



EXPANSION OF THE GROUND STATIONS NETWORK

IDS WORKSHOP 2026, WIESBADEN

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1. OVERVIEW OF THE NETWORK'S FEATURES

OVERVIEW OF DORIS GROUND NETWORK

GOALS

> *Serving POD and geodesy:*

- Even distribution of stations
- Continuous service of tracking stations
- Precise positioning of ground stations
- Long-term life and stability of stations
- Co-location with other techniques

MAIN FEATURES

> *Outstanding strengths:*

- 55-60 stations over the past 20 years
- Good data availability (over 85%)
- Long time series of station position:
 - 52 stations co-located with GNSS ++
 - 29 stations co-located with tide gauge

KEY IMPROVEMENTS

- Monument stability (since 2000)
- Standardizing installations (since 2007)
- System integrity monitoring (since 2010)
- Equipment upgrade (since 2014)
- Antennas environment (constant focus)
- Co-location (continuous progress)

ONGOING DEVELOPMENTS

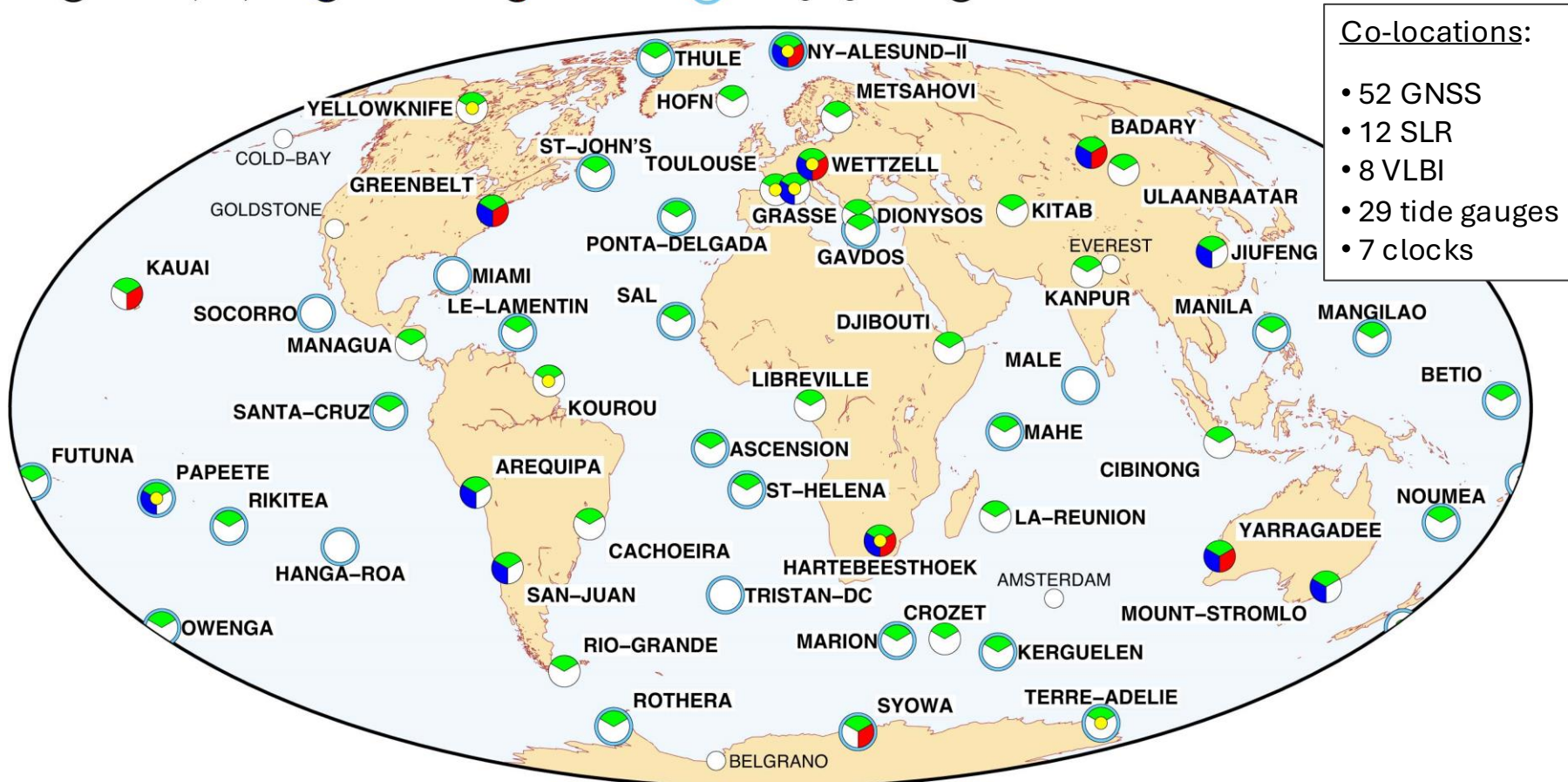
- Gradual replacement of the equipment with new generation
- Site renovation
- Connection to external clocks
- Expansion of the station network**

