



ROSCOSMOS

GLONASS STATUS AND PROSPECTS OF DEVELOPMENT

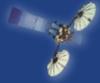
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HEAD OF GLONASS APPLICATIONS DIVISION
ROSCOSMOS STATE SPACE CORPORATION

**The 15th Meeting of International Committee on Global Navigation Satellite Systems
September 28, 2021**

GLONASS STATUS

Multifunctional Space Relay System "Luch"



Geostationary space vehicles

Total 3 SV
Operational 2 SV
Maintenance 1 SV

MEO navigation space vehicles



GLONASS-M batch



GLONASS-K batch

Global Roscosmos ground station network

46 stations in Russia
13 stations abroad

Regional and local augmentations

77 stations of the Ministry of Transport
71 stations of the Federal Service for State Registration, Cadaster and Cartography

Fundamental facilities

3 telescopes (32 m)
2 telescopes (7 m)
3 correlators
1 cold-atom optical frequency reference system
73 stations of the national fundamental astronomic and geodetic network

Ground segment

System Control Center
The network of measurement stations
Processing computing systems
The network of uplink stations
The network of satellite laser ranging stations

The constellation continuously provides global PNT services (availability – 99.997%)



Σ 26 SV

23 SV
operational

2 SV
in-orbit testing

1 SV
maintenance

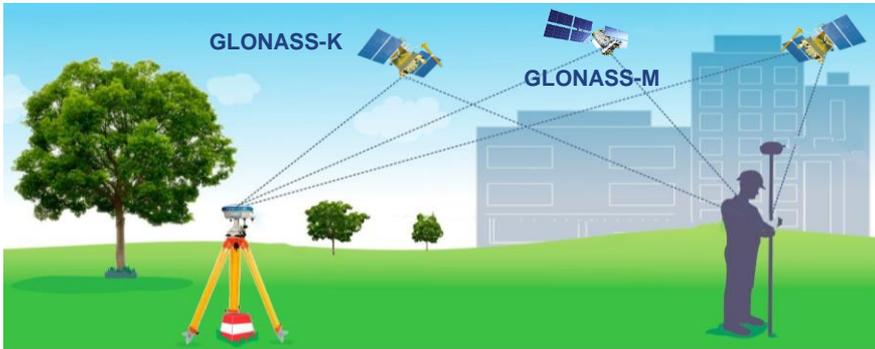
GLONASS SERVICES



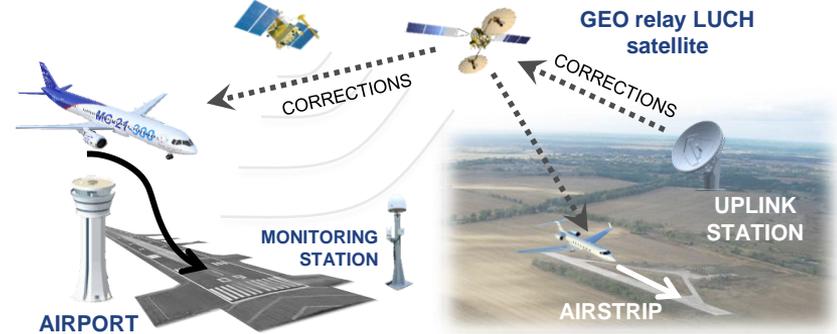
OPEN SERVICE



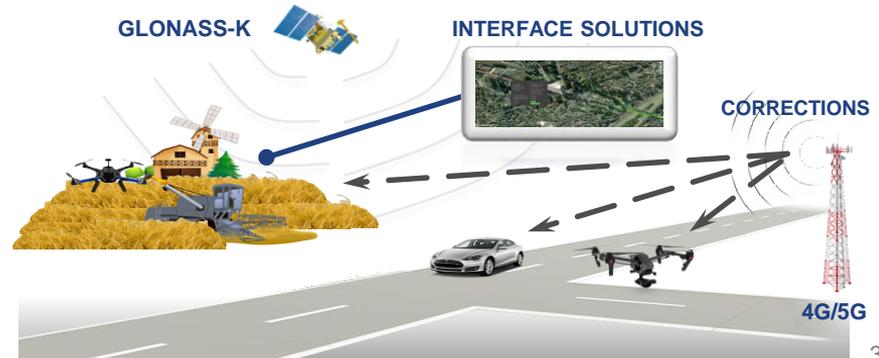
RELATIVE NAVIGATION SERVICE



AUGMENTED SERVICE



HIGH-ACCURACY SERVICE



GLONASS PROGRAMS RESULTS BY 2021 AND 2030



OPEN SERVICE (global coverage)

