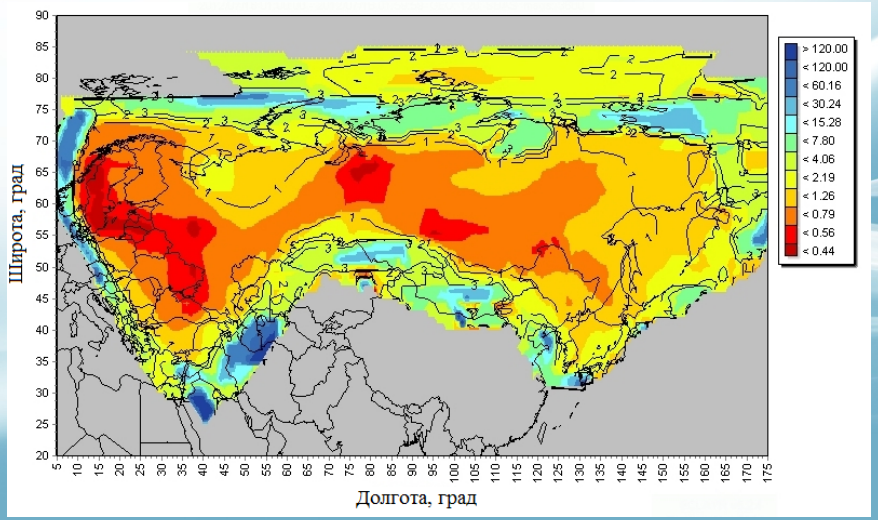


- Q - elevation angle
- P1 (Q) - SDCM signal level at the surface (direct beam)
- P2 (Q) - SDCM signal level at the surface (7 deg to the north)

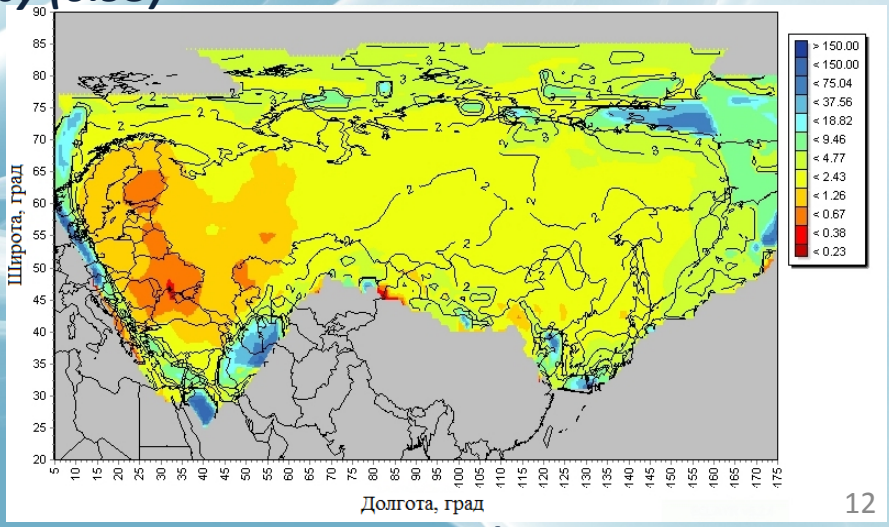
Coverage



Accuracy (0.95)



