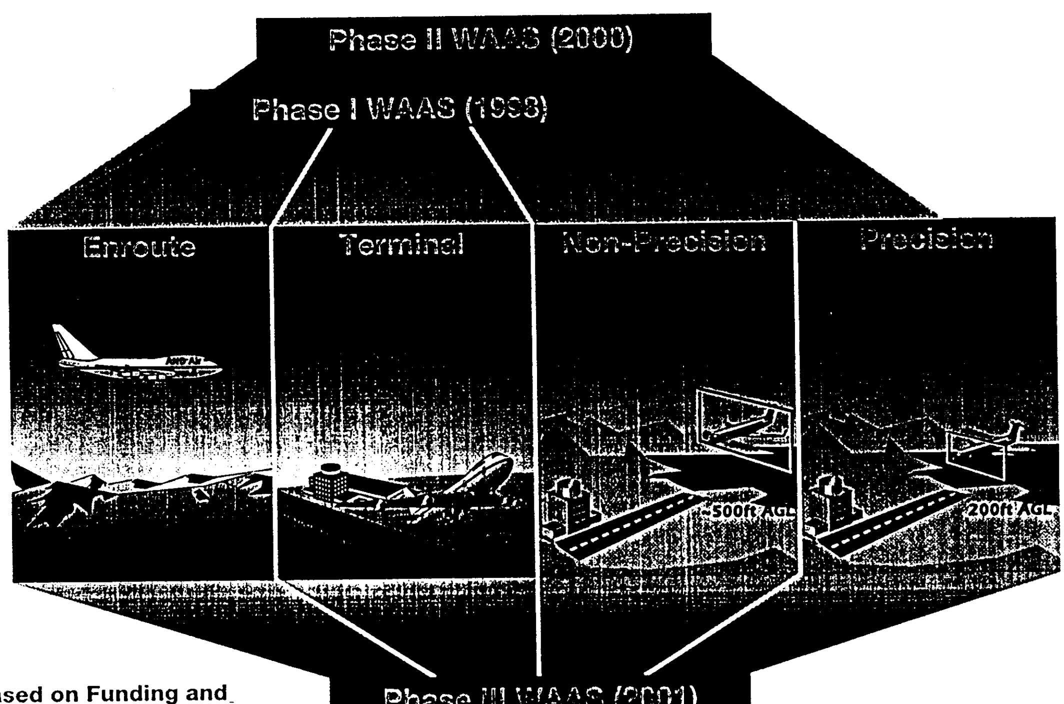
WAAS Phases

Phase 1	May 1,1996- November 30,1998
Phase 2	December, 1998 - June 2000
Phase 3	June, 2000 - December 2002
ICMLS Option 1 Year	January - December 2002

Phase 2 SOW Tasks (24 Months)

WAAS Capabilities



Phases Based on Funding and Contractual Constraints Does Provide a Phased Increase of Capabilities

Phase I WAAS (Initial Operational System)

SATNAV
SATELLITE NAVIGATION

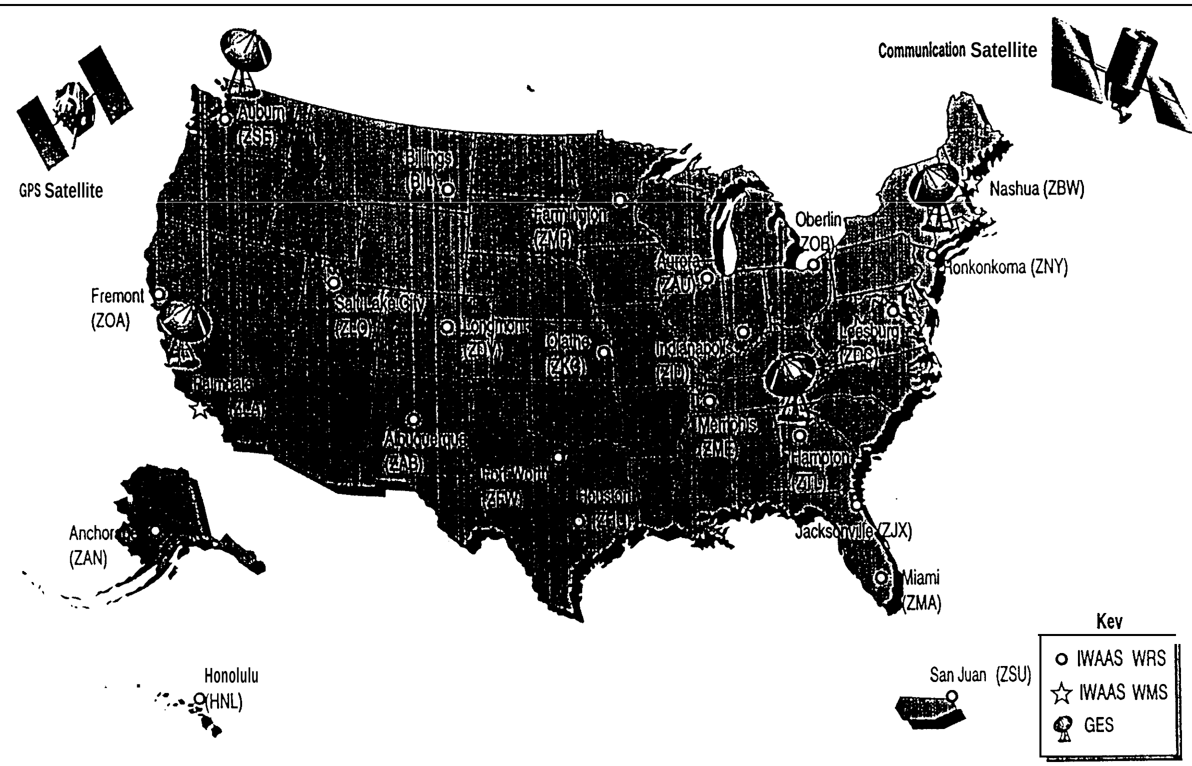
Functional Verification System		Operational WAAS
FY97* **Software** • Code and Off-the-Shelf **Hardware** • 2 WMS • 5 WRS	FAA	**FY98*** **Software** • Minimum Certified Code and Off-the-Shelf **Hardware** • 2 WMS • 24 WRS
Leased Services • 1 CSAT • 2 GUS	**INMARSAT**	**Leased Services** • 2 CSAT's* • 4 GUS's

CSAT	Communication Satellite
GUS	Ground Uplink System

*** Reduction to 2 CSAT's Due to INMARSAT Allocation of AOR-E to European Consortium for EGNOS**

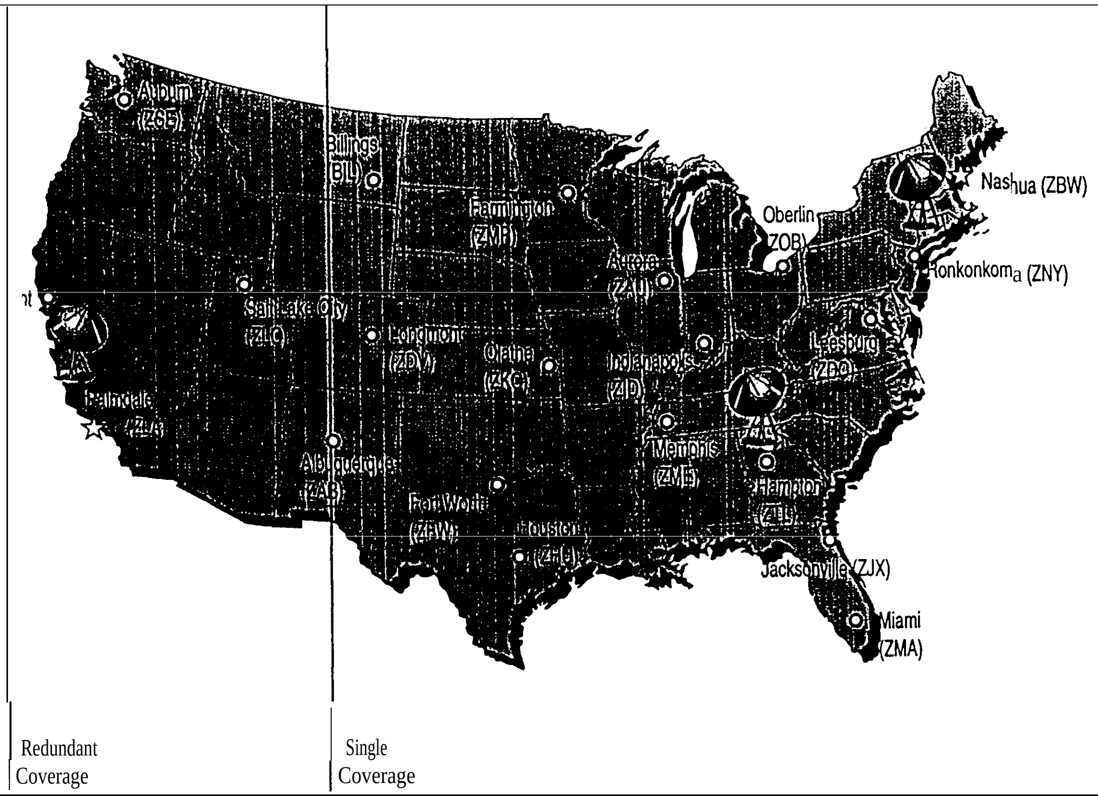
Initial WAAS

WAAS



Initial WAAS Geostationary Coverage

SATNAV SATELLITE NAVIGATION



Comm Team Provides...

	Satellite Communications	Terrestrial Communications
Phase 1	• 2 GEOs (Inmarsat 3) • 4 GUSs *Buy 4 or 5 small sat's* • 35% Dual Coverage • Ranging Sources to Meet Phase 1 CON and CoFD	• Redundant, Diverse, High-speed, High Integrity Terrestrial Communications Between all Phase 1 Sites
Phase 2	• Up to 4 GEOs (2 I-3+2 other GEOs or equivalent) • Up to 8 GUSs • 100% Redundant Coverage • Ranging Sources to Meet Phase 2 CON and CoFD	• Redundant, Diverse, High-speed, High Integrity Terrestrial Communications Between all Phase 1 and 2 Sites
Phase 3	• Up to 8 GEOs (2 I-3+6 other GEOs or equivalent) • Up to 16 GUSs • 100% Redundant Coverage • Ranging Sources to Meet Phase 3 CON and CoFD	• Redundant, Diverse, High-speed, High Integrity Terrestrial Communications Between all Phase 1, 2 and 3 Sites

Phase II WAAS

SATNAV SATELLITE NAVIGATION

Option 1

FY99*

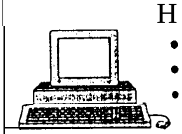
Software

- Additional Certified Code (If Required)
- Availability Coverage Model (ACM)
- Service Volume Model (SVM)
- NOTAMS
- 0 & M Upgrade

FAA

Option 2

FY99*



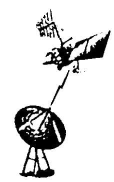
Hardware

- WMS
- 8 WRS
- Processors for ACM, SVM, and NOTAMS

FAA

Option 3

FY99*



Leased Services

- 2 CSAT's
- 4 GUS's

Unknown Satellite Provider (Based on Sept 96 Request for Services)

Phase III WAAS (End State System)

SATNAV SATELLITE NAVIGATION

Option 4

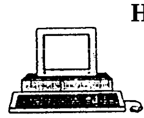
FY00 *

Software

- Additional Certified Code (If Required)
- Integrate Into AF Operational Control Center Concept
- RMMS
- Accept International WAAS

Option 5

FY00*



Hardware

- 1 WMS
- 8 WRS
- Replace All Hardware

Option 6

FY00*

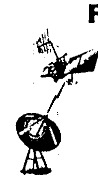
Leased' Services

- 2 CSAT's
- 4 GUS's

Unknown Service Provider

Option 7

FY00*



Leased Services

- 2 CSAT's
- 4 GUS's

Unknown Satellite Provider

Hardware

Phase **2**

WMS - 2 (6 Months)
WRS - 2 (12 Months)
SGS - 4 (12 Months)

O&M **Processors**
1 - **NOTAMS** (6 Months)
1 - SVM (6 Months)
1 - O&M (6 Months)
FVS **Hardware** (2 Months)

Exercise - NTL FQR

Phase **3**

WMS - 2 (6 Months)
WRS - 2 (12 Months)
SGS - 8 (12 Months)

Hardware Replacement WAAS/FVS
6 WMSs (80% **of** Cost)
41 WRSs (75% of Cost)
SGS - 8 (50% **of** Cost)
TDS - 1 (100% **of** Cost)
(18 **Months** POP)

Exercise - NTL **End of Phase** 2 - 6 **Months**

Communications

Phase **2**

Upgrade Network Design (6 Months)
2 GEOs Based on 10-year Lease Period (60 Months)
4 RFUs Based on 10-year Lease Period (42 Months)

Exercise - FQR (June 1997 Likely)

Phase **3**

Upgrade Network Design (6 Months)
Exercise - NLT End of Phase (2 - 6 Months)
2 GEOs Based on 10-year Lease (36 Months)
4 RFUs Based on 10-YEar Lease (18 Months)

Exercise - NTL End of Phase 1

Key Events

June 8, 1994	Request for Proposals Released
March 10, 1995	WAAS Competitive Range Briefing to Administrator
May 1, 1995	Fact Finding Started
August 3, 1995	Contract Award
August 28, 1995	Post Award Conference
October 2, 1995	System Requirements Review Conducted - Approval Completed January 4, 1996
December 5-8, 1995	Program Overview Meeting
March 4-8, 1996	System Design Review
April 28, 1996	Contract Termination
May 1, 1996	Hughes Letter Contract

Major Steps

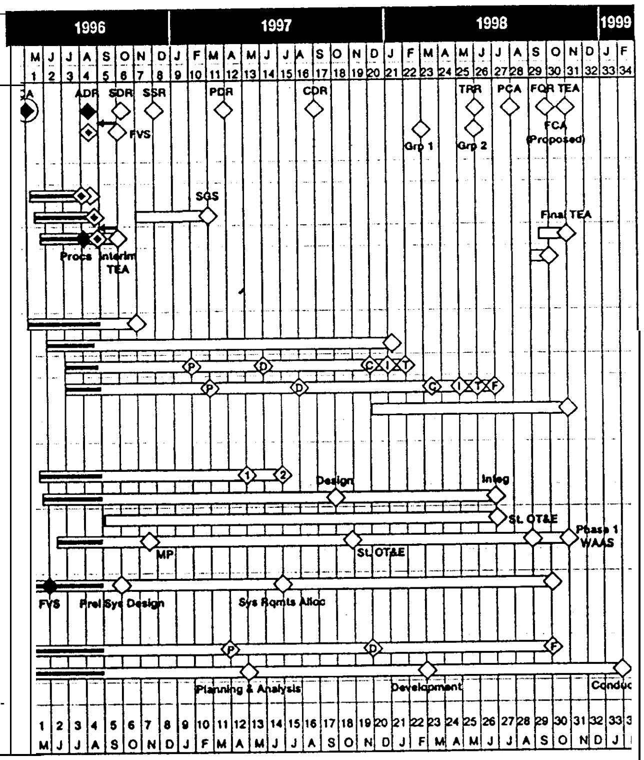
- Terminate Wilcox Electric, Inc. (28 April 96)
- Issue Letter Contract With Not-to-Exceed to Hughes Aircraft Corp. (1 May 96)
- Definitive and Award Sole Source Contract (Fixed Priced Incentive) to Hughes as Systems Integrator and Software Developer (Oct 96)
- Expand Existing COMSAT Agreement for Satellite Communications (Sep 96)
- IWAAS Complete (Nov 98)
- Phase II Start (Jun 98) Complete (July 2000)
- Phase III Start (Nov 99) Complete (Dec 2001)

Draft

WAAS Program Master Schedule (Phase 1)

SATNAV
SATELLITE NAVIGATION

Activity Description	CLINs
Major Milestones	
Site Implementation	
Functional Verification System (FVS)	
Hardware Procurement (FVS)	0001
FVS Field & Integrate	0003
FVS System TEAs	0004
FVS Reconfiguration	0006
Software Engineering	
SRS Development	0007
Software Prototyping	0007
Support/Test Software Development	0007
Operational Software Development	0007
Software Sustaining	0007
System Design, Integration & Test	
WAAS Hardware Procurement	0008
TCN Design & Integrate	0009
WAAS System Fielding & Integration	0010
System Tests/Eval/Acceptance (TEA)	0011
System Engineering	0014
Logistics/Training	
Logistics/Technical Manuals	0005.1
Training	0005.2



Summary

WAAS

- No Significant Changes
- End-State Requirements are Same
- Less Time Overall to Complete

National Satellite Test Bed (NSTB)

- Purpose
- Configuration
- Geographic Coverage
- Timeline of Milestones
- Funding

NSTB Upgrade Purpose

- Continue Validation and Verification of Algorithms Developed for IWAAS
- Define End-State WAAS Requirements
- Facilitate International Tie-in
- Ionospheric/Tropospheric Modeling

Approach

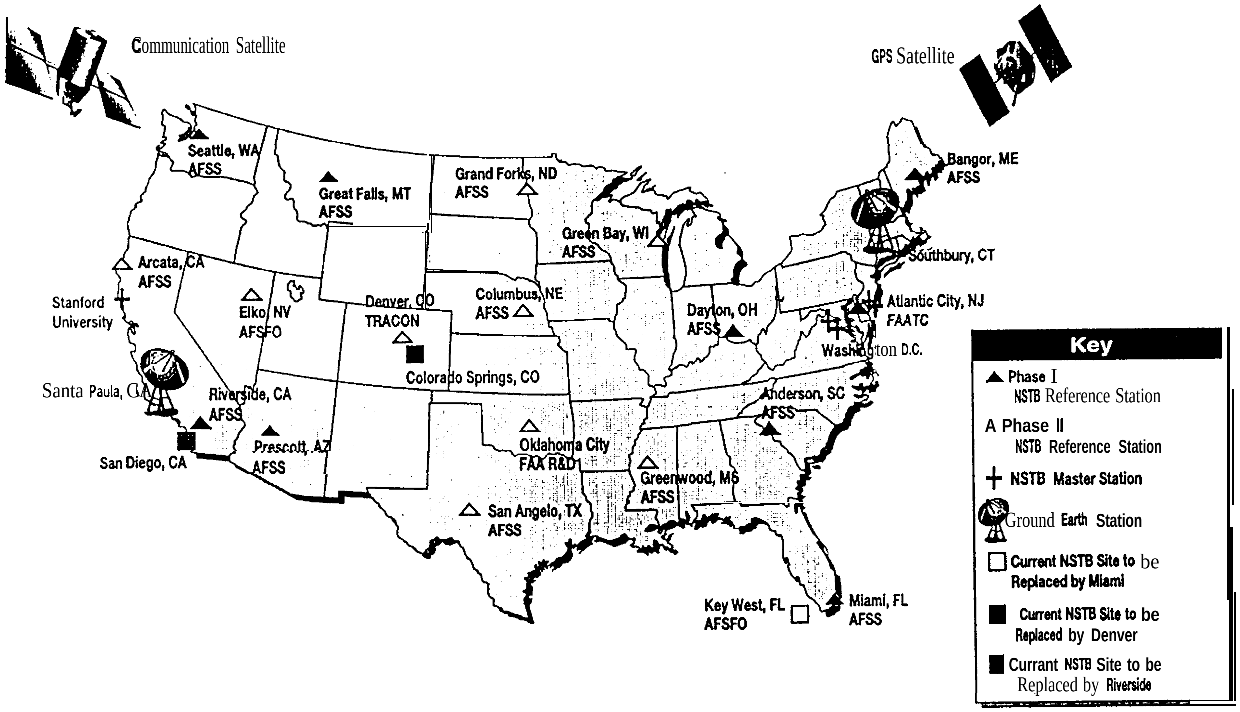
18 Testbed Reference Stations (TRSs)

5 Testbed Master Stations (TMSs)

2 Geostationary Earth Stations

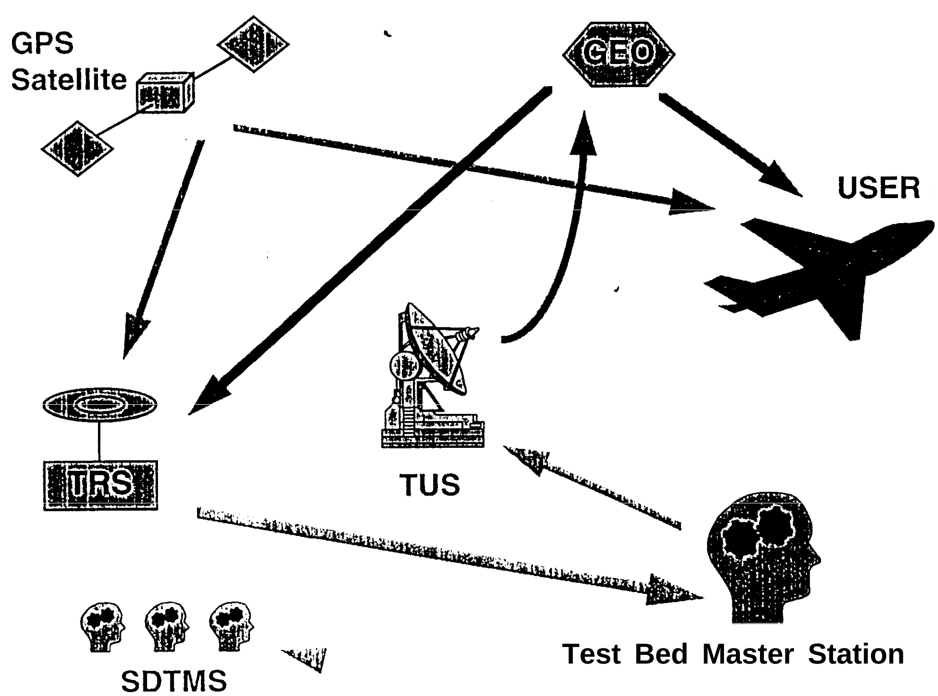
- FTS-2000 Terrestrial Communications
- Dual Thread Instead of Triple
- Software Written DO-178B Safety Standard
- Developing as Closely to WAAS Specification as Possible Given Funding Constraints

