

3.4.4 International DORIS Service (IDS)

Overview The current report presents the different activities held by all components of the International DORIS Service (IDS). In a first step, we will present the current status of the DORIS system (available satellites and tracking network). In a second step, we will present the activities of the IDS Central Bureau (IDS Web site management and DORIS-related email distributions). We will then focus on the most recent activities conducted by the Analysis Centers (ACs) and the Analysis Coordination. Finally, we will present other activities related to meetings and publications.

1 DORIS system

1.1 DORIS satellites

During this report period (2014), the number of DORIS satellites has remained the same as the previous year at five (see Table 1).

Two missions with DORIS onboard are planned for 2015: Jason-3 and Sentinel-3A. In the same year, SPOT-5's mission will end, and with it, the last DORIS instrument of 2nd generation. Afterwards, the constellation will be only composed of DGXX receivers.

Some other DORIS missions are under development and should guarantee a constellation with at least 4 DORIS contributor satellites through 2030:

- Jason-CS (Eumetsat/ESA/CNES) is expected from 2020
- SWOT is foreseen for 2020

1.2 DORIS network

The DORIS network maintained a high level of performance: many prompt and effective maintenance operations (equipment replacement) and the return to service of Socorro eagerly awaited since several years made it possible to keep up the network availability rate with a 91% annual mean of operating stations.

As regards the ground equipment, the deployment of the remote control system allowing more rapid reaction to hardware failure

Table 1: DORIS data available at IDS Data Centers. As of December 2014

Satellite	Start	End	Type
SPOT-2	31-MAR-90 04-NOV-92	04-JUL-90 15-JUL-09	Remote sensing
TOPEX/Poseidon	25-SEP-92	01-NOV-04	Altimetry
SPOT-3	01-FEB-94	09-NOV-96	Remote sensing
SPOT-4	01-MAY-98	24-JUN-13	Remote sensing
SPOT-5	11-JUN-02	–	Remote sensing
Jason-1	15-JAN-02	21-JUN-13	Altimetry
ENVISAT	13-JUN-02	08-APR-12	Altimetry, Environment
Jason-2	12-JUL-08	–	Altimetry
Cryosat-2	30-MAY-10	–	Altimetry
HY-2A	1-OCT-11	–	Altimetry
SARAL	14-MAR-13	–	Altimetry

