



Kartverket

# ESA Space Weather portal -- GNSS Performance Indicator

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The screenshot shows the ESA Space Weather portal interface. At the top, the ESA logo and 'space situational awareness' text are visible. Below this is a navigation menu with options like 'About SWE', 'What is Space Weather', 'SSA Space Weather Activities', 'Current Space Weather', and 'Contact'. A secondary menu lists 'Service Domains' including 'Spacecraft Design', 'Spacecraft Operation', 'Human Spaceflight', 'Launch Operation', 'Transionospheric Radio Link', 'Space Surveillance and Tracking', 'Power Systems Operation', 'Airlines', 'Resource Exploitation System Operation', and 'Dineline Operation'. The main content area is titled 'Federated products from the Norwegian Mapping Authority (NMA)' and features a 'Kartverket Calculator Help About' section. A text box explains: 'The GNSS Performance Indicator initial tool is an on-demand tool concept that provides a measure of space weather impacts on a specified Use Case, based on data from various products in the space weather portal. The indicator is given as a number, a color, and a text description. A machine-to-machine interface is also available (See "Help").' Below this is a form titled 'Select location, time and usecase' with input fields for 'Latitude: \*' and 'Longitude: \*'. The latitude field has a hint: 'User location in WGS84. Decimal degrees (DD): for example 41.40338, 2.17403'. The longitude field has a hint: 'Spatial coverage depends on Use Case. See "Help" for details.'