SIS URE

1.4 m

2020

0.3 m

2030

Availability in difficult conditions

78%

2020
in Russia

95%

2030
in Russia

49%

2020
globally

65.4%

2030
globally



RELATIVE NAVIGATION SERVICE (coverage – Russia)

Accuracy

0.03 m

2020

0.03 m

2030

Robustness (jamming)

30 dB

2020

60 dB

2030



AUGMENTED SERVICE (coverage – Russia)

Availability

87.6%

2020

100%

2030

Accuracy

1 m

2020

0.5 m

2030

Integrity

6 s

2020

6 s

2030



HIGH-ACCURACY SERVICE (coverage – Russia)

Availability

10%

2020

100%

2030

Accuracy (real time)

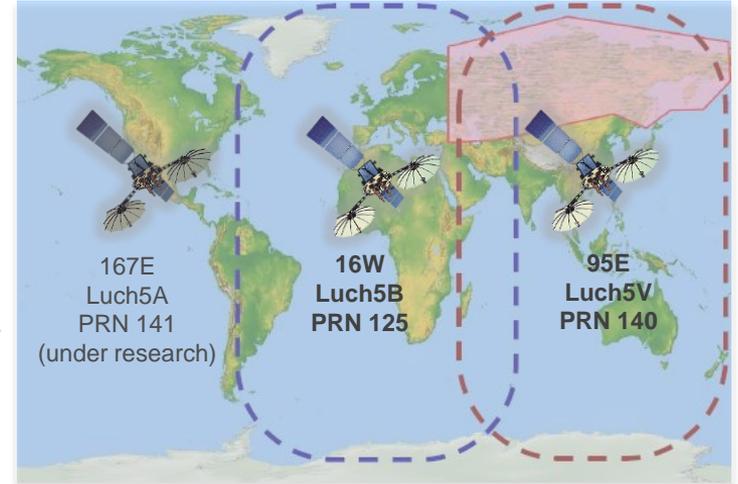
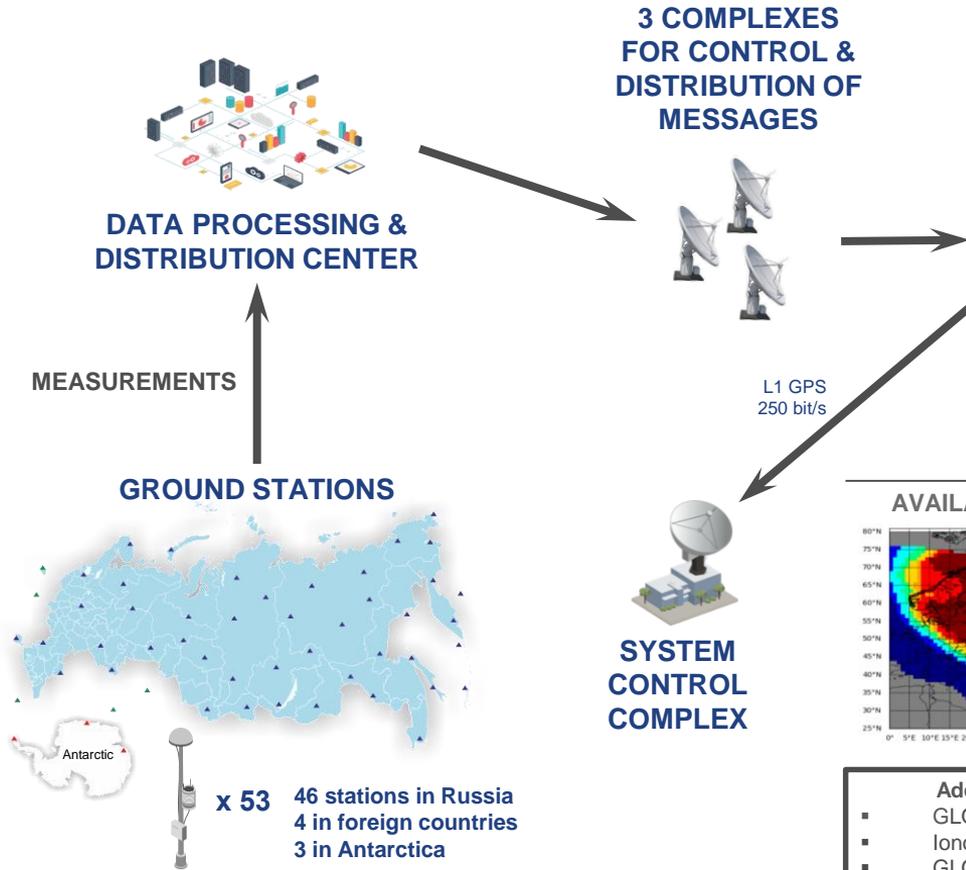
0.1 m