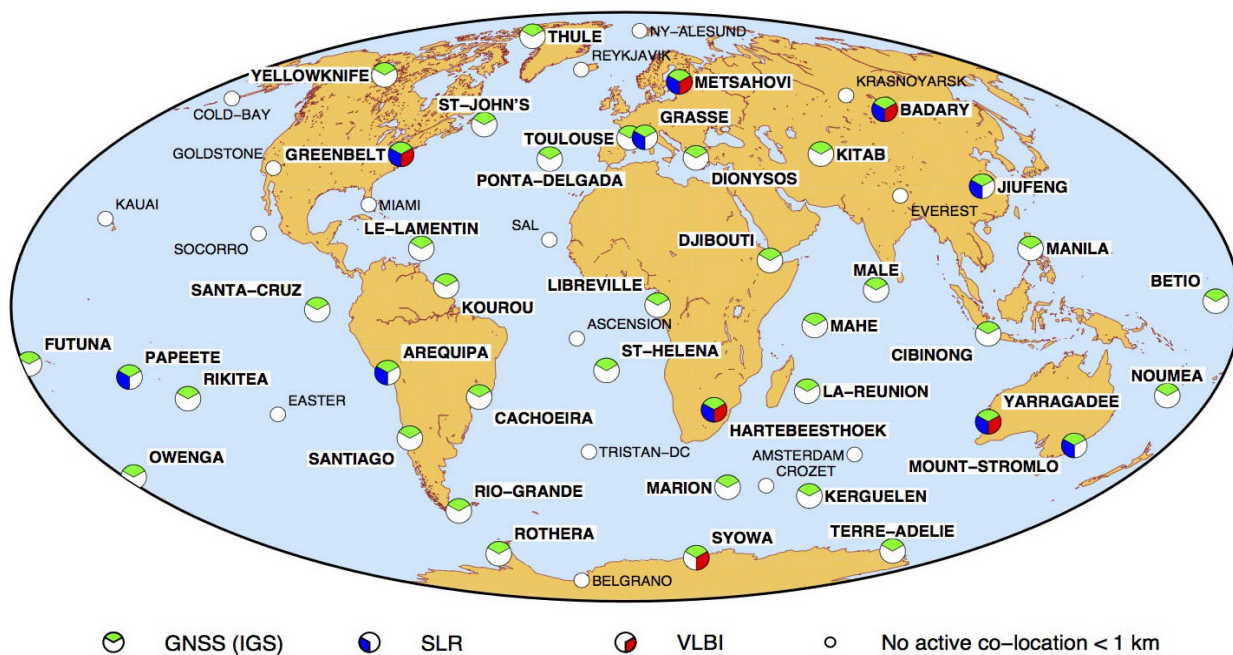


Fig. 1: The permanent DORIS network – 55 stations – and co-location with other IERS techniques (as of Dec. 2014).

is mostly complete. A new antenna type begins to roll out across the network. The letter “C” appears at the end of acronyms when this antenna type is used. This antenna is the same as the former one but the manufacturing process has been consolidated with more stringent specifications in order to better characterize the relative position of all the characteristic points of the antenna and draw up a more realistic error budget.

Efforts continued in the field to improve the monument stability at any new installation and to carry out high precision local tie surveys.

The main highlights for 2014 are:

- Due to recurring maintenance issues, two stations have been decommissioned: Gavdos (Greek island part of Crete) in March and Port Moresby (Papua New Guinea) in May 2014.
- With a view to move Easter and Santiago stations, reconnaissance in Chile.
- Major renovation with a shift of 260m in Socorro island in Mexico, back to operation after 5 years of inactivity.
- New site Owenga replacing Chatham in New Zealand.
- With a view to installing a new station, Wettzell in Germany was visited.

With regard to the off-network stations dedicated to IDS for scientific purposes, objectives and priorities have been redefined at the beginning of that year as follows:

Table 2: Composition of the IDS Governing Board (January 2013 – December 2014)

Name	Institution	Country	Mandate
Richard Biancale	CNES	France	Member at large
Pascale Ferrage	CNES	France	System representative
Frank Lemoine	GSFC	USA	Analysis Coordinator
Brian Luzum	GSFC	USA	IERS representative
Guilhem Moreaux	CLS	France	Combination Center representative
Carey Noll	GSFC	USA	Data flow Coordinator
Michiel Otten	ESOC	Germany	IAG representative
John Ries	U. Texas/CSR	USA	Member at large
Jérôme Saunier	IGN	France	Network representative
Laurent Soudarin	CLS	France	Director Central Bureau
Pascal Willis (chair)	IGN/IPGP	France	Analysis Center representative

- Wettzell, Germany: 4 techniques GGOS site; DORIS station installation planned in 2015
- Guam island, North Pacific Ocean: IGS “GUUC” + tide gauge co-location
- Sejong, Korea: future 4 techniques GGOS site

2 IDS Governing Board

In accordance with the Terms of Reference of the IDS, two positions within the Governing Board became vacant at the end of 2014: the position of Frank Lemoine as the Analysis Coordinator, and the position of John Ries as one of the Members at Large. Both have served for two terms consecutively, and therefore cannot be a candidate to a seat for another term. After the elections organized in Fall 2014, the new members elected by the IDS Associates to serve for the next four-year term 2015–2018 are:

- Hugues Capdeville (CLS)/Jean-Michel Lemoine (CNES) as Analysis Coordinator,
- Marek Ziebart (UCL) as a Member at Large.

It is important to note that Hugues Capdeville and Jean-Michel Lemoine will share together the responsibility and the work of the Analysis Coordination. From January 1st 2015, the tandem can be contact at <ids.analysis.coordination@ids-doris.org>.

The Governing Board and Central Bureau would like to friendly and warmly thanks Frank and John for their valuable contribution to the IDS. The composition of the new Governing Board is given in Table 2.