CURRENT GROUND NETWORK INFRASTRUCTURE

Very uniform geographical distribution + numerous co-locations with other techniques

62 stations

GNSS (IGS) SLR VLBI Tide gauge External clock No active co-location

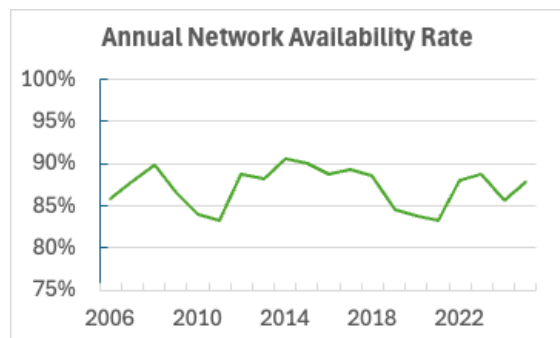


GM 2026 Jun 03 19:04:38 This map was created by IGN-France

CURRENT NETWORK STATUS

87.2%

**Availability Rate of
the station Network
over the past 20 years**



62

DORIS stations

24

**Stations out of
service for over a
year in the
network history**

30 years

**Median age of the
network stations**

10 years

**Longest station
outage**

Santa Cruz (Galapagos):
2009 > 2019

2. PURPOSE AND STATUS OF THE NETWORK EXPANSION

“

**TO MAKE THE SYSTEM MORE
ROBUST AGAINST STATION
OUTAGES, THE INSTALLATION OF
ABOUT 10 MORE STATIONS IN
CRITICAL AREAS IS
ENCOURAGED.”**

Christian Jayles
CNES DORIS System Manager

A RECOMMENDATION FROM THE IDS RETREAT 2018

IDS STRATEGIC PLAN

The purpose of the retreat was to review the activities, overall scientific direction and future of the service. This seminar resulted in the development of strategic plan based on 4 themes:

- Technological developments
- Expanding DORIS community
- Reducing barriers to entry
- **Infrastructure - Data processing**