2020

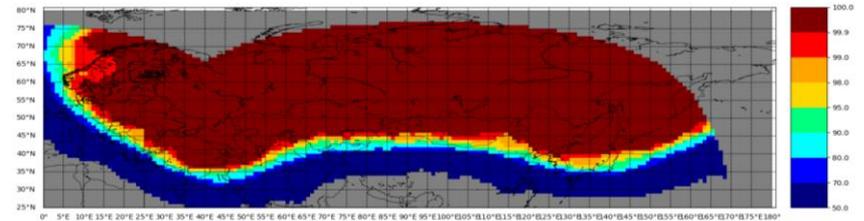
0.05 m

2030

CURRENT STATUS OF SDCM



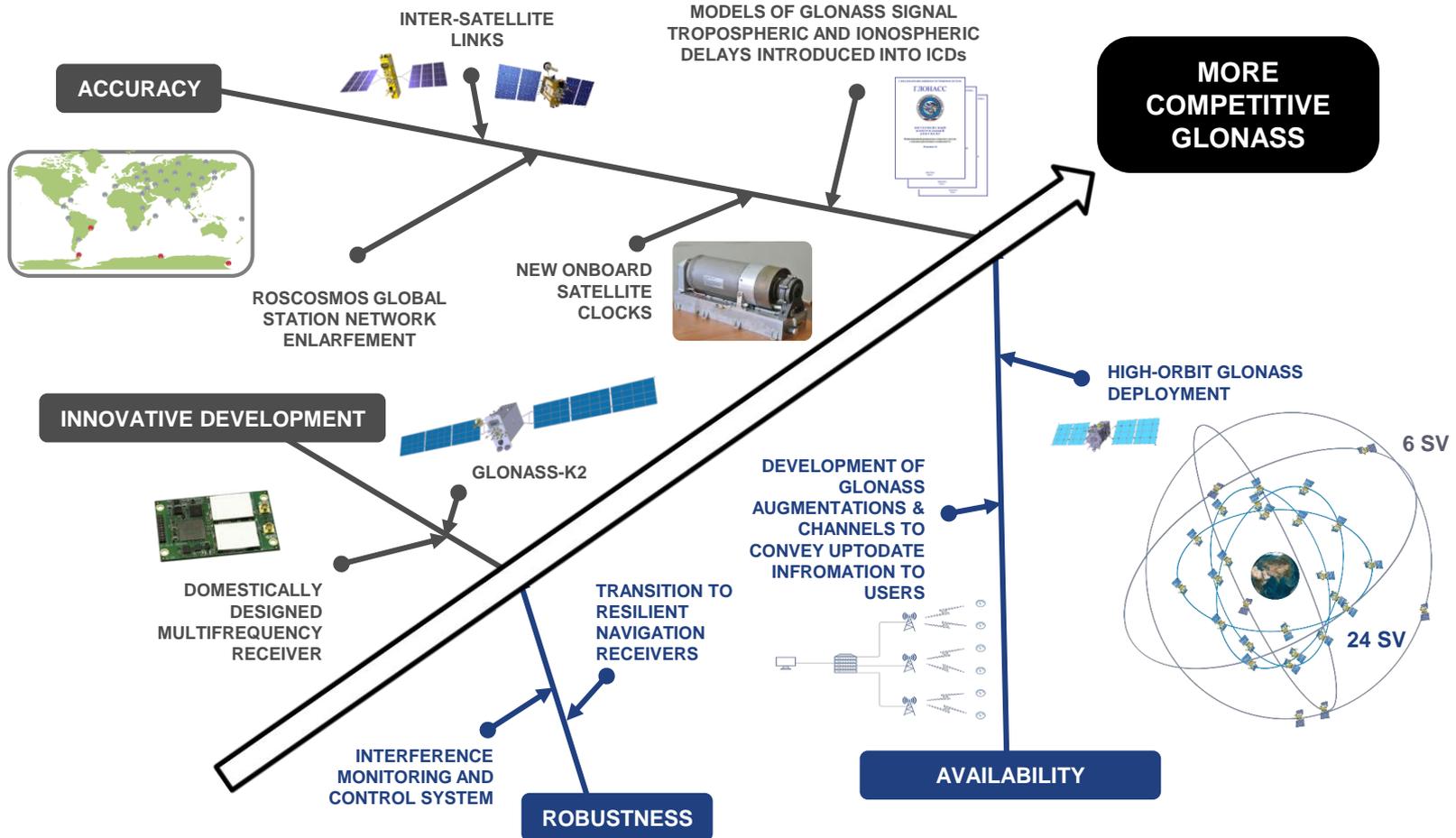
AVAILABILITY



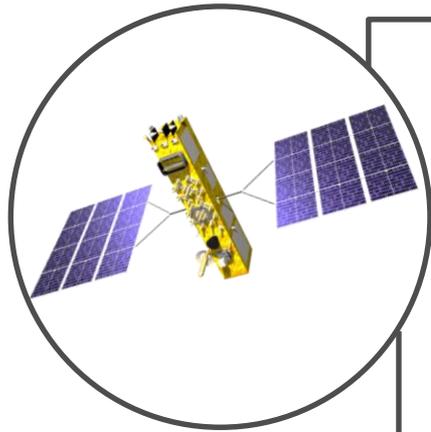
Additional services:

- GLONASS/GPS/SDCM integrity assessment.
- Ionospheric delay calculation.
- GLONASS/GPS/SDCM performance monitoring and navigation support.

GLONASS DEVELOPMENT ROADMAP



GLONASS CONSTELLATION MODERNIZATION



GLONASS-K2
N 13L



**Launch
2022**



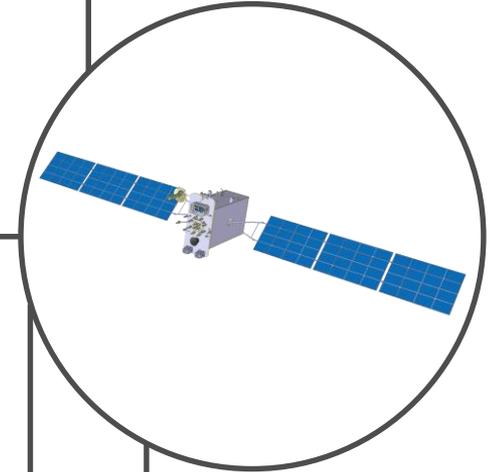
New Passive H-maser

- Non-pressurized platform
- > 10 years lifetime

- FDMA signals: L1, L2
- CDMA signals: L1, L2, L3
- Radio inter-satellite links
- Two-way/one-way onboard laser ranging equipment
- Optical inter-satellite links with high data rate
- COSPAS – SARSAT payload