NSTB Sites

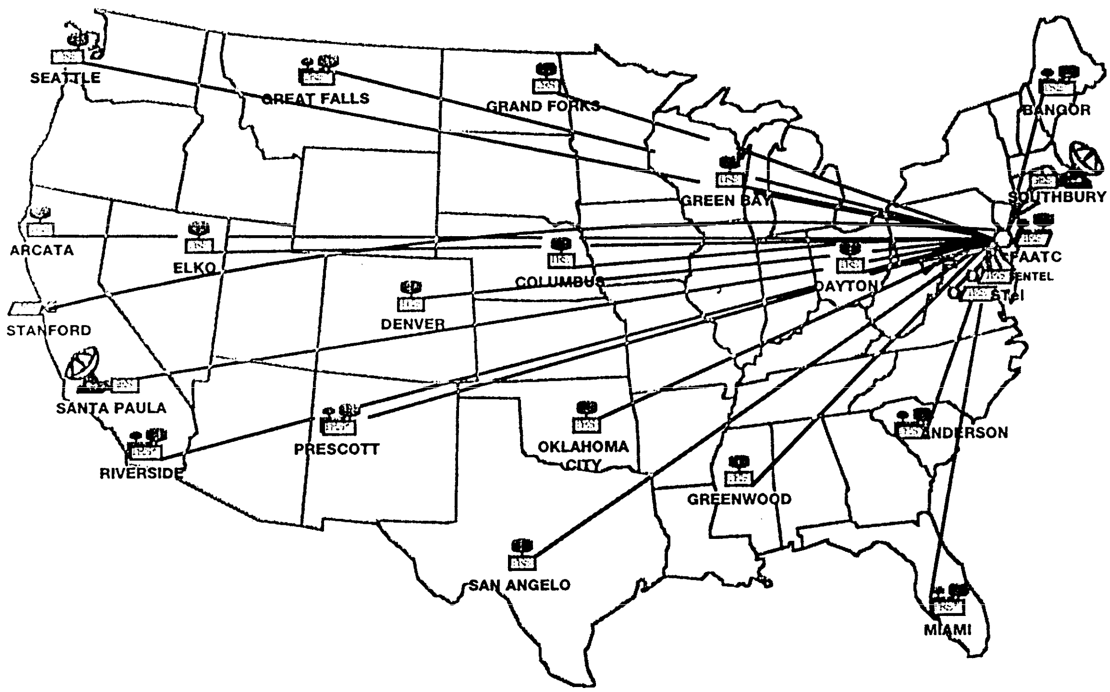


FM 116-02

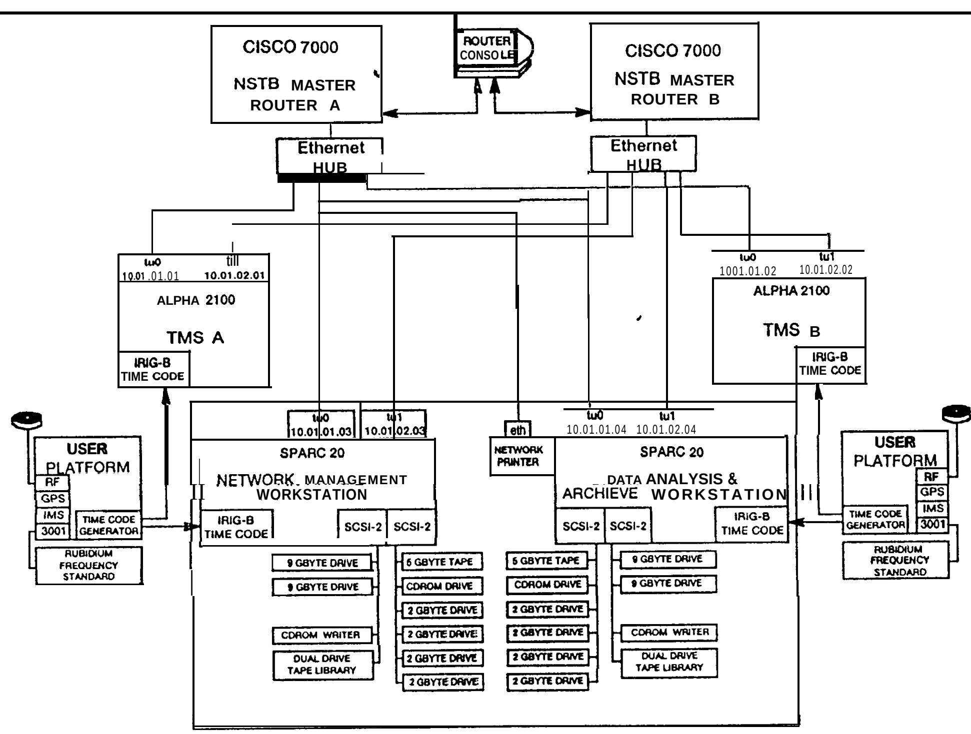
Overview



National Satellite Test Bed
Upgrade-CONUS Installations

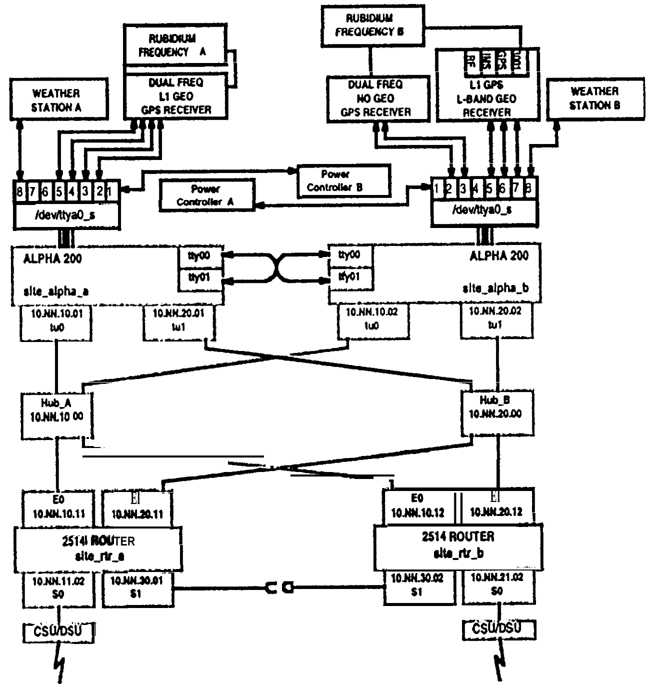


National Satellite Test Bed
Master Station Architecture

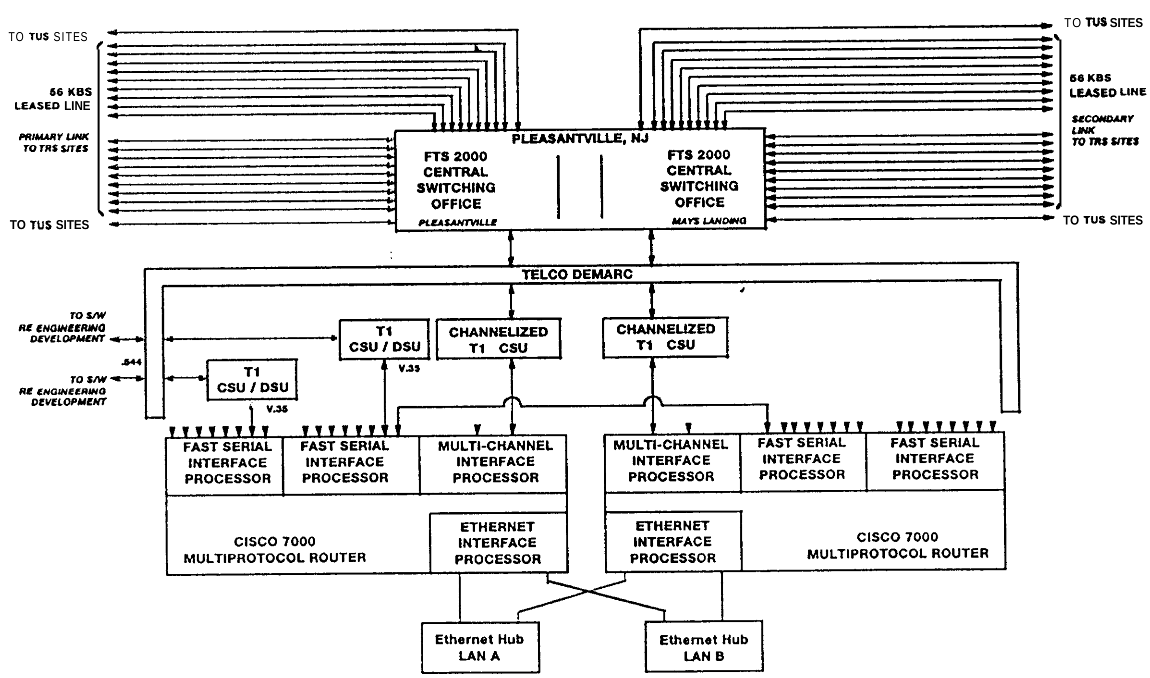


National Satellite Test Bed Reference Station Architecture

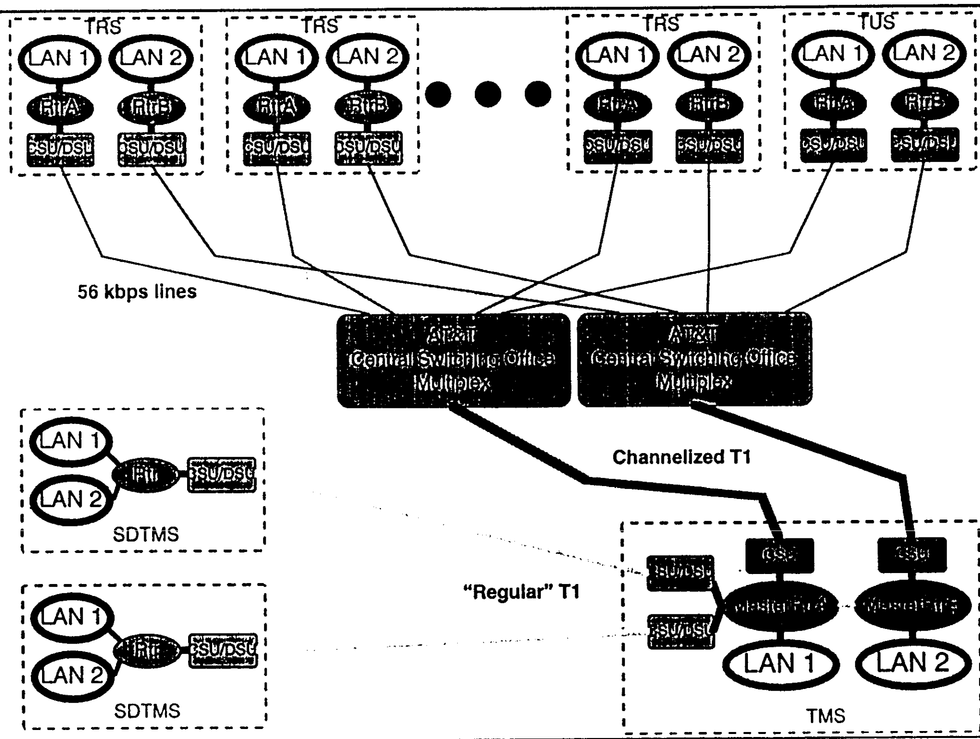
Net Num	Testy Bed Reference Station Location	Site Ident
010	ANDERSON, SC	AND
011	RIVERSIDE, CA	RIR
012	SEATTLE, WA	SEA
013	GREAT FALLS, MT	GTF
014	DAYTON, OH	DAY
015	MAIMI, FL	MIA
016	PRESCOTT, AZ	PRS
017	BANGOR, ME	BGR
018	GREEN BAY, WI	GRB
019	ARCATA, CA	ACV
020	GREENWOOD, MS	GWO
021	COLUMBUS, NE	COL
022	DENVER, CO	DEN
023	GRAND FORKS, ND	GFK
024	ELKO, NV	EKO
025	OKLAHOMA CITY, OK	OKC
026	SAN ANGELO, TX	SAG



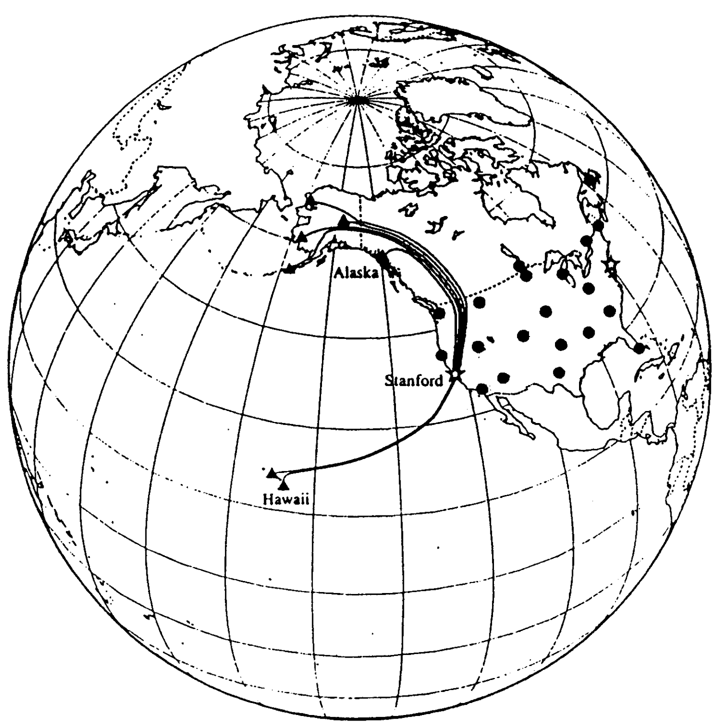
National Satellite Test Bed FTS-2000 Configuration



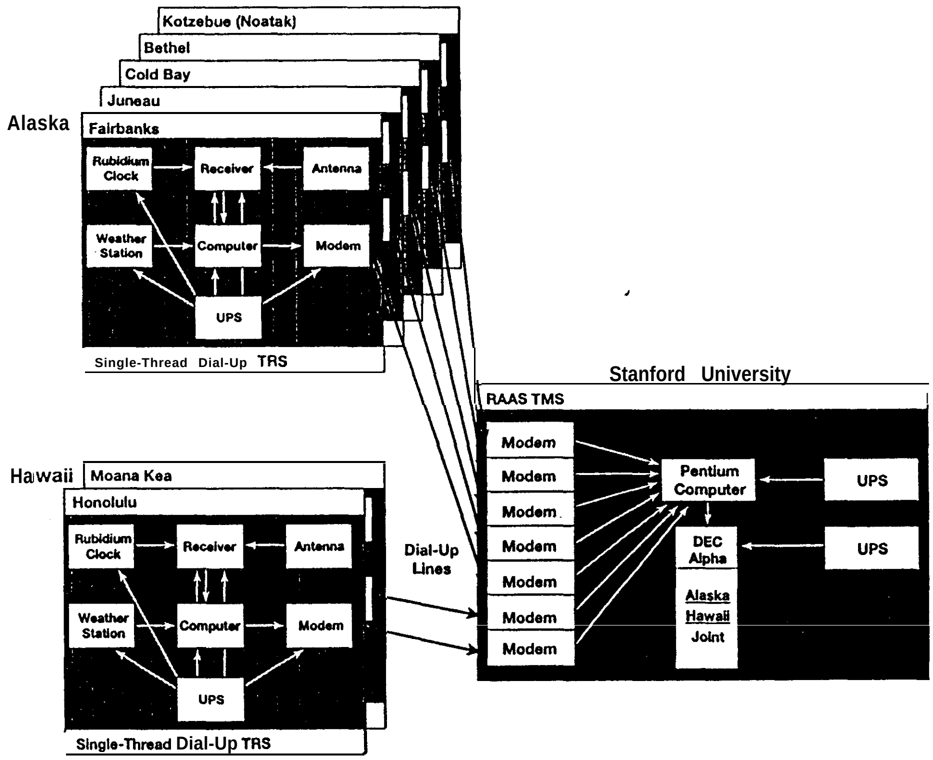
The Double Network



Proposed NSTB Expansion



Alaska - Hawaii Network Layout



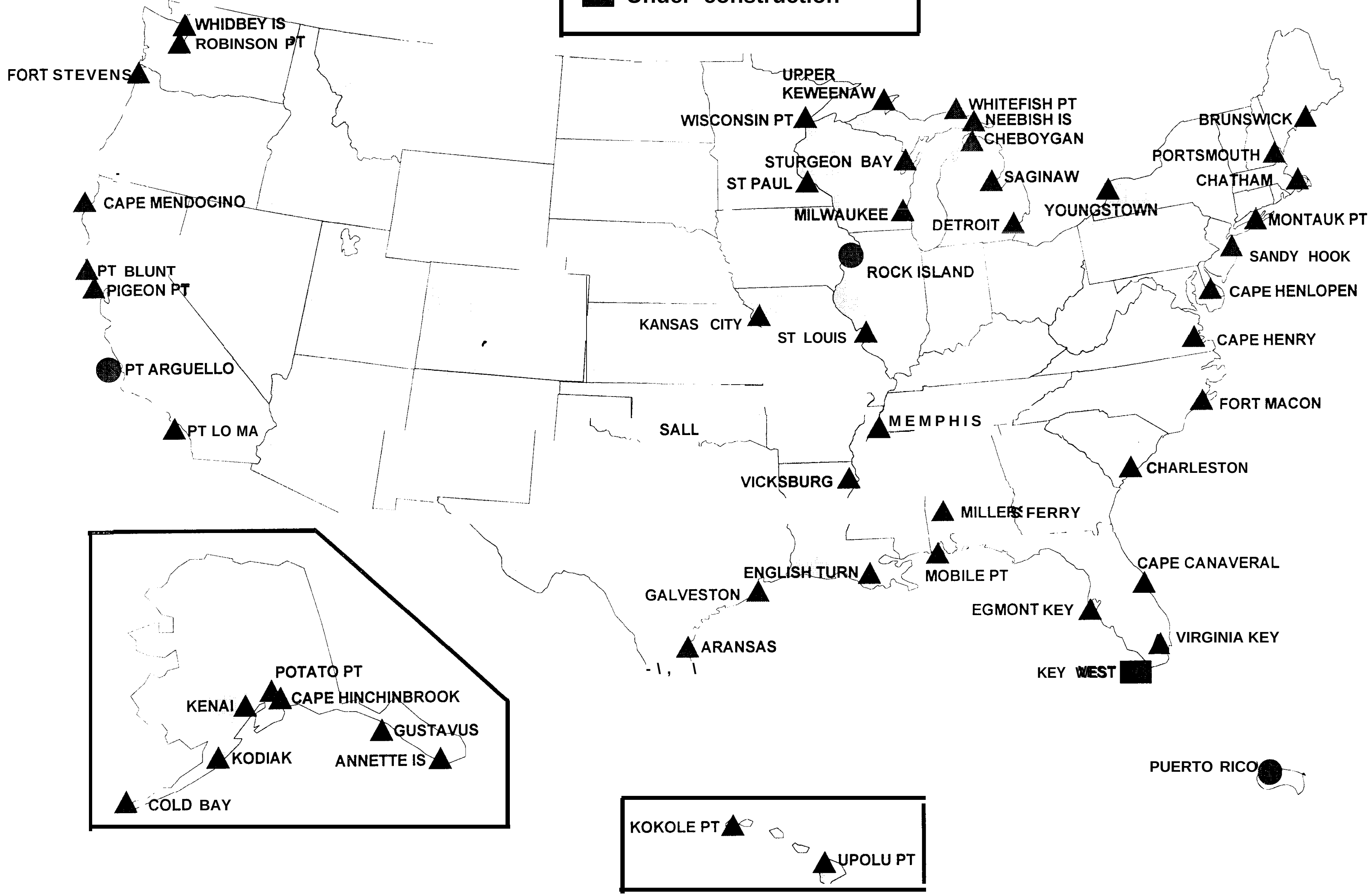
NSTB Milestones

Fielding to be Completed	August 1996
Communications Network Complete	January 1997
Software Development Complete	May 1997
Integration and Testing Complete	August 1997
Signal Available	October 1997

DGPS SITES

▲ Fully Operational
● Transmitting, No Comms
■ Under construction

09/13/96



APPEND X L

APPENDIX M

GPS - CHARTING CONCERNS

David Simpson, UK Hydrographic Office

INTRODUCTION

The purpose of this paper is to bring to the attention of chart users some of the navigational implications which have become apparent with the growing adoption of GPS (Global Positioning System) at sea. Action taken by the UK Hydrographic Office to make users aware of weaknesses in both GPS and charting are also discussed, as are possible future trends.

It should be noted that the views expressed herein are the result of the author's own experience and do not necessarily represent fully the current official policies of the UK HO.

THE SATELLITE ERA

In the 1960s satellite technology provided the means of defining a global datum based on the Earth's centre of mass and this has resulted in the development of the WGS 84 Datum, which relates the satellite-derived spheroid to the Geoid. A means of relating positions referenced to this global geocentric (ie. centred on the Earth's centre of mass) system to those referenced to local datums, as are most of the charts in the British Admiralty (BA) series, must be established. Figures 3 and 4 indicate the range of regional national and local datums in use.

TRANSFORMATIONS - SHIFTS FROM ONE DATUM TO ANOTHER

In order to convert positions on one datum to positions on another it is necessary to establish the relationship between a number of known points, common to both datums. The quality of the transformation so determined is dependent, amongst other factors, on the number and quality of these common points; generally, the more numerous, the better. However, no transformation is perfect since both the original datum and the datum to which positions are adjusted have inherent weaknesses which vary *over* their areal extent. Depending on the objective, transformation parameters may be tailored to provide best fit over limited areas, while introducing degradation in other, less important regions. The point being made is that datum transformations introduce errors which may be significant in the area of operation. GPS is referenced to WGS 84 Datum but most receivers have options to provide output positions referenced to any one of a large number of local datums in addition to WGS 84. However, the embedded parameters for the transformations are likely to be mean values for the whole area and their application, particularly in the extremities of the area of use of a given datum, might introduce errors of hundreds of metres. It is therefore preferable, from a navigational point of view, to maintain positions referenced to WGS 84 Datum whenever possible.

HORIZONTAL DATUMS AND CHARTS

Approximately 10% of the world-wide BA series of 3300 navigational charts are on WGS 84 Datum (ie having a WGS 84 graticule) with a much smaller and diminishing number on the superseded WGS 72 Datum. The shift between these datums reaches a maximum of about 17 metres at the Equator, being zero at the poles, and is therefore significant for charts of about 1:50,000 scale and larger, especially in low latitudes. There are several reasons why so few charts in the BA series are, as

yet, referenced to WGS 84:

(1) WGS 84 is a recent development and it would take a considerable period of time to replace existing charts with new editions using the new datum.

(2) National consistency, such as the mapping and charting of the UK. It is currently UKHO charting policy to publish charts referred to the national datum, OSGB 36, so that both charts and maps are referred to a common horizontal datum and thereby provide a seemless base for users. **However**, recent commitments to the creation of a digital database in vector form, for use in ECDIS (Electronic Chart Display and Information Systems), require that positions are referenced to WGS 84 Datum. It is inconceivable to have paper and digital charts on different horizontal datums!

(3) Lack of control data available to calculate a shift from the chart datum, if indeed the chart is on a defined datum, to WGS84 Datum.

Where charting policy is to maintain reference to a national or local datum, it has been recognised that, with the rapid increase in GPS use for navigation at sea, there is a need for shift values which relate the local chart datum to WGS 84 Datum so that satellite - derived positions can be adjusted and plotted directly. To date, these have been calculated and are quoted for about 45% of the BA series. They are expressed in minutes of latitude and longitude but are provided only if there is sufficient, good quality horizontal control in the area and errors would not be plottable at the scale of depiction. For example, if, in a given area the relationship between local horizontal datum and WGS 84 Datum cannot be established to an accuracy better than, say 20 metres and positions can be plotted to a precision of 0.2 millimetres, it would mean that this error would become significant at scales larger than 1:100,000. Thus, shift values could not be provided for larger scale charts, which would remain referenced to the local datum only. Similarly, if the relationship between the chart datum and WGS 84 Datum can be calculated to a high degree of accuracy and it happens to be small, then it will only be significant at the largest scales and smaller scale charts may be stated as being on WGS 84 Datum, because the shift is not plottable. This is relatively simple when scales of depiction are fixed, but becomes more problematical as chart data is provided for ECDIS systems, where users may increase scale inappropriately and fail to realise the significance of poor positional accuracy.

GPS - HOW COMPATIBLE WITH CHARTS?

The development of GPS (Global Positioning System) has made available a continuous, world-wide, all-weather positioning system which has the potential to provide users with greater accuracy than has been possible before.

The application of SA provided a major stimulus for the development of Differential GPS whereby corrections to the pseudoranges measured between each satellite and the receiver are transmitted to the user's receiver from a Reference Station, whose position has been determined accurately. This method can eliminate almost completely the effects of SA and enables real-time positional accuracies of 5-10 metres to be attained at sea. However, there remains the problem of integrity, whereby a user seeks assurance that his positional accuracy remains within tolerances. Large deviations from true position may occur but there are, as yet, no guarantees that these excursions can be detected and eliminated in real-time. Users must therefore be cautious of over-reliance on the system.