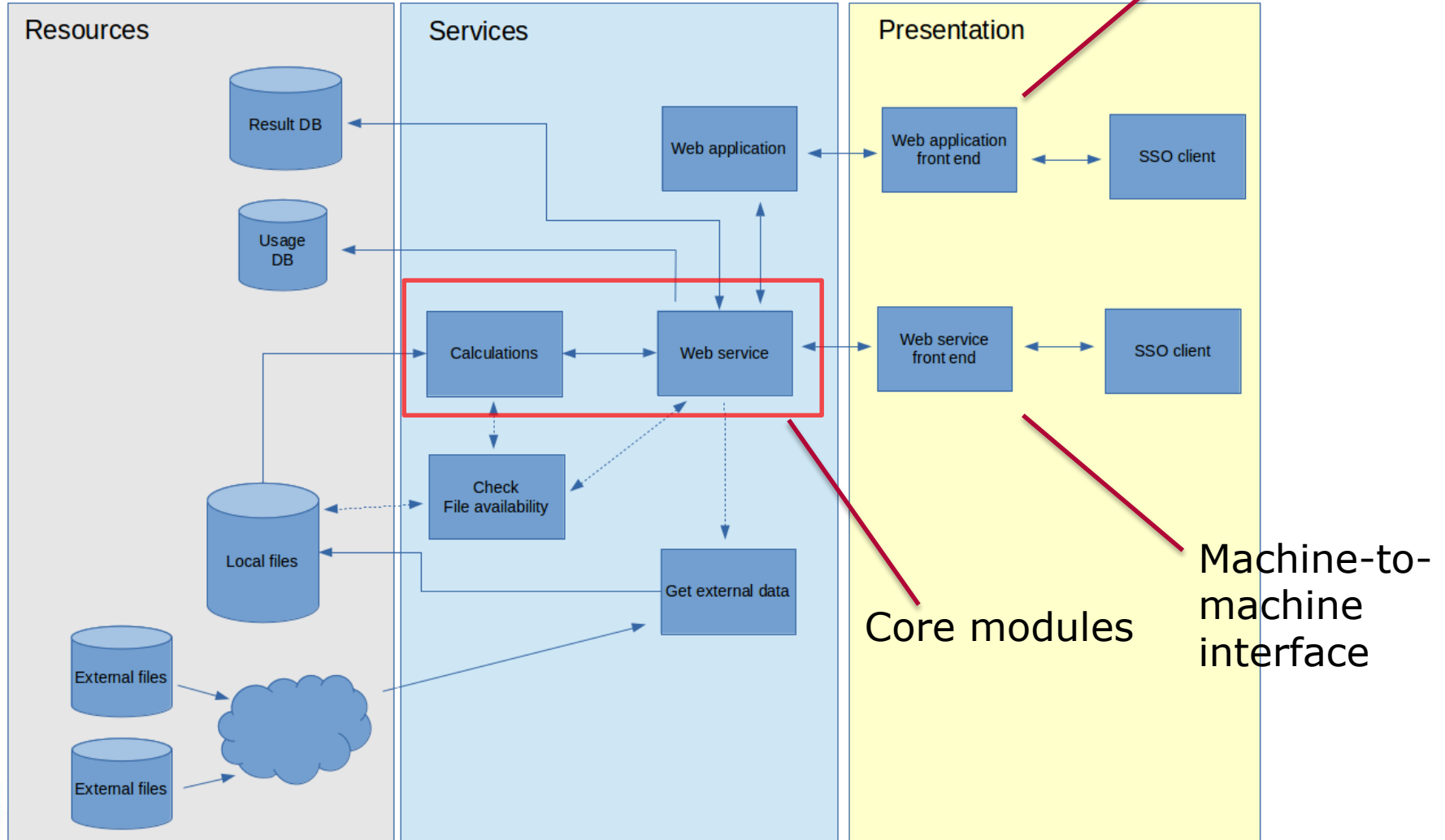
# Introduction

The GNSS performance indicator (GPI) tool

- **Main objective:** Provide the SWE end user with an indication of current GNSS uncertainties resulting from ionospheric conditions, based on data available at the Space Weather portal.
- This year, an initial web interface has been established and deployed to the portal. It is intended to be further developed and expanded.
- We present the current state of the GPI tool, its web and machine-to-machine interfaces, and the current status for its future development.

# System Architecture

System Architecture

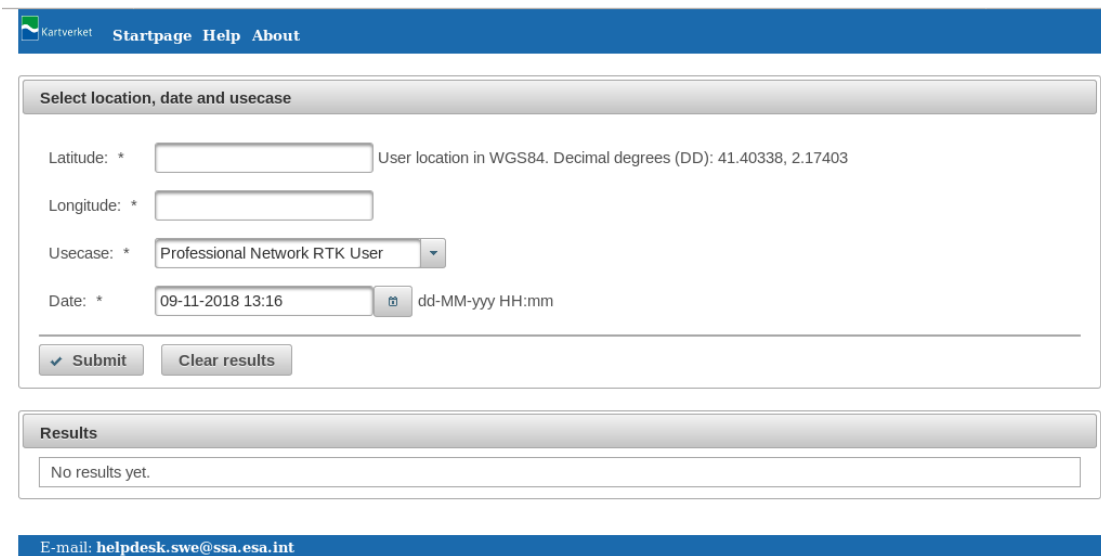


# Web interface

## Usage example

Input:

- Location
  - Latitude & Longitude in fractional degrees
- Use case
  - Select from a list
- Date & Time



The screenshot shows a web interface for Kartverket. The header includes the logo and navigation links: Startpage, Help, and About. The main form is titled "Select location, date and usecase" and contains the following fields:

- Latitude: \* [input field] User location in WGS84. Decimal degrees (DD): 41.40338, 2.17403
- Longitude: \* [input field]
- Usecase: \* [dropdown menu] Professional Network RTK User
- Date: \* [input field] 09-11-2018 13:16 [calendar icon] dd-MM-yyy HH:mm

Below the form are two buttons: "Submit" and "Clear results".

The "Results" section shows a message: "No results yet."

