

CGSIC-meeting 1998-09-13 – 09-15

1 (8)

1998-09-10

National report from SWEDEN to the CGSIC-meeting in Nashville 13-15 September 1998.

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 with WGS 84 (G730) within 0.5 meter and with ITRF 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.

GPS is today used in several surveying applications like detail measurements by both surveyors from the government agencies and from the private consulting companies. The reference network for the construction of the large bridge between Sweden and Denmark in the sound "Öresund" 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.

c. Navigation activities

In Sweden GPS is today an important part of many navigation systems.

2. Differential Services

a. EPOS

EPOS is a commercial service which is managed by the Swedish company Teracom. Pseudorange corrections from twelve SWEPOS stations are broadcasted via the RDS channel on the FM radio network. The EPOS service offers two levels of accuracy; one basic level which gives a position accuracy below 10 m (2 drms) and one premium level which gives an accuracy below 2 m (2 drms). The users are charged approx. 150 USD for the basic level and approx. 900 USD for the premium level

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

b. SWEPOS

The SWEPOS service is managed by the National Land Survey of Sweden. Dual frequency GPS raw data are available from twenty-one stations, see appendix, via Internet or a dialled-up BBS. Pseudo range corrections are delivered from twelve SWEPOS stations to the Epos service. SWEPOS is planned to reach IOC-status in May 1998 and a small user fee was introduced on 1 January 1998.

SWEPOS data are used e. g. for 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

Station name	Latitude	Longitude	EPOS-service	EUREF/IGS-Station
Umea	63035'	19031'		
Ostersund	63027'	14051'		
Sundsvall	62014'	17040'	Yes	
Sveg	62001'	14042'	Yes	
Martsbo	60036'	17016'	Yes	Yes
Leksand	60043'	14053'		
Karlstad	59027'	13030'	Yes	
Lovo	59020'	17050'	Yes	
Vanersborg	58°42'	12002'		
Norrkoping	58035'	16015'	Yes	
Jonkoping	57045'	14004'		
Boras	57043'	12053'		
Visby	57039'	18022'	Yes	Yes
Onsala	57024'	11056'	Yes	Yes
Oskarshamn	57°04'	16000'		
Hassleholm	56006'	13043'	Yes	

c. DGPS of the National Maritime Administration

The DGPS service of the National Maritime Administration is operational since 1 May 1996 00^h UTC. The network originally consisted of seven reference stations, but now are eight stations in operation. The DGPS corrections are transmitted via radio beacons, are uncoded and there are no direct user fees. 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%

List of DGPS stations

Station name	Latitude	Longitude	Frequency (KHz)	ID
Bjuroklubb	64-29N	21-35E	303,5	461
Jamas	63-29N	19-39E	306,5	462
Orskar	60-32N	18-23E	291,5	463
Almagrundet	59-09N	19-10E	287,0	464
Nynashamn	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

3. Development activities

a. Land use

- development of an operational network of permanent reference stations, SWEPOS - National Railway Administration, the National Road Administration, the Swedish Civil Aviation Administration, the National Maritime Administration, the Telecommunications Administration, the Swedish State Railways, the Swedish Defence and the Swedish association of local authorities
- studies of the land up-lift using SWEPOS data - Onsala Space Observatory
- activities from companies and agencies to use GPS realtime carrier phase technique in automatic guidance systems for construction machinery.

b. Maritime use

- hydrographic surveying - National Maritime Administration
- development of a GNSS transponder - National Maritime Administration

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
- research towards real-time carrier phase measurements using the SWEPOS network - Collaboration between National Land Survey, Onsala Space Observatory and Teracom.

4. Industrial aspects

A Scandinavian GNSS Industry Council (SGIC) was formed on October 16, 1996. The first constitutional meeting was held in connection with the conference on GPS Augmentation & Management Implications for Scandinavian Users in Gothenburg on April 26-27, 1996.

5. 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 the National Road Administration co-operates with the National Land Survey.

6. National Responsible Authorities

a. Land use

National Road Administration
S-781 81 Borlänge
Tel: + 46 243 750 00
Fax: + 46 243 846 40

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

b. Maritime use

National Maritime Administration
S-601 78 Norrköping
Tel: + 46 1119 10 00
Fax: + 46 1110 19 49

c. Aviation use

Civil Aviation Administration
S-601 79 Norrköping
Tel: + 46 1119 20 00
Fax: + 46 1119 25 75
Web: <http://www.lfv.se>

d. Space use

Swedish Space Corporation
P. O. Box 4207
17104 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
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f. Time/frequency use

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Research Institute
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Fax: + 46 33 12 50 38
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g. Survey/geodesy/GIS

National Land Survey
S-801 82 Gävle
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Fax: + 46 26 6106 76
Web: <http://www.lm.se>

7. Conferences/Seminars/Exhibitions held within nation

GPS seminar, Gavle, 17-18 March 1998 - 170 participants. Organised by National Land Survey.