Whereas positional accuracies available via satellite systems are improving rapidly the fact is that charts are based on a mixture of old and newer data which are melded together by the art of the compiler. It is not possible to standardise or improve rapidly charts whose construction is constrained by source material of variable quality. Even when positional information becomes available such that a shift to WGS 84 Datum can be calculated with confidence, what does this mean for offshore features surveyed by leadline and horizontal sextant angles in the last century? With what degree of confidence can they be stated to be referenced to WGS 84 Datum?

CHART POSITIONAL ERRORS CORRECTED BY SATELLITE IMAGERY

During the last dozen or so years the UKHO has made increasing use of satellite imagery such as LANDSAT and SPOT to assist in the rectification of gross positional discrepancies. It has become a routine procedure to acquire satellite imagery in support of revised or new charting in areas where conventional data is lacking or is of dubious quality. Often, the use of such imagery represents the only reliable, quick and cost-effective means of correcting coastlines and positioning visible features of navigational significance.

A recent example is offered by the revised scheme of charts of the Maldive Islands. The general cover of these islands in the Indian Ocean has been provided by three fathoms charts, 66A, B and C, at a scale of approximately 1:280,000 and dating from the middle of the nineteenth century. Acquisition of LANDSAT imagery has enabled a new metric series of four charts to be compiled at a scale of 1:300,000. The satellite imagery allowed repositioning of atolls and rectification of distortions in their shapes. In some cases these positional shifts have amounted to 4 minutes of longitude while in others they have been negligible, thus indicating the lack of overall positional control in the island chain. The larger positional discrepancies would certainly be significant to a navigator placing undue trust in the relationship between charted positions and those output by his WGS 84 referenced GPS receiver.

The large areal coverage provided by satellite imagery has enabled the limited horizontal control available to be extended throughout the island group such that the new metric charts have been referenced to WGS 84 Datum. Replacement of the fathoms charts of the Maldives by metric charts 1011 - 1014 was completed during 1993.

SUMMARY AND FURTHER COMMENTS

1. The increasing use of global navigation satellite systems such as GPS promotes the need to reference charts to WGS 84 Datum.

2. With charts referenced to WGS 84 Datum there is no need to degrade GPS positional output by datum transformation.

3. In cases where there is limited horizontal control available to define WGS 84 in the area of chart coverage it might be possible to estimate the likely error and indicate to the user that a chart is referred to WGS 84 Datum to an accuracy of, say, ±50 metres throughout its extent.

4. It is considered useful to include a worked example if a datum shift note appears on a chart. This should help to avoid the doubling of error which results if shift values are applied in the wrong sense.

5. The practice of qualifying positions by quoting a horizontal datum should be encouraged. This serves to remind users of the possible significance of plotting a position referred to one datum on a graphic (including ECDIS) referred to another, as could happen if, for example, a Notice to Mariners issued by country X, on their national datum, was to be plotted on a BA chart referred to WGS 84 Datum.

"In operation Desert Storm, B-52s missed targets because they initialized their INS at Diego Garcia on a different datum from the one used to reference the target location. The datum shift exactly equaled the miss direction and distance. To add further confusion, 11 different datums covered the theater of war." (Naval Aviation MC&G Handbook)

6. Mariners should use the indicators provided by charts to assess the likelihood of positional problems. These include positions notes which might state that horizontal datum cannot be determined. Other indicators such as the antiquity of the source material or the lack of reference to horizontal control beneath the title should also be considered. Similarly, notes may caution that sections of coastline, or islands, have been reported to be out of position. All these can provide clues to the reliability of positional control.

For example, BA 203 - Nisos Zakinthos to Nisos Paxoi - is a modern metric chart depicting part of the west coast of Greece at a scale of 1:150,000. It is on ED50 and carries notes providing shift values for satellite - derived positions and warning of positional discrepancies between it and fathoms charts of the area. Part of BA 203 is covered at a larger scale, 1:51,040, by fathoms chart 3496. This was published in 1905 and was compiled from surveys conducted in 1892 and 1904. There is no reference to a defined horizontal datum but the chart carries two notes, one of which indicates that, "longitudes should be diminished by about one minute (1928)" while the other points out discrepancies between it and BA 203 and recommends the transfer of position by distance and bearing.

Also within the limits of BA 203 is a panel on BA 1620. This is a fathoms chart published in 1866. The 1:48,500 scale plan of part of Levkas Island is ungraduated and is based on a survey of 1864. The only positional reference is the quoted latitude and longitude of the Custom House beneath the title.

Charts 3496 and 1620 were withdrawn during 1995 but provided the largest scale representation of their respective areas until then.

7. Users must be aware of the limitations and inaccuracies of GPS.

8. When using GPS, especially in Differential mode, it should be appreciated that positional accuracy of charted features may be considerably poorer than the navigation system.

9. Reporting of GPS referenced positions would assist in the calculation of adjustments to charts. In July 1995 a form (H102b) was introduced in weekly BANMs. This requests ships' observations, preferably alongside, of GPS position (WGS 84 Datum) and position on the chart (chart datum). To date this exercise has revealed more about the knowledge of the observers than useable data!

10. User education. Annex A is a reproduction of a recently issued Notice to Mariners, number 2649(P) of 1996, which summarises many of the consequences of using GPS derived positions on BA charts.

CONCLUSION

Many charts have significant inherent positional weaknesses resulting from the antiquity and inadequacies of some of the source material used in their compilation. Thus, a mariner may be tempted to make use of his apparent 10 metre navigational accuracy provided by DGPS to skirt dangers whose charted positions could be many hundreds of metres from their real location, rather than give them a suitably wide berth. The problem of having a navigation system which can be many times more accurate than the charts on which positions are plotted becomes more significant as we enter the ECDIS era. This important topic is receiving the attention of the International Hydrographic Organisation.

It is essential that the mariner is made aware of the potential inaccuracies and weaknesses in both his navigational fixing system and his charts and, whenever possible, makes use of independent navigation aids to confirm positions.

Charts can be demonstrated to be compatible with GPS to varying degrees. It is the responsibility of the chart maker to improve the positional accuracy of his product and to warn users of existing failings and weaknesses. It is incumbent on the user to heed these warnings and to make use of both charts and GPS (GLONASS etc) prudently.

ms5.001

NM2649(P)/96 - SATELLITE NAVIGATION SYSTEM POSITIONS AND BRITISH ADMIRALTY CHARTS

1. The United States NAVSTAR Global Positioning System (GPS) is a satellite navigation system which is operated by the US Department of Defense and provides a continuous world-wide position fixing system. The accuracy quoted in Standard Positioning Service (SPS) mode is 100 metres for 95% of the time. This degree of accuracy is artificially constrained by the use of Selective Availability (SA) which is a method employed by the US DoD to degrade the signals and thereby prevent all but authorised users from making use of the full potential of GPS. Mariners should not attempt to navigate to a greater accuracy since there is currently no indication of the real time system performance. This accuracy of 100 m approximates to 0.05 arc min of Latitude.

2. Differential GPS is based on the use of a reference station at a known position which can negate much of the degrading effect of SA and other GPS errors (ie clock, ionospheric and tropospheric errors etc.) by providing frequent satellite range corrections to the mobile whose position is required. dGPS networks are becoming increasingly available in coastal waters and for port approach. In order to make use of corrections transmitted from reference stations it is necessary to have suitably enhanced receiver/aerial.

3. The GLONASS (Global Navigation Satellite System) constellation of 24 satellites became operational in January 1996. It is operated by the Russian Federation and is similar in concept to GPS with the notable exception that signals are not degraded by SA. Receivers capable of using signals from both GPS and GLONASS are available and these combined sources of positional information should lead to greater confidence of accuracy.

4. Details of GPS, dGPS and GLONASS are given in Admiralty List of Radio Signals, vol 2.

5. GPS is referenced to the World Geodetic System 1984 (WGS 84) Datum. This datum relates positions on the Earth's surface, or in space, to a mathematically defined figure, in this case the WGS 84 spheroid (often referred to as an ellipsoid) which is used to approximate, or model, the complex shape of the Earth. Its origin is the Earth's centre of mass and it provides positional reference throughout the world. WGS 84 is thereby a global, geocentric datum. GLONASS uses the SGS-90 spheroid, whose relationship to the WGS 84 spheroid can be determined.

6. Local or regional datums such as European Datum 1950 (ED 50) use different, non-geocentric spheroids which provide close approximation to the shape of the Earth over a selected area but become progressively poorer beyond that region.

It is **essential**, wherever possible, that the datum to which positions are referred is compatible with the datum used for the chart on which the position is to be plotted. If this is not the case then care must be taken to take account of differences.

7. Charts referred to WGS 84 Datum are currently few in number, but enable GPS-derived positions, referred to WGS 84 Datum, to be plotted directly. The objective is to refer all charts to WGS 84 Datum, but this will take time and can only be progressed as relationships between existing charted detail and that datum are established.

8. Charts having a 'SATELLITE-DERIVED POSITIONS' note provide latitude and longitude shift values which enable GPS-derived positions

to be adjusted before plotting on the chart. However, the absence of such notes should **not** be taken to imply that WGS 84 Datum positions can be plotted directly on a chart, simply that the chart has not been examined and updated positionally since 1981. Tables of shift values for additional, which have been examined but not yet updated, are issued periodically as Preliminary NMs and will be made available in subsequent Annual NMs.

9. Recent shift notes include an example, unique for each chart, which depicts how the adjustment should be applied. For instance, if the shift is 0.07 min S, 0.24 min E, the example might be:

Sat-Derived posn (WGS 84 Datum)	64 22.00 N,	121 30.00 W
Lat/Long adjustments	0.07 St	0.24 E
	---- ---- ---	----- ----- -
Adjusted posn (compatible with chart)	64 21.93 N,	121 29.76 W

In this example, by no means exceptional, the shift equates to approx 230 metres, which is plottable at all scales greater than about 1:1,000,000.

10. Most GPS receivers now have the facility to permit the transformation of positions from WGS 84 Datum to a variety of ***local*** horizontal datums. The generalised parameters used in the software may differ from those used by the UKHO, resulting in the possibility that positions may not agree with the chart, even if the horizontal datum is stated to be the same. It is therefore recommended that the **GPS** receiver is kept referenced to **WGS 84** Datum and the position shift values provided on the chart are applied before **plotting.**

11. The remaining charts, some of which carry a note stating that a satellite-derived position shift cannot be determined, are those for which insufficient details of horizontal datum are known. It is important to note that in the worst cases, such as isolated oceanic islands or charts of great antiquity, positions may be several miles discrepant from those derived from GPS. Internal positional discrepancies in such charts are the result of horizontal control inconsistencies within, and between, sources of data used in their compilation and MAY BE SIGNIFICANT TO **NAVIGATION.** Mariners are therefore advised to make greater use of classical methods of observational position fixing when closing the shore of navigating in the vicinity of dangers. The relative positions of features may be more reliable for navigation than the use of unadjusted satellite - derived positions on a chart whose horizontal datum cannot be defined.

12. Mariners visiting regions where charts carry no note, or bear the note stating that differences cannot be determined, are requested to report observed differences between positions referenced to chart graticule (ie chart datum) and those from GPS, referenced to WGS 84 Datum, using Form H102b - included in every weekly edition of NMs. The results of these observations are examined and may enable the calculation of approximate shift values between WGS 84 Datum and the datum of the chart.

13. WGS 84 Datum was introduced as the reference datum for GPS in January 1989 and superseded WGS 72 Datum. The maximum difference between these reference datums occurs at the Equator and amounts to 4.5 metres in latitude and 17.1 metres in longitude. These differences reduce to zero at the Poles. Several Admiralty charts still carry a note giving the positional shift from WGS72 Datum "Satellite-Derived positions" to the horizontal datum of the chart. These shift notes will be altered to refer to WGS 84 Datum on future New Charts and New Editions but, in the interim, a shift of 0.01 min Westward must be applied to WGS 72 positions to convert to WGS 84 Datum.

14. positions plotted on, or extracted from, a chart will contain an element of imprecision related to the scale of the chart. Thus, for example, at a scale of 1:600,000, a chart user who is capable of plotting to a precision of 0.2 millimetres must appreciate that this represents approximately 120 metres on the ground. A position shift, say from one datum to another, of this magnitude is therefore meaningless at such a scale. Similarly, at 1:25,000, the plotting error may be about 5 metres.

Thus, if WGS 84 positions could be defined only to an accuracy of 10 metres, this would be unplottable at the smaller scale, in the example, (the chart could effectively be said to be on WGS 84 Datum) but would be plottable, and therefore significant, at the larger. This explains why it is not uncommon for small and medium scale approach charts to be referenced to WGS 84 Datum while the larger scale port plans have no quoted horizontal datum.

Hydrographic Office (HA 405/06/04/01).

CIVIL GPS SERVICE INTERFACE COMMITTEE MEETING, SEPTEMBER 1996

GPS CHARTING CONCERNS

David Simpson

UK Hydrographic Office

ADMIRALTY CHARTS AND PUBLICATIONS

Fig 1

3. HORIZONTAL CHART DATUMS

- 10% BA charts on WGS (72/84)
- 45% on known datum
- 45% on unknown datum

Therefore electronic versions have unquantified error when displaying WGS 84 positions obtained from GPS

Hydrographic Office

Fig 2

NUMBER OF CHART PANELS ON EACH HORIZONTAL DATUM

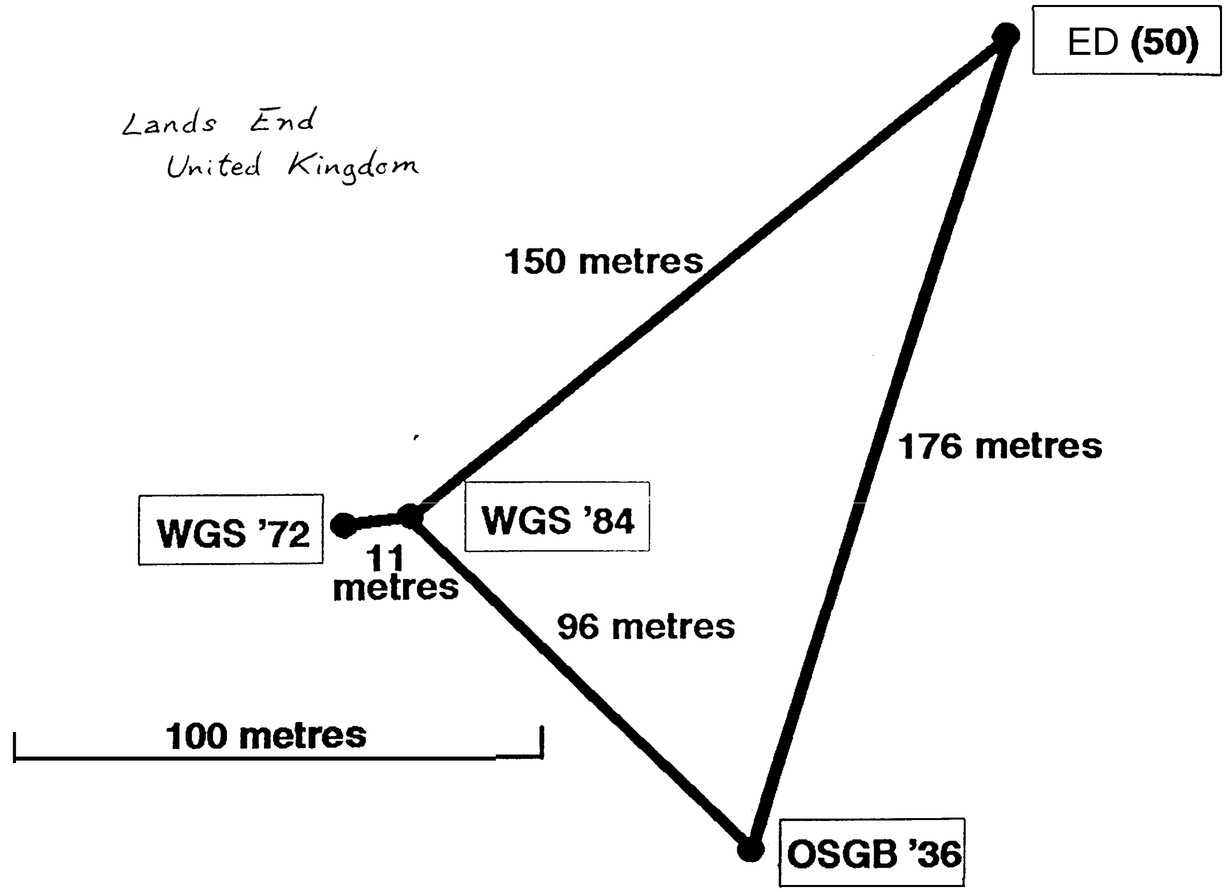
ABIDJAN	3
ARC (1950)	12
ARC (1960)	1
AUSTRALIAN GEODETIC	287
BATAVIA, JAVA, JAKARTA	5
BISSAU BASE NORTH WEST END PILLAR	5
BOGOTA	1
BUKIT RIMPAH	4
CASTELO DI SAO JORGE (LISBOA) {BESSEL}	1
CASTANIA	5
CORREGO ALEGRE	36
GUX 1 ASTRO	30
EUROPEAN (1950)(ED50)	801
FIJI (1986)	2
FIJI (1956)	21
GEODETIC DATUM (1949)	69
FINNISH (HELSINKI)	8
HERMANSKOGEL (VIENNA)	20
HJORSEY	5
HONG KONG (1963)	13
IGN (NORTH BLOCK, BELLEVUE)	20
IGN (SOUTH BLOCK, TANNA)	9
INDIAN (SURVEY OF INDIA)	58
ITARARE N BASE, ITAJUBA-SANTA CATARINA	2
KANDAWALA (1933)	12
REVISED KERTAU	39
LE POUCE	3

Fig.3

NAPARIMA (1955)	11
NORTH AMERICAN DATUM (1927) (NAD27)	206
NORTH AMERICAN DATUM (1983) (NAD83)	20
NOUMEA, NOUVELLE-CALEDONIE IGN (1972)	1
ORDNANCE SURVEY OF GREAT BRITAIN (1936)	641
OLD HAWAIIAN	11
ORDNANCE SURVEY OF IRELAND	136
PANAMA COLON	4
PHARE D'AYABELLE	2
PICO DE LA NIEVES	3
NEW PORTO SANTO	5
PROVISIONAL SOUTH AMERICAN (1956) PSAD56	46
REYKJAVIK	1
FALKLAND ISLANDS (1943)	44
SOUTH EAST ISLAND	10
SIERRA LEONE (1960)	6
TETE	1
TIMBALAI (1948) {BESSEL}	23
TIMBALAI (1948) {EVEREST}	2
TOKYO	185
VITI LEVU (1916)	1
WGS (1972)	111
WGS (1984)	41
OGB & OSI	11
UNKNOWN	3723
TOTAL	6938

(Total of 6938 panels on 3306 navigational charts)

Fig.4



HYDROGRAPHIC OFFICE Fig 5

GPS AND NAUTICAL CHARTS

HOW COMPATIBLE?

