2000-11-26

**National report from SWEDEN to the meeting of the International Information Subcommittee in Monaco, 30 November – 1 December 2000.**

## 1. National Activities

a. Time / frequency activities

Swedish National Testing and Research Institute routinely use GPS for time- and frequency services. The Swedish National time scale is maintained using three cesium atomic clocks, linked to the international atomic time scale (TAI / UTC) by GPS time transfer via the International Bureau of Weights and Measures (BIPM).

b. Survey / geodesy / GIS activities

A high-precision national reference system for GPS-measurements, SWEREF 93 has been established. SWEREF 93 agrees within half a metre with WGS 84 (G873), which agrees with ITRF94 within a few centimetres. Transformation parameters between the national terrestrial reference systems RT 90 (horizontal), RH 70 (height), RN 92 (geoid) and SWEREF 93 are available from National Land Survey.

GPS is routinely used for densification of the national triangulation network and for establishment of local control networks since the beginning of the nineties. Since 1989 the main part of the reference networks for road and railway construction projects have been established using the GPS technique. In 1993 a guide for GPS-measurements was published. A new revision of this guide has been released in 1996.

In aerial photography GPS is used to navigate the aircraft, enable automatic exposures at preselected positions and to determine the position of the airborne camera at the time of the exposure.

Both surveyors from the government agencies and from the private consulting companies today use GPS in several surveying applications like detail measurements. The reference network for the construction of the large bridge crossing the sound between Sweden and Denmark is based on five reference stations for GPS, which are broadcasting RTK-data in the format RTCM ver 2.1. Some projects for machine guidance for road construction are also going on in Sweden.

Data capture for GIS is also a GPS activity, which is increasing.

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c. Navigation activities

In Sweden GPS is today an important part of many navigation systems, e. g .maritime and aviation application, fleet management, agricultural and forestry applications.

## 2. The Swedish Network of Permanent Reference Stations

a. SWEPOS

The SWEPOS network was established as a collaboration project between Onsala Space Observatory and National Land Survey. Since 1995 the SWEPOS service is designed and financed by a co-operation group of Swedish governmental agencies and managed by the National Land Survey of Sweden. At present the co-operation group consists of the National Railway Administration, the National Road Administration, the Swedish Civil Aviation Administration, the National Maritime Administration, the Telecommunications Administration, the Swedish State Railways and the Swedish Defence.

SWEPOS reached IOC-status on July 1st 1998, i. e. the availability of SWEPOS-data for post-processing purpose on the centimetre level and DGPS-data in real-time on the meter-level follows a given specification, see www.swepos.com for further information. The long-term goal is that user fees shall cover a part of the operation cost for SWEPOS.

Dual frequency GPS raw data is available from twenty-four stations, see appendix, via Internet. At present the subscription cost for data from five selectable SWEPOS-station is 1250 USD for a year and from all twenty-four stations 3750 USD for a year. DGPS-data is distributed nation-wide using the Epos service and RTK-data in selected areas using the Ciceron-service, see below.

SWEPOS data for post-processing purposes is used for e. g. photogrammetric work, studies of movements of the earth's crust and connections of positioning projects to the national reference system. Some of the SWEPOS stations are also included in the European network of permanent reference stations, EUREF and the IGS network.

List of SWEPOS stations

| **Station name** | **Latitude** | **Longitude** | **EPOS service** | **EUREF/IGS station** |
|---|---|---|---|---|
| Kiruna | 67°53' | 21°04' | Yes | Yes |
| Overkalix | 66°19' | 22°46' | | |
| Arjeplog | 66°19' | 18°07' | | |
| Skelleftea | 64°53' | 21°03' | Yes | |
| Vilhelmina | 64°42' | 16°34' | Yes | Yes |
| Umea | 63°35' | 19°31' | | |
| Ostersund | 63°27' | 14°51' | | |
| Sundsvall | 62°14' | 17°40' | Yes | |
| Sveg | 62°01' | 14°42' | Yes | |
| Martsbo | 60°36' | 17°16' | Yes | Yes |
| Leksand | 60°43' | 14°53' | | |
| Vasteras | 59°39' | 16°34' | | |
| Karlstad | 59°27' | 13°30' | Yes | |
| Lovo | 59°20' | 17°50' | Yes | |
| Vanersborg | 58°42' | 12°02' | | |
| Norrkoping | 58°35' | 16°15' | Yes | |
| Jonkoping | 57°45' | 14°04' | | |
| Boras | 57°43' | 12°53' | | |
| Goteborg | 57°42' | 11°58' | | |
| Visby | 57°39' | 18°22' | Yes | Yes |
| Onsala | 57°24' | 11°56' | Yes | Yes |
| Oskarshamn | 57°04' | 16°00' | | |
| Hassleholm | 56°06' | 13°43' | Yes | |
| Malmo | 55°36' | 13°02' | | |

## 3. Differential Services

a. EPOS

EPOS is a commercial service, which is managed by the Swedish company Teracom. Pseudorange corrections (DGPS-data) from twelve SWEPOS stations are broadcasted via the RDS channel on the FM radio network. The EPOS gives a position accuracy below 2 m (2 drms). The users are charged approx. 900 USD.