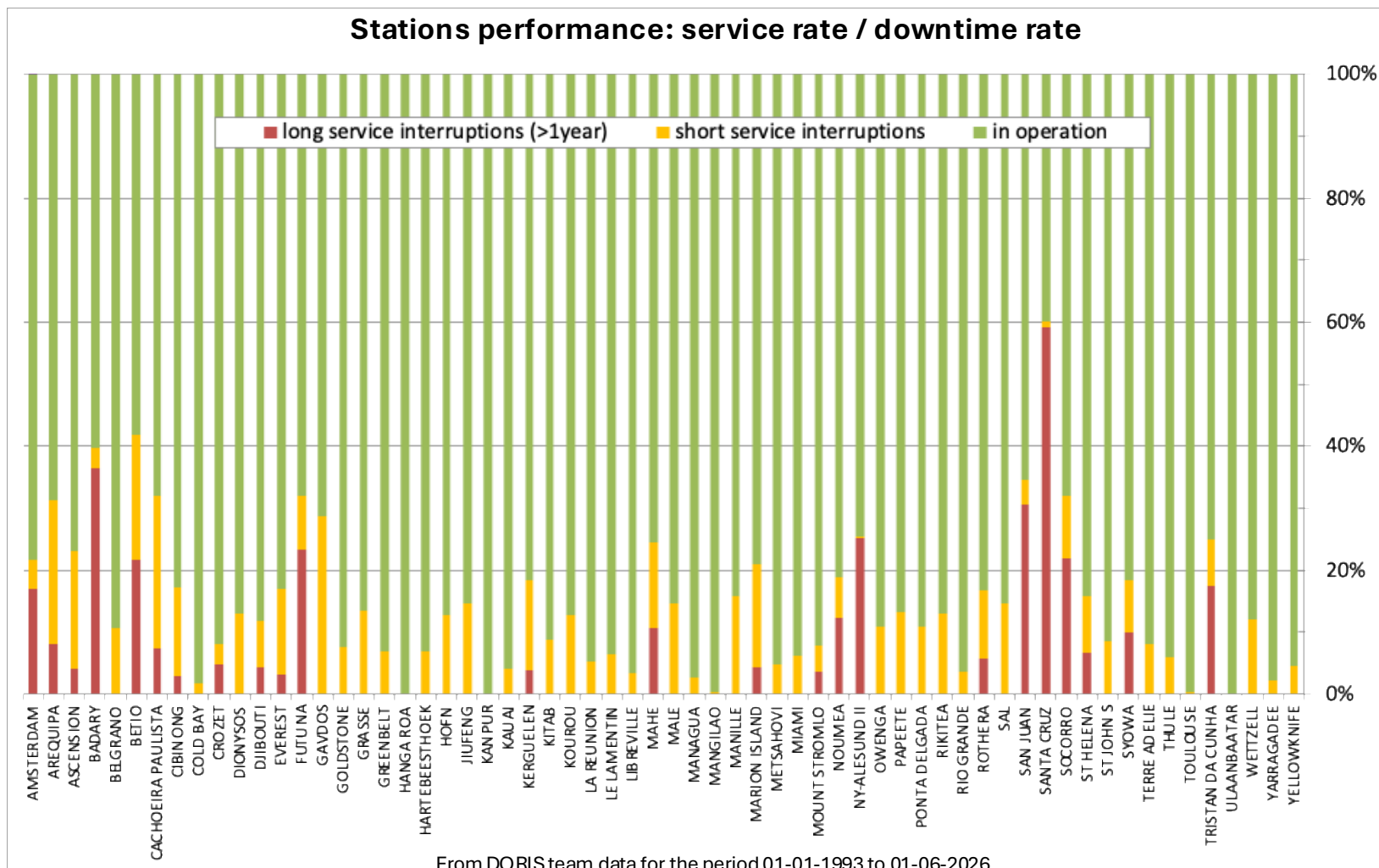
NETWORK EXPANSION + 10

This IDS recommendation was supported by a justification report from CNES:

- Maintain a high level of service
- Improve real-time orbit determination
- Improve the accuracy of scale factor
- Multiply co-location with other tech.
- Better contribute to science
- Anticipate future needs in terms of precision

KEEPING STATIONS IN OPERATION IN CHALLENGING AREAS (1/2)

Some areas of the current network need additional stations to improve robustness, or even station relocations when major recurring problems are identified.