Hydrographic Office

Fig 6

CHARTS - STRENGHTS

1. WORLD-WIDE COVER
2. REPUTATION FOR RELIABILITY
3. UPDATED FOR CHANGE
4. ESTABLISHED FORMAT

Hydrographic Office

Fig 7

CHARTS - WEAKNESSES

1. VARIABLE QUALITY OF SOURCE MATERIAL
2. POSITIONAL ACCURACY
3. LACK OF FLEXIBILITY

Hydrographic Office

Fig 8

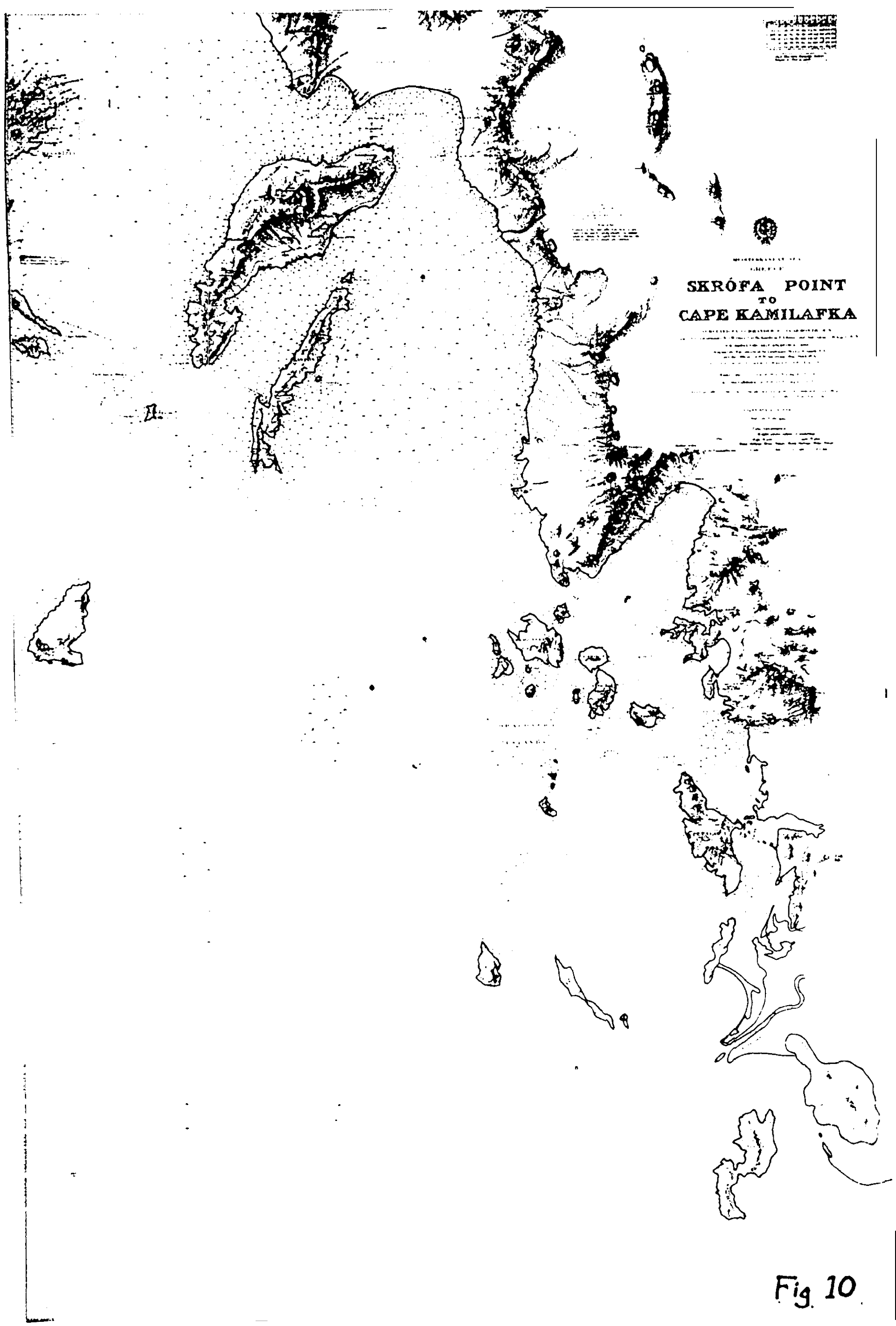

SKRÓFA POINT
TO
CAPE KAMILAFKA

Fig 10

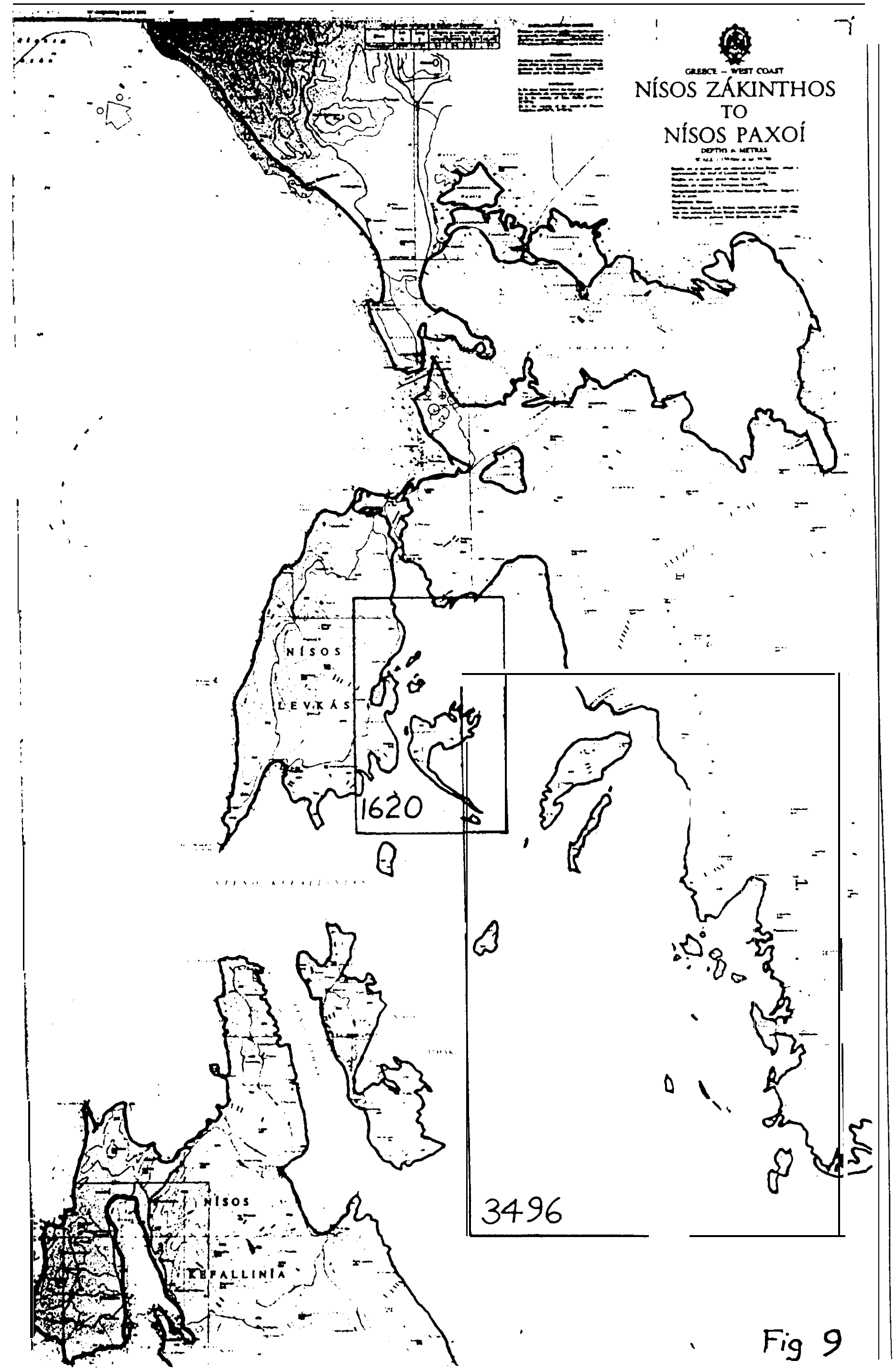

GREECE – WEST COAST
NÍSOS ZÁKINTHOS
TO
NÍSOS PAXOÍ
DEPTHS in METRES
NÍSOS
LEVKÁS
1620
3496
NÍSOS
KEFALLINÍA

Fig 9

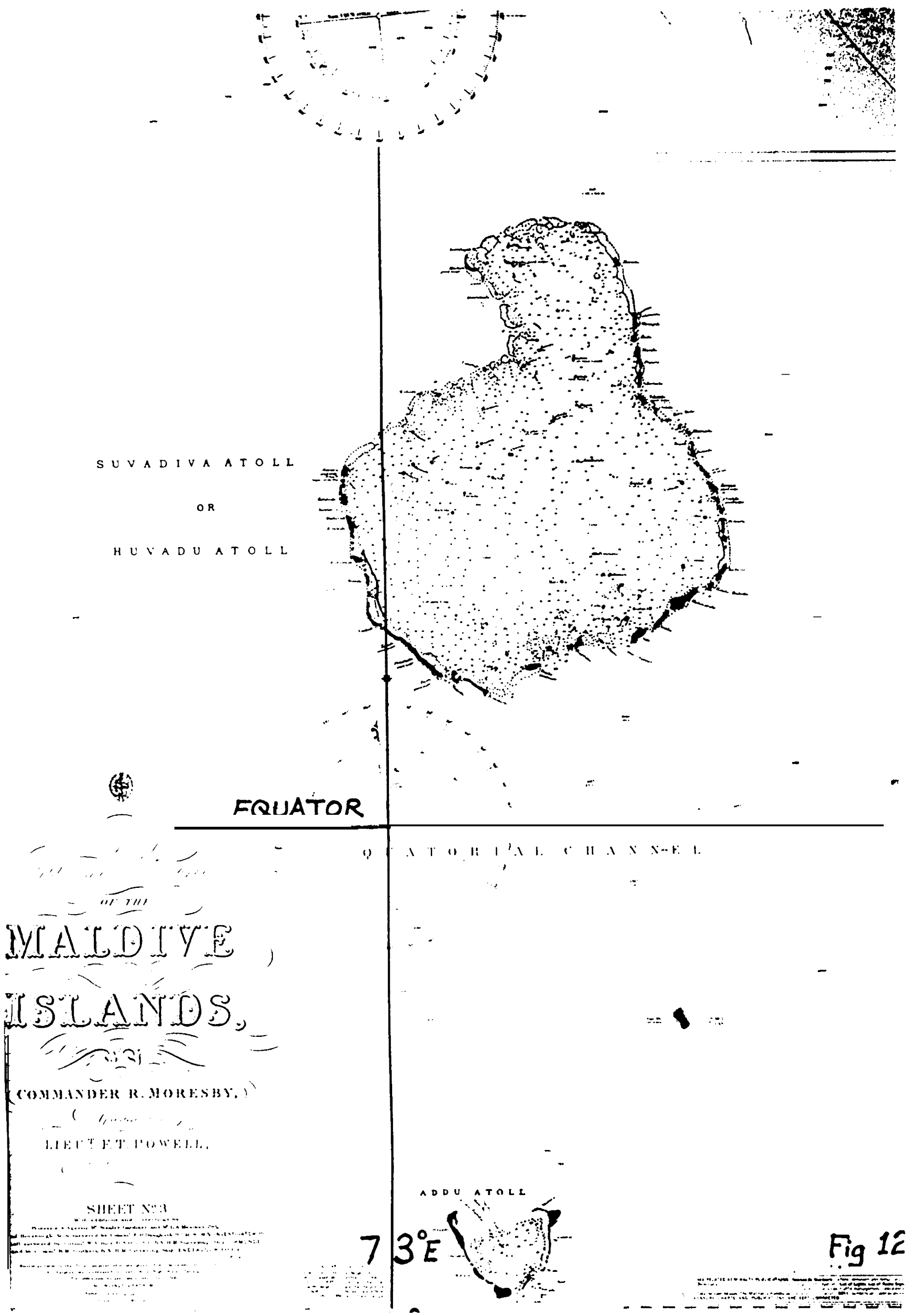

SUVADIVA ATOLL
OR
HUVADU ATOLL
EQUATOR
ATORIAL CHANNEL
MALDIVE
ISLANDS,
COMMANDER R. MORESBY,
LIEUT. F.T. POWELL,
SHEET No. 3
ADDU ATOLL
73°E

Fig 12

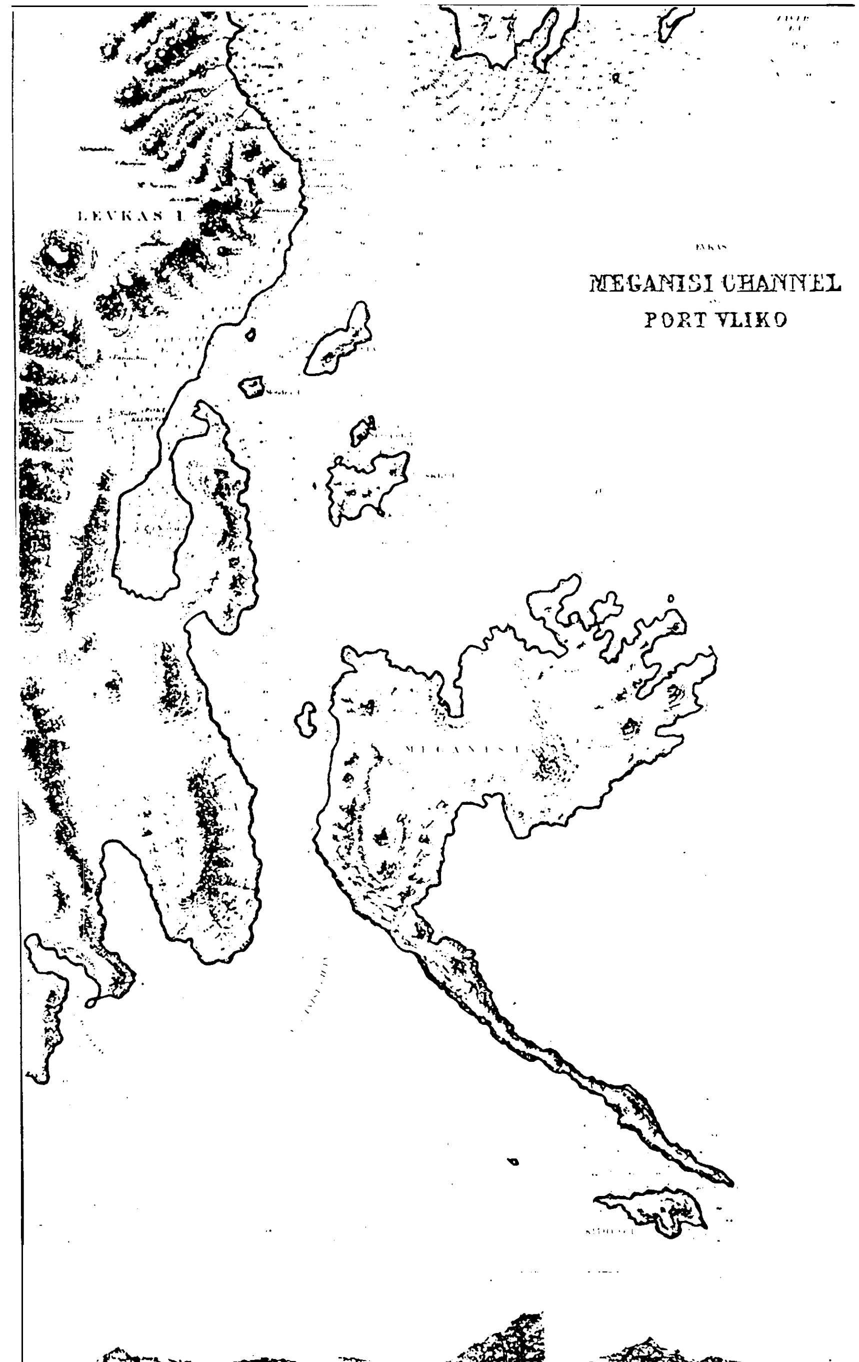

LEVKAS I.
MEGANISI CHANNEL
PORT VLIKO

Fig 11

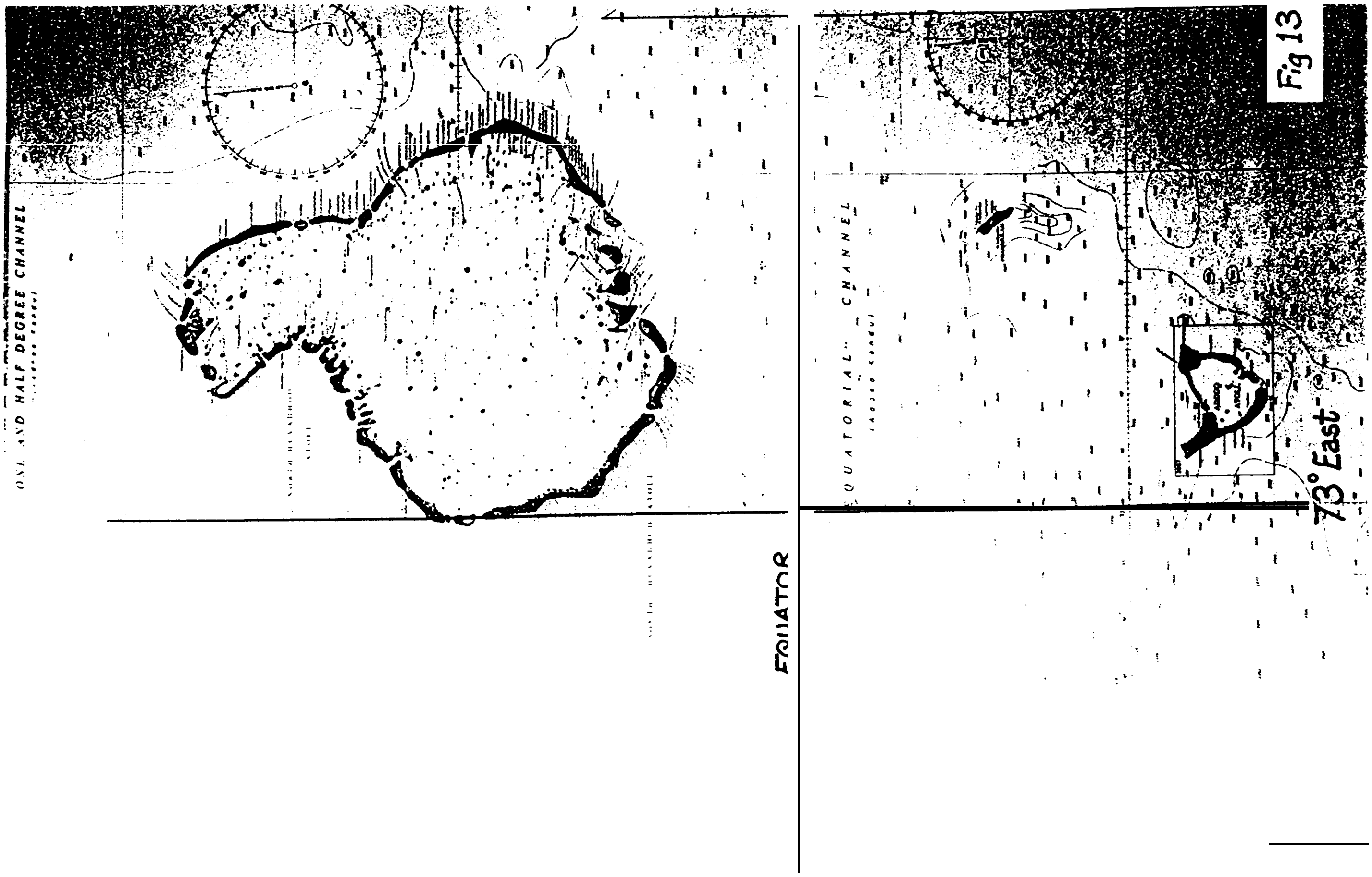


Fig 13

CHARTS - OPPORTUNITIES

1. DIGITAL DATA LEADING TO DEVELOPMENT OF 'ECDIS'
2. TAILOR PRODUCTS TO MEET PARTICULAR USER NEEDS

Fig 14

Hydrographic Office

CHARTS - THREATS

1. USER IGNORANCE / OVER-RELIANCE
2. ACCESS TO DATA IS NOT GUARANTEED

Hydrographic Office

Fig 15

ACTION

1. EDUCATE
   STRENGTHS & WEAKNESSES OF BOTH
   [BA NMs 942 & 943 OF 1993]
2. REFER CHARTS TO WGS 84 DATUM
   SHIFT NOTES
   WGS 84 GRATICULE

Fig 16

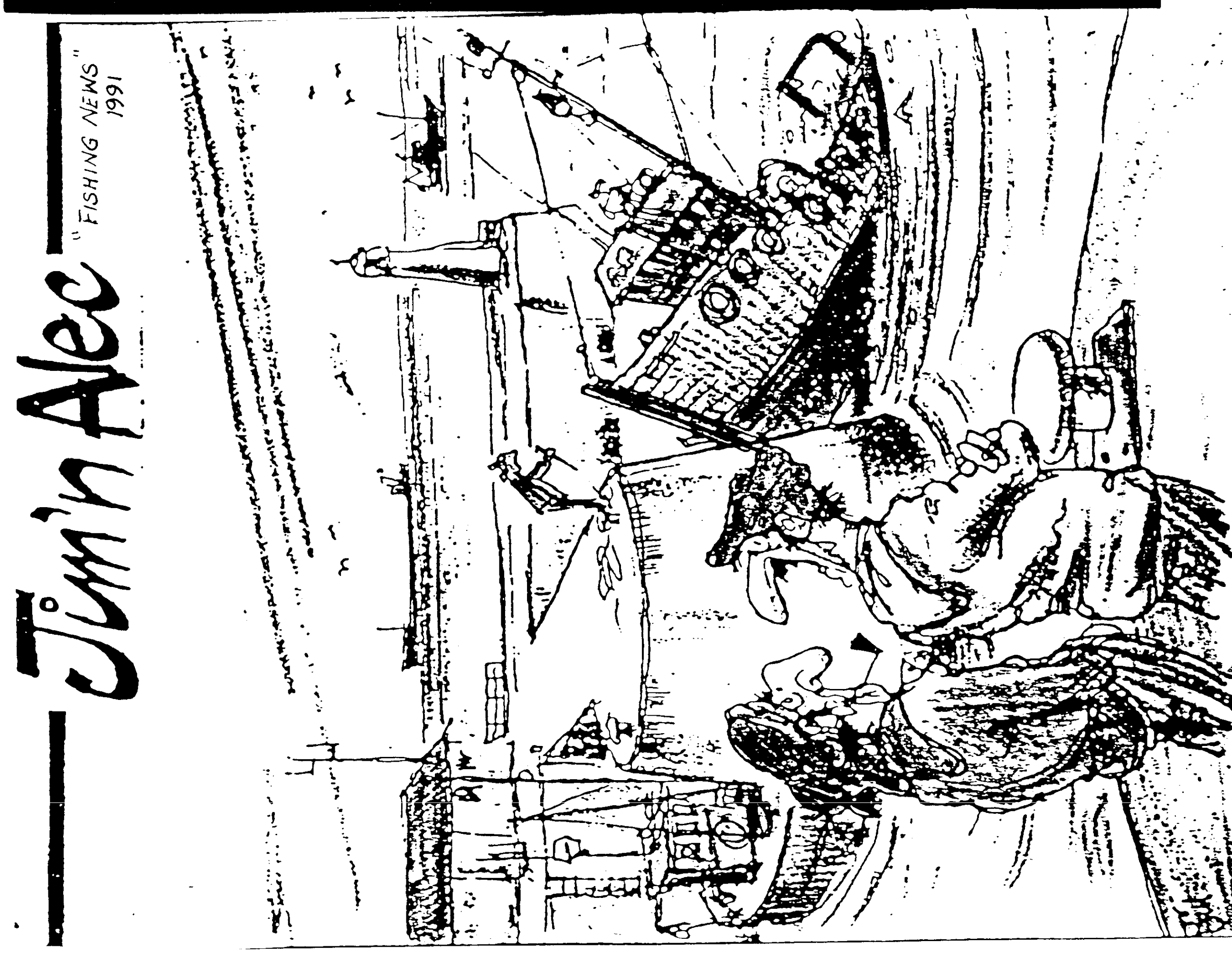
Hydrographic Office

CONCLUSION

CHARTS CAN BE DEMONSTRATED TO BE COMPATIBLE WITH GPS TO VARYING DEGREES. IT IS THE RESPONSIBILITY OF THE CHART MAKER TO IMPROVE THE POSITIONAL ACCURACY OF HIS PRODUCT AND TO WARN USERS OF EXISTING FAILINGS AND WEAKNESSES. IT IS INCUMBENT ON THE USER TO HEED THESE WARNINGS AND TO MAKE USE OF BOTH CHARTS AND GPS PRUDENTLY.

Hydrographic Office

Fig 17



"The interface between global positioning systems and the human brain deserves further critical attention."

Fig 18

International Federation of Surveyors
Federation Internationale des Geometres
Internationale Vereinigung der Vermessungsingenieure

FIG'98

- Founded in 1878 in Paris
- Federation of national associations
- UN-recognized non-governmental organization
- Nearly 100 countries represented
- Nine technical commissions
- A country hosts administrative offices for 4 years
  - Currently located in London, UK
  - Next term beginning 1999, located in USA

International Federation of Surveyors

In addition to their involvement with FIG congresses and working weeks, commissions, many of which establish their own working groups, organise or co-sponsor a wide range of seminars and workshops, sometimes in collaboration with member associations

Member associations are each entitled to appoint one national delegate to each commission; and commission chairmen often co-opt additional experts to assist with particular aspects of their work programmes

HOW IS FIG ADMINISTERED?
By its permanent committee - members of the bureau, delegates of the member associations and chairmen of the commissions -which meets annually during the FIG working week or the FIG congress. The permanent committee debates and approves policies. Responsibility for polices implementation rests with the bureau, which meets at least twice a year.

For the moment, FIG has no permanent office. Each bureau is therefore provided on a four-year rotational basis from within the member associations. The administering association provides five members of the bureau - the president, one of the three vice-presidents, the secretary-general, the treasurer and the congress director. The two other vita-presidents are nominated respectively by the preceding and successor administrations.

The work of the permanent committee and the bureau is assisted by an advisory committee of commission officers; ad hoc task forces appointed from time to time to review existing and develop new strategies; and three permanent institutions the International Office of the Cadastre and Land Registry (OICRF), the FIG multi-lingual dictionary board and the FIG archives.

HOW DOES FIG COMMUNICATE?
The Figtree, which is available on the Internet World Wide Web *(e-mail address: http://www.ps.ucl.ac.uk/figtree), and* includes:

- the FIG plan of work
- names and addresses of bureau members, commission officers, member associations, correspondents, sponsor members and national delegates to the commissions
- forthcoming events
- a list of FIG publications

The FIG annual report - an overview of major activities and achievements and FIG's main medium of external communication

The FIG bulletin a quarterly newsletter and the main medium of internal *communication*

m m -

International Federation of Surveyors

The FIG publications series - formal policy statements and ethical, educational and technical guidelines.

Proceedings of FIG congresses and of selected technical seminars sponsored or co-sponsored by FIG's commissions and member associations.

Commission newsletters - for the dissemination of information specifically concerned with the work of individual commissions.

HOW IS FIG FINANCED?
Operating costs are largely financed by subscriptions paid by member associations and sponsor members. Rates are approved annually by the permanent committee.

Other activities, including congresses, technical seminars and administrative meetings, are selffinancing. In the case of meetings income is raised from registration fees, which may be supplemented by income from an accompanying technical exhibition, by subventions from the host government or association or by grants from aid agencies.

WITH WHOM DOES FIG CO-OPERATE INTERNATIONALLY?
As a United Nations-recognised NGO, FIG has developed strong links with several UN ● gencies, notably the UN Centre for Human Settlements (UNCHS - HABITAT), the Food and Agricultural Organisation (FAO) and the UN Department of Development Support and Management Services (DDSMS). FIG collaborates with these agencies, often through joint workshops, in identifying problems associated with the ownership and management of land and in developing practical solutions.