Applications of the Epos service are e. g. cadastral surveying, data capture for GIS, farming, forestry, several kind of maritime activities (as a back up system for the IALA / DGPS service of the National Maritime Administration), and aerial photography.

b. CICERON

CICERON is a commercial service, which is managed by the Swedish company Teracom. Single station RTK-data (RTK = Real-Time Kinematic) from seven SWEPOS stations are broadcasted via the DARC channel on the FM radio network. In an area about 20 kilometres around the used SWEPOS-stations the Ciceron gives centimetre accuracy and the subscription fee for one year is about 3000 USD.

c. IALA / DGPS of the National Maritime Administration

The DGPS service of the National Maritime Administration is operational since 1 May 1996. The network originally consisted of seven reference stations, but now is eight stations in operation. The DGPS corrections are transmitted via radio beacons, uncoded and there are no direct user fees. The system applying to, and in accordance with, the IALA DGPS-standard concept. A densification of the maritime DGPS network is in progress and the goal is that all places shall be covered by signals from at least two radio beacons in year 2000, in order to obtain a signal availability of 99.8%
A new kind of frequency plan for the transmission is planned, which is co-ordinated in the whole Europe. It is planned to be introduced 00.12.01.

List of DGPS stations

| **Station name** | **Latitude** | **Longitude** | **Frequency (KHz)** | **ID** |
|---|---|---|---|---|
| Bjuroklubb | 64-29N | 21-35E | 303,5 | 461 |
| Jarnas | 63-29N | 19-39E | 306,5 | 462 |
| Orskar * | 60-32N | 18-23E | 291,5 | 463 |
| Kapellskar | 59-43N | 19-04E | 287,0 | 464 |
| Nynäshamn | 58-56N | 17-57E | 289,5 | 468 |
| Hoburg | 56-55N | 18-09E | 302,0 | 465 |
| Kullen | 56-18N | 12-27E | 293,5 | 466 |
| Hjortens Udde | 58-38N | 12-40E | 297,0 | 467 |

***** Orskar station will be moved about 70 km WNW to Skutskar during year 2000.

A new station will be established in the Gothenburg-area at the West Coast of Sweden during 2000. After these steps an investigation will be made, how to optimize the system.

## 4. Development activities

a. Land use

### development of routines for maintenance of the railway using GPS for automatic guidance of the machinery – National Railway Administration in international co-operation

### studies of the land up-lift using SWEPOS data - Onsala Space Observatory

### activities from companies and agencies to use GPS real-time carrier phase technique in automatic guidance systems for construction machinery.

### research towards real-time carrier phase measurements using the SWEPOS network – the project NeW-RTK which is collaboration between National Land Survey, Onsala Space Observatory and Teracom.

b. Maritime use

### real time carrier phase measurements in hydrographic surveying - National Maritime Administration

### The use of an Automatic Identification System for ships, based on time- and positioninformation from a GNSS is tested by the National Maritime Administration. It is expected that a carriage requirement for the system will be adopted by IMO in May 2000.

c. Aviation use

### participation in the North European CNS / ATM applications project - The Swedish Civil Aviation Administration

### participation in the North European ADS-B Network. Main objectives of this project are to develop, evaluate and demonstrate new technologies for air-to-air and air-to-ground data links (STDMA) and ground data networks.

### En-route and Non precision approach under development.

d. Space use

None known.

e. Military use

### GPS-applications for evaluation of weapon systems - Defence Materiel Administration and Defence Research Establishment.

f. Time / frequency use

### development of time / frequency services including comparisons, transfers and calibrations - Swedish National Testing and Research Institute and Onsala Space Observatory.

g. Survey / geodesy / GIS

### data capture for GIS - the Forestry Research of Sweden,.
### real-time carrier phase measurements for geodetic surveying - National Land Survey of Sweden

## 5. Industrial aspects

The Scandinavian GNSS Industry Council (SGIC) was formed on October 16, 1996 and is a Swedish association of companies promoting and producing products and systems for satellite positioning and navigation. The objectives of SGIC are to promote commercial development of GPS and communicate to industry, User groups and Authorities. These objectives are achieved by SGIC Internet Website, arranging seminars, conferences and workshops, attending international activities on the behalf of the membership, distributing collected relevant information to members and co-operating with organisations with complementary objectives. SGIC membership is open both for commercial companies and agencies and for educational institutions, which are related to GNSS activities.