8. The national point of contact

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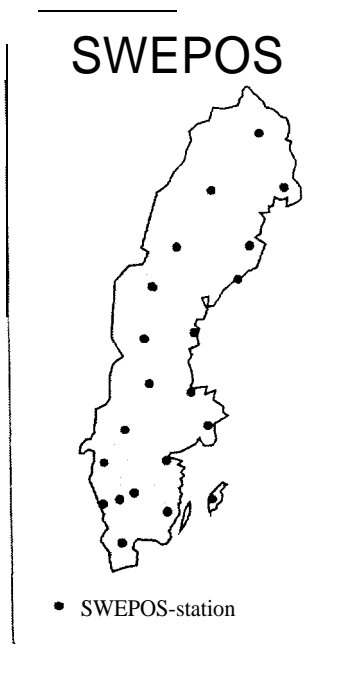


Figure 1. The SWEPOS network

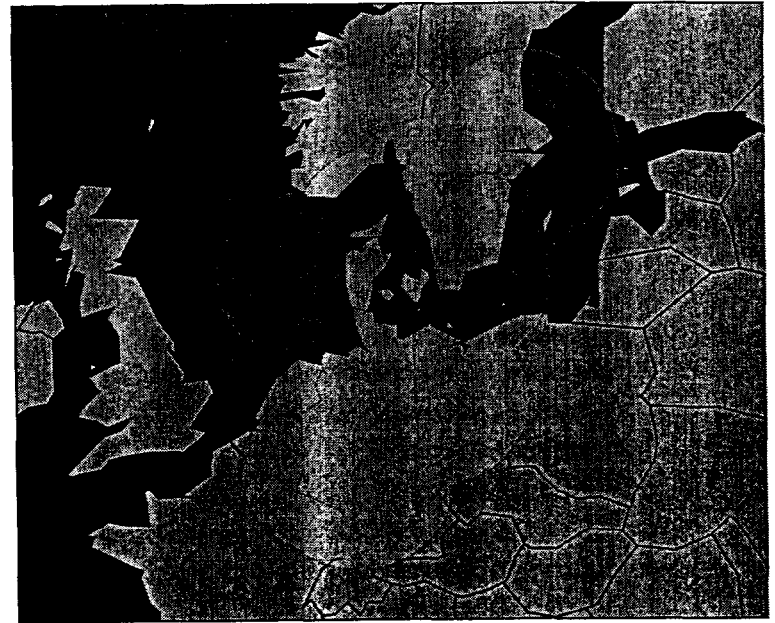


Figure 3. The North European CNS/ATM application project

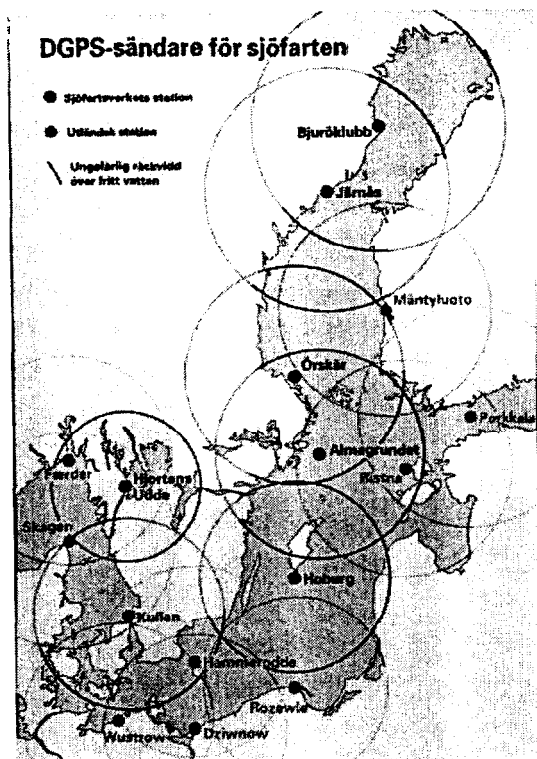


Figure 2. DGPS network of National Maritime Administration, including those of neighbouring countries.

Ciceron

A research project aiming for real-time centimeter accuracy.

Ciceron

Ciceron is a Swedish research project with participants from Onsala Space Observatory, National Land Survey and Teracom. The project started in 1996 and shall pinpoint and possibly solve problems for a RTCM/RTK-service broadcast with national coverage over Sweden. The project shall also perform research in related areas and investigate the possibilities to develop algorithms that shall make it possible to provide a real-time service with centimeter accuracy at distances up to 100 km from a reference station. The project will support the RTCM format for the RTK information to the GPS receiver.

