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1 INTRODUCTION

This document is the Galileo Enhanced Service Search and Rescue Service (SAR/GALILEO) Public Performance Report for the period of July, August and September 2021. Following the declaration of the SAR/Galileo Enhanced Services in January 2020, issue 2.0 of [SAR-SDD] was published and is the reference document for the present performance report.

This document reports on the following performance parameters, with respect to their Minimum Performance Levels (MPLs) declared in the [SAR-SDD]:

- Forward Link Service, Detection and Location Performance;
- Return Link Service, RLM Delivery Latency and Reception Probability Performance;
- European MEOLUT and Space Segment Availability Performance.

The document comprises the following sections:

Section 1: is an introduction to this report. It includes the status of Galileo constellation for the Search and Rescue Service over the quarterly reported period.

Section 2: Provides an executive summary of the achieved performance. Details are reported in the following chapters.

Section 3: Provides the detailed performance for the SAR/Galileo Forward Link Service.

Section 4: Provides the detailed performance of the SAR/Galileo Return Link Service.

Section 5: Provides the detailed performance for the SAR/Galileo Space Segment infrastructure availability.

Section 6: Provides supplementary performance metrics of interest, not subject to MPL.

Section 7: Lists the reference documents.

Section 8: Defines the acronyms and abbreviations used in the document.
Table 1 provides the status of the relevant SAR/Galileo space constellation, for which the performance data has been derived for the reported period.

<table>
<thead>
<tr>
<th>Satellite Code</th>
<th>SV ID (PRN)</th>
<th>Cospas-Sarsat ID</th>
<th>Orbital Slot</th>
<th>Status</th>
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<td>419</td>
<td>C04</td>
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<tr>
<td>GSAT-0104</td>
<td>20</td>
<td>420</td>
<td>C14</td>
<td>Available ¹</td>
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<tr>
<td>GSAT-0201</td>
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<td>418</td>
<td>Ecc ²</td>
<td>Available</td>
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<td>GSAT-0202</td>
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<td>GSAT-0222</td>
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<td>433</td>
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<td>Available</td>
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</tbody>
</table>

Table 1: Galileo Reported Constellation Information for the SAR/Galileo Service

For the most up-to-date information, please refer to the European GNSS Service Centre (GSC) Web pages listed in Table 2 hereafter.

¹ Galileo satellite GSAT-0104 SART is active and used in operations only for SAR/Galileo FLS Service.
² Although Galileo satellites GSAT-0201 and GSA-0202 are located in an eccentric orbit, they have been declared operational for the SAR/Galileo Services
³ Galileo satellite GSAT-0204 SART is operational and available for SAR/Galileo FLS only, since May 4th 2020.
## GNSS Service Centre Web Resources

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactive support to users</td>
<td><a href="http://www.gsc.europa.eu/helpdesk">www.gsc.europa.eu/helpdesk</a> (Raise your questions)</td>
</tr>
</tbody>
</table>

### Table 2: GSC Main Information Web pages About Galileo Status

Note that the Galileo Help Desk allows close interaction with users, both to support the exploitation of Galileo services and collect relevant information on signal performance as observed by the users.

Finally, GSC provides an important service which consists in the provision of detailed orbit data for the Galileo satellites on a server accessible to the SAR community. Access to this server can be requested via the Galileo Help Desk.
2 EXECUTIVE SUMMARY

During the reported period, the measured SAR/Galileo Service performance figures exceeded the Minimum Performance Level (MPL) targets specified in the [SAR-SDD] with significant margins. The following dashboards (Table 3a and Table 3b) summarise the compliance with the MPLs, using the colour coding defined in the subsequent legend Table 3c.