3 IDS Central Bureau

Address: <<http://ids-doris.org/webservice>>

3.1 DOR-O-T, the IDS Webservice

In September, the Central Bureau announces the launch of the IDS web service named DOR-O-T for DORis Online Tools (pronounced like the French given name Dorothée). The current version pro-

vides tools to browse time series in an interactive and intuitive way. It includes a network viewer to select sites and a family of plot tools to visualize the following time series: (1) station position differences at observation epochs relative to a reference position; (2) DORIS data residuals and the amount of available station observations as deduced from the CNES Precise Orbit Ephemeris processing, (3) outputs of the IDS Combination Center analysis, such as the Helmert parameters, and the WRMS. In addition to visualizing DORIS station coordinate time series, the web service also incorporates the time evolution of GNSS stations that are in co-location with DORIS, thanks to collaboration with the IGS Terrestrial Reference Frame Combination Center.

3.2 IDS Web and ftp sites

The IDS Central Bureau (CB) maintains the IDS web (<<http://ids-doris.org>>) and ftp (<<ftp://ftp.ids-doris.org/pub/ids>>) sites.

The main updates of 2014 are reported hereafter.

- The presentations of the AWG meeting held in Paris, France, March 26–27, were put on line on a dedicated page:
<<http://ids-doris.org/report/meeting-presentations/ids-awg-03-2014.html>>
- The presentations of the IDS Workshop held in Konstanz, Germany, October 27–28, have been made available:
<<http://ids-doris.org/report/meeting-presentations/ids-workshop-2014.html>>
- The data analysis summary of the DORIS weekly SINEX series submitted by the Analysis Centers and used for the DORIS contribution to ITRF 2014 is shown in a table:
<<http://ids-doris.org/contribution-itr2013.html>>
- The main events (system, station, data, Earthquake) that occurred on the DORIS space segment and ground segment are presented in one single table:
<<http://ids-doris.org/system/table-of-the-events.html>>
- All the documents and files related to the DORIS/RINEX format is now gathered on a new page in the Analysis Coordination section:
<<http://ids-doris.org/about-doris-rinex-format.html>>
- The list of the peer-reviewed publications related to DORIS has been enriched with 10 new references of articles published in 2014:
<<http://ids-doris.org/report/publications/peer-reviewed-journals.html#2014>>
- The activity reports for 2013 (IDS Activity report, report for IERS) as well as the minutes of the IDS GB meetings held in 2014 (Paris, Konstanz) and several presentations in mee-

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tings (IERS DB, GGOS, ...) were added on the page of the Governing Board's documents:

<<http://ids-doris.org/report/governing-board.html>>

- The page gathering IDS-related presentations was updated with several presentations:
<<http://ids-doris.org/report/meeting-presentations/ids-related-presentations.html>>
- Some DORIS-related presentations were added:
<<http://ids-doris.org/report/publications/on-line-publications.html>>

New documents and files were put on the IDS ftp site. They are listed hereafter:

- “DORIS site standard configuration” is a new document describing the standard configurations compliant with the DORIS system requirements applicable to the management of the DORIS station network:
<ftp://ftp.ids-doris.org/pub/ids/stations/DORIS_Site_Standard_Configurations.pdf>
- “Introduction to DORIS RINEX” gives a quick description of the DORIS/RINEX format. The principle chosen in this document is to take an example of RINEX content and describe the main parameters.
<<ftp://ftp.ids-doris.org/pub/ids/data/IntroductionToDORISRINEX.pdf>>
- Routines to read DORIS/RINEX files. The “tar file” contains the Fortran90 subroutines used in GINS to read the RINEX files (courtesy by Jean-Michel Lemoine, CNES).
<ftp://ftp.ids-doris.org/pub/ids/data/DORIS_RINEX_subroutines_from_GINS.tar>
- Version #6 of the document describing the DORIS satellite models implemented in CNES POE processing. It includes updates on SPOT-5 solar panel offsets.
<<ftp://ftp.ids-doris.org/pub/ids/satellites/DORISSatelliteModels.pdf>>
- Updated version of the mass and center of mass history file for Jason-1. The X value of the initial Center of Gravity was increased by 2 cm to +0.955 m to agree with the value recommended by CNES/SOD and given in the document describing the DORIS satellite models implemented in CNES POE processing.
<<ftp://ftp.ids-doris.org/pub/ids/satellites/ja1mass.txt>>
- Leaflet presenting the IDS web service DOR-O-T:
<ftp://ftp.ids-doris.org/pub/ids/DOR-O-T_Webservice_2014.pdf>

3.3 IDS Mail system

Several types of emails are distributed by the IDS Central Bureau:

- DORISMail: general DORIS interest
- DORISReports: reports related to DORIS data and products
- AWG and IDS Analysis Forum: technical discussion between analysis centers, combination and coordination
- DORISstations: information about station events (data gap, positioning discontinuities)

Everyone is welcome to subscribe to any of these emails. See more details on <http://ids-doris.org/report/emails.html>.