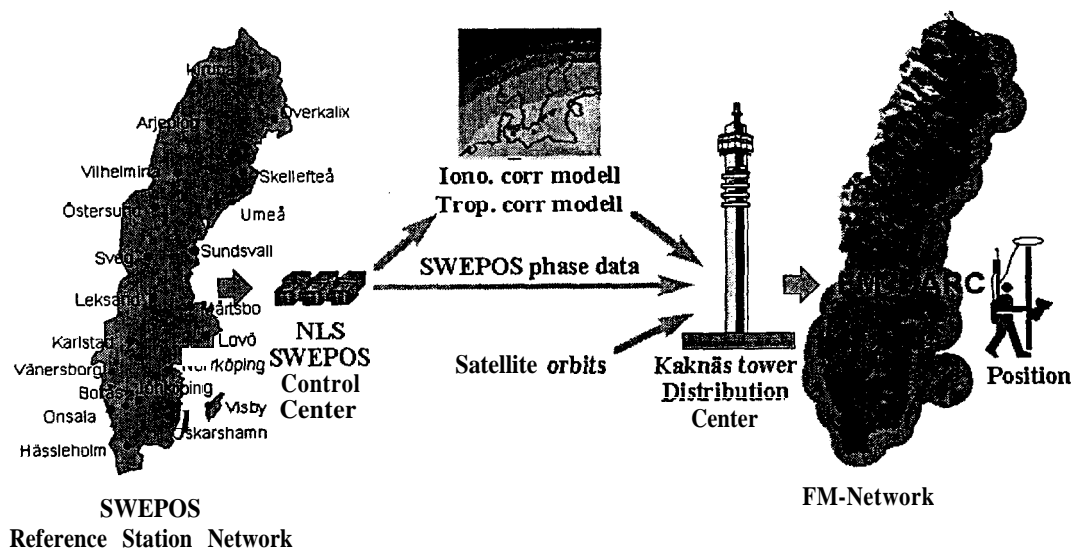
Resources

SWEPOS is a Swedish network of reference stations for GPS. SWEPOS consists of 21 stations placed at a distance of 200 km from each other. The network has been designed and established by the National Land Survey of Sweden in cooperation with Onsala Space Observatory. Data from all 21 stations is collected in real-time by the SWEPOS Control center where the data is being monitored.

Today, cm-dm accuracy can be achieved, using RTK, at distances up to 10 - 20 km from a reference station (depending on the ionosphere/troposphere conditions). The goal is to reach a high accuracy even at longer distances, up to 100 km, which is the same as the maximum distance to the reference stations in SWEPOS. Therefore, an error correction model is needed.

The radio link used for broadcasting the carrier phase measurements will be the sub-carrier DARC (DATA Radio Channel). DARC is a new FM sub-carrier of the similar to R(B)DS. DARC is an ETSI standard approved by ITU (International Telecommunication Union). The difference is that DARC has a much higher data rate, 16000 bps raw bit rate compared with the 1100 bps of R(B)DS. A nationwide network containing 54 large FM-transmitters and over 100 slave FM-transmitters is to be used.

The Concept



The fully implemented concept includes at least 21 reference stations and a nationwide FM / DARC network. The limitations of RTK are reduced, by separating and modeling the error sources and using virtual reference stations.

Ciceron

A research project aiming for real-time centimeter accuracy.

What has been accomplished ?

Studies based on over 5 years of high quality GPS data has given a lot of knowledge about the error sources and how to deal with them. The first steps to implementing an error correction model are now being taken.

Studies and tests of the opportunities and limitations that the DARC channel can offer have been carried out successfully.

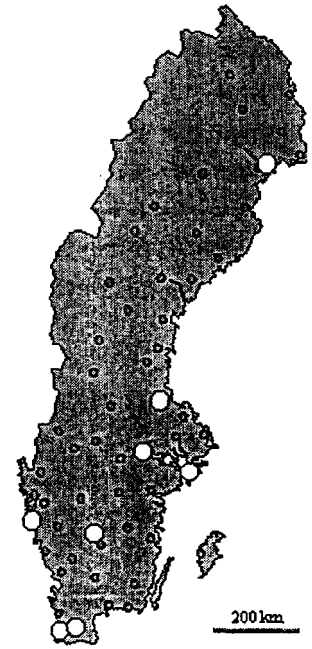
A test platform including 8 FM-stations is being implemented where customers and GPS representatives can test the concept RTCM/RTK via DARC but without the error model. (see picture, *Ciceron test platforms*)

A data link has been established between the SWEPOS control center and Teracom's distribution center.

RTCM/RTK functionality tests and compatibility tests between different manufactures have been made.

The Ciceron project is cooperating with other European projects and broadcasters to establish a standard for RTCM/RTK services via DARC in Europe.

In parallel with the technical project, marketing studies have been carried out in order to form marketing strategies for a nation wide RTK service.



○ Ciceron test platform
● Major FM station

Ciceron test platforms

More information

If you or someone else wants to know more about Ciceron, please contact us:

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