## 6. National Policy and decisions

In Sweden the responsibility for installation, operation and maintenance of navigation systems is delegated from the concerned ministry to one of its agencies. Thus the responsibility for civil maritime navigation lies with the National Maritime Administration and the Swedish Civil Aviation Administration is responsible for all aviation navigation matters. Both authorities belong under the Ministry of Communication. The situation is not so straight forward concerning navigation on land. In this field there is a co-operation between the National Road Administration, the National Rail Administration and he National Land Survey.

## 7. National Responsible Authorities

a. Land use

National Road Administration
S-781 81 Borlänge
Tel: + 46 243 750 00
Fax: + 46 243 846 40
Web: http:/ / www.vv.se

National Rail Administration
S-781 85 Borlänge
Tel: + 46 243 44 50 00
Fax: + 46 243 44 56 17
Web: http:/ / www.banverket.se

National Land Survey
S-801 82 Gävle
Tel: + 46 26 63 30 00
Fax: + 46 26 68 75 94
Web: http:/ / www.lm.com

b. Maritime use

National Maritime Administration
S-601 78 Norrkoping
Tel: + 46 11 19 10 00
Fax: + 46 11 10 19 49
Web: http:/ / www.sjofartsverket.se

c. Aviation use

Civil Aviation Administration
S--601 79 Norrkoping
Tel: + 46 11 19 20 00
Fax: + 46 11 19 25 75
Web: http:/ / www.lfv.se

d. Space use

Swedish Space Corporation
P. O. Box 4207
171 04 Solna
Tel: + 46 8 627 62 00
Fax: + 46 8 98 70 69

e. Military use

Swedish Defence
S-107 85 Stockholm
Tel: + 46 8 788 75 00
Fax: + 46 8 788 77 78

f. Time / frequency use

Swedish National Testing and
Research Institute
P. O. B ox 857
S-501 15 Boras
Tel: + 46 33 16 50 00
Fax: + 46 33 12 50 38
Web: http:/ / www.sp.se

g. Survey / geodesy / GIS

National Land Survey
S-801 82 Gavle
Tel: + 46 26 63 30 00
Fax: + 46 26 61 06 76
Web: http:/ / www.lm.com

h. Industry

Scandinavian GNSS Industry Council
Ola Modinger
Spectra Precision AB
Tel: + 46 705 28 20 50
Fax: + 46 706 15 20 50
Web: http:/ / www.gpsradet.a.se

## 8. Conferences/Seminars/Exhibitions held within nation

A seminar on the use of GPS / GLONASS and the status of Galileo was held in Gavle on 7-8 March 2000 with about 150 participants. Further information on www.swepos.com.