4 IDS Data Centers

The IDS data flow organization remains the same. It is based on two data centers: one on the East Coast of the U.S. (CDDIS at NASA GSFC) and one in Europe (IGN in France). They are both exact mirrors of each other, and so, are able to continue on an operational basis, even if one of them is inaccessible due to a temporary failure.

These two data centers archive the DORIS data as well as the IDS products (station coordinates and velocity, geocenter motion, earth orientation parameters, ionosphere data, etc.).

The main events of the year are listed hereafter:

- In the fall of 2012, the IDS Analysis Working Group requested a test data set where data from stations in the South Atlantic Anomaly (SAA) were reprocessed by applying corrective models. Data from 2011 in DORIS V2.2 format from the Jason-1 satellite (cycles 104 through 368) were submitted to the IDS data centers in late 2012 and 2013; a set of SPOT-5 data (cycles 138 through 456, 2006 through Sept. 2014) were provided in 2013 and 2014. These files were submitted to the IDS data centers and archived in dedicated directories.
- The data centers supported the IDS Analysis Coordinator and Combination Center in the generation of the IDS contribution to ITRF2013.
- SSALTO implemented a improvements to the accuracy of the measurements in the RINEX formatted data. Therefore, all Jason-2, Cryosat-2, HY-2A, and SARAL RINEX data were reprocessed and delivery to the data centers will begin in early 2015.

5 IDS Analysis Centers and IDS Analysis Coordination

The activities of the past two years (2013–2014) have been dominated by the efforts of all the DORIS analysts to implement improvements in their processing, and to reprocess all the DORIS data, and prepare weekly SINEX files from 1993 to 2014 for the development of the IDS contribution to ITRF2013. The face-to-face meetings at the different Analysis Working Group meetings were supplemented at various times by telecons that involved the

Table 3: List of IDS Analysis Centers participating in the analysis activities in 2014.

Acronym	Analysis Center	Country	Software package
ESA	ESOC	Germany	NAPEOS
GOP	Geodetic Observatory Pecny	Czech Rep.	Bernese
GSC	GSFC	USA	GEODYN
IGN	IGN	France	GIPSY/OASIS
INA	INASAN	Russia	GIPSY/OASIS
LCA	CNES/CLS	France	GINSDYNAMO

DORIS analysis centers and the IDS Combination. The purpose of these supplementary meetings was to try and maintain the pace of progress in assessing the model improvements, and to resolve issues associated with the reprocessing of the DORIS data. The IDS endeavored to meet the original objective of delivering a combination to the IERS by April 2014 (based on data processed through the end of 2013). It met its objective, but as it became clear that the other geodetic techniques were considerably delayed in their submissions, it allowed some updating of the submissions on the part of the ACs, and refinement of the IDS combination by the Combination Center. Near the end of the year 2014, the IERS requested that IDS process data through 2014 and submit these data by February 2015. Because of data latencies, the IDS replied that its ACs would only supply SINEX files through the end of the week of August 31, 2014. Thus ITRF2013 officially became ITRF2014.

For ITRF2014, the six active analysis centers had agreed to submit new SINEX solutions. In addition, the CNES POD center is lead DORIS analysis center. They do not submit SINEX solutions for the IDS combination, but since they have prime POD responsibility for many of the DORIS satellites, they are the source for much of the spacecraft information needed for processing. In addition, they prepare the DORIS format 2.2 data (the range-rate format) that is used by the IDS ACs. We note that in the past year we have had participation by three other institutions: GFZ, TU/Delft, the University College/London. The GeoForschungsZentrum (GFZ) has participated in several of the IDS meetings, and focused on the POD analysis for altimeter satellites. TU/Delft is analyzing data from Cryosat-2, and has made available the spacecraft quaternions for use by other team members. UCL is interested in working with individual DORIS ACs on the refinement of non-conservative force modeling for DORIS satellites. We note that a representative of the Norwegian Mapping Authority (NMA) also attended the IDS Workshop in Konstanz (Oct. 2014), and expressed an interest in analysis of DORIS data, and also in multi-technique analyses. In the future, the participation of the NMA and other potential IDS ACs should continue to be encouraged.