KEEPING STATIONS IN OPERATION IN CHALLENGING AREAS (2/2)

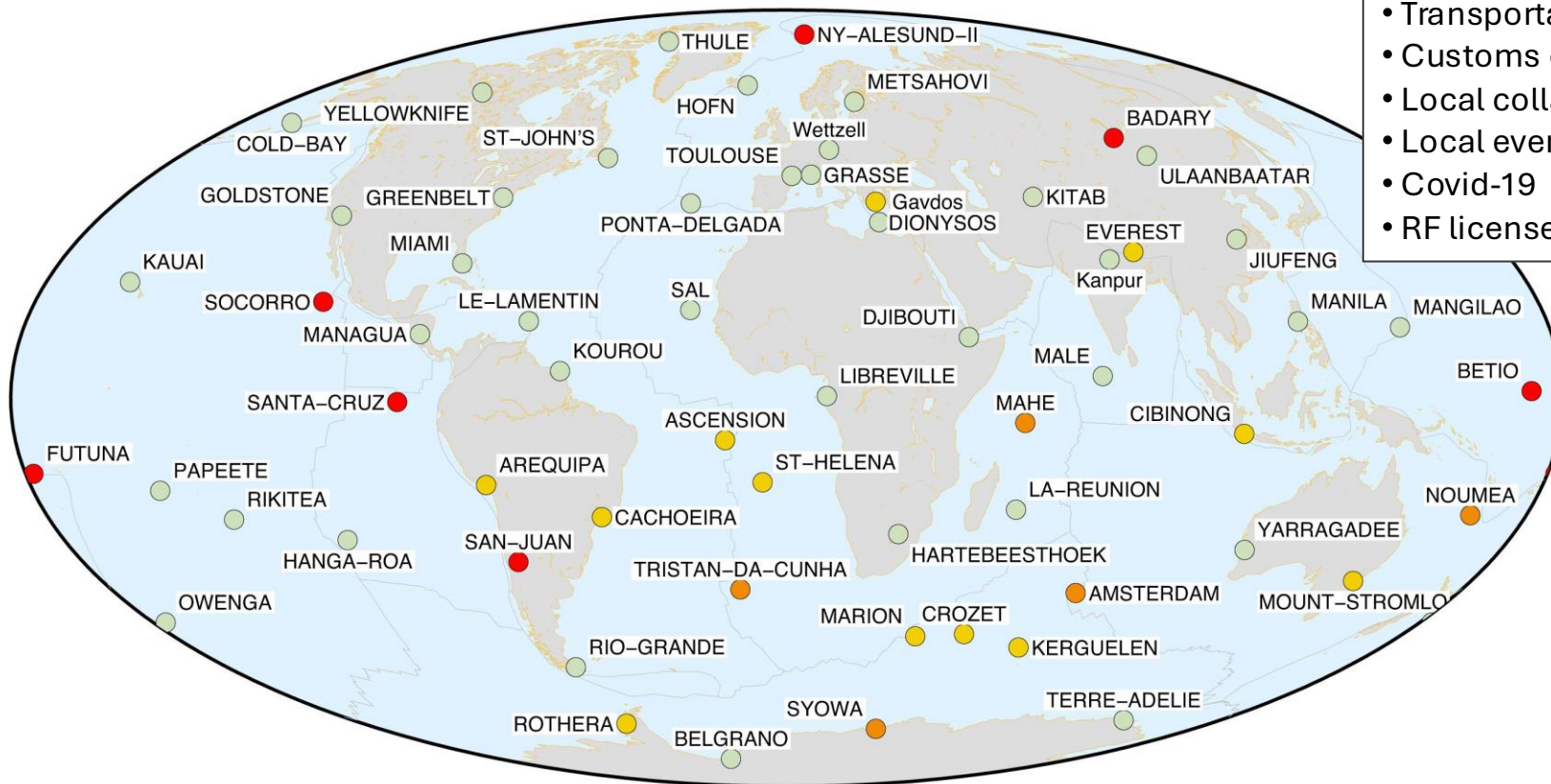
More problems in the Southern Hemisphere, in remote areas, particularly on islands

Mapping of extended service interruptions (> 1 year) that affected the service level

● service rate < 80%
 ● 80% < service rate < 90%
 ● service rate > 90%

Main issues:

- Access
- Transportation
- Customs clearance
- Local collaboration
- Local events
- Covid-19
- RF license