Plane



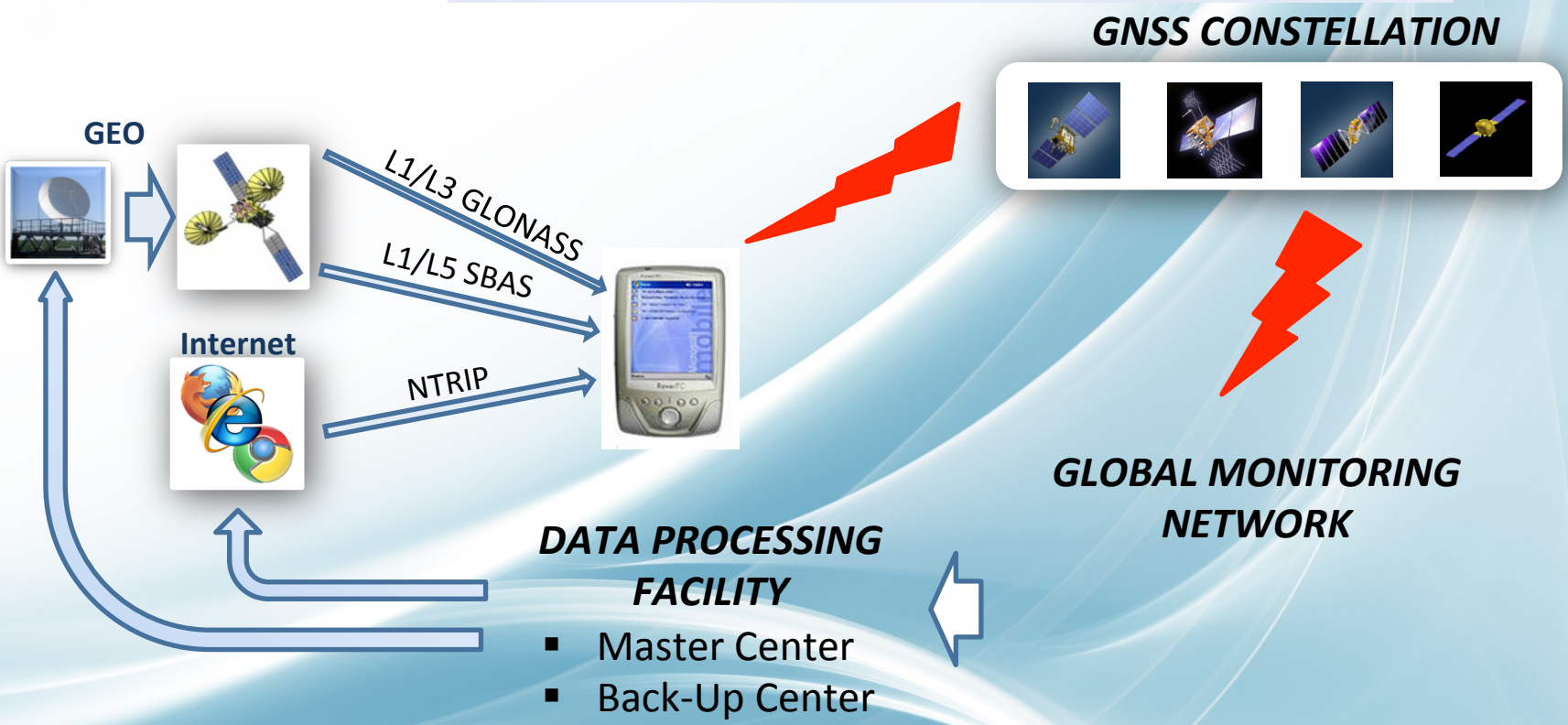
Height

Global Precise Positioning System Architecture

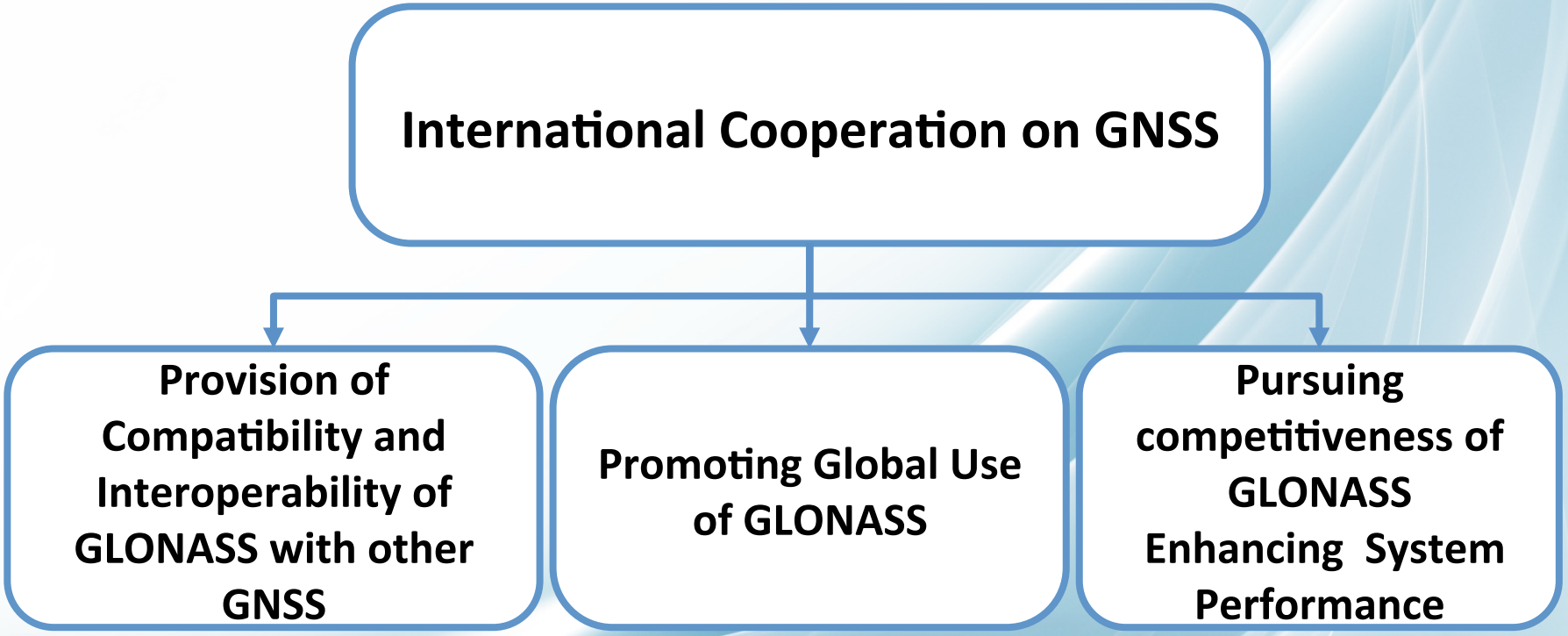
BROADCASTING FACILITY

Objectives:

- Global Precise Point Positioning service (real time)
- Precise Orbit and Clock generation (real-time and post-processed)



International Cooperation



Bilateral Cooperation

China

- 13 October 2014 – Signing Memorandum of Understanding
- Committee on Strategic Projects on Satellite Navigation
- Deployment of monitoring stations on mutual basis

Brazil

- Deployment of GLONASS tracking stations

USA

- 9 June 2012 - Renewed Statement of Cooperation between GLONASS and GPS

EU

- Consultations on Agreement on Cooperation in Satellite Navigation

Summary

- GLONASS Program is among priorities of the Russian Government Policy
- GLONASS open service is free for all users
- GLONASS Program (2002-2011) completed, goal achieved
  - Performance is comparable with GPS
  - Full constellation (24 sats) deployed
- New GLONASS Program (2012 – 2020) approved 3 March 2012
  - Government commitments for major performance characteristics
  - GLONASS sustainment, development, use
- GLONASS will continue
  - Keep the GLONASS traditional frequency bands
  - Transmit existing FDMA signals
  - Introduce new CDMA signals
- International cooperation aims at making GLONASS one of the essential elements of the international GNSS infrastructure for worldwide user benefits

Thank you for attention!