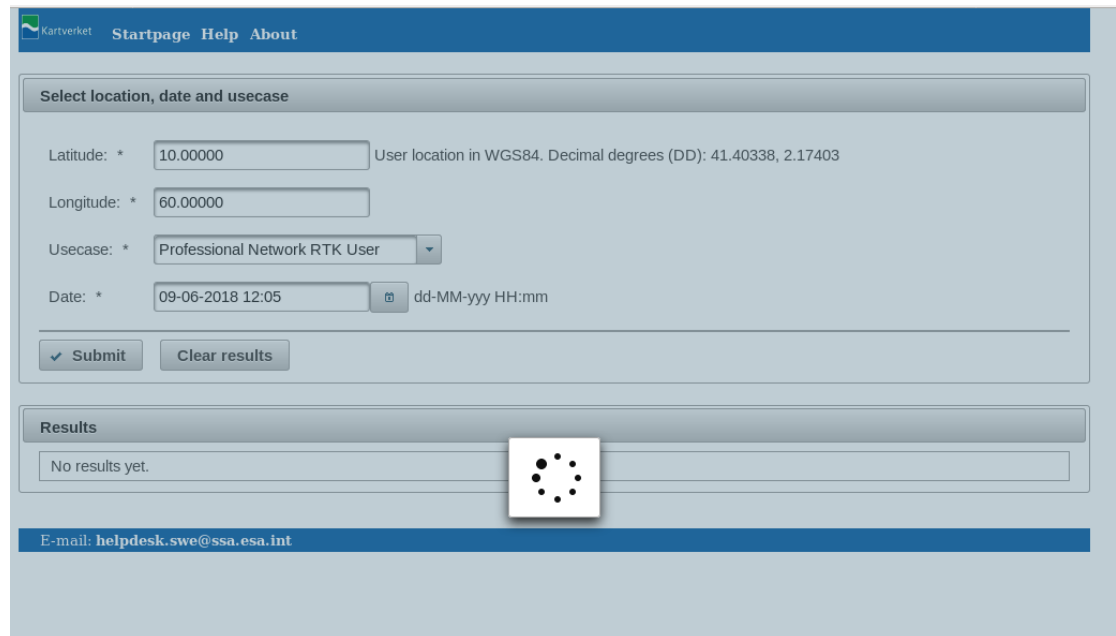
At the bottom, there is a footer with the email address: E-mail: [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)

# Web interface

## Usage example

After clicking «Submit», the wait animation plays while data is acquired and processed.

(should only last for a couple of seconds)



The screenshot displays the Kartverket web interface. The top navigation bar includes the logo and links for "Startpage", "Help", and "About". The main form is titled "Select location, date and usecase" and contains the following fields:

- Latitude: \*  User location in WGS84. Decimal degrees (DD): 41.40338, 2.17403
- Longitude: \*
- Usecase: \*
- Date: \*   dd-MM-yyyy HH:mm

Below the form are two buttons: "Submit" and "Clear results".

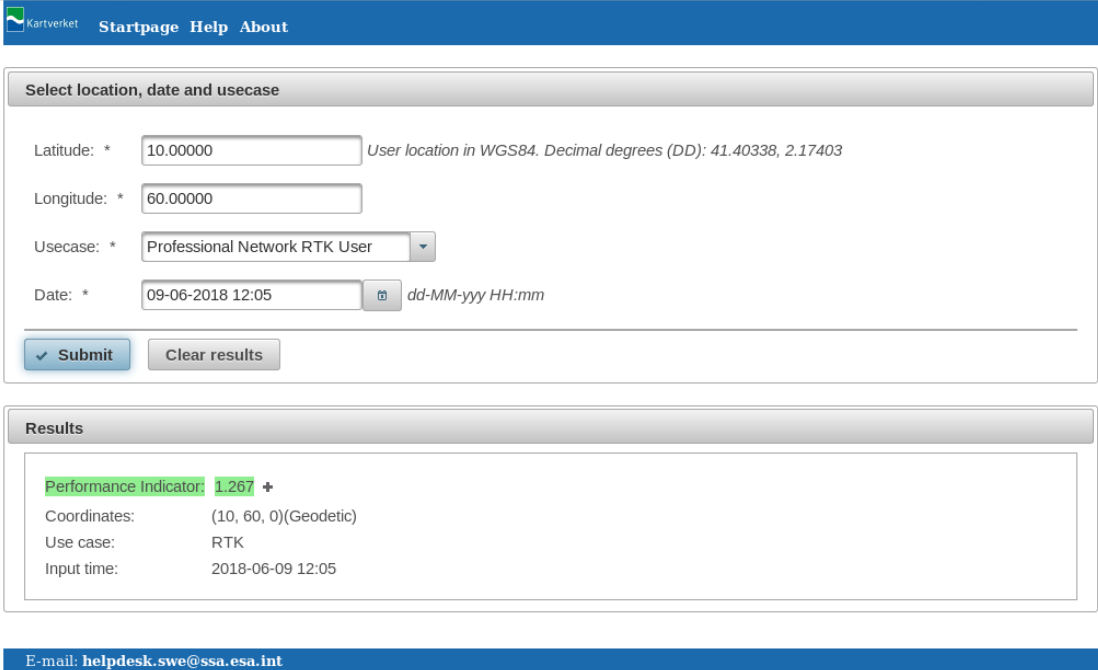
The "Results" section below the form shows "No results yet." and a wait animation (a square with a circle of dots) in the center.