<table>
<thead>
<tr>
<th>SAR MPLs</th>
<th>Target Value</th>
<th>Element</th>
<th>Jul-21</th>
<th>Aug-21</th>
<th>Sep-21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection (Probability)</td>
<td>Valid</td>
<td>&gt;=99%</td>
<td>GAL-EU1 - Toulouse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU2 - Spitsbergen</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU3 - Santa Maria</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU4 - Maspalomas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU5 - Larnaca</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Localization (Quality)</td>
<td>5 km [1-12 B]</td>
<td>&gt;=95%</td>
<td>GAL-EU1 - Toulouse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU2 - Spitsbergen</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU3 - Santa Maria</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU4 - Maspalomas</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU5 - Larnaca</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 km [SB]</td>
<td>&gt;=90%</td>
<td>GAL-EU1 - Toulouse</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU2 - Spitsbergen</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU3 - Santa Maria</td>
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<td></td>
<td></td>
<td>GAL-EU4 - Maspalomas</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU5 - Larnaca</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L.Prob. [SB]</td>
<td>&gt;=90%</td>
<td>GAL-EU1 - Toulouse</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>GAL-EU2 - Spitsbergen</td>
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<td></td>
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<td></td>
<td>GAL-EU3 - Santa Maria</td>
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<td>GAL-EU4 - Maspalomas</td>
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<td></td>
<td>GAL-EU5 - Larnaca</td>
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<tr>
<td></td>
<td>L.Prob. [1-12 B]</td>
<td>&gt;=98%</td>
<td>GAL-EU1 - Toulouse</td>
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<td></td>
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<td>GAL-EU3 - Santa Maria</td>
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<td>GAL-EU4 - Maspalomas</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>GAL-EU5 - Larnaca</td>
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</tr>
<tr>
<td>RLM Delivery</td>
<td>Latency &lt;= 15 [min]</td>
<td>&gt;=99%</td>
<td>Average among all REFBEs</td>
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<td></td>
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<tr>
<td>RLM Reception</td>
<td>Probability</td>
<td>&gt;=99%</td>
<td>Average among all REFBEs</td>
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Table 3a: MPL Fulfilment Status Dashboard
<table>
<thead>
<tr>
<th>SAR MPLs</th>
<th>Target Value</th>
<th>Element</th>
<th>Jul-21</th>
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</tbody>
</table>

Table 3b: MPL Fulfilment Status Dashboard (Availability)

**Legend**

- **MPL measurement not available or not applicable**
- **Target Value for MPL is fulfilled**
- **Target Value for MPL is NOT fulfilled (less than 10% away from the Target Value)**
- **Target Value for MPL is NOT fulfilled (more than 10% away from the Target Value)**

Table 3c: Dashboards legend colour code

The SAR/Galileo Forward Link and Return Link Service MPLs are computed based on the five SAR/Galileo Reference Beacons (REFBE) located in the SAR/Galileo Coverage area (SGC) defined in the [SAR-SDD] and are provided for the worst and best REFBE location for each of the applicable individual performance parameters.

The **Availability of the SAR/Galileo Forward Link Service** met the MPL target set to 99% during the reporting period with annually normalised value of **99.80%** in September.
The Availability of the SAR/Galileo European MEOLUT Facilities in “Nominal” and “Nominal + Degraded” modes during the reported period remains at excellent levels with annually normalised values in September better than 97.6% and 98.8% respectively, always above the MPL targets of 95% in “Nominal” and 97.5% in “Nominal + Degraded” modes.

The Performance of the Detection Service is above expectations, with monthly values of a valid message detection probability after a single transmitted burst of 100% every month of the reported period, where the MPL target is 99%.

The Performance of Location Probability achieved excellent values with monthly values higher than 98.4% for single burst, where the MPL target is 90%, and 99.3% after 12 transmitted bursts (multi-burst), where the MPL target is 98%.

The Performance of Location Accuracy surpasses the targets with monthly values higher than 99.1% for single burst and 99.7% for multi-burst transmissions with an accuracy better than 5km, while the MPLs are 90% and 95% respectively.

The Availability of the SAR/Galileo Return Link Service was above 99.44% in August and 100% in July and September with an MPL set to 95%.

The RLS Delivery Latency within 15 min was above 99.97% and at 99.99% in average over the reported period for an MPL set to 99%.

The RLS Reception Probability was 100% each month of the reported period for an MPL set to 99%.

The Availability of the SAR Transponders achieved excellent levels of performance with satellite transponder monthly availability of 100% for all space vehicles during the reported period and long-term availability above the MPL of 95%, except for GSAT-0104 and GSAT-0204 which experienced orbit reallocations in April and May and for which the long-term availability is 86.03% and 91.39% respectively.
3 SAR/GALILEO FORWARD LINK SERVICE PERFORMANCE

This section reports the following detailed performance figures for the SAR/Galileo Forward Link Service:

- Service availability in section 3.1;
- European MEOLUT facility availability in section 0;
- Detection Probability in section 3.3;
- Location Probability in section 3.4.1;
- Location Accuracy in section 3.4.2.

3.1 FORWARD LINK SERVICE AVAILABILITY

The MPL for the Forward Link Service availability is defined in the [SAR-SDD] 4. The Forward Link Service availability MPL is defined over a period of twelve months (long-term), with a sliding window moving one month ahead every month. Figure 1 below also report the short term (monthly) FLS availability to show the performance trend over time. During the reported period, the monthly FLS availability was 100%.

The normalised value was 99.8% every month compliant with the MPL target of 99% defined over 12 months.

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4 Ref.: [SAR-SDD], §5.1.1 (Table 9)
3.2 EUROPEAN MEOLUT FACILITY AVAILABILITY

The MPLs for the availability of the SAR/Galileo European MEOLUT Facility are defined in the [SAR-SDD] over a period of twelve months (long-term), with a sliding window moving one month ahead every month. Figure 2 and Figure 3, below, also report the short term (monthly) EU MEOLUT Local Facility availability to show the performance trend over time.

