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National report from SWEDEN to the meeting of the International Information Subcommittee in Brussels , 5th - 6th December 2002

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

Lantmäteriet (the National Land Survey of Sweden) and Onsala Space Observatory have been active in international projects. The European countries have collaborated in building up a network of permanent GPS stations (EPN-network) as well as computing national realisations of the adopted European three dimensional reference system ETRS 89. This work is done under the IAG Subcommission for Europe (EUREF). EUREF is also engaged with the establishment of a common vertical reference system based on the national levelling networks and the European GPS campaign EUVN.

The realisation of ETRS 89 in Sweden is called SWEREF 99 and replaces SWEREF 93. SWEREF 99 was (certified) accepted by EUREF in June 2000 and is defined by the 21 complete SWEPOS stations.

GPS is routinely used for densification of the national triangulation network and for the 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.

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Both surveyors from the government agencies and from the private consulting companies today use GPS in several surveying applications like detail measurements. 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.

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, SWEPOS ä

The SWEPOS™ network was established as a collaboration project between Onsala Space Observatory and Lantmäteriet (the National Land Survey). Since 1995 the SWEPOS service is designed and financed by a co-operation group of Swedish governmental agencies and managed by Lantmäteriet. 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 metre-level follows a given specification, see http://www.swepos.com for further information. The long-term goal is that user fees shall contribute to the operation cost for SWEPOS.

Data from the SWEPOS network is available for the end user via the following services

- Post-processing data through a WWW/FTP service
- Automatic Computation Service on the SWEPOS Web
- The DGPS-service Epos run by the Swedish company Cartesia
- The DGPS-service Mobipos run by the Swedish company Generic Mobile
- The global WADGPS-service run by the multi-national company Fugro

21 of the SWEPOS-stations are mounted on bedrock and have redundant equipment for GNSS-observations, communications, power supply etc. (complete SWEPOS station). Another twenty stations are mostly located on the top of buildings and have less redundant equipment. The main task for these stations is real-time RTK services.

List of the 21 complete SWEPOS stations:

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

3. Post-processing services

a. Data from SWEPOS for post-processing

SWEPOS data is available on a WWW / FTP server in RINEX-format. Quality checked data is available on the WWW / FTP server for download within one hour after the observation on the SWEPOS station.

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 (EPN) and the IGS network.

b. Automatic Computation Service on the SWEPOS Web

Lantmäteriet has developed an automated processing service in order to facilitate the use of SWEPOS for accurate static post-processed point positioning. The Bernese GPS software and a webpage / e-mail is used for the computations and presentation. The position for any site in Sweden can be computed by submitting an observation file containing dual frequency data in RINEX format to the Automatic Computation Service via the SWEPOS Web-site.

4. Real time Services

a. The DGPS service EPOS, operated by Cartesia

Epos is a single station DGPS service based on SWEPOS data and operated by the Swedish private companyCartesia., Cartesia broadcasts the corrections via the FM network on the RDS channel of the public channels three and four. An accuracy of 1-2 metre (95%) is achievable over most land and sea areas of Sweden.

b. The DGPS service Mobipos, operated by Generic Mobile

Mobipos is a single station DGPS service based on SWEPOS data and operated by the Swedish company Generic Mobile. Generic Mobile broadcasts the corrections via the FM network at the DARC (Data Radio Channel) channel at the public channel three. An accuracy of 1-2 metre (95 %) is achievable over most land and sea areas of Sweden.

c. The network WADGPS-service, operated by Fugro

OmniSTAR is an international Wide Area DGPS service operated by the multi-national company Fugro. Data from one SWEPOS station is included. OmniSTAR is a world wide service using geostationary satellites for the distribution of the corrections. The elevation to the geostationary satellites is low at high latitudes, which reduce the availability especially for land applications in northern parts of Sweden. An accuracy of 1-2.5 metres is achievable over most land areas world wide.

d. Regional Positioning Services

Lantmäteriet is operating regional positioning services, in collaboration with Local Authorities, Governmental Agencies and Private Consultancy Firms, with a few centimetres horisontal positioning accuracy, see www.swepos.com and figure 4.

e. IALA / DGPS of the National Maritime Administration

The DGPS service of the Swedish Maritime Administration is operational since 1 May 1996. The network originally consisted of seven reference stations, but now ten stations are in operation. The DGPS corrections are transmitted via radio beacons in accordance

with the IALA DGPS-standard concept. The signals are uncoded and there are no direct user fees. All Swedish waters are covered by signals from at least two radio beacons in order to obtain a signal availability of at least 99.8 %. A new frequency plan for the transmission will be implemented 2001-09-18 / 19 and the receiving conditions is expected to be improved within the European Maritime area.