FIG is a member of the International Union for Surveys and Mapping (IUSM) and an international scientific associate of the International Council of Scientific Unions (ICSU).

FIG BUREAU MEMBERS, 1996-99

President:	Peter Dale (UK)
Vice-presidents:	Bob Foster(USA)
	Tom Kennie (UK)
	Grahame Lindsay (Australia)
Secretary-general:	Roy Swanston (UK)
Treasurer	Michael Rainbird (UK)
Congress director:	John Leonard (UK)

For further information
consult the Figtree or contact the FIG Bureau office

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international **Federation** of Surveyors
Fédération International. **des Géomètres**
Internationale Vereinigung der Vermessungsingenieure

The International Federation of Surveyors is an international, non-governmental organisation whose purpose is to support international collaboration for the progress of surveying in all fields and application

APPENDIX N

mm - International Federation of Surveyors

mm - International Federation of Surveyors

mm - International Federation of Surveyors

WHO ARE SURVEYORS?

Surveyors are professional people whose academic qualifications and post-graduate training enable them to advise on the management and use of land and property, both rural and urban and whether developed or undeveloped. Surveyors understand the legislation governing land and property; the markets trading in it; the services supporting it; and the economics of construction, management, maintenance, acquisition and disposal.

Practice of the surveyor's profession revolves a broad range of activities which may occur on, above or below the surface of the land or the sea, and which may be carried out in association with other professionals.

WHAT IS FIG?

FIG was founded in 1878 in Paris. It is a federation of national associations and is the only international body that represents all surveying disciplines. It is a UN-recognised non-governmental organisation (NGO) and its aim is to ensure that the disciplines of surveying and all who practise them meet the needs of the markets and communities that they serve. It realises its aim by promoting the practice of the profession and encouraging the development of professional standards

FIG's activities are governed by a plan of work which is regularly reviewed against a longer-term strategic plan. The current plan of work focuses on the surveyor's response to social, economic, technological and environmental change and the particular needs of countries in economic transition. FIG also recognises that markets for surveyors' services are constantly changing. The plan accordingly lays emphasis on strengthening professional institutions; promoting professional development; and encouraging surveyors to acquire new skills and techniques so that they may be properly equipped to meat the needs of society and the environment.

WHO ARE THE MEMBERS OF FIG?

Nearly 100 countries are represented in FIG - mainly by member association which are the leading professional societies of surveyors in their respective countries. In countries where surveying is organised in separate associations representing different activities of the profession, more than one national association may belong to FIG.

Correspondents may be appointed in countries in which there is not as yet an association of surveyors that would be eligible for membership of FIG.

FIG also appoints sponsor members - organisations, institutions or agencies which operate or provide commercial services in areas in which surveyors are active

HOW DOES FIG OPERATE?

FIG's technical work is led by nine technical commissions with the following terms of reference.

Commission 1 - Professional Standards and Practice
Chairman Ken Allred (Canada)
Fax + 14034293374
Codes of ethics and guidelines relating to the provision of services; standards of business practice and total quality management; the operation, management and structure of surveying practices; international legislation affecting the profession; the role of surveyors in the public service.

Commission 2 - Professional Education
Chairman: Prof. Stig Enemark (Denmark)
Fax: +45 98156541 e-mail: enemark@i4.auc.dk
Education and teaching methods; continuing professional development and training; the interaction between education, research and practice; encouragement of the exchange of students and personnel between countries.

Commission 3 - Land Information Systems
Chairman: Helge Onsrud (Norway)
Fax: +47 22342759
Land and geographic information systems - their design, establishment and administration; methods used for the collection, storage, analysis and dissemination of and access to data within those systems.

Commission 4 - Hydrography
Chairman: Wilfried Schleider (Germany)
Fax: +49 4941602378
The marine environment; hydrographic surveying: data processing and management; nautical charts and bathymetric maps - analogue, digital and electronic.

Commission 5 - Positioning and Measurement
Chairman: Larry Hothem (USA)
Fax: + 17036484722 e-mail: lhothem@usgs.gov
The science of measurement; acquisition of accurate, precise and reliable survey data related to the position, size and shape of natural and artificial features of the earth and its environment.

Commission 6 - Engineering Surveys
Chairman: Prof. Chen Yongqi (China)
Fax +852 23302994
e-mail: lsyqchen@hkpucc.polyu.edu.hk
Acquisition, processing and management of topographic and related information throughout the life cycle of a project; setting out methods in engineering projects; validation and quality control for civil construction and manufacturing; deformation prediction, monitoring, analysis and interpretation.

Commission 7 - Cadastre and Land Management
Chairman Prof. Ian Williamson (Australia)
Fax +61 3 347 4128
e-mail Ian Williamson@mac. unimelb edu.au
Land management and administration; cadastral reform and multi-purpose cadastres; parcel-based land information systems and computerisation of cadastral records; cadastral surveying and mapping; land titling, land tenure, land law and land registration; land consolidation; national and international boundaries.

Commission 8 - Spatial Planning and Development
Chairman: Markku Villikka (Finland)
Fax: +358 788801442
e-mail: markku.v.m.villikka@hollola.hollola.elisa.fi
Regional and local structure planning; urban and rural land use planning; planning policies and environmental improvement; urban development and implementation; environmental impact assessment.

Commission 9 - Valuation and the Management of Real Estate
Chairman: Brian Waldy(UK)
Fax: +44 1714778573 e-mail: e.b.d.waldry@city.ac.uk
Valuation of property; property investment and development finance, management of property; maintenance of systems to ensure the efficient use of resources; investment planning; advice on housing finance.

Commission 9 has established a working group to further the work of FIG in the field of construction cost economics.

Commission activity

The commissions prepare and conduct the programme for FIG's international congresses, which are held every four years and are attended by several thousands of participants from all over the world. Keynote addresses by internationally acknowledged experts, technical sessions and visits, and a major exhibition provide unique opportunities for the exchange of information, the acquisition of knowledge and the development of professional and technical skills

The next congress, FIG'98, will be held in Brighton, UK, on 19 - 25 July 1998. The following one will be in the USA in spring 2002

In each non-congress year FIG holds a working week, hosted by one of its member associations. This combines meetings of FIG's administrative bodies with technical seminars organised by some or all of the commissions During the period 1996-99 working weeks will be held in Argentina (15 - 19 April 1996), Singapore (11 - 15 May 1997) and South Africa (summer 1999).

INTERNATIONAL FEDERATION OF SURVEYORS
FEDERATION INTERNATIONALE DES GEOMETRES
INTERNATIONALE VEREINIGUNG
DER VERMESSUNGSINGENIEURE

FIG

Versión en Español

Commission 5

Positioning and Measurement

Chair (1994-1998): Mr. Larry Hothem (USA)

NEWS Sept. 12, 1996

Work Plan 1994-1998

Recommended Sites

Calendar

Current Officers

Working Groups

Publications | Reports & Minutes | Other FIG Sites | Become a Correspondant Member | Call for Papers

Website: http://surveying.wb.psu.edu/mainfig5.htm

FIG - Commission 5

Current Officers.

La versión en Español, puede encontrarse aquí.

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E-mail: lhothem@usgs.gov

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Sweden
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EMail: slaboch@Panurgos.fsv.cvut.cz

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Mr. Matt Higgins, Co-Chair
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Mr. W.J. Trevor Greening, Co-Chair
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EMail: msi@usa.net

WG 5.3-Satellite Positioning Systems
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EMail: marsella@dits.ing.uniroma1.it

WG 5.4-Kinematic Positioning Methods
Dr. Elizabeth Cannon, Co-Chair
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Mr. Holger Schade, Co-Chair
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(O) 41-71-70-3239, (FAX) 41-71-72-3710
EMail: hschah@lah.leica.ch

WG 5.5-Instrumentation and Data Access
Prof. Michel Kasser, Chair, WG 5.5
Director, Ecole Superieure des Geometres et Topographer
18 Alle Jean-Rostand, EVRY CEDEX, 91025, FRANCE
(O) +33-1-60780042, (FAX) +33-1-6936742
EMail: N/A

Back to FIG-Commission 5 Home Page.

This page was created on May 27, 1996.

FIG - Commission 5

Future Events and Meetings.

June 25-28, 1996- 8th International Symposium on Deformation Measurements, Hong Kong. Organized by Commission 6 with Commission 5 a cooperating organization.

July 13, 1996- Special IUSM **Technical Session on Automated Control Measurements** (ACM), in conjunction with **ISPRS** Congress, Vienna, Austria.

September 7-16, 1996- XII International Course in Engineering Geodesy, Graz, Austria, in cooperation with **IAG** and FIG Commission **5** and **6**. For additional information contact: Institute for Geodesy and Photogrammetry, Technical University of Graz, Steyrergasse 30, A-8010, Graz, Austria. Fax: (+43-316) 83-1793.

September 30, October 1 and 2, 1996 - **South American Workshop on the Future of Geodetic Control Networks**. La Plata, Argentina. Contact: Prof. C. Brunini.

October 2, 3 and 4 - **Property Surveying in the XXI Century**. La Plata, Argentina. Contact: Prof. C. Brunini.

November 13-14, 1996- International Symposium on "Application of Laser, GPS and GIS Technologies in Geodesy," Sofia, Bulgaria. Contact: Prof. G. Milev. FIG co-organizer.

January 23-27, 1997 - **ISO TC 211** 4th plenary meeting, Sydney, Australia

May 11-16, 1997 - Commission 5 co-organize with Commission 6 a joint technical session for Symposia held during the 64th FIG PC, Singapore.

June 2-6, 1997 - **Surveying of Large Bridge and Tunnel Projects**. Copenhagen, Denmark.

Commission 5 co-organize with Commission 4 and 6. Contact: S.K. Johansen, Danish delegate for FIG C6

June 3-7, 1997 - International Symposium in Kinematic Systems in Geodesy, Geomatics, and Navigation (KIS97), Banff, Alberta, Canada Commission 5 joint with IAG is organizing technical sessions. Contact: E. Cannon.

August 24-28, 1997 - Conference of South African Surveyors, iKUSASA, Durban, South Africa. Jointly organized sessions with other Commissions. Contact: Dr. Clarissa Fourie.

September 3-9,1997- IAG Scientific Assembly and XVIII Brazilian Congress of Cartography, Riocentro, Rio de Janeiro, Brazil. Contact: Denizar Blitzkow, EPUSP-PTR, Cx. Postal: 61548,05424-970, Sao Paulo, Brazil. E-mail: iag97@org.usp.br

Fall-Winter 1997 - (tentative) "Integrated Sensors for Positioning and Orientation," in cooperation with ISPRS and IAG Working and Study Groups, Rome, Italy

July 19-25,1998- XXI *FIG* Congress, Brighton, UK

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"Developing the Profession in a Developing World"

John Leonard CBE, Congress Director

"**The XXI International** Congress of Surveyors **(FIG '98) will** take place in Brighton on the south coast of England on 19-261998. We believe that attendance at this event will be important to all members of the surveying profession around the **world,** whatever their particular role in the management and use of land and **property.** The **programme** will be **comprehensive.** Supported by a major **exhibition,** it will cover all aspects of the surveying of land and marine resources and will reflect both technical and commercial facets of the property and construction **industry.** And of **course,** there will be lots of opportunities for meeting each other and enjoying **ourselves.**

This announcement is designed to allow you to get onto our mailing **list,** and to encourage you to make **a** note of the dates in **your diary. It will be followed by a programme** and booking form which will provide you with all the detail you need to reserve your **place.**

Please download and complete an application form so that we can send you the information you **need.**

I cannot address every potential **delegate** in their own **language,** but I hope that nevertheless you feel the warmth of our welcome **- I look** forward to greeting you at FIG '98.

Brighton, United Kingdom

APPENDIX O

WARSAW UNIVERSITY OF TECHNOLOGY
INSTITUTE OF GEODESY AND GEODETIC ASTRONOMY

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E-mail: sledzinski@gik.pw.edu.pl

GPS TECHNIQUES IN GEODETIC AND GEODYNAMIC PROGRAMMES OF THE CEI (CENTRAL EUROPEAN INITIATIVE)

Progress Report

Janusz Śledziński

Chairman and International Coordinator of the CEI Section C "Geodesy"
Chairman of the IAG Subcommission "Geodetic and Geodynamic Programmes of the CEI"
Co-Chairman of the CEI Project CERGOP

Paper presented at the 28th Meeting
of the Civil GPS Service Interface Committee (CGSIC)
Kansas City, Missouri, USA
16-17 September 1996

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INTRODUCTION

Central European Initiative (CEI) is an organisation established in 1989 with the aim to encourage an international cooperation of European countries in various areas of science, culture and economy. This organisation was formerly known as QUADRAGONALE, PENTAGONALE and in 1992 it was renamed as CENTRAL EUROPEAN INITIATIVE. The following countries are now full member countries of CEI Albania, Austria, Belarus, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Italy, Macedonia, Poland, Romania, Slovakia, Slovenia and Ukraine The main objectives of the CEI cooperation are to strengthen the stabilisation within the region of Central Europe and to promote all-European integration processes. It was agreed that a Summit (Heads of Governments and Foreign Ministers) would be held once a year in October and a meeting of Foreign Ministers of the member countries would be organised every year in April. Working Groups constitute the basic structural component of the CEI The cooperation in the Earth sciences and, in particular in geodesy, is developed within the Working Group "Science and Technology" established in June 1990. The programme of the Working Group on Science and Technology includes presently several endorsed scientific and technological projects (committees); one of them is Earth Science Committee that consists of three sections: Section A "Geology", Section B "Geophysics" and Section C "Geodesy". The cooperation in the Section C focuses mainly on three themes: (a) interconnection of geodetic control networks, (b) problems of GIS/LIS, and (c) geodynamic investigations.

GPS EUREF CAMPAIGNS IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

The significant essential changes of the political map of Europe resulted in the last time in longed-for real sovereignty and independence of most European countries Some of them express a wish to join the military NATO organisation and therefore to observe all NATO standards. The first essential action for geodetic services of these countries is to join the geocentric WGS-84 reference system. The easiest way to fulfil this task is to perform the EUREF (European Reference Frame) GPS campaigns. This action gives both connection to a unified European geodetic system and interconnection of geodetic control networks of all European countries. The EUREF campaigns are organised in cooperation with the IAG Subcommission EUREF by the Institut fur Angewandte Geodäsie (IfAG), Frankfurt/Main, Germany.

Many CEI Section C resolutions recommend that the national geodetic services of CEI countries should join the WGS reference system as soon as possible It is also recommended that transformation parameters from the ITRF/ETRF (International (IERS)/European Terrestrial Reference Frame) to the national coordinate systems used in particular countries and vice versa should be available as soon as possible for each CEI country.

In Table 1 you can find a list of all main EUREF GPS campaigns organised by the IfAG since 1990. In Fig. 1 the area of Europe covered by EUREF network is shown. To comment on the present situation it can be stated that all Central European countries have used the chance for a quick connection to the geodetic system of Western countries; the great efforts are now needed to persuade the East European countries to perform the EUREF campaigns in the near future.

CENTRAL EUROPE REGIONAL GEODYNAMICS PROJECT (CERGOP)

Project CERGOP (Central Europe Regional Geodynamics Project) initiated in 1993 by Hungarian and Polish scientists was approved for realisation by the CEI member countries in May 1993 in Książ Castle, Poland. Eleven countries participate in the CERGOP Project.: Austria, Croatia, Czech Republic, Germany, Hungary, Italy, Poland, Romania, Slovakia, Slovenia, Ukraine. One of the main objectives of the Project is to provide a precise geodetic frame - so called Central European GPS Reference Network (CEGRN) - necessary for studies on geodynamics of Central European Region (in particular Pannonia Basin, Bohemian Massif, Teisseyre-Tornquist Zone, Carpathian Orogenic Belt and Subalpine Region) and for connection of local geodynamic networks established on the territory of participating countries. Project CERGOP has got a financial support from European Union COPERNICUS Programme. As the Project Coordinator serves the Institut für Angewandte Geodäsie Frankfurt, FRG. The Project Steering Committee consists of the representatives of Germany, Hungary, Italy and Poland.

For technical reasons the number of sites of the CEGRN was limited to about 30 (Fig. 2). It was also decided that Graz Lustbühel Computing Centre (Austria) would serve as the CERGOP Data Centre. There are six CERGOP Processing Centres which process the observations of the CEGRN campaigns. These centres are: IfSR DSG Graz (Austria), IGGA WUT Warsaw (Poland), FÖMI SGO Pent (Hungary), VUGTK Pecny (Czech Rep.), STU Bratislava (Slovakia) and IfAG Frankfurt (Germany).

The first GPS zero-epoch observation campaign (pilot-project) of the CEGRN'94 was organised from May 2nd to May 6th 1994. The follow-up CEGRN'95 campaign was performed from 29 May to 3 June 1995. The third campaign CEGRN'96 ran from 10th to June 15th 1996.

Ten study groups were formed to carry out research in particular fields: investigation of tropospheric delays; CERGOP site quality monitoring; CERGOP reference frame; standardisation of data and processing centres; permanent and epoch GPS stations; CEGRN and precise height determination; CERGOP gravity network; geotectonic analysis of the region of Central Europe; monitoring of recent crustal movements in Eastern Alps with GPS; threedimensional plate kinematics in Romania.

The conferences of national representatives of the participating countries are organised twice a year to discuss the progress of scientific research within the Project. The First Working Conference was held in February 1994 in Warsaw (Poland) and was followed by the Second Conference in November 1994 in Penc/Budapest (Hungary). Next Conferences were: in May 1995 in Pent (Hungary) and in November 1995 in Warsaw (Poland), fifth Conference was held in May 1996 in Reisseck (Austria) and sixth fall 1996 Conference will be organised by Italian colleagues in October 1996 in Trieste (Italy). In the meantime many seminars and workshops of the CERGOP Study Groups are organised In the frame of the CERGOP Project there are prepared five monographs devoted to five important geotectonic units of the region of Central Europe These regions are: Pannonian Basin, Carpathian Orogenic Belt, Teisseyre-Tornquist Contact Zone, Bohemian Massif and Subalpine Region

PERMANENT GPS STATIONS IN CEI COUNTRIES

The role of permanent and epoch GPS stations in all geodynamical studies and in establishment of local and regional geodynamic networks has grown significantly in the last time. The following aspects of using the long series of permanent satellite GPS observations may be pointed out:

(1) Permanent stations are an indispensable tool for determination, upgrading and maintenance of the International Terrestrial Reference Frame (ITRF); fulfillment of this duty is the task of two international global services IGS (International GPS Service for Geodynamics) and IERS (International Earth Rotation Service). The contribution of Europe to the ITRF is the continental European control network EUREF (European Reference Frame) being an exactly defined part of the ITRF.

(2) Permanent GPS stations are commonly used as reference control points for establishment of national geodetic control networks and for development of national and international air, marine and land navigation systems. Active positioning and real-time navigation systems are needed for many public and emergency civil and military services, e.g. transport, monitoring of traffic lines, police, health service, fire departments, etc.

Table 1. EUREF campaigns organised by IfAG in the years 1990-1995.

EUREF Campaign	Date of the campaign	Number of EUREF points	Number of all points observed in the campaign
EUREF North-West'90	23.07-1.08.1990	20	36
EUREF-CS/H'91	29.10-3.11.1991		27
Hungary		5	
Czech Republic		3	
Slovakia		3	
Poland		2	
EUREF-POL'92	4-8.07.1992		31
Poland		11	
Lithuania		2	
EUREF-BAL'92	2808-4091992		24
Estonia		5	
Latvia		4	
Lithuania		4	
EUREF-BULGARIA'92	4-8.10.1992	7	15
BULGARIA'93	October'93	15	
EUREF-CYPRUS'93	27.01-1.02.1993	6	10
EUREF-D/NL'93	10.05-15.05.1993	4	35
EUREF-LUXBD'94	14.03-18.03.1994		19
Luxemburg		4	
Belgium		6	
EUREF Densification Camp	3005-306 1994		22
Slovenia		8	
Croatia		10	
EUREF Croatian Coast-Line'94	700-1006 1994	17	
EUREF-Romania'94	2609-3009 1994		
Romania		7	
Bulgaria		4	
Hungary		5	
Turkey		1	
Planned EUREF Campaigns 1995-1997			
(Ukraine) ?	camp '95 cancelled	during observation	campaign !
(Belarus) ?	camp '95 cancelled		
Macedonia			
Albania			
Malta			
Bosnia, Serbia, Monte negro			

△ SLR or VLBI stations
• EUREF-89 Densification stations
▪ EUREF 1990/91/92/93/94/95

Fig. 1. Present stage of the EUREF Network (H.Seeger, 1995)

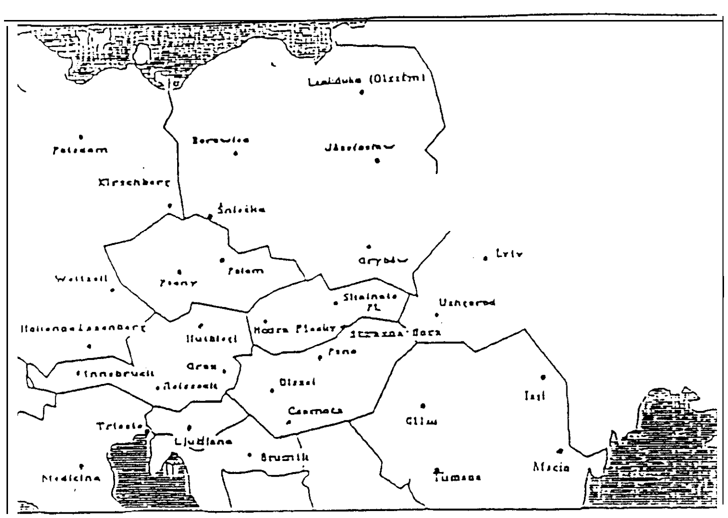

Fig. 2. Stations of the Central Europe GPS Reference Network (CEGRN)

(3) Long series of permanent satellite observations collected at the permanent GPS stations enable us to perform more exhaustive geodynamic interpretation of possible recent Earth crustal movements and displacements, since also short periodic variations can be detected, determined and permanently monitored. This is a new modern approach and seems to be a new future philosophy of geodynamic studies. Thus, the permanent GPS stations can replace the classical geodynamical net works that gave the possibility to achieve only a very generalized picture of possible displacements.

The above mentioned aspects are considered deeply in the programme of geodetic and geodynamic studies of the CEI Section C "Geodesy". There is why the recommendation to organise in each CEI country at least one permanent GPS station has been pointed out in the CERGOP Project as one of the essential and subsistence actions. Thus, the main aim of the activities of the CERGOP Study Group "CERGOP Permanent and Epoch Stations" established within the Project CERGOP is to help and support the scientists and institutions in establishing permanent or epoch GPS stations in those countries where such stations are not yet operating. The action of this Study Group includes also the cooperation with IGS (International GPS Service for Geodynamics) and EUREF in using permanent and epoch GPS observations for updating and upgrading the reference frames.

An example of such action is the Processing Centre of the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology. This Processing Centre is engaged in the international cooperation as (1) IGS Regional Network Associate Analysis Center (IGS RNAAC), (2) EUREF Local Analysis Centre (EUREF LAC) and (3) CEI CERGOP Processing Centre. Rough GPS observations from the Institute's permanent GPS station Józefosław and systematically processed data from twelve European permanent stations are sent at daily/weekly basis to the world and regional data centers at CDDIS (USA), IfAG (Germany), Graz (Austria) and Brussels (Belgium).

In Table 2 you will find a summary outlook into the present stage of operating and planned permanent GPS stations in CEI countries. In general, this situation seems to be satisfactory.