During the reported period, all EU MEOLUT Local Facilities show a long-term normalised "Nominal" mode availability performance compliant with the MPL target specified at 95%, achieving in September 2021 values of 98.9%, 99.2% and 97.6% for respectively Larnaca, Maspalomas and Spitsbergen EU MEOLUT Facilities long term availability.

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Figure 2: Per MEOLUT Facility Monthly Availability of Nominal Mode [%]

Ref.: [SAR-SDD], §5.1.2 (Table 10)
The "Nominal + Degraded" mode availability is reported in Figure 3 below with annually normalised values obtained per European MEOLUT Facility during the last twelve months of service, with an MPL target specified at 97.5%. The cumulative values always exceed the MPL for all the three European MEOLUT Facilities during the reported period achieving in September 2021 values of 99.4%, 99.6% and 98.8% for respectively Larnaca, Maspalomas and Spitsbergen EU MEOLUT Facilities long term availability.

Figure 3: Per MEOLUT Facility Monthly Availability of "Nominal + Degraded" Mode [%]
3.3 DETECTION PERFORMANCE

The detection probability performance is computed for each Reference Beacon as the valid message detection probability after 1 transmitted burst. The detailed computation process for this performance parameter is described in the [SAR-SDD]. The MPL specified at 99% is valid whether the SAR/Galileo MEOLUT Facilities are in Nominal or Degraded mode.

Figure 4 below shows the monthly valid message detection probability for each Reference Beacon which achieved 100% every month during the reported period.

Figure 4: Per Reference Beacon Valid Message Detection Probability [%]

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6 Ref.: [SAR-SDD], §5.1.3 (Table 11)
3.4 LOCATION PERFORMANCE

3.4.1 LOCATION PROBABILITY

The location probability performance is computed for each Reference Beacon after 1 transmitted burst (single-burst) and after 12 transmitted bursts (multi-burst). The detailed computation process for this performance parameter is described in the [SAR-SDD] and the MPLs specified at 90% \(^7\) in single burst and 98% in multi-burst are valid when the SAR/Galileo MEOLUT Facilities are in Nominal Mode.

Figure 5 below shows the monthly single-burst location probability which comfortably exceeds the defined MPL of 90% for each of the SAR/Galileo Reference Beacons, with a minimum value of \(98.4\)%, a best value of \(100\)% and an average over the reported period of \(99.7\)%.

---

\(^7\) Ref.: [SAR-SDD], §5.1.4 (Table 12)
Figure 6 below shows the monthly multi-burst location probability which meets the defined MPL of 98% for each of the SAR/Galileo Reference Beacons, with a minimum value of 99.3%, a best value of 100% and an average over the reported period of 99.9%.
3.4.2 LOCATION ACCURACY

The location accuracy performance is defined in the [SAR-SDD] as the probability to produce a location with an error bounded by a given threshold, namely 2km and 5km. The location accuracy MPLs specified in the [SAR-SDD] are valid when the MEOLUT is in Nominal mode and the results are presented per Reference Beacon in Figure 7 and Figure 8 for the 5km error in single-burst and multi-burst and in Figure 10 for the 2km threshold in multi-burst only (reported only as metric).

Figure 7 below shows the monthly single-burst 5km location accuracy which meets the defined MPL of 90% for each of the SAR/Galileo Reference Beacons, with a minimum value of 99.1%, a best value of 100% and an average over the reported period of 99.6%.

---

8 Ref.: [SAR-SDD], §5.1.4 (Table 12)
Figure 8 below shows the monthly multi-burst 5km location accuracy which meets the defined MPL of 95% for each of the SAR/Galileo Reference Beacons, with a minimum value of 99.7%, a best value of 100% and an average over the reported period of 99.9%.
4 RETURN LINK SERVICE PERFORMANCE

4.1 RETURN LINK SERVICE AVAILABILITY

The MPL for the Return Link Service availability is defined in the [SAR-SDD] ⁹.

The Return Link Service availability MPL is defined over a period of twelve months (long-term), with a sliding window moving one month ahead every month.

During the reported period, the monthly RLS availability was 100% in July and September and 99.44% in August. The normalized value was above 99.93% every month compliant with the MPL target of 99% defined over 12 months.

Figure 9: Return Link Service Availability - monthly and long-term trend

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⁹ Ref.: [SAR-SDD], §5.2.1 (Table 14)
4.2 RLM DELIVERY LATENCY AND RECEPTION PROBABILITY

The Galileo System delivery latency and RLM Reception Probability MPLs always refer to the percentage of time that the RLS is available and are bounded by transmission of the Galileo Navigation Message in the SIS and the probability of an error free decoding of the RLM fields of the Galileo Navigation Message retrieved from the SIS at the GNSS receiver in, or connected to, the originating alert beacon.