The footer of the interface displays the email address: E-mail: [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)

# Web interface Usage example

The results are displayed as both a color and a numerical value.

The inputs are also repeated along with the results.



The screenshot shows a web interface for Kartverket. At the top, there is a blue header with the logo and navigation links: "Kartverket Startpage Help About". Below this is a form titled "Select location, date and usecase". The form contains four input fields: "Latitude: \*" with the value "10.00000" and a tooltip "User location in WGS84. Decimal degrees (DD): 41.40338, 2.17403"; "Longitude: \*" with the value "60.00000"; "Usecase: \*" with a dropdown menu set to "Professional Network RTK User"; and "Date: \*" with the value "09-06-2018 12:05" and a tooltip "dd-MM-yyy HH:mm". Below the form are two buttons: "Submit" and "Clear results".

Below the form is a "Results" section. It displays the following information:

- Performance Indicator: 1.267 +
- Coordinates: (10, 60, 0)(Geodetic)
- Use case: RTK
- Input time: 2018-06-09 12:05

At the bottom of the interface, there is a blue footer with the text "E-mail: [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)".

# Web interface

## Usage example

Clicking the + sign next to the result shows more details from the processing.

The screenshot displays the Kartverket web interface. The main page has a blue header with 'Kartverket Startpage Help About'. Below the header is a form titled 'Select location, date and usecase' with input fields for Latitude (10.00000), Longitude (60.00000), Usecase (Professional Network), and Date (09-06-2018 12:05). There are 'Submit' and 'Clear results' buttons. Below the form is a 'Results' section showing a table with one row: 'Performance Indicator: 1.267 +'. A 'Result Detail' popup window is open over this result, showing a table of details:

Result Detail	
Performance Indicator:	1.267
Coordinates:	(10, 60, 0)(Geodetic)
Input time:	2018-06-09 12:05
Use case:	RTK
Error message:	0
Error message text:	No errors.
Performance Indicator Uncertainty:	
Performance Indicator Unit:	TECU/min
Performance Indicator Text:	
Data products used:	Data Products used:I.109b RTIM ROTI@Ground maps (Fennoscandia);
Additional information:	Additional information:GPS 2 at IPP (19.8266, 55.4736, 364535)(Geodetic) has ROTI = 0.470614. ;GPS 5 at IPP (24.0418, 51.2278, 363021)(Geodetic) has ROTI = 0.414612. ;GPS 23 at IPP (-3.94297, 61.1458, 366421)(Geodetic) has ROTI = 0.46279. ;GPS 26 at IPP (4.14919, 51.5098, 363123)(Geodetic) has ROTI = 0.347228. ;GPS 29 at IPP (10.6921, 50.1938, 362643)(Geodetic) has ROTI = 0.314563. ;

At the bottom of the page, there is an email address: E-mail: helpdesk.swe@ssa.esa.int

# Web interface Information pages

The information page «Help» contains general information about the tool, and specific information for each use case.



## General information

The GNSS Performance Indicator service is intended to process the data available at the space weather portal to make an indicator of the impact that a user can expect. The indicator will be given as a number, a color, and a text description.