Table 2. Present stage of permanent GPS stations in CEI (CERGOP) countries

Country	Operating permanent stations	Planned permanent stations
AUSTRIA	3	2
CROATIA	2 (DGPS)	1
CZECH REP	1	
GERMANY	2	12
HUNGARY	1	
ITALY	7	2
POLAND	4 + 2 DGPS	5
ROMANIA		
SLOVAKIA		1
SLOVENIA		1
UKRAINE		
T o t a l	22	24

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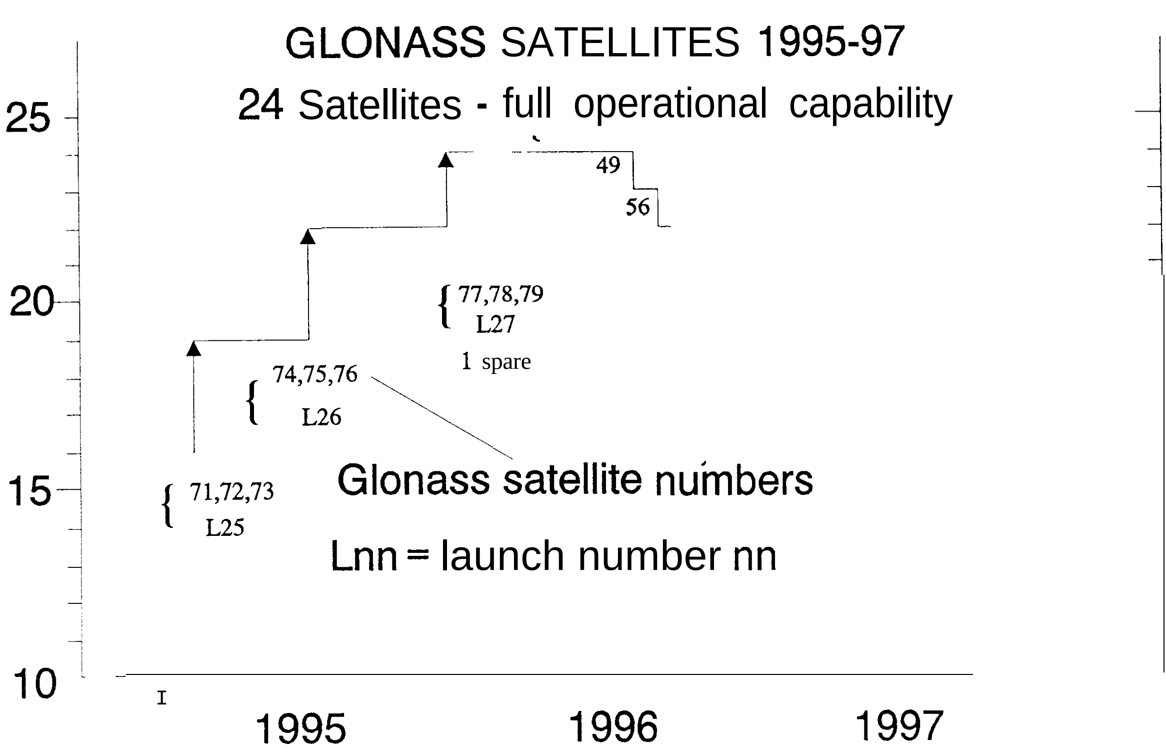
GLONASS status

P Daly

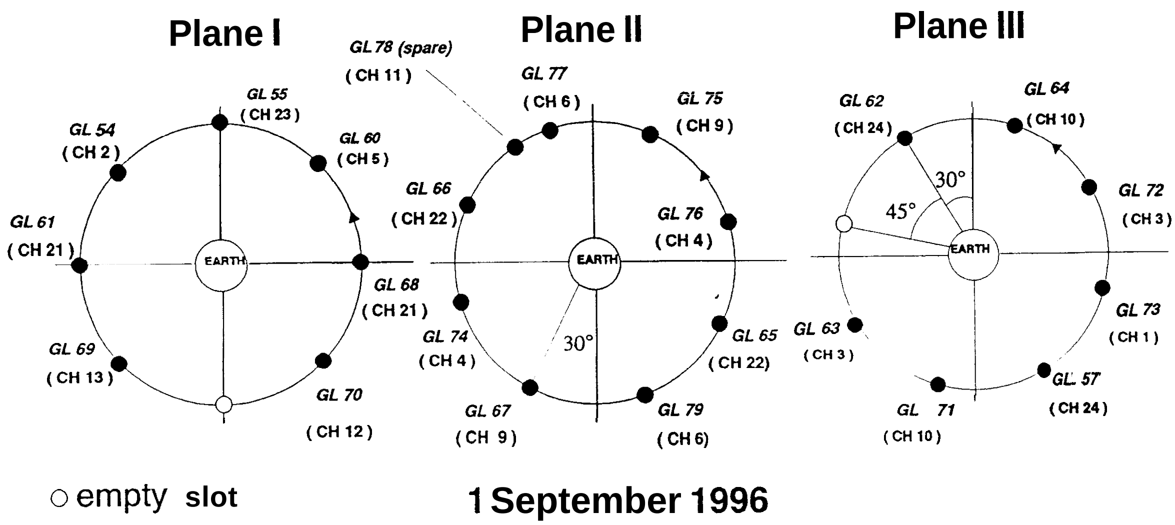
CAA ISN, University of Leeds

- ☐ Space complement
- ☐ Tests & demonstrations
- ☐ Communications
- ☐ Receiver development



APPENDIX P

GLONASS ORBIT PLANES



1 September 1996

22 Operational satellites + 1 spare

GNSS SATELLITE LAUNCHES		
4-YEARLY INTERVALS		
	GPS	GLONASS
1978-81	7	\
1982-85	4	13
1986-89	5	22
1990-93	18	18
1994-97	3	18
SVs in total	37	71
SVs active	25	22
SVs spare	\	1
Date:- 2 September 1996		

Coordinational Scientific
Information Center (CSIC)
Russian Space Forces
Mail: Kazakova st.,23
Moscow,103064,Russia

Tel: +7 095333-81-33
+7 095261-63-71

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E-mail: sfcsic@iki3.bitnet
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sfcsic@mx.iki.rssi.ru

Home page WWW.IKI
http://www.mx.iki.rssi.ru

Intergovernment Navigation

& Information Center

Voice: (095) 926-28-83
Fax/modem: (095) 917-33-83
E-Mail: postmaster@internavi.msk.su

2, B.Vusovsky Lane, Moskow,

Russia, 109028

GLONASS space complement

- ☐ GLONASS full 24-satellite constellation
  Operational:- 18 Jan 1996

- ☐ GLONASS 249 (49) Plane 1 Slot 5
  Removed 15-Aug-1996 NAGU 187-960815

- ☐ GLONASS 774 (56) Plane 3 Slot 24
  Removed 26-Aug-1996 NAGU 188-960827

- ☐ GLONASS 758 (64) Plane 3 Slot 18
  Restored 29-Aug-1996 NAGU 192-960830

- ☐ GLONASS status on 16 Sep 1996 → 22 satellites

PLANS FOR GLONASS-M

- **TESTING PHASE → 1995**
- **FIRST LAUNCH → FIRST QUARTER 1996**
- **CARRIES → 2 GLONASS + 1 GLONASS-M**
- **PROTON → 3 GLONASS-M**

Information supplied by CSIC, Moscow, Russia

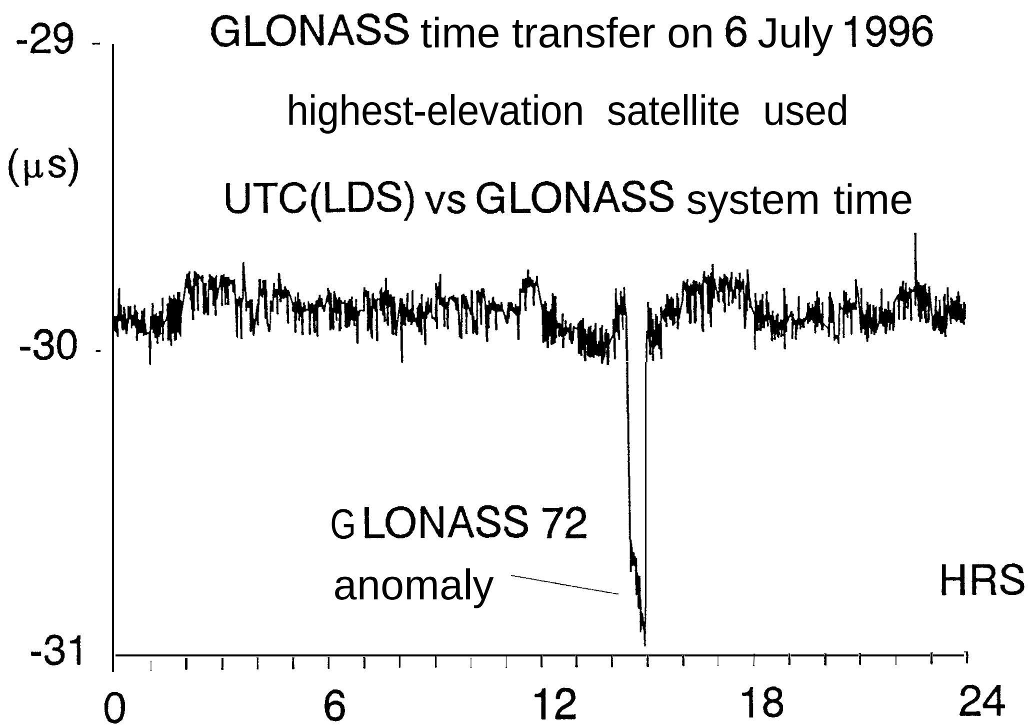
PROPERTIES OF GLONASS-M

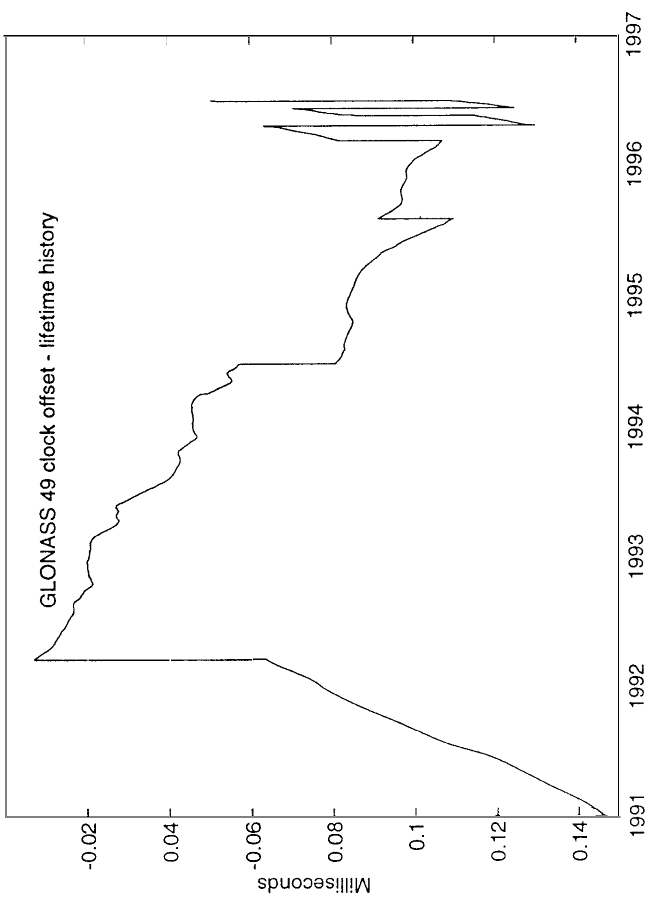
- **MASS → 1500 KG**
- **INTER-SATELLITE RANGING PLANNED**
- **NARROW-BAND CODES ON L1 & L2**
- **NON-AUTHORISED USE OF WIDEBAND CODES NOT RECOMMENDED**

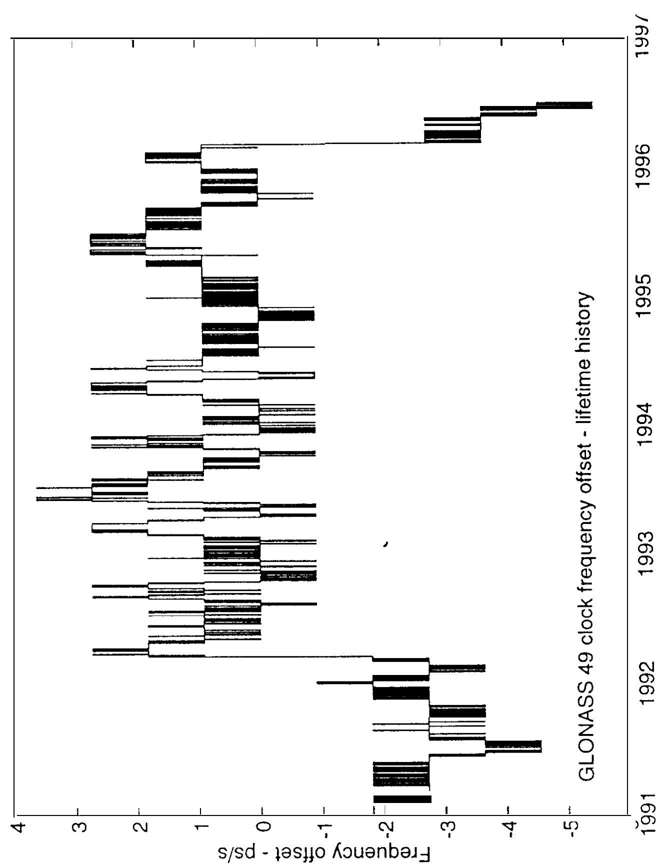
Information supplied by CSIC, Moscow, Russia

UNIVERSITY OF LEEDS GNSS RECEIVER

- **20 independent GPS or GLONASS channels**
- **Static survey - Aberdeen/Leeds**
  - *realtime RTCM differential GNSS via Skyfix datalink → Jan 1996*
- **RAF Comet: Brize Norton, UK → North Pole → June 1995**
- **DRA BAC 1-11**
  - *stand-alone GPS → March 1994*
  - *stand-alone GPS & GLONASS → November 1995*
  - *realtime RTCM differential GNSS via VHF datalink → March 1996*
    - *realtime ARINC 743 differential → summer 1996*
    - *precision approach/landing → 1996 onwards*


GLONASS time transfer on 6 July 1996
highest-elevation satellite used
UTC(LDS) vs GLONASS system time
-29
(μs)
-30
-31
GLONASS 72
anomaly
HRS
0
6
12
18
24


GLONASS 49 clock offset - lifetime history
Milliseconds
-0.02
0.04
-0.06
0.08
0.1
0.12
0.14
1991
1992
1993
1994
1995
1996
1997


GLONASS 49 clock frequency offset - lifetime history
Frequency offset - ps/s
4
3
2
1
0
-1
-2
-3
-4
-5
1991
1992
1993
1994
1995
1996

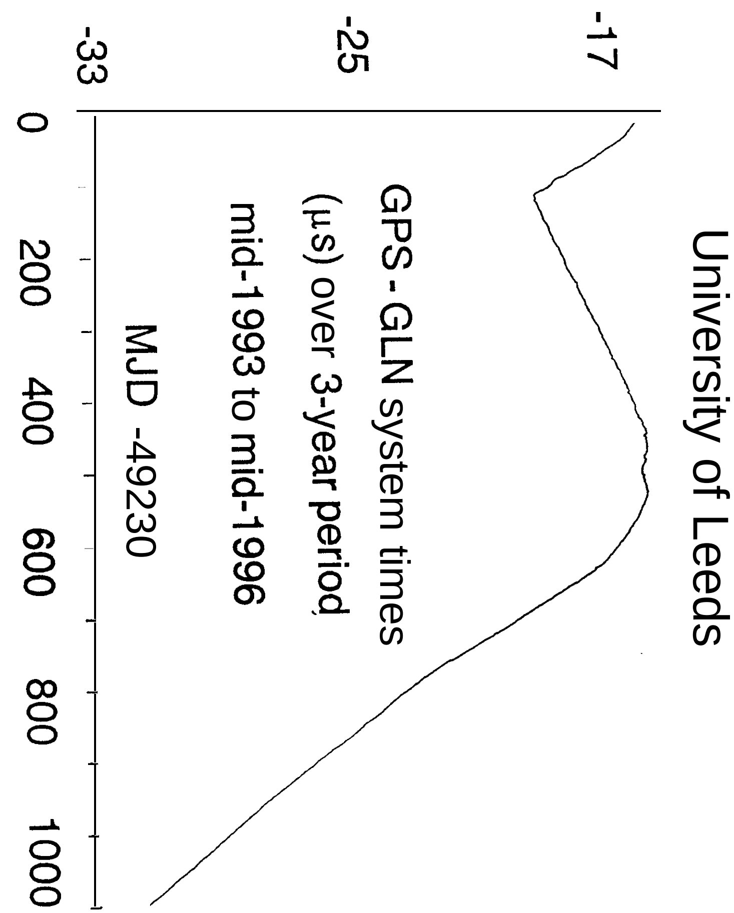
GLONASS equipment - September 1996

US

- ☐ Ashtech - GG 24
- ☐ 3S

Western Europe

- ☐ Sextant Avionique
- ☐ DASA
- ☐ Nortel (simulator)
- ☐ Man Technologie



ARAB INSTITUTE OF Navigation

الجمعيــــة العربيـــة للملاحـــة

مشهرة برقم ٧٩/٦٦٧

Ref: 10/2-1/313 القيد :

Date: 15-9-1996 التاريخ :

FAX

To : Rebecca Casswell Fax nr. 1-703-313 -5805
Executive Secretary, CGSIC

From : Alfonse Sadek Fax nr. 03/5862325
Arab Institute of Navigation - Alexandria

Reference is made to your fax dated 09-03-96 regarding civil service interface committee.

1- A DGPS reference station has been installed in Alexandria for experimenal purposes. The differential station is operated on the Marine frequency 304 KH2., the coverage range extends to about 100 miles.

2- Regional DGPS is proposed to cover both the Mediterranean and Red sea coasts of Egypt . Seven sites are recommended by which total coverage of the navigable waters is achieved, the project is expected to be completed by late 1997 .

3- GPS Receivers are now manufactured in Egypt by Arab Optronics company for both civilian and military purposes .

4- The Arab Institute of Navigation held an international conference and Exhibition on GPS in Dec.1995 distinguished speakers from USA and Europe have participated in the conference .

Best Regards
Yours,

A. Sadek A.Sadek

عمارة زهراء زيزينيا ١٢ شارع عباني زيزينيا – الاسكندرية – جمهورية مصر العربية ت : ٥٨٦٢٣٢٥

Zahraa Zizinia - 12 Abany St. Zizinia Flat (22) Alex. Egypt / Tel : 5862325 Fax : 5862325

APPENDIX Q

NATIONAL REPORT FROM JAPAN TO CGSIC MEETING IN KANSAS CITY, USA, SEPTEMBER 1996.

1. National Activities

a. Japanese national time *service* is conducted by CRL (The Communication Research Laboratory, a state-run institute), who routinely uses Cesium at mic clocks. CRL also, as a member of CGGTTS, has been studying GPS Com on View method, and works for TAI (International Atomic Time) GPS time transfer.

b. Survey/Geodesy/GIS Activities.

The geographical Survey Institute (GSI), has established GPS network with 610 permanent stations distributed throughout Japan in March,1996. Additional 250 stations will be installed to the network by March,1997. This network is used for not only for monitoring the regional crustal deformation in Japan, but also surveying and mapping. The re-surveying for electronic coastal charts based on WGS-84 is in a planning stage of implementation.

c. Navigation Activities.

The entire national fleets of coastal support vessels, Coast Guard vessels and lifeboats have now been fitted with Loran C and some of them have mounted GPS receivers also, 90% in the ocean and fishery vessels, 15% in coastal fishing boats as of today. The GPS services for maritime are now under experiment.

2. Differential Services.

Ref Station	Operator	Distribution	Charge	Users
Not decided	Japan Civil Aviation Bureau (JCAB)	1. Not Decided		
Daiouzaki & Tsurugizaki	Maritime Safety Agency (JMSA)	2. Maritime Radio Beacon	Free	Under Trail
Beppu City	Fisherman's Union	3. Marine Phone	---Under Planning--	
7 sites (Planning)	Private Sector J/V	4. FM Radio DARC	Free	Car-Nav PDA et
Kawasaki City	A Private Sector	5. Cellular Phone	Charging for Coastal Boats Commercial purposes	
Osaka Area	Mobile Radio Center	6. Digital MCA	--Under Planning--	
Kobe Area	Mobile Radio Center	7. Allocated Freq. for RTK	Not decided	

3. Development Activities

a. Land Use.

Remote controlled operation system for civil engineering and construction machinery has been developed and now in field works. This system is combined with using GPS based positioning RTK) and CCTV graphic 1 data network.

b. Machine Use.

Coastal DGPS Infrastructure.

c. Aviation Use.

MSAS (MTSAT Satellite Based Augmentation System).

d. Space Use.

Under R & D for the improvement of the launched vehicle control and rendezvous technique in space.

e. Time/Frequency Use.

Improvement of the pager services using GPS based frequency synchronization.

f. Survey/Geodesy/GIS.

Educational programs for step-by-step switching of the conventional triangular net survey system to the GPS-based survey system in the years to come.

4. Industrial Aspects.

The Japanese car-navigation market is still in a remarkable growth. The trendy products toward "car-multimedia" will push the demand more than previous sales record.

5. National Policy Activities and Decisions.

An influential recommendation report was published recently by a half-year study group composed by the related Ministries and industries. It recommended the necessity of a coordination system for policy issues like "Minister Interface Committee for Satellite Based Positioning System" and promotion of international cooperation by private sector organizations as a role of

APPENDIX R

Japanese contribution. The government consultation meeting between the U.S. and Japan commenced from this August.

6. National Responsible Authorities

Use	Responsible Authority
Land	National Land Agency
Maritime	Maritime Safety Agency Ministry of Transportation
Aviation	Ministry of Transportation
Space	National Space Development Agency Science Technology Agency
Military	Defense Agency
Time/Frequency	Communication Research Laboratory Ministry of Posts and Telecommunications
Survey/Geodesy/GIS	Geographical Survey Institute Ministry of Construction
Industrial Affairs	Ministry of International Trade and Industry Ministry of Posts and Telecommunications
National Coordination	Under preparing

7. Relevant Conferences/Seminars/Exhibitions held within nation.

So many in the every academic and industry fields.

8. National Point of Contact: For Civil Association

Mr. Hiroshi Nishiguchi
Yushima Hokutoh Bldg 5F
3-24-11 Yushima
Bunkyo-Ku
Tokyo 113
JAPAN
+81-3-3839-6844 - Telephone
+81-3-3839-2166 - Telefax.
jgpsc@da2.so-net.or.jp or
INET:QZC01241@NIFTYSERVE.OR.JP

RECOMMENDATIONS REPORT

by a Study Group within Japan

1. Published in **June, 1996** by a study group of the related Ministries and Industries including **JGPSC**

2. Main Theme

- on WHAT the Future of Global Satellite based Positioning System SHOULD **BE.**
- Japanese Role & Contribution to it
- What should we do now !