 2026 Jun 29 14:52:44 This map was created by IGN-France
 From DORIS team data for the period 01-01-1993 to 01-06-2026

REMAINING COVERAGE GAPS DESPITE A VERY UNIFORM DISTRIBUTION

Covering the Pacific Ocean is the most difficult task

Mapping of visibility circles for LEO satellites (800km altitude)



85% Low-Earth Orbit coverage (800km) 97% coverage at 1300km altitude

GOAL OF 70 STATIONS: OUTCOMES EXPECTED

IMPROVE GEOGRAPHIC COVERAGE

Fill in several gaps in coverage:

- Pacific Ocean
- Northeast Asia
- Northern Australia
- Indian Ocean

STRENGTHEN THE NETWORK WHERE IT IS VULNERABLE

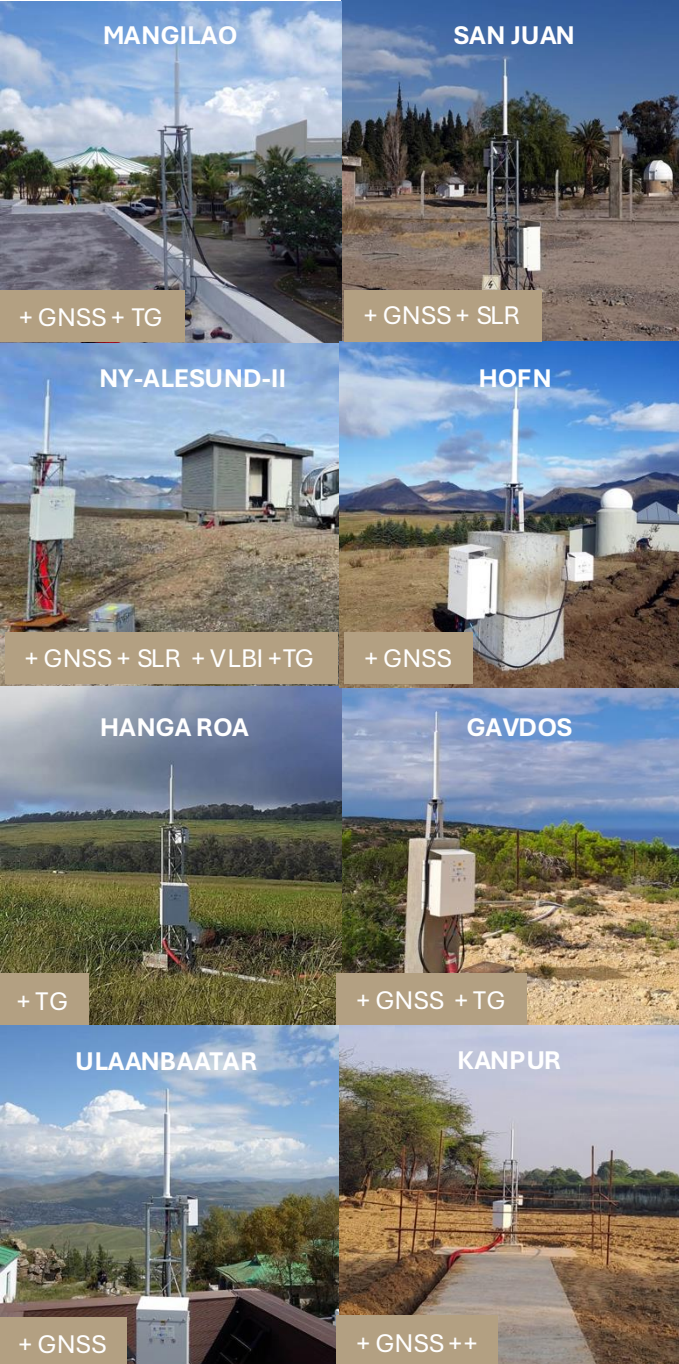
Where we experienced prolonged service interruptions due to:

- Access issues
- Customs clearance
- Diplomatic issues
- etc...