- Onboard clock stability $0,5...1 \times 10^{-14}$

- One common navigation antenna



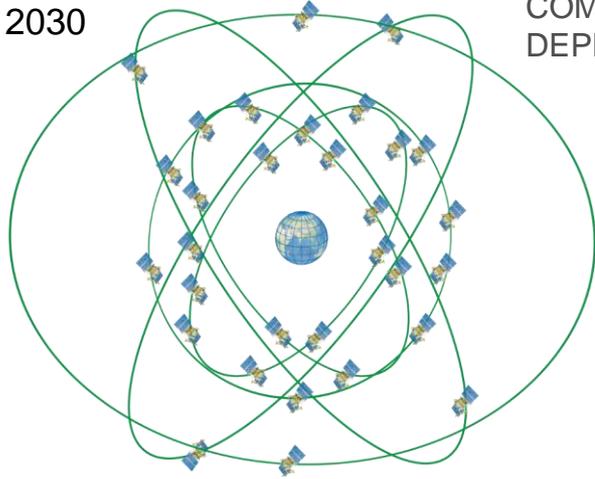
GLONASS-K2
N 24L and further

**Launch
2024**



HIGH-ORBIT GLONASS COMPLEX

2030



COMPLETE
DEPLOYMENT

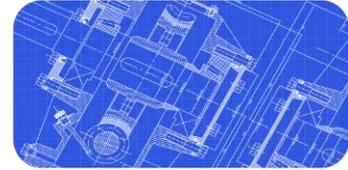
2025



FIRST HIGH-ORBIT GLONASS
SATELLITE LAUNCH

PRODUCTION & TESTING

DEVELOPMENT PHASE
(finalization)



Orbital planes	3
Ground tracks	2
The number of SV	6
Orbital inclination	64.8°
Semi-major axis, km	42 164.142
Orbital period, s	86 164
Eccentricity	0.072
Longitude of the ascending node	60°, 120°



Results:

- 25% navigation accuracy improvement over Eastern hemisphere
- Better navigation in difficult conditions e.g. dense urban areas & northern high-latitude territories



dense urban areas



accuracy improvement

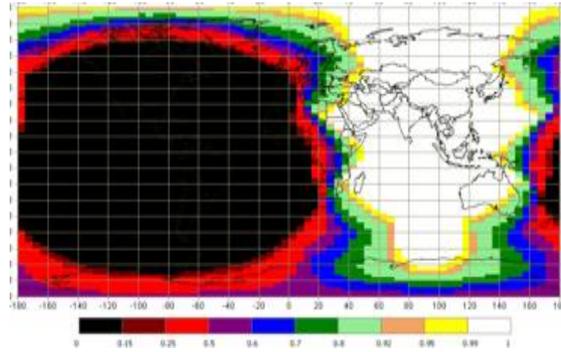
POTENTIAL CHARACTERISTICS OF HIGH-ORBIT GLONASS