## 9. The national point of contact

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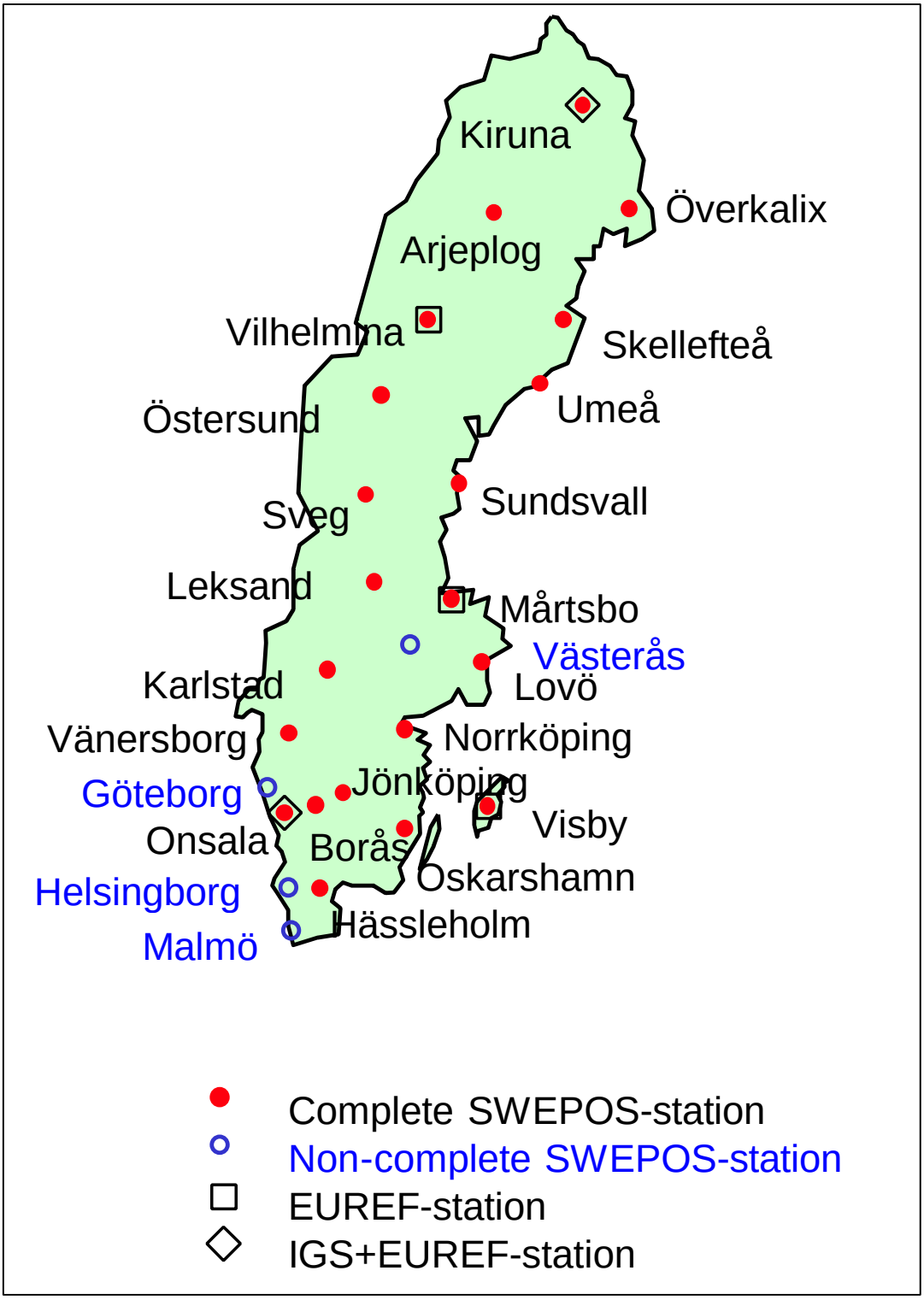