INCREASE CO- LOCATION WITH OTHER TECHNIQUES

Better contribute to geodesy:

- Realization of the International Terrestrial Reference Frame
- Constant comparison between techniques



WHERE DO WE STAND SINCE 2018?

**+ 8 NEW STATIONS INSTALLED
AND 1 DECOMMISSIONED : 57 > 62 STATIONS**

Among these new sites, two are replacements for older sites:

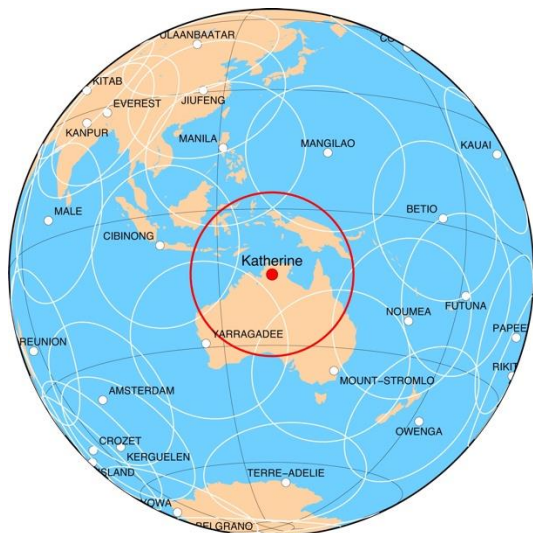
Site	Location	Purpose	Start	Total
Mangilao	Guam, USA	New site	04-2018	58
San Juan	Argentina	New site	10-2018	59
Ny-Alesund II	Svalbard, NO	Replacement	10-2018	59
Höfn	Iceland	Replacement	09-2020	59
Krasnoyarsk	Russia	Removal	04-2022	58
Hanga Roa	Easter, CH	New site	04-2023	59
Gavdos	Crete, GR	New site	09-2023	60
Ulaanbaatar	Mongolia	New site	10-2024	61
Kanpur	India	New site	02-2026	62

NEW SITE PROJECTS CURRENTLY IN PROGRESS

62 > 65 STATIONS

KATHERINE, AUSTRALIA

End of 2026 (TBC)
Co-location GNSS + VLBI



KOKSHETAU, KAZAKHSTAN

Early 2027 (TBC)
Co-location GNSS



GAMAK, SOUTH KOREA

Mid 2027 (TBC)
Co-location GNSS + SLR



3. CRITERIA, FACTORS, AND CHALLENGES

DURATION OF A NEW DORIS SITE PROJECT

SITE	COUNTRY	HOST AGENCY	START	END	DURATION
COLD BAY	USA	National Weather Service	Jan-09	Nov-10	669
GOLDSTONE	USA	NASA	May-10	Mar-15	1765
OWENGA	NEW-ZEALAND	LINZ	Oct-11	Nov-14	1127
LE LAMENTIN	FRENCH INDIES	Météo France	Nov-11	Jun-13	578
MANAGUA	NICARAGUA	INETER	Jan-12	Jan-16	1461
HANGA ROA	CHILE	Universidad de Chile	Mar-13	Apr-23	3683
SAN JUAN	ARGENTINA	Universidad Nacional de San Juan	Jan-14	Oct-18	1734
WETTZELL	GERMANY	BKG	Mar-14	Sep-16	915
KATHERINE	AUSTRALIA	Geoscience Australia	Apr-15	Sep-26	4171
NY-ALESUND II	NORWAY	IPEV	May-15	Oct-18	1249
MANGILAO	GUAM; USA	University of Guam	Jun-15	Apr-18	1035
HOFN	ICELAND	LMI	Apr-18	Sep-20	884
GAVDOS	GREECE	Technical University of Crete	Mar-20	Sep-23	1279
ULAANBAATAR	MONGOLIA	Institute of Astronomy and Geophysics	Mar-22	Sep-24	915
KANPUR	INDIA	IITK	Apr-22	Feb-26	1402