The major efforts over the last two years focused on the development of the processing standards for ITRF2013(4). The details in the modeling for the ITRF-related time series submitted by the different analysis centers are reported on the IDS website at the URL: <http://ids-doris.org/contribution-itr2013.html>. The major changes that were validated in 2013–2014, included the following:

(1) The implementation and validation of the phase law for the DORIS antennae in the software of the different IDS Analysis Centers; (2) The introduction of new satellites into the DORIS weekly solutions; (3) The improvement in the troposphere modeling by some of the different IDS Analysis Centers; (4) The testing of improved gravity models, and associated models for atmospheric and ocean de-aliasing; (5) The identification of discrepancies in the processing for different analysis centers through comparison of the time series of empirical accelerations.

As a conclusion, we may highlight that six DORIS Analysis Centers successfully processed 20 years of data to 11 satellites and submitted SINEX files that were combined into an IDS solution for ITRF2014. The IDS Community should not rest on its laurels, as there are still many substantive issues that remain to be addressed, even with the current data already processed.

6 IDS Combination

The IDS Combination Center spent all the year 2014 to the realization of the IDS contribution to ITRF2013. From April 17th to December 5th, the IDS Combination Center delivered to IERS 5 versions of the IDS combined SINEX files. Each version is a set of eleven hundreds of weekly SINEX files including station coordinates and earth orientation parameters, covering the time period from 1993 to 2014. These IDS series are the result of the combination of weekly solutions from six Analysis Centers (ACs) from six different institutions (ESA, Geodetic Observatory of Pecny, NASA, IGN, INASAN, CNES/CLS) using five different software packages for orbit determination. The data comes from three generations of DORIS receivers onboard of eleven satellites (Cryosat-2, Envisat, HY-2A, Jason-1/2, Saral, SPOT2/5 and TOPEX/Poseidon) supported by a beacon network of nearly sixty stations uniformly spread across the globe. Due to Jason-1 and SPOT5 USO's sensitivity to the South Atlantic Anomaly (SAA), for these 2 missions IDS made available SAA corrected data. Evaluation of the IDS contribution to ITRF2008 (series 01) and to ITRF2013 (series 07) with respect to ITRF2008 (see Figure 2) showed:

- Improvements of Tx, Ty and Tz after 2002 (lower STDs, less annual signal) thanks to time variable gravity fields use in the ITRF2013 contribution.
- Scale offset (between the IDS contributions to the 2 ITRF) due to beacons PCVs in ITRF2013 processing.

3.5.1 Earth Orientation Centre

- Less scale spurious values early 1994 (SPOT2 is no more included in the combined scale) in IDS series 07.
- No more scale factor discontinuity in 2002 thanks to beacon frequency offset estimations.
- Improvement of scale stability between end of TOPEX (late 2004) and Jason-2 start (mid 2008) thanks to Jason-1 including.
- Scale factor increase mid 2012.
- Better week-to-week repeatability of Helmert parameters of ids 07 (solution more consistent).

In addition, the evaluation process also pointed out that the IDS contribution to ITRF2013 gives higher differences of mainly X-pole estimates with the IERS C04 than the IDS contribution to ITRF2008 series. The explanation of that substantial degradation could be that the new solution uses 2 ACs less than the previous one.

Last but not least, in 2014, the IDS Combination Center joined both EGU General Assembly and AGU Fall Meeting where it presented two oral presentations respectively titled “IDS contribution to ITRF2013” and “IDS and ITRF2013: Contribution and Evaluation”.