Figure 1. The SWEPOS network

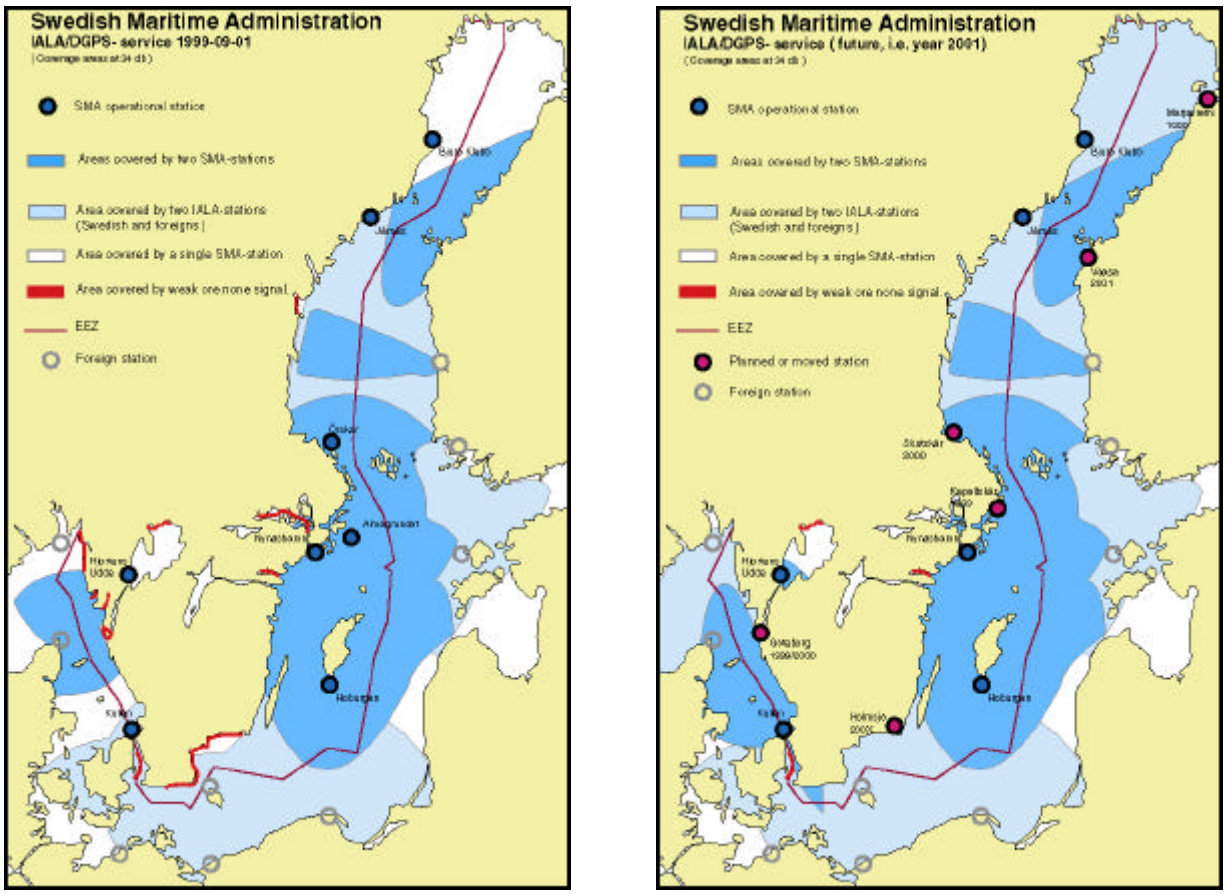


Figure 2. SMA IALA / DGPS network

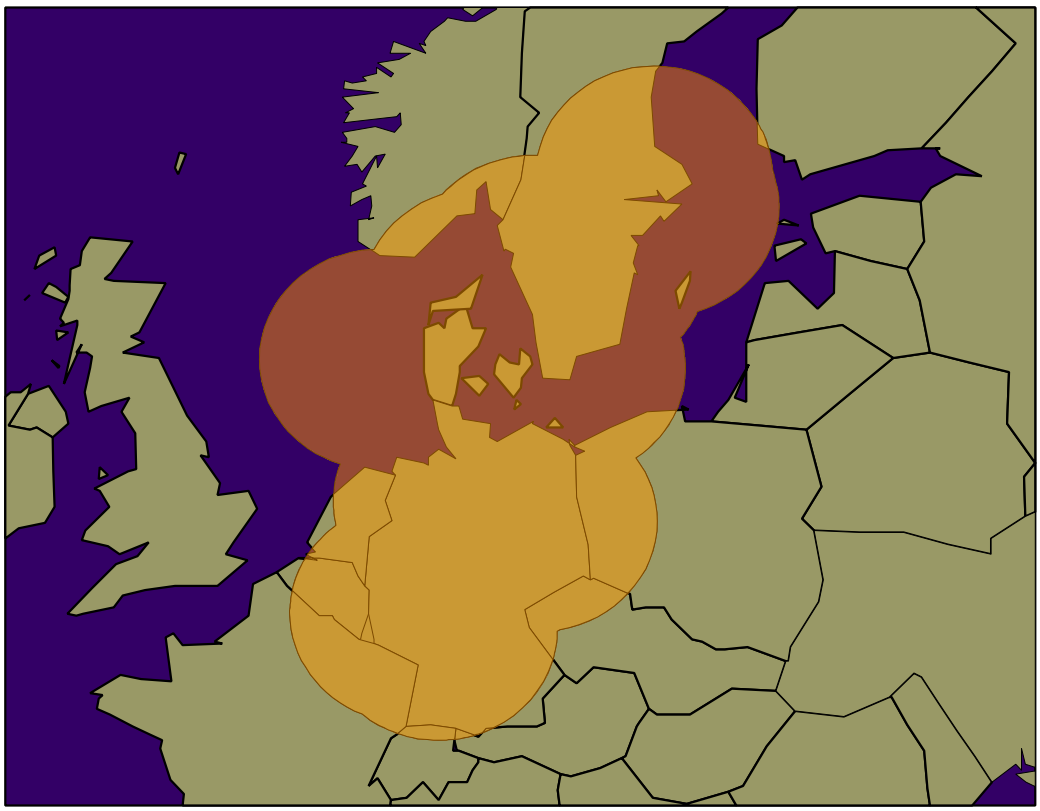

Figure 3. The North European CNS / ATM application project