Difficult conditions

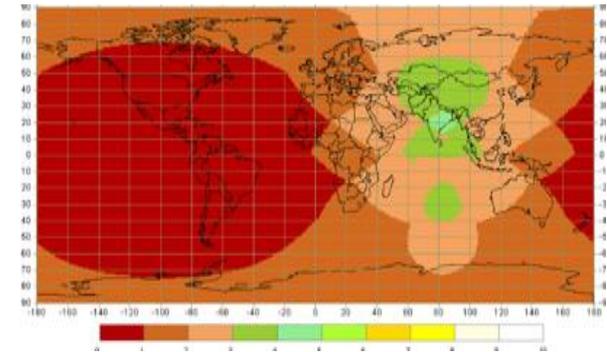


dense urban areas

PDOP



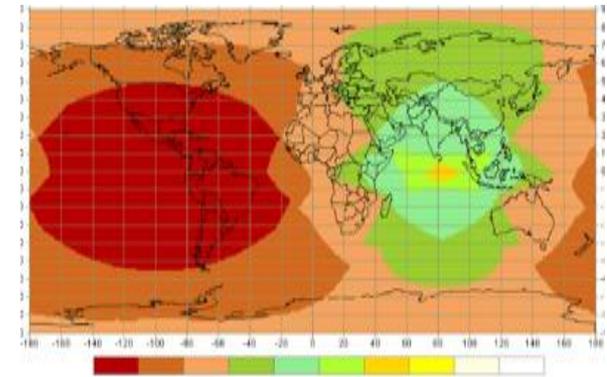
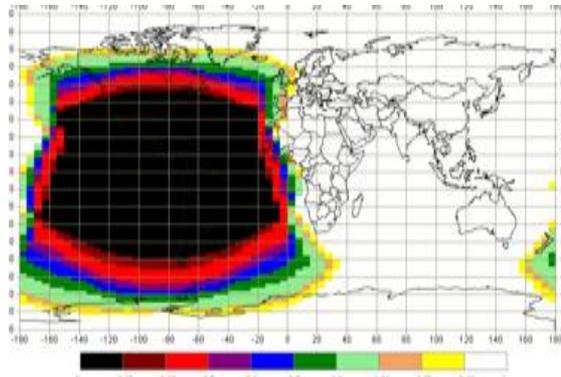
MINIMAL NUMBER OF SV IN VIEW



Open terrain



Trees, low-rise buildings



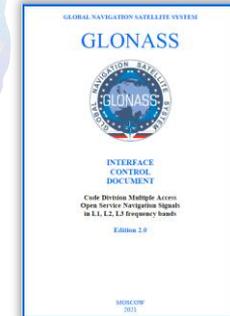
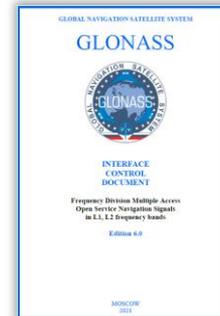
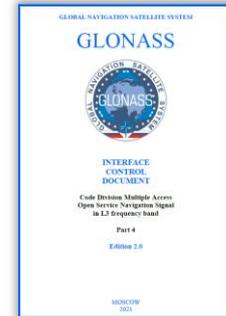
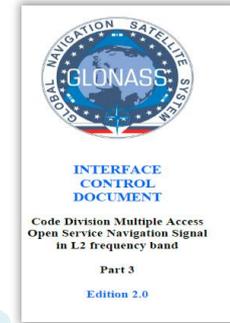
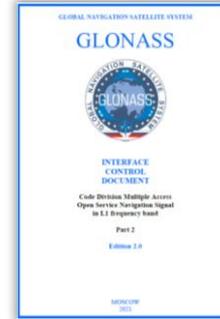
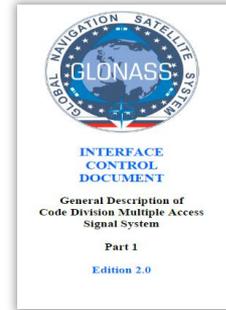
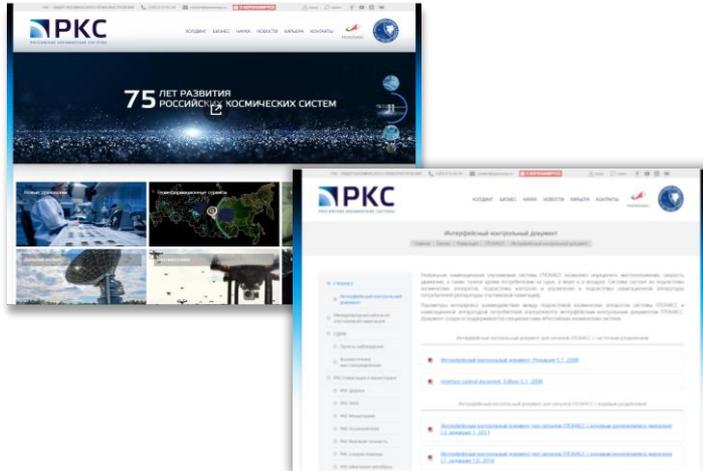
NEW VERSION OF INTERFACE CONTROL DOCUMENT

NEW IONOSPHERIC MODEL:

broadcasting the parameters of the model in navigation signals

NEW TROPOSPHERIC MODEL:

Introducing the model of propagation environment into the interface control document



BILATERAL COOPERATION WITH CHINA IN SATELLITE NAVIGATION



China-Russia cooperation in satellite navigation

Milestones ahead





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