4.2.1 DELIVERY LATENCY

The RLS delivery latency within 15 [min] performance is computed over a calendar month. The boundaries of the monitored loop are defined in the [SAR-SDD] and the MPL is specified at 90\%. During the reported period, the monthly delivery latency was above the MPL with an average value of \(99.99\%\).

<table>
<thead>
<tr>
<th>SAR/Galileo RLS Delivery Latency within 15 min [%]</th>
<th>July 2021</th>
<th>August 2021</th>
<th>September 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPL Target [99%]</td>
<td>99.97%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4: Return Link Service Monthly Delivery Latency within 15 min, July – September 2021

4.2.2 RECEPTION PROBABILITY

The RLS reception probability performance is computed over a calendar month. The MPL defined in the [SAR-SDD] is set to 99\% \(^{10}\). During the reported period, the monthly reception probability was above the MPL with a monthly and an average value of \(100\%\).

<table>
<thead>
<tr>
<th>SAR/Galileo RLS Reception probability [%]</th>
<th>July 2021</th>
<th>August 2021</th>
<th>September 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPL Target [99%]</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 5: Return Link Service Monthly Reception Probability, July – September 2021

\(^{10}\) Ref.: [SAR-SDD], §4.4 and §5.2.2 (Table 16)
5 SAR/GALILEO SPACE SEGMENT AVAILABILITY

The MPL defined in the [SAR-SDD] is set to 95% \textsuperscript{11} for every single SAR transponder (SART), to be annually normalised. All the Galileo SARTs obtained an excellent availability performance of 100% every month of the reported period.

All the satellites met the SAR Transponder availability MPL for the reporting period with values above 96.9\% except for GSAT 0104 and GSAT 0204 which respectively achieved minimum values of 86.03\% and 91.39\% in September, this is the consequence of the low availability in April and May during the orbit reallocation operations which affects the normalised value of the SAR Transponder availability for the 12 consecutive months.

\textsuperscript{11} Ref.: [SAR-SDD], §5.3 (Table 18)
6 SUPPLEMENTARY METRICS

This section reports relevant performance metrics of the SAR/Galileo Service that are not MPLs.

6.1 LOCATION ACCURACY PERFORMANCE WITHIN 2KM

Multi-burst location accuracy within 2km is an expected value defined in the [SAR-SDD] at 90%\(^{12}\).

The expected value is met during the reported period for all the reference beacons as displayed in Figure 10.

Figure 10 below shows the monthly multi-burst 2km location accuracy which comfortably exceeds the expected value of 90% for each of the SAR/Galileo Reference Beacons, with a minimum value of 95.8%, a best value of 98.5% and an average over the reported period of 97.4%.

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\(^{12}\) Ref.: [SAR-SDD], §5.1.4 (Table 13)
6.2 SAR/GALILEO SERVER AVAILABILITY

The [SAR-SDD] does not define a specific target for the SAR/Galileo Orbit Data Server availability, nevertheless it achieved an average value of **99.77%** during the reported period.

The monthly average availability of orbital data for all Galileo satellites equipped with SAR Transponders and declared available for service is shown in Table 6 for information.

<table>
<thead>
<tr>
<th>Other SAR/Galileo Ground Segment Elements</th>
<th>July 2021</th>
<th>August 2021</th>
<th>September 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAR/Galileo Orbit Data Server Availability [%]</td>
<td>99.84%</td>
<td>99.87%</td>
<td>99.60%</td>
</tr>
</tbody>
</table>

Table 6: SAR/Galileo Orbit Data Server Monthly Availability, July – September 2021
REFERENCES

This section identifies the documents explicitly referenced in this SAR/Galileo Enhanced Service Public Performance Report.


The [SAR-SDD] defines the SAR/Galileo Enhanced Service and its associated Minimum Performance Levels (MPLs).
### LIST OF ACRONYMS

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<tr>
<th>Acronym</th>
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<td><strong>Cospas-Sarsat</strong></td>
<td>Cosmicheskaya Sistyema Poiska Avariynich Sudow-Search and Rescue Satellite-Aided Tracking</td>
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<tr>
<td><strong>EU</strong></td>
<td>European Union</td>
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<td><strong>FLS</strong></td>
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<td>Galileo Satellite</td>
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<td><strong>GSC</strong></td>
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<td><strong>MEOLUT</strong></td>
<td>Medium Earth Orbit Local User Terminal</td>
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<td><strong>MPL</strong></td>
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<td><strong>SDD</strong></td>
<td>Service Definition Document</td>
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<td>SAR/Galileo Coverage</td>
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<td>Signal In Space</td>
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European GNSS Service Centre:

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