3. Examined

- Definition of Requirements for civil use
- Technical issues & new applications in Japan
- Issues about Whose initiative for systems control
- Scope of contribution of Japan
- Role sharing by Private sectors and Government Organs
- Future Administrative systems in Japan
- International relationship

4. RECOMMENDATIONS

(1) To form "Ministerial Interface Committee" for satellite based positioning system (MICSBPS) in earlier stage

(2) Establishment of Japan's basic policy for SBPS

(3) Strengthening of International Relations
- with U.S.A
- with Europe, Asia and Oceania
- with International Organs

(4) Support & Promotion of international cooperation by the Private Sector Association

CSNG

RICS / AGI
Guidelines for the Use of GPS in Surveying

- Royal Institution of Chartered Surveyors & Association of Geographic Information
- Academics, receiver manufacturers, survey companies, national survey organisations, RICS, UKOOA
- Standards and guidelines on GPS surveying tec miques
- Four workshops 1995/96
- Draft guidelines to be published in September
- Consultation phase

NATIONAL REPORT OF POLAND TO CGSIC MEETING IN KANSAS CITY, USA, SEPTEMBER 1996

1. National Activities

a. Time/frequency activities

National Bureau of Standards and the Astrogeodynamical Observatory of the Polish Academy of Sciences are using GPS time signals for synchronisation of their time standards with UTC.

b. Survey/geodesy/GIS activities

The national geodetic control network POLREF has been completed and fragments of the second order network are measured and processed.

c. Navigation activities

Most of civil vessels of the fishery fleet as well as cargo and passenger fleet are equipped with GPS receivers.

2. Differential Services

Three experimental DGPS stations are operating. Two of them, Rozewie and Dziwnow, belong to the Marine administration. One is located in Warsaw.

3. Development Activities

a. Land use

b. Maritime use

c. Aviation use

Space Research Centre of the Polish Academy of Sciences works about the integration of the low-cost inertial unit with DGPS system.

d. Space use

Spacecraft CESAR is supposed to be equipped with GPS receiver.

e. Military use

f. Time/frequency use

g. Survey/geodesy/GIS

3 IGG station are in routine operation:
Borowiec - Space Research Centre of the Polish Academy of Sciences
Jozefoslaw - Warsaw University of Technology
Lamkowko - Academy for Agriculture and Technology in Olsztyn

One more permanent EUREF station in Borowa Gora near Warsaw is in preparation - belongs to the Institute for Geodesy and Cartography.

4. Industrial Aspects (Reports on any noteworthy industrial activities, especially where there is some form of established and active GPS or GNSS industrial group)

Small number of C/A code GPS receivers are manufactured by POLSPACE Ltd. in Warsaw.

5. National Policy activities and decisions

6. National Responsible Authorities (Department names and addresses)

a. Land use	Ministry of Agriculture
b. Maritime use	Ministry of Transportation
c. Aviation use	Ministry of Transportation
d. Space use	Committee for Space Research
e. Military use	Ministry of Defense
f. Time/frequency use	National Bureau of Standards
g. Survey/geodesy/GIS	Ministry of Physical Planning
h. Industrial affairs (if appropriate)	

7. Relevant Conferences/Seminars/Exhibitions held within nation

Conferences
3 seminars on GPS per year:
- one devoted to maritime navigation
- one to aviation navigation
- one seminar on satellite geodesy.

APPENDIX U

8. Details of the formally notified National Point of Contact, including name, address, telephone, telefax and electronic mail address.

National Point of Contact:

Prof. Janusz B. Zieliński
Polish Academy of Sciences
Space Research Centre
00-716 Warsaw, Bartycka 18A
POLAND

Ph/fax: (48-39) 121273
E-mail: jbz@cbk.waw.pl

CGCIC-MEETING 1996-09-16

1996-09-10

National report to CGSIC-meeting 16-17 September 1996 in Kansas City from SWEDEN

1. National Activities

a. Time/frequency activities

Swedish National Testing and Research Institute routinely use GPS for time- and frequency services

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 (plane), 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. In 1993 a guide for GPS-measurements was published.

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 private consulting companies. 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.

APPENDIX V

BO JONSSON
GEODETIC RESEARCH DIVISION, NATIONAL LAND SURVEY OF SWEDEN, S-80182 GÄVLE, SWEDEN
VISITING ADRESS: LANTMÄTERIGATAN 2 TEL: 026-633000, DIRECT: 026-633738, FAX: 026-610676:
E-MAIL DIRECT: jonsson@[illegible]

2. Differential Semites

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 ca 150 USD for the basic level and ca 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), aerial surveying and aerial photography

b. SWEPOS

The SWEPOS service is managed by 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. Today there are no fees for SWEPOS data since the network is not yet declared operational.

SWEPOS data are used e. g. for photogrammetric work, studies of crustal movements 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.

List of SWEPOS stations

Station name	Latitude	Longitude	EPOS-service	EUREF-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	

[illegible]	[illegible]	[illegible]		
Station	**Latitude**	**Longitude**	**EPOS-service**	**DGPS-station**
Karlstad	[illegible]	[illegible]	Yes	
[illegible]	[illegible]	[illegible]	Yes	
[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	Yes	
[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	Yes	Yes
Ons[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] mn	57°04'	[illegible]		
[illegible]	[illegible]	[illegible]	Yes	

c. DGPS of the National Maritime Administration

The DGPS service of the National Maritime Administration is operational since 1 May 1996 00h UTC. The network consists of seven reference stations, see appendix and the DGPS corrections are transmitted via radio beacons. The transmissions are un coded and there are no direct user fees.

List of DGPS stations

Station	Latitude	Longitude	Frequency (KHz)	ID
[illegible]	[illegible]	[illegible]	[illegible]	401
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Almagrundet	[illegible]	[illegible]	[illegible]	404
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kullen	56-18N	12 27E	293.5	406
Hjortens Udde	[illegible]	[illegible]	[illegible]	[illegible]

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 the SWEPOS data - Onsala Space Observatory

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

---

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 - Swedish National Testing and Research Institute

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

4. Industrial aspects

A Swedish GNSS Industry Council (SGIC) was formed on April 261996 in connection with the conference on GPS Augmentation & Management Implications for Scandinavian Users in Gothenburg.

5. National Policy and decisions

In Sweden the responsibility for installation, operation and maintenance of navigation systems is delegated from the concerned department 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 Department 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 usc

National Road Administration
S-781 81 Borlange
Tel: + 4624375000
Fax: + 46 243 846 40

National Land Survey
S-801 82 Gävle
Tel + 4626633000
Fax: + 46 26 68 75 94

b. Maritime use

National Maritime Administration
S-601 78 Norrkoping
Tel: + 46 11 19 10 00
Fax: + 4611101949

c. Aviation use

Civil Aviation Administration
S--601 79 Norrkoping

Tel: + 4611192000
Fax: + 4611192575

d. Space use

Swedish Space Corporation
P. O. Box 4207
171 04 Solna
Tel: + 4686276200
Fax: + 468987069

e. Military use

Swedish Defence
S-107 85 Stockholm
Tel: + 4687887500
Fax: + 4687887778

f. Time/ frequency use

Swedish National and Testing Institute
P.O. BOX 857
S-501 15 Boras
Tel: + 46 33 16 50 00
Fax: + 4633135502

g. Survey/geodesy/GIS

National Land Survey
S-801 82 Gavle
Tel: + 4626633000
Fax: + 4626610676

7. Conferences/Seminars/Exhibitions

GPS seminar, Gavle, 19-20 March 1996 - 200 participants. Organised by National Land Survey

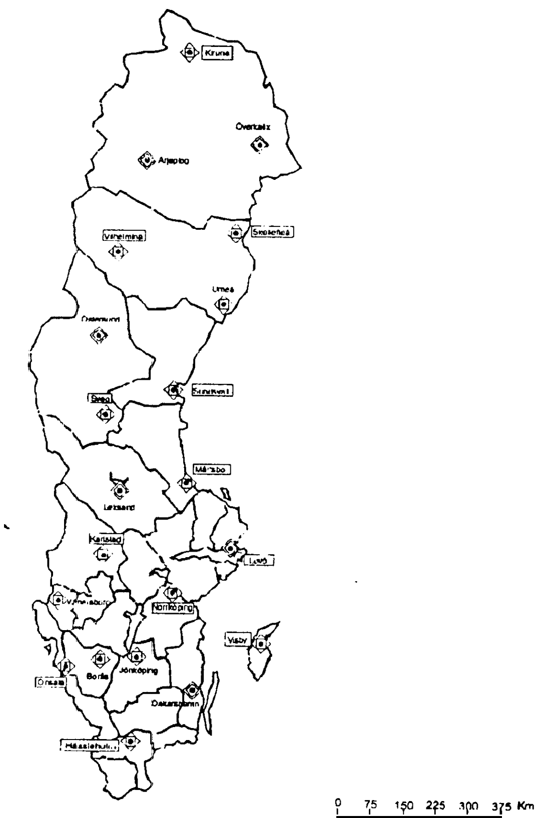
GPS Augmentation & Management, Implications for Scandinavian Users, Gothenburg, 26-27 April 1996-42 participants. Organised by Orbit Communications

Geodetic applications of GPS, Bastad, 26- 31 Aug. 1996. Organised by the Nordic Geodetic Commission of Geodesy (NKG)

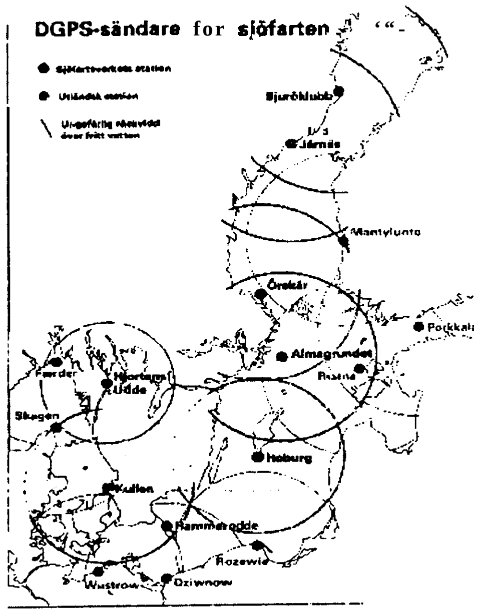
8. National Point of Contact

Bo Jonsson
National Land Survey of Swec en
Geodetic Research Division
Lantmaterigatan 2
S-801 82 Gavle
Tel: + 46 26 63 37 38
Fax: + 46 26 610676
E-mail: bo.jonsson@lm.se

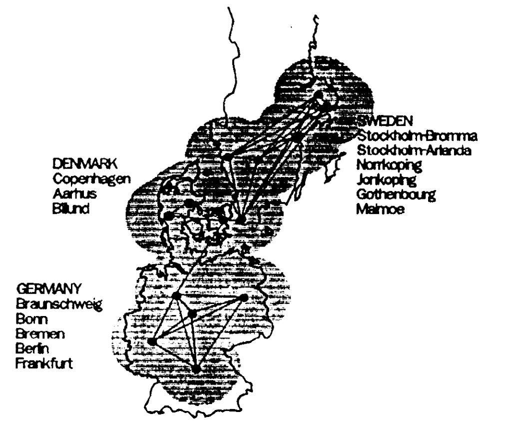
SWEPOS



SWEPOS Installed GPS-rec eivers. 1996-02-05		
	(symbol)	2 Ashtech Z12
	(symbol)	1 Ashtech Z12 + 1 TurboRogue
	(symbol)	RDS-station



DGPS network of National Maritime Administration



The north European CNS/ ATM applications projekt

National report to CGSIC meeting in Kansas City, USA, september 1996
REPORT FROM NORWAY

1. National Activities

a. Time/frequency activities

Nothing to report

b. Survey/geodesy/GIS activities

The Norwegian Mapping Authority (Statens kartverk) is running a multipurpose national referencesystem for satellitebased accurate positioning and navigation called SATREF. Ten reference- and monitor-stations (with geodetic GPS-receivers) is connected to a controlcentre (with central integrity monitoring and alarmsystem) for realtime transmission of raw GPS-data and DGPS-data. Standard samplerate is 1 second. Raw GPS and DGPS-data is the distributed via magnetic tape, diskett, e-mail, ftp, modem.etc for post mission use. DGPS-data is transmitted in realtime via FM-network (see differential service below) and to other distributors (public and private). In addition to the 10 SATREF-stations there is 4 permanent GPS stations.

The new Norwegian geodetic basenet, EUREF89, consists of approx. 140 primary 1st order stations and approx. 900 primary 2nd order stations. There has been/is observation campaigns in 1994, 1995 and 1996 for the primary 1st order stations, and during the campaigns observations is carried out over a period of three days, 24 hours a day. The positions are computed by means of the GIPSY-program and exact ephemerides. Final coordinates are computed for 108 stations in ETRF89 using the method recommended by the EUREF-commision. The last 28 primary 1st order stations in the network are measured in a campaign running this month (september 1996).
The primary 2nd order stations are situated along roads between the primary 1st order stations at individual distances of mostly between 14 and 25 km. Roughly 50% of all primary 2nd order stations were measured in 1995 with an average of approx. 5 vectors from each stations. Observation time was 4 hours for each vector. Strong connections were made to primary 1st order stations. The adjusted positions show a RMS of mainly 3-7 mm. The observation campaign is still running and by end of 1996 a total of 90% of the primary 2nd order stations is planned to have been measured.

Norwegian Hydrographic Service (a division in Statens kartverk) uses a local differential GPS system (50 km range) on all vessels operating along the Norwegian coast. This means a total of 8 units, of which 3 arc reference stations. In addition 3 receivers arc used for geodetic purposes.

c. Navigation activities

Approximately 3000 users of the national maritime differential GPS service.

2. Differential Services

Ref Station	Operator	Distribution	Charges	Users
12 stations along coastline	Norwegian Coast Directorate	Maritime radio beacon	None	Maritime users
SATREF (se 1b) (10 ref.stations)	Norwegian Mapping Authority	1. FM/RDS (nationwide)	1. Free of charge	primarely land-users (survey/GIS, locating, navigation), secondary for maritime users
		2. For post-processing	1. No cost for science.	Geodesy/IGS
			2. Minor charge for commercial	Geodesy, survey, GIS
3 ref.stations in Norway (part of global system)	Fugro Starfix (Europe) AS	1. Inmarsat	Commercial	Offshore, maritime
4 ref. stations in Norway (part of global system)	Racal Survey	1. Inmarsat A	Commercial	Offshore
3 ref. stations in Norway (part of global system	Oceonics	1. Inmarsat A 2. Norsat	Commercial	Offshore, marine

3. Development Activities

a. Land use

The Highway Directorate, Norw. Mapping Authority, private transportcompanies and systemdealers cooperate in a transportproject. Electronic roadmap and vehiclenavigation by use of GPS are parts of the project.

b. Maritime use

Local and central integrity monitor systems for the national differential system is still under development.

c. Aviation use

Civil Aviation Administration is running a one year test in Bodo Airport. A SCAT1-referencestation is installed at the airport. All the Widerøe Airlines will be equipped with DGPS navigation systems.

d. Space use

Norway participates the European Space Agency's (ESA) project, Artes element 9, through the Norwegian Space Centre. The Artes 9 project includes EGNOS (equal to FAA's WAS in US), GNSS1 and GNSS2.

e. Military use

Norw. Armed Forces has nothing to report.

f. Time/frequency use

None

g. Survey/geodesy/GIS

APPENDIX W

Improvement of the SATREF reference station to meet full international IGS standards (choke ring antenna)

4. **Industrial Aspects**
A Norwegian company, Seatex, has developed/produced the system for distribution of DGPS-corrections via FM/RDS-network Norwegian Mapping Authority is working for an International standard/agreement for distribution of DGPS-corrections via FM/RDS which is system undependant.

5. **National Policy activities and decisions**
The Norwegian guidelines for radionavigation are still not approved
Norwegian government authorities (Ministry of Transport, Ministry of Fisheries) take part in the group initiated by the European Commision on possible future European GNSS. The Ministry of Fisheries do also take part in the Advisory Group for an European Radionavigation plan.

6. National **Responsible Authorities**

The Ministry of Fisheries is responsible for coordination of civil aids to navigation. The ministry is also responsible for installation and running of maritime aids to navigation

Use	Responsible Authority	Address
Land (navigation)	Ministry of Transport and Communication	
Maritime navigation	Ministry of Fisheries	
Aviation	Ministry of Transport and Communication (Civil Aviation Administration)	
Space	National Space Centre	
Military	Ministry of Defence	
Time/frequency	?	
Survey/geodesy/GIS	Norwegian Mapping Authority	
Industrial affairs	Ministry of Industry	
National Co-ordination	Ministry of Fisheries	

7. **Relevant Conferences/Seminars/Exhibtions held within nation**
None

8. **National** Point of Contact

National point of contact for CGSIC:
Norwegian Mapping Authority
Att Brede Gundersen
N-3500 Hønefoss, Norway
Tel.: +47 32118442 (direct)
Fax: +47 32118101
E-mail: brede.gundersen@gdiv.statkart.no

National point of contact for navigation
Adviser Inger-Lise Sogstad, The Royal Norwegian Ministry of Fisheries
P o Box 8118 Dep
N 0032 Oslo, Norway
Tel: + 47 22246428
E-Mail: inger-lise.sogstad@fid.dep.telemax.no

STATENS KARTVERK

SATREF

Satellitebased Reference System

Norwegian Mapping Authority, January 1996

1 INTRODUCTION

The SATREF project was initiated in 1989 by the Geodetic Institute, a division of the Norwegian Mapping Authority, as a development project with the objective of establishing a national satellite-based reference system. The project was carried out in cooperation with Seatex A/S, a private company in the city of Trondheim.

A national system was considered to have the advantage that many different user groups would be able to use the same infrastructure. Quality control/ integrity monitoring would be an important function of SATREF to secure reliable data and services for users.

1.1 Objectives

SATREF shall offer data and services in connection with the use of GPS and DGPS. In due time SATREF shall also support other satellitebased systems like the russian system Glonass. The area of interest is both real time use (navigation and positioning) and post mission use for a wide range of applications (and accuracies) in use on land, at sea and for air operations. Distribution of the data will be according to user´s needs.

The Norwegian Mapping Authority, alone or in cooperation with official partners, will offer data and services direct to the end user and to private firms which can provide value-added services based on SATREF. The main objective is to offer SATREF reference data for navigation and positioning, and GPS data for positioning (meter level) and surveying (cm level).

The need for better navigation reliability is considerable, and SATREF is an important service together with the Norwegian Mapping Authority s strong efforts on electronic chart systems.

It has not yet been decided how the service should be financed when declared operational. It is proposed that the users will have to pay for post processing data and accurate (better than two meters) navigation data. Less accurate DGPS data for navigation, transmitted by maritime radio beacons, are accepted to be free of charge for the users. It is recommenced that also DGPS-data transmuted via the FM network (RDS) should be free of charge. As per today, the services are in a testoperational period and the costrecovery is following the principles described above. The services will be declared operational in 1997 and the costrecovery principles will at that time be settled.

1.2 Background

The NAVSTAR (Navigation System with Time and Ranging) GPS (Global Positioning System) is a satellite based navigation system which has been developed by the US Department of Defence (DOD). The system was declared Fully Operational Capability in 1995. GPS can be used for navigation and positioning anywhere on the Earth's surface, 24 hours per day, and independent of weather conditions. Although the system has been declared operational, it is extensively pointed out that one should use the system at own risk.

GPS offers signals and data for two types of users, military and civilian. The military part of GPS gives the highest accuracy and is called PPS (Precise Positioning Service). Use of PPS requires additional cryptography equipment. Civilian users have access to the SPS (Standard Positioning Service). SPS is intentionally degraded by DOD with the technique called Selective Availability (S/A). By use of one satellite receiver, SPS users will obtain about 100 metres accuracy (95 %) in two dimensions If DOD had turned of the S/A, an accuracy of 20-30 meters would be possible. In a Presidential Decision Directive issued by President Clinton march 1996, the GPS signals are offered free of direct user charge to the global users

1.3 Differential GPS for navigation/positioning.

An accuracy of 100 metres is not acceptable for many users. Differential GPS (DGPS) is a technique where a GPS receiver placed at a point (reference station) with given accurate coordinates is **used to** determine error caused by S/A and inaccuracy in the satellite observations. A DGPS user will therefore be able to employ these calculated corrections (reference data/ differential corrections), to correct observations within a distance of several hundred kilometres from the reference station. This constitutes an Improvement in the user's positional accuracy, typically to an accuracy of about 5 metres.

1.4 Geodetic use of GPS

By use of geodetic relative measurements one can obtain an accuracy within centimetres or better. This method require the use of at least two geodetic receivers which arc stationary over a period of time.

2. SATREF REFERENCE SYSTEM

The main components of SATREF reference network is (fig.1):

- reference and monitor stations,
- control centre,
- distribution systems
- communications lines to connect the various components.

In addition there are the user units. The *user* unit can either be based on receiving reference data in real time, or be equipped with data storage capacity for subsequent post-processing

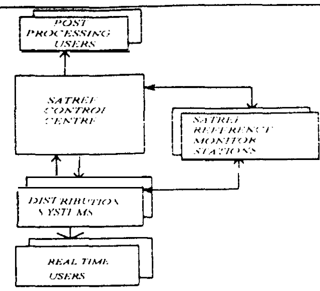


Figure 1 SATREF - Main components

2.1 The Reference Stations

The reference stations consist of GPS receivers, LAN network components. receivers for monitoring and processing units The main GPS receiver is Trimble 4000SSi (12 channel, dual frequencies) and backup receiver is Ashtech Sensor II (12 channel. one frequency) The receivers are placed at the top of a five meter high mast to avoid disruption, caused by nearby trees, buildings, etc.. of the GPS-signals.

Reference data from one reference station can be sent directly to one or more distribution/broadcasting systems and to the control centre.

Main functions at the reference stations:

- Calculation of differential corrections
- Transmitting of GPS/DGPS data to the control centre. Standard sample rate is 1 Hz (one sample per second), optional 2 Hz (one sample per 0,5 second)
- Transmitting of DGPS data (RTCM) to Norwegian Coast Directorate for broadcasting via maritime radio beacon
- DGPS data sent from control centre (rerouted from other reference stations) can be transmitted if local GPS receivers is malfunctioning/ removed
- Communication to control centre is automatic reconnected if connection has been broken. Data is stored at the station when connection is down and sent to Control Centre when the l me is reconnected. When the connection is down the station will serve as an autonomous station.
- Local Integrity Monitoring (LIM)

Local Integrity Monitoring:

- Monitoring of generated and broadcasted DGPS data.
  Own beacon Receiver Monitoring
  - age of message
  - mean correction rate
  - standard deviation on rate
  - Correction Quality Indicator (CQI) for monitored radio beacon data.
  - monitor radio parameter, signal to noise ratio (SNR) and signal strength
- Temporarily storage of recorded and generated GPS/DGPS data
- choose GPS/DGPS data from main or backup receiver based upon QC
- Statistics on GPS receiver data (will later be implemented at the control centre):
  <u>1. Dion.</u>
  Measurement of phase noise and ionosphere (cycle slip counts).
  <u>2. MP1 and MP2.</u>
  Measurement of pseudorange receiver noise and multipath (tracking performance) on L1 and L2 frequencies
- generation of integrity messages (alarms) to control centre

Reference stations are continuously monitored and can be remotely controlled from the control centre.

The Norwegian Mapping Authority use data from reference stations in scientific work. Accordingly, the reference system must meet the strict requirements set for the scientific work with regard to establishment location and accuracy

2.2 The network/communication linles.

All the stations are connected to the control centre by 64 kbps full duplex lines. The connection to Ny - Ålesund (Spitzbergen) is via Norsat B satellite (Intelsat 702),

2.3 Control Centre

The control centre is connected to all reference / monitor stations by 64 kbps leased lines. GPS observations, corrections and status information are sent to the control centre from each reference station in near real time.