List of DGPS stations:

Name	**Position**	**Frequency**	**ID**	**Bit rate**
Holmsjö	N56 26 E15 39	292,0	460	100
Bjuröklubb	N64 29 E21 35	311,5	461	100
Järnäs	N63 29 E19 39	289.0	462	100
Skutskär	N60 37 E17 26	299.5	463	100
Kapellskär	N59 43 E19 04	307,5	464	100
Hoburg	N56 55 E18 09	297.5	465	100
Kullen	N56 18 E12 27	293.0	466	100
Hjortens Udde	N58 38 E12 40	302.0	467	100
Nynäshamn	N58 56 E17 57	298.0	468	100
Göteborg	N57 37 E11 58	296,5	469	100

5. 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.
- Lantmäteriet in collaboration with the local authorities, universities and governmental agencies also carries out pilot projects for Network-RTK in three areas. These areas are located in the most southern part of Sweden, the Stockholm area and the western part of Sweden. The purpose of these projects is to obtain experiences of the operation and performance using currently available Network-RTK systems.

b. Maritime use

- Real time carrier phase measurements in hydrographic surveying – National Maritime Administration
- The use of an Automatic Identification System (AIS) for ships, based on time- and position information from a GNSS is used by the Swedish Maritime Administration. A carriage requirement for the system is adopted by IMO and is effective from July 2002 for new ships and for existing ships from later dates depending on type of ship and size.

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 – the Swedish Defence Materiel Administration and Defence Research Establishment
- In June 2001 the Swedish Defence Materiel Administration adopted a policy for the use and purchase of GNSS equipment for military applications

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

6. 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 the industry, User groups and Authorities. These objectives are achieved by SGIC Internet Web-site (www.gnssindustry.com), 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.

7. 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 Lantmäteriet (the National Land Survey).

8. National Responsible Authorities

a. Land use

National Road Administration
SE-781 81 Borlänge
Tel: +46 243 750 00
Fax: +46 243 755 50
Web: http://www.vv.se

National Rail Administration
SE-781 85 Borlänge
Tel: +46 243 44 50 00
Fax: +46 243 44 50 09
Web: http://www.banverket.se

Lantmäteriet (National Land Survey)
SE-801 82 Gävle
Tel: +46 26 63 30 00
Fax: +46 26 68 75 94
Web: http://www.lantmateriet.se

b. Maritime use

National Maritime Administration
SE-601 78 Norrköping
Tel: +46 11 19 10 00
Fax: +46 11 10 78 41
Web: http://www.sjofartsverket.se

c. Aviation use

Civil Aviation Administration
SE-601 79 Norrköping
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
SE-171 04 Solna
Tel: +46 8 627 62 00
Fax: +46 8 98 70 69
Web: http:/www.ssc.se

e. Military use

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

Swedish Defence Materiel Administration
Banérgatan 62
SE-115 88 Stockholm
Tel: +46 8 782 4000
Fax: +46 8 667 5799
Web: http://www.fmv.se

f. Time/frequency use

Swedish National Testing and Research Institute
P.O. Box 857
SE-501 15 Borås
Tel: + 46 33 16 50 00
Fax: + 46 33 13 55 02
Web: http://www.sp.se

g. Survey/geodesy/GIS

National Land Survey
SE-801 82 Gävle
Tel: + 46 26 63 30 00
Fax: + 46 26 61 06 76
Web: http://www.lantmateriet.se

h. Industry

Scandinavian GNSS Industry Council
John Holm
Magnus Ladulåsgatan 16
SE- 118 66 Stockholm
Tel: +46 8 428 9020
Fax: + 46 8 428 9021
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9. The national point of contact

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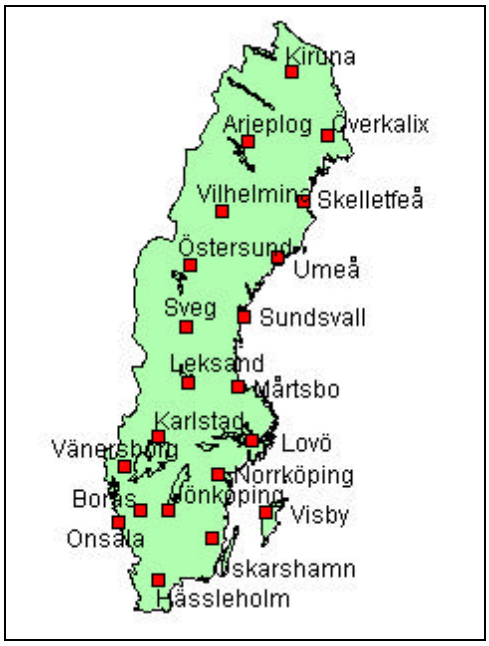

Figure 1. The SWEPOS network (21 complete stations)