A new project typically takes between 2 and 10 years, depending on the challenges encountered. **Average duration: 4 years**

15 new DORIS sites over the past 17 years

Key Points

- Agreement in principle from the host
- Site survey
- Frequency clearance / RF compatibility
- Signing of the tripartite agreement
- Site selection / Technical specifications
- Construction work
- Shipment and customs clearance of the equipment
- Station installation and commissioning

SITE SELECTION CRITERIA

EVALUATION CHART

Site evaluation could be based on a grading scheme with 5 criteria:

1. **Location:** network coverage, network robustness
2. **Contribution to geodesy:** co-location with other techniques, plate motion monitoring...
3. **Compliance with system requirements:** antenna environment, housing conditions, monument stability...
4. **Ease of Maintenance:** access, administrative procedures, security...
5. **Commitment of the Host Agency:** abilities, means, collaboration...

FACTORS

STAKEHOLDER SUPPORT

As public institutions, the CNES and the IGN are facing budget constraints. Any additional station entails costs in terms of:

- Equipment supply
- Equipment installation
- Monitoring and maintenance
- Logistics

EQUIPMENT AVAILABILITY

The inventory of 4th generation beacons is decreasing.

- Remaining sites to be equipped (13)
- Some spare beacons are necessary for network maintenance
- A new order involves a 5th gen beacon project

STABILITY OF THE CURRENT NETWORK

Any major problem at the current stations will slow down the network expansion:

- Withdrawal from a host agency
- Closure of a site
- Geopolitical issue

CHALLENGES

MEET BOTH OPERATIONAL AND SCIENTIFIC NEEDS

These two needs are sometimes incompatible:

- Some areas are already over covered, as in Europe
- Co-location with VLBI is complicated and time-consuming
- Operational requirements will take priority

PLACE STATIONS WHERE THERE ARE GAPS

We can't set up operations everywhere:

- Oceans = 2/3 of the Earth's surface
- Remote areas are not always adequately equipped to operate a station
- Some countries are not DORIS friendly

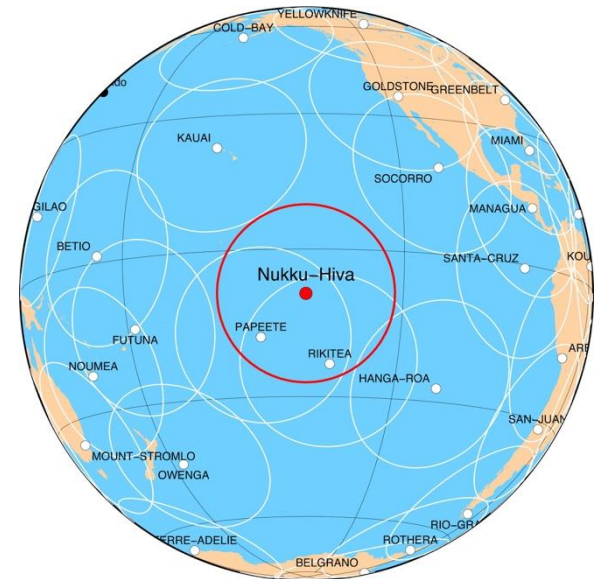
4. OUTLOOK AND STRATEGY

THE NETWORK CONTINUES TO EXPAND

ONGOING PROJECTS

The implementation of these projects depends on the successful completion of the necessary administrative procedures: signing the agreement with the host agency, obtaining frequency clearance...