Functions at the control centre:

- storage of GPS/DGPS data
- real time and post mission distribution of data
- software at reference stations to be updated from controlcentre
- remote control of reference stations
- Network Management System
- Central Integrity Monitoring (CIM)

Central Integrity Monitoring

- Quality Control of all data from all reference stations (GPS/DGPS data)
- alarms to operator via pager, printer, log, etc
- misc. plots and statistics

A multiserver at the control centre prepare data for real time distribution:

- FM/RDS
- telephone
- other operators/distributionsystems

GPS/DGPS data for post mission:

- generation of GPS data according to RINEX-format (optional sample rate)
- generation of multireference file (DGPS data from a selection of reference stations)
- DGPS correction data on SATREF format (timetagged data)

The UNIX based control centre has an operator friendly Graphical User Interface (GUI) and the main menu gives an overview of the operators tasks

- HP Openview (network software)
- File **Transfer Menu**
- **Backup Menu**
- **Spesial Message (RTCM message type16)**
- **Beacon message Menu (RTCM message type 7)**
- **Reroute Stations Menu**
- **Data Export Menu**
- **GraphicTimeseries Menu**
- Merge menu (for postdata)
- Operator System Menu
- Alarm System Menu
- Quality Control Menu

Both the GPS observations and the corrections are stored. The control centre is therefore able to supply users who need GPS observations and/or corrections at a later date. This is data for surveying, positioning and more scientific purposes such as ionospheric research, satellite orbit analysis, etc.

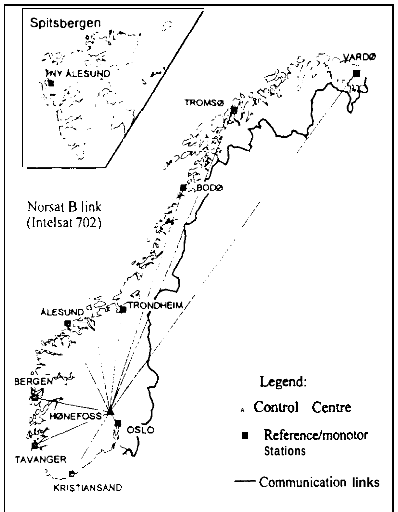


Fig 2 SATREF® Referance Network

Today, The Norwegian Mapping Authority has established nine reference/monitor stations on the mainland pluss one in Spitsbergen (fig. 2). The stations will be declared fully operational in 1997.

2.4 Distribution of SATREF Data

At the control centre there is a multiserver, for generation of SATREF data to the different distribution systems. SATREF cooperate with other agencies for distribution/broadcasting of SATREF GPS data in real time. The distribution of data is mainly based on the use of existing communications systems, ground and satellitebased.

2.4.1 Distribution via Coast **Directorate/maritime** radio **beacon.**
The Norwegian Coast Directorate operates the maritime radio beacons which are used by the shipping as directional beacons. The beacons are upgraded to broadcast both directional beacon signals and DGPS data for use in coastal waters.
This concept is *in* accordance with international plans to use maritime radio beacons to broadcast DGPS corrections. The International Association of Lighthouse Authorities (IALA) has submitted a frequency plan for the transmission of DGPS data by means of maritime radio *beacons*.

The Norwegian Coast Directorate and Norwegian Mapping Authority has went into an agreement and are cooperating with the distribution of SATREF DGPS data over maritime radio beacons.

At present, ten beacons along the coast are upgraded to serve this purpose. Two more radio beacons will be upgraded in 1996, and it will be possible to receive DGPS data along the whole coastline (except Spitsbergen).

2.4.2 Distribution **via Telenor/FM network.**
Telenor (Norwegian Telecommunication Agency) operates the FM network on behalf of NRK (Norwegian Broadcasting Corporation). Telenor and SATREF (Norwegian Mapping Authority) has went into an agreement and DGPS corrections are broadcasted via the FM network using the *RDS* (Radio Data System) subcarrier. The FM network covers approx. 99 % of the populated area of mainland Norway (except Spitsbergen). The FM distribution is at present in a "test operation" period and will be declared operational in 1997.

2.4.4 Distribution via private operators.
SATREF is at present supporting private companies which offer SATREF-data, along with data from other referencestations, via satellite distribution like Inmarsat to e.g. offshore users.

2.4.4 AM **network.**
SATREF and Telenor are testing AM systems for broadcasting of SATREF data. *DGPS-corrections* **distributed via the AM-transmitter in** Kvitsøy (Stavanger) is being received in Germany.

2.4.5 Distribution via FM/DARC channel (Eureka development project)
The above mentioned distribution systems have limited transmission capasity. The Norwegian Mapping Authority accordingly participate in an Eureka project along with the telecommunication agencies from France, Sweden and Norway. The objective of the project is to develop a prototype system (tranmitter/receiver) for real time transmitting of data (incl. GPS/DGPS data) using the FM subcarrier DARC. The DARC channel has a net capasity of approx. 9 kbps. The prototype *system* is ready and pilot projects are planned. The system is also compatible with the next generation of

groundbased distribution system DAB (Digital Audio Broadcasting).

2.4.6 GPS/DGPS-data for post mission
SATREF is also able to offer GPS/DGPS data for post mission use according to user specifications The data will be on RINEX-format or SATREF-format and distributed via magnetic tapes, diskettes, Internet, E-mail, FTP, modem etc.

3. FURTHER INFORMATION

Further information about the SATREF system and services are available by contacting Norwegian Mapping Authority, telephone +47 32 11 81 00 - fax +47 32 118101.

AUSTRIA

submit ted by B. Hofmann-Wellenhof, Technical University Graz, Surveying and Land information, Steyrergasse 30, A-8010 Graz, Austria. This report, compiled for the Kansas Meeting of the Civil GPS Service Interface Committee, is based on a German version by the Austrian GPS Network Civil Engineering Company.

The Austrian GPS reference network AREF-1

1 Introduction

The foundation of the Austrian GPS Network Civil Engineering Company was initiated by the Federal Organization of Architects and Civil Engineers. Any civil engineer may become a member of this company. Currently, some 110 civil engineers for surveying are members of the company. The main objective is to produce the Austrian GPS reference network AREF-1, a precise and homogeneous network as basis for most of the modern geodetic tasks.

2 Structure and site selection of AREF-1

Since 1990, the Federal Office of Metrology and Surveying at Vienna and the Austrian Academy of Sciences, Department of Satellite Geodesy, have established the GPS network AGREF (Austrian Geodynamic Reference network) consisting of some 80 points with an average dist ante of about 40 km and the maximum dist ante of 50 km. Because of the rapidly changing requirements, the density of these points became inefficient. For this reason, the con cept of AREF- 1 was investigated.

The network points of AREF-1 are hierarchically partitioned into four levels, cf. Brunner (1996). The first level are the three IGS stations Graz-Lust bühel, Wettzell, and Zimmerwald. The second level are 10 Austrian permanent stations. The third level covers seven sessions with 40–45 points each. These points, in total some 300, establish the AREF- 1 network. The fourth level covers the densification of AREF-1 and is mainly a project of the future.

The main objective of AREF-1 is a homogenoeus GPS network for Austria with average distances of 20 km (in the maximum 25 km). The already available 80-point AGREF network is embedded in AREF-1, cf. Hofmann-Wellenhof (1996). The AGREF points were remeasured in the frame of AREF-1.

Preliminary results of the AREF-1 points: the accuracy amounts to ±15 mm for the horizontal position and ±20 mm for the height. The final results of all 300 points are to be expected for November 1996.

3 Densification

The future densification of AREF-1 will be denoted as AREF-2, AREF-3, ... and will be carried out by local meas urements. The civil engineers will be obliged to link any local GPS campaign to at least one of the A REF-1 points. Some of these densification projects were already realized.

4 Scientific and technical coordination

The concept of the AREF-1 network arose from discussions of the GPS Network Civil Engineering Company and the Austrian Geodetic Commission. This means that practitioners as well as scientists developed the project.

References

[1] Brunner FK (1996): Entwurf für die AREF Netzstruktur. Internal report, Graz, 1996.

[2] Hofmann-Wellenhof B (1996): Einige Überlegungen zu AGREF und AREF-1. Internal report, Graz, 1996.

APPENDIX X

MEMORANDUM FOR: FGCS, GIAC, and Work Group Members

FROM: Captain Lewis A. Lapine, NOAA
Chair, GPS Interagency Advisory Council
Federal Geodetic Control Subcommittee

SUBJECT: Minutes of GIAC Meeting, September 17, 1996

The GIAC meeting was held in conjunction with the Civil GPS Service Interface Committee (CGSIC) at the Kansas City Marriott, Kansas City, Kansas, on September 17, 1996, from 1:00 p.m. to 5:00 p.m. This was the fifth meeting of the GIAC, the meeting agenda is provided (attachment 1).

After attendee introductions, Mr. M. K. Miles, USACE, Chaired the meeting for Captain Lapine and gave an update on Interagency GPS Executive Board (IGEB). Mr. Miles described the management structures of the various agencies involved witl GPS and how they are interconnected through the IGEB. He also explained GIAC's relationship to IGEB and its responsibility to share information openly at most meetings and, at times, to discuss policy (including contractual agreements) in closed session when necessary.

The following report was given by William Strange, NOAA, to the CGSIC during the meeting on September 16 and reiterated by M. K. Miles to the GIAC members and guests:

On September 12, 1995, the GPS Interagency Advisory Council (GIAC) was chartered within the Federal Geodetic Control Subcommittee (FGCS), under the Federal Geographic Data Committee (FGDC) which is chaired by Interior Secretary Bruce Babbitt.

On September 11, 1996, Secretary Babbitt presented the 14 Federal agencies represented on the FGDC with Vice President Al Gore's Hammer Award at Department of the Interior headquarters in Washington, DC The group was honored for its vision and efforts toward creating a national, readily accessible source of accurate geospatial data. The Hammer Award is Vice President Al Gore's Special recognition for contributions in support of the President's National Performance Review principles. Those principles are: putting customers first, cutting red tape, empowering employees, and getting back to basics.

As Director of the National Geodetic Survey, Captain Lewis A. Lapine, NOAA, chairs FGCS and represents GIAC on the permanent Interagency GPS Executive Board, jointly chaired by the Departments of Defense and Transportation. This Board manages GPS and U.S. Government augmentations, with other departments and agencies participating as appropriate. The Department of State coordinates with departments and agencies, foreign governments, and international organizations to assess the feasibility of developing standards and guidelines on the provision and use of GPS services worldwide.

The GIAC concentrates its interests and efforts on the timing and positioning issues of GPS and related navigation issues. The minutes of meetings, action items, and general information about FGCS and GIAC are provided on the Worldwide Web over Internet at the following address:

http: //www.ngs.noaa. gov/FGCS/fgcs.html

Since its creation last year, the GIAC has addressed the following issues and topics:

GIAC Activities

1. PDD - Department of State - International Working Group
   US - Japan Bilateral Negotiations
   Fair Trade Policy
   Standardization Issues for Navigation, Spectrums and Positional Accuracy

2. Spectrum Allocation Issues
   DOD/DOT Spectrum Allocation for L5 Carrier Phase Tracking
   Theater Denial Consequences for Civil Users
   System Interference Testing

3. Federal Radionavigation Plan
   Open Meeting in Boston
   Formal Review

4. DOT Study for Full Implementation of USCG Differential Beacons

5. L5 Informational Presentations Prepared for:
   Federal Geodetic Control Subcommittee
   Civil Applications Committee

6. GIAC News Flash Service Initiated on Internet

7. USCG Improved Correctors

8. Interagency Questionnaire

9. Continuously Operated Reference Stations
   75 Sites Operated by 10 Federal and State Agencies
   Interpolation Algorithm

10. GIAC Agency Demonstrations given to date:
NGS, NSF and USACE

11. L2 Full Wavelength Carrier Phase Tracking versus L5

An overview of the previous FGCS meetings was given by John Spencer, NOAA. Mr. Miles reported on status of action items from previous GIAC meetings. All items are on schedule except the reporting of GPS questionnaire responses which are still being evaluated by Ken Lamm, DOT. Previous meeting minutes were distributed to the attendees.

The agenda was revised to include the GPS Demonstration project by USACE during the open meeting time. It was presented by Bill Bergen, USACE.

The USACE Inland Waterway Navigation Systems was discussed and excellent visuals enhanced the presentation. Copies of Mr. Bergen's slides used during his presentation were provided to attendees. Additional copies are available from Mr. Bergen, tel: 202-761-1553 or at his e-mail address: william.bergen@inet.hq.usace.army.mil.

As part of his presentation, Mr. Bergen provided a ten year chronology of events involving cooperative efforts between the USACE and USCG, herewith included (attachment 2).

Immediately after Mr. Bergen's presentation, Mr. Richard Shamberger, Federal Railroad Administration, stressed the importance of the inland navigation systems to support railroad real time positioning activities. He strongly suggested that the Air Force's nationwide GWEN sites be included in the developing of inland navigation systems. After much discussion concerning these sites, the Federal Highway Administration has the action to investigate the utilization of the 54 GWEN sites for inland navigation.

After the USACE presentations, the following status reports were presented:

Interagency GPS Survey (questionnaire) -Ken Lamm, DOT - reported:

144 responses plus NOAA survey have been received to date and analysis has not been completed. Additional input is still welcomed. All previously received information will be assessed with the exception of a few submittals that were received unreadable.

Interagency Work Group (IWG) on International GPS Issues - Bill Strange, NOAA reported:

-PDD
- Department of State International Working Group activities
-Fair Trade Policy, particularly involving Japan
-Standardization Issues, worldwide, for Navigation, Spectrums, and Positional Accuracy.

Continuously Operating Reference Stations (CORS) -Bill Strange, NOAA reported:

-How to retrieve CORS data, and provided handout maps of CORS coverage, including proposed/future sites. He requested agencies to provide the contact person for their agency specific CORS information which will be posted with CORS information on home page.
-Netsite program can interpolate down to 1-5 seconds.
-RINEX files, approximate positions, now correct NAD 83 positions of RINEX header files.
-New firmware will improve CORS delivery system soon by multipathing future type of improvements for better accuracy.

The open informational meeting of the GIAC was concluded and the following discussions were conducted behind closed doors, no one other than federal sector members were present in room.

GPS Interface Testing Authority (GITA) -Larry Hothem, USGS, reported that at the request of IGEB, two GITA ad hoc Working Groups are being set up as follows:

- Working Group one - Policy -Larry Hothem is a member of this work group which will:
(1) develop criteria to evaluate DOD requests and
(2) identify functions and/or agencies that might be impacted.

- Working Group two - Procedures - Rebecca Casswell is a member of this working group which will determine procedures for processing DOD notices/requests to conduct interference/jamming testing, as well as training exercises that may interfere with normal civil GPS operations and to assemble definitive lists of who should be contacted and how (handouts were provided to attendees.)

This procedures work group will also address the following issues:

-Direct vs. Public Notification of Testing, where signals may be out or have interference during certain time frames or areas. Who is notified and how.
-When disrupting a GPS service the list of points of contact for coordinating the notices between DOD and the Civil community will need to be identified.
-Classified *issues* to deal with include the following question...what happens when national security vs. an unclassified user that is by mission, using the service, but cannot be notified of the disruption.

-Identify testing ranges (places, i.e., large military bases) that will not effect the user community, not a we-they, but an us issue. The work group plans to have policy/procedures in place by the end of the calendar year.

-How about disruptions that would be a matter of life and death... notification only that testing is going on, therefore, we may provide bad data and we know about it, but we can't tell you when or what caused it since it is classified...

-A matter of committed investment at the time of disruption, how is this minimized.

Please submit input on any of these issues directly to Larry Hothem or Rebecca Casswell. If you wish to discuss in closed session with other GIAC members, send comments or agenda items to either Captain Lapine, NOAA, or M. K. Miles, USACE, which can be arranged at the next GIAC meeting.

New Civilian Frequency (L5) Ken Lamm, DOT, reported and handed out L5 Frequency Selection Fact Sheet, dated September 6, 1996, which presents the three possible choices for L5 frequency. The fact sheet is available from Mr. Lamm, contact his e-mail for copy: Ken. Lamm@ost.dot.gov. He also discussed the following:

-Option for second civilian frequency being considered by the end of October will not be exercised this year.

A civilian industry has grown utilizing the L1 and L2 frequency. L1 is the only civil frequency that has been agreed to for civilian use by the DOD. Furthermore, we are entering into a period of high solar activity and frequency interference as well.

-Action taken at January, 1996, meeting of the joint DOD/DOT Positioning and Navigation (POS/NAV) Working Group

-L1=1575.42 MHz

-L2=1227.6 MHz

-L5=????? MHz undecided as of yet (see handout fact sheet mentioned above)

-L2 has evolved into a capability that is being used by squatters rights only; no formal DOD approval of use has been granted to anyone outside of DOD.

-What does the civil community need on a second frequency? Define it first, specific requirements, need benefit documented. How can a L5 be justified without a cost/benefit analysis?

-DOD wants civilians to move off of L2. However, users need a second carrier frequency/dual frequency.

***ACTION*: DOT has lead. Brainstorm/outreach, if L-2 goes away what do you as a user need in a L-5 type frequency? How do we get timely input with justification/benefits analysis to follow?**

-DOD wants civil input on what you need with regards to GPS frequencies and commitment of monetary support.

-What if before the year 2006 DOD turns selective availability off while excluding L-2 from civil use?

-Need to look at technical solutions by technical experts gathering together in forum or exchange group at next CGSIC or sooner to address worst cast situations.

-Window of opportunity will close on L-5 on October 31, 1996. Since we will not be able to make that window, we look forward to the next window in FY 98.

New business:

-Submeter Real-time GPS - was not discussed, it will be addressed at next meeting.

Prior to meeting closure, the Forest Service was invited to present the GPS demonstration project at the sixth GIAC meeting to be held at NOAA Headquarters, Silver Spring, MD, to be scheduled during the general meeting activities of the FGCS in mid January, 1997, tentatively set for January 14-16, 1997.

The meeting ended at 5:00 p.m. Consensus of attendees expressed the desire to continue to meet coincidentally with CGSIC in the future. The next CGSIC meeting is scheduled on March 17-18, 1997. We plan to schedule the seventh GIAC meeting during this same time frame. Let me know by e-mail if you cannot attend the meetings planned for January and March. Send your comments to: llapine@ngs.noaa. gov.

cc: N - W. Wilson
DUS - D. Josephson

Attachment 1

SUBJECT: GPS Interagency Advisory Council (GIAC) Meeting Agenda
Date: September 17, 1996
Time: 1:00 p.m. - 5:00 p.m.
Place: Kansas City Marriott
200 West 12th Street
Kansas City, Missouri

1. Attendee introductions and Opening remarks - Captain Lewis A. Lapine, NOAA

2. GIAC previous meeting overview/minutes - M.K. Miles, USACE

3. Status Reports

IWG on International GPS Issues - Captain Lapine, NOAA

Interagency GPS Survey (questionnaire) - Ken Lamm, DOT

New Civilian Frequency, L5 - Sally Frodge, DOT

Continuously Operating Reference Stations-Bill Strange, NOAA

GPS Interference Testing Authority - Bill Strange, NOAA

4. GPS Demonstration Project

Inland Waterway Navigation System - Bill Bergen, USACE

5. New business

Submeter Real-time GPS - Captain Lapine, NOAA

6. Meeting review, assignments and closure - Captain Lapine, NOAA

Attachment 2

EXPANSION OF US COAST GUARD NAVBEACON DGPS NETWORK INLAND WATERWAY NAVIGATION/FLOOD CONTROL SYSTEM COOPERATIVE EFFORT--CORPS OF ENGINEERS & US COAST GUARD CHRONOLOGY OF EVENTS

1987 SEP USACE/New Orleans District code DGPS Hydro Survey Tests: --achieved 8-16 m 2 DRMS -(Limited DGPS use due to lack of 24 hour satellite availability)
1989 USACE/Savannah District Tests: Real-time LADGPS v Microwave Hydro Surveys--S/B Halcyon
1989 First USCG navbeacon activated at Montauk Point --USCG buoy tender tests
1991 DEC USACE Lower Miss Valley Div. (LMVD) (LADGPS committee meets in Cape Girardeau, MO
-purpose: establish LADGPS network from Head of Passes, LA to Hannibal, MO
-2 to 6 m 2DRMS positioning accuracy required
-25 station network from Gulf to Hannibal - 35 mile UHF radio link range ...$2.25M est. cost
1992 JAN USACE/LMVD requested LADGPS UHF frequency allocation through DOD
1992 SEP USACE/New Orleans District activates LADGPS site at Venice, LA
- UHF radio link for Southwest Pass dredging/surveying ...est 5m 2 DRMS
1991 OCT OMB Inquiry: reported potential USACE/USCG duplication of LADGPS service
1992 DEC Initial USACE/USCG meeting @ HQUSCG (in response to OMB inquiry):
-Investigate feasibility of expanding USCG Navbeacon in LMVD vice USACE LADGPS
-Conduct testing in New Orleans District to evaluate potential 6 m accuracy
1993 APR USCG/USACE/NOAA jointly establish English Turn, LA Navbeacon test site
1993 May USCG 2nd District requests expansion of Navbeacon into Western Rivers
1993 JUN USACE tests Navbeacon accuracy relative to carrier OTF: 2 m 2DRMS achieved
1993 JUN Based on tests, USCG Navbeacon deemed viable alternative for LMVD DGPS network
1993 JUN Great Flood of 1993 in Middle Mississippi: microwave positioning control lost
- Impetus for accelerating DGPS network construction in Miss. Riv. & Trib. (MR&T) region
1993 JUN GAO initiates investigation of Federal DGPS duplication
1993 AUG HQUSACE recommends implementation of USCG Navbeacon in LMVD/Corps wide
- LMVD cost estimate $750K vs. Corps LADGPS @ $2.25M

1993 SEP USACE Corps-wide LADGPS frequency authorized: VHF 162-174 MHz
1993 OCT USCG/USACE/LMVD meeting in Memphis to draft expansion MOA (signed FEB 94)
1994 JAN HQUSACE issues DGPS Policy Memorandum: directs use of Navbeacon Corps wide
1994 MAR USACE/St. Louis District activates USCG Navbeacon in (Middle Mississippi/Lower Ohio
1994 APR USACE/Memphis District Navbeacon on line (Middle Mississippi coverage)
1994 MAY USACE/Vicksburg District Navbeacon on line (Lower Miss, Ouachita/Blk R, Red R)
1995 JUL USACE/St. Paul District Navbeacon on line at Fountain City Service
1995 SEP Mobile District Navbeacon activated at Millers Ferry, AL
-coverage: Alabama-Black Warrior W/W and Lower Tennessee-Tombigbee W/W
1995 OCT Rock Island District Navbeacon on line: Middle Miss & Illinois W/W
1995 OCT Continuous Navbeacon coverage for entire Mississippi River: Gulf to St. Paul, MN
1996 JAN USCG Navbeacon status: Initial Operational Capability nation-wide
1996 MAR Tulsa District Navbeacon on McClellan-Kerr Arkansas W/W at Sallisaw, OK
1996 APR Kansas City District Navbeacon on line... covering Missouri River

(ON-GOING/FUTURE ACTIONS)
1996/7 Louisville District: Ft. Knox Navbeacon, middle Ohio River, Kentucky & Green Rivers
1997 JAN Omaha District: Navbeacon coverage to head of Missouri navigation at Sioux City, Iowa
1997? Phila District: C&D Canal, Upper Delaware/Chesapeake Bay coverage
1997? Walla Walla District: Upper reaches of Columbia/Snake Rivers to Lewiston, Idaho
1997? Huntington/Pittsburg/Nashville Districts..expand coverage into Upper Ohio, Cumberland,
? Kanawha, Tennessee, Clinch, Allegheny, Monogahela navigation projects

Lillian Foster tel: 301-713-3169
NOAA, National Geodetic Survey fax: 301-713-4175
1315 East West Highway, N/NGS
Silver Spring