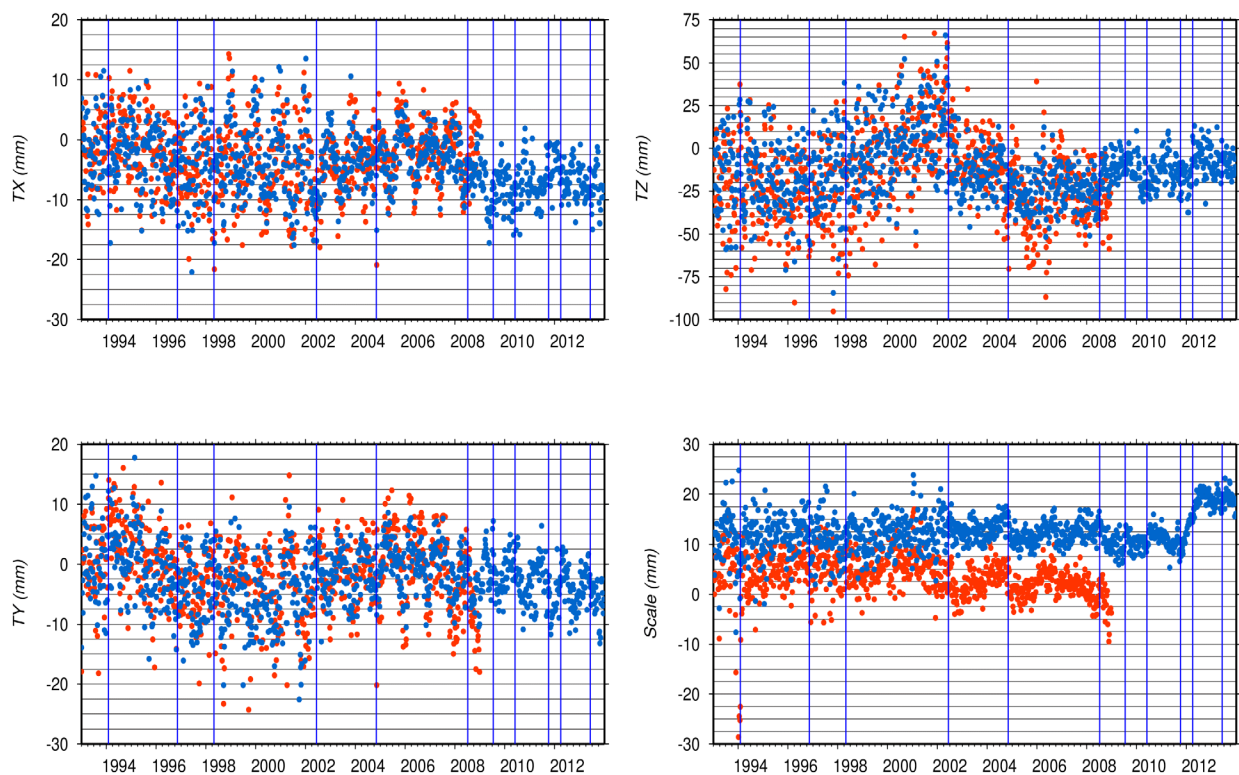


Fig. 2: Helmert parameters (translations and scale of the IDS contributions to ITRF2008 (red) and ITRF2013 (blue) with respect to ITRF2008.

7 Meetings

In 2014, the IDS organized a DORIS Analysis Working Group (AWG) meeting, in Paris, France, on March 26 and 27, as well as the IDS Workshop held in Konstanz, Germany, on October 27 and 28.

All the presentations from these meetings are made available by the Central Bureau on the IDS website at:

[ids-awg-03-2014.html](http://ids-doris.org/report/meeting-presentations/ids-awg-03-2014.html)

[ids-workshop-2014.html](http://ids-doris.org/report/meeting-presentations/ids-workshop-2014.html)

8 Publications

IDS published a 2013 activity report that was broadly distributed to all DORIS participants and relevant services (see <http://ids-doris.org/report/governing-board.html#activity>).

All DORIS related articles published in international peer-reviewed journals are available on the IDS Web site <http://ids-doris.org/report/publications/peer-reviewed-journals.html>.

Conclusions

Again, the DORIS community had a productive year in 2014. Like in 2013, the activities have been dominated by the efforts of all the DORIS analysts to implement improvements in their processing, to reprocess all the DORIS data, and to prepare weekly SINEX files from 1993 to 2014 for the development of the IDS contribution to ITRF2014. However there are still many substantive issues that remain to be addressed. The next work for the Analysis Centers is also the processing of the DORIS phase measurements of the DGXX instruments delivered in RINEX DORIS 3.0 format. This matter is indeed a new crucial project for IDS since this type of measurement and this format are the only ones available from the forthcoming missions (Jason-3, Sentinel 3A, ...).

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