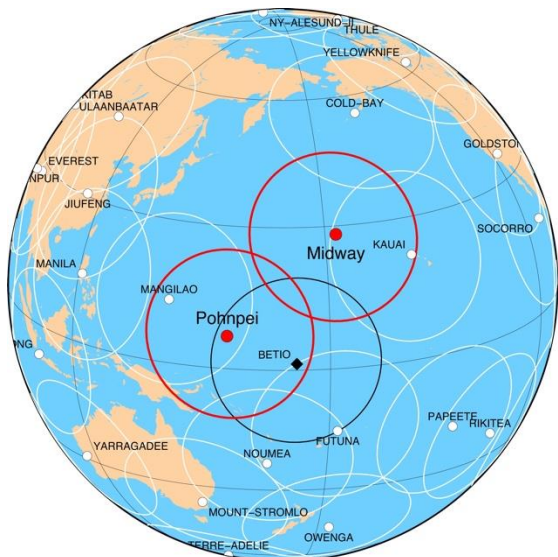
- **3 new stations by the end of 2027:**
Katherine (AU), Kokshetau (KZ), Gamak (KR) **62 > 65**
- **Geodetic and Geophysical Observatory of Polynesia**
In the site selection phase following an initial site survey and RF measurements campaign **> 66**



A FEW SUGGESTIONS

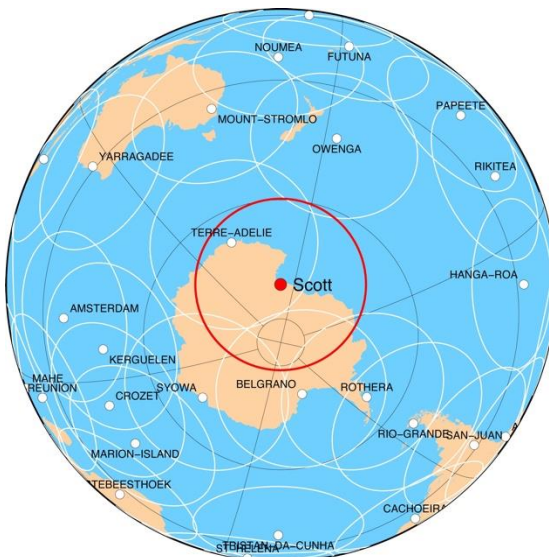
PACIFIC OCEAN COVERAGE

2 new stations to replace one (Betio)



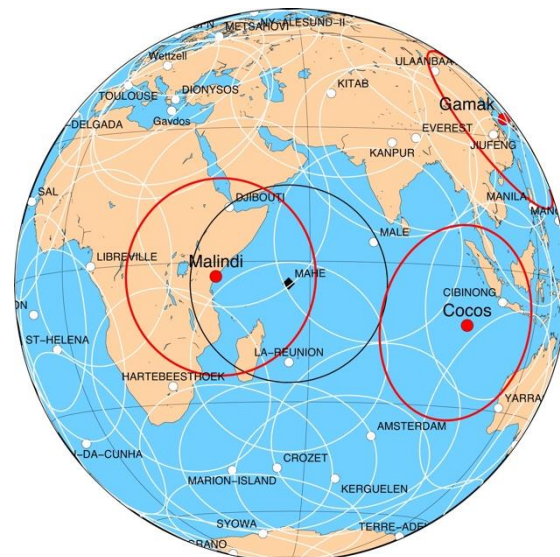
ANTARCTICA ROBUSTNESS

Scott Base (NZ)



INDIAN OCEAN COVERAGE

2 new stations to replace one (Mahé)



STRATEGIC PLAN

FIVE NEW SITES TO BE SELECTED

These sites must be carefully selected based on the defined criteria

- **Focus on meeting the network's coverage and reliability needs**
- **Target sites co-located with IGS stations**
- **Use an evaluation grid to select sites**
- **Set a schedule with CNES and IGN that is compatible with their constraints**
- **Manage equipment inventory and plan accordingly the 5th generation beacon**
- **Spread out implementation projects over time to effectively maintain the network**

IN SUMMARY

- The network is a major component of DORIS
- The goal of network expansion is to improve the system performance and reliability
- This long-term endeavor is well underway
- Current plans for new sites could soon bring the total number of stations to 65
- Future new sites must be selected based on strict criteria, and their implementation will be spread out over time



MERCI POUR VOTRE ATTENTION