As there are many different ways to use the GNSS signals, it is not possible to define a single indicator that can cover all users. Thus, the user must specify what kind of "Use Case" she is interested in.

For the initial service, the number of use cases is low. It is intended to expand the list of use cases during further development of the service. Potential other developments include generation of time series and maps of the performance indicators.

## Use Case - Professional Network RTK User

This use case is intended for a user of a Network RTK service. It may also be useful for users of similar services. The targeted user operates geodetic-quality dual-frequency equipment and requires high accuracy (1 - 10 cm) in real-time.

The performance indicator is based on measurements of fluctuations in the ionospheric component of the phase observables. These fluctuations will cause fluctuations in the final coordinate solutions, and may cause both the user receiver and the RTK network software to have difficulties to achieve a "fix" solution. This may lead to a deterioration of the coordinate solutions and/or delays in the initialization of the equipment.

It is not possible to exactly quantify the effect on a given receiver or network, so the main result of this service is a rough description of what kind of behavior that is likely given a certain level of the observed ionospheric disturbances. The possible results are:

"Low activity. No adverse effects expected."

"Normal activity. For most users, this level of activity will not cause problems. A slight increase in position error may be detected in high-accuracy applications."

"Moderate activity. Network RTK users may have difficulty getting a good coordinate solution."

"High activity. Network RTK users will have difficulty getting a good coordinate solution. Network base stations may lose lock on satellites."

E-mail: [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)



# Web interface Information pages

The information page «About» contains miscellaneous information including contact details.



[Startpage](#) [Help](#) [About](#)

This web page forms part of the ESA Space Situational Awareness Programme's network of space weather service development activities, and is supported under ESA contract number 4000106762/12/D/MRP. For further product-related information or enquiries contact helpdesk. E-mail: [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int) All publications and presentations using data obtained from this site should acknowledge NMA and ESA/SSA-SWE. For further information about space weather in the ESA Space Situational Awareness Programme see: [www.esa.int/spaceweather](http://www.esa.int/spaceweather) Access the SSA-SWE portal here: [swe.ssa.esa.int](http://swe.ssa.esa.int)



Kartverket (The Norwegian Mapping Authority) bears nationwide responsibility for geographical information, operates the national property registry and undertakes all property registration in Norway. The Norwegian Mapping Authority's Geodetic Institute is responsible for earth observation and establishes data for mapping, positioning and all other geographical information. More information.



Kartverket

The GNSS Performance Index service is intended to be further developed. One part of the development is to integrate algorithms for new use cases. These algorithms may be developed by third parties. Interested parties are encouraged to email the helpdesk ([helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)), which will put you in contact with the correct people for further discussions.

E-mail: [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)

# Machine-to-machine interface

The web service interface is accessed via a URL:

<http://swertim.statkart.no/gnssperformanceWS/analysis>

It must be called with a valid set of input variables.

Example of usage:

<http://swertim.statkart.no/gnssperformanceWS/analysis?east=10&north=60&height=0&usecase=RTK&unixtime=1541592000&coordsys=Geodetic>