Figure 2. SMA IALA / DGPS network

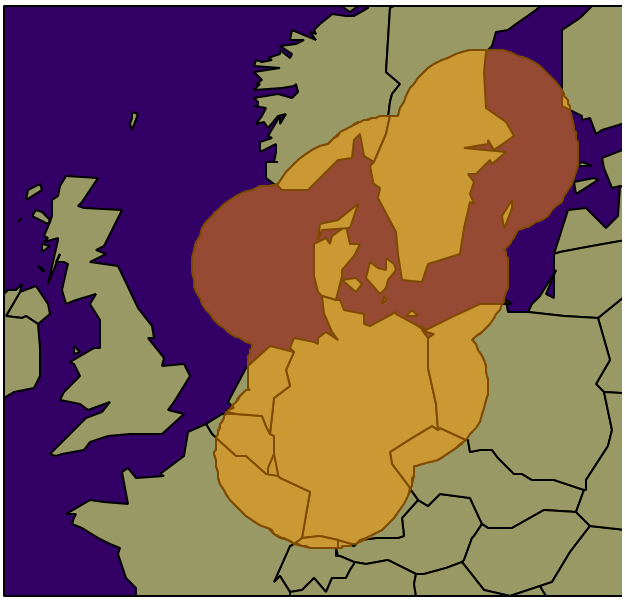

Figure 3. The North European CNS / ATM application project

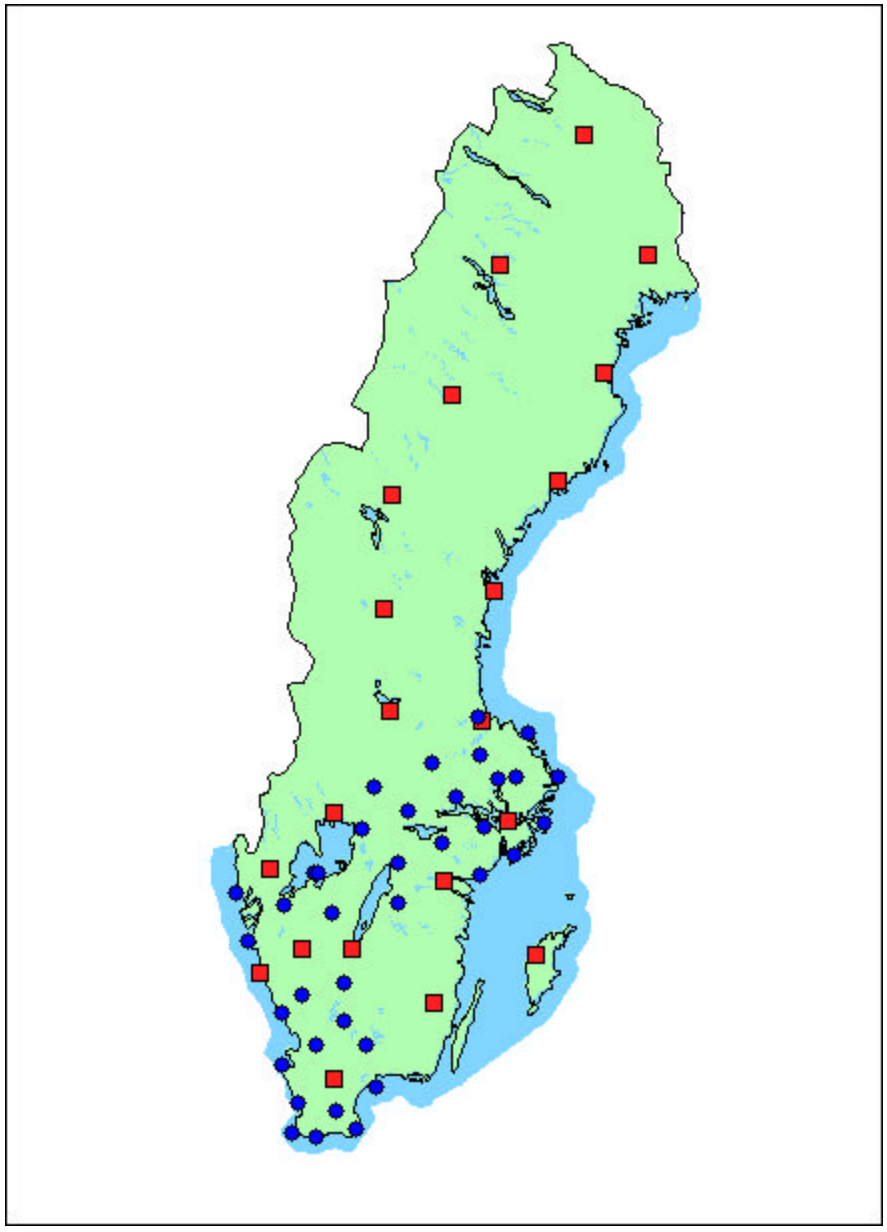

Figure 4. Complete (red squares) and simplified (blue circles) SWEPOS stations for a regional positioning service.

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