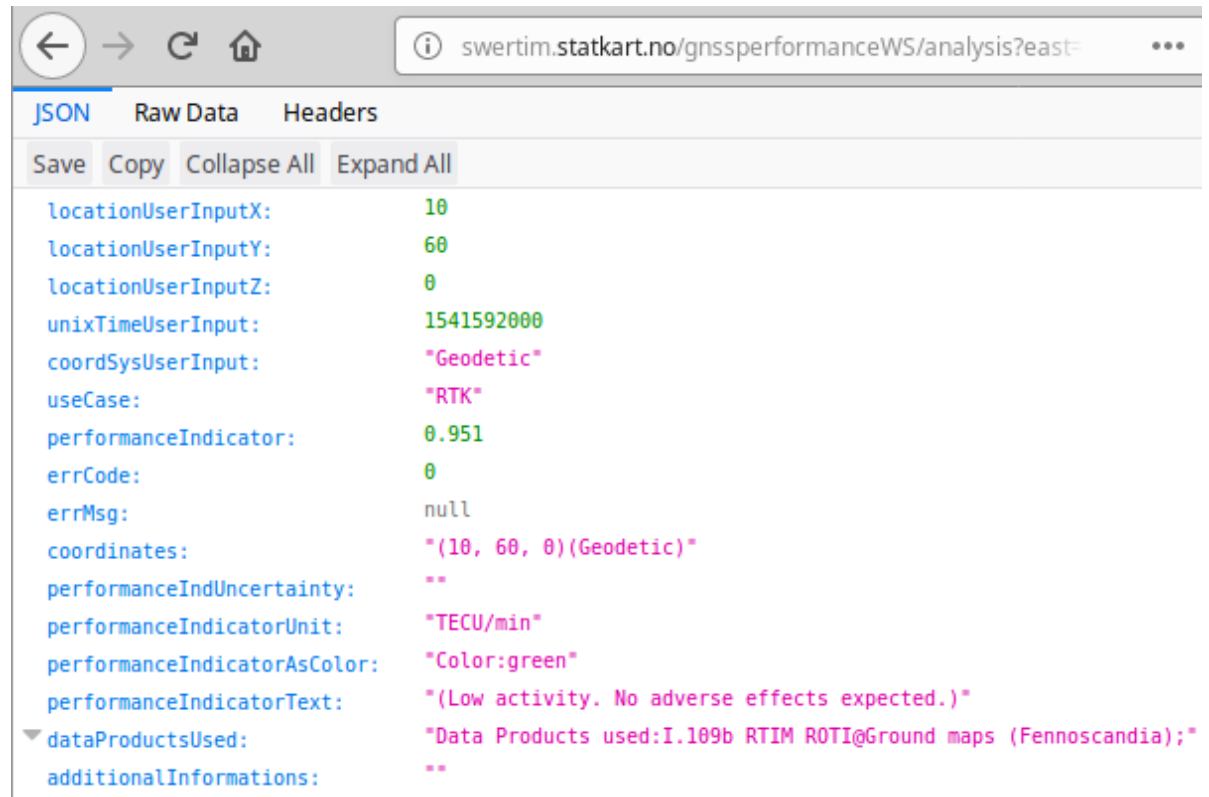
# Machine-to-machine interface

Example of raw output from the web service: JSON format text

```
{"locationUserInputX":10.0,"locationUserInputY":60.0,"locationUserInputZ":0.0,"unixTimeUserInput":1541592000,"coordSysUserInput":"Geodetic","useCase":"RTK","performanceIndicator":0.951,"errCode":0,"errMsg":null,"coordinates":"(10, 60, 0) (Geodetic)","performanceIndUncertainty":"","performanceIndicatorUnit":"TECU/min","performanceIndicatorAsColor":"Color:green","performanceIndicatorText":"(Low activity. No adverse effects expected.)","dataProductsUsed":"Data Products used:I.109b RTIM ROTI@Ground maps (Fennoscandia);","additionalInformations":""}
```

# Machine-to-machine interface

Example of output from the web service: JSON data interpreted by a browser



The screenshot shows a web browser window with the URL `swertim.statkart.no/gnssperformanceWS/analysis?east=`. The browser's developer tools are open, displaying the JSON response from the web service. The JSON data is as follows:

```
locationUserInputX: 10
locationUserInputY: 60
locationUserInputZ: 0
unixTimeUserInput: 1541592000
coordSysUserInput: "Geodetic"
useCase: "RTK"
performanceIndicator: 0.951
errCode: 0
errMsg: null
coordinates: "(10, 60, 0)(Geodetic)"
performanceIndUncertainty: ""
performanceIndicatorUnit: "TECU/min"
performanceIndicatorAsColor: "Color:green"
performanceIndicatorText: "(Low activity. No adverse effects expected.)"
dataProductsUsed: "Data Products used:I.109b RTIM ROTI@Ground maps (Fennoscandia);"
additionalInformations: ""
```

# New developments

- The GNSS Performance indicator is intended to be improved and expanded in several ways. In particular:
  - Better user interface
  - Dynamic time series and/or maps
  - More use cases

# New developments

Earlier this year, ESA announced an ITT to develop a new or improved version of the GNSS Performance Indicator.

NMA is part of one of the consortia that has submitted a proposal.

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APPLICATION DEVELOPMENT

**Activity No. 1000026642** in the “esa-star” system

**Ref:** Item no. 19.118.20 (in the list of ESA intended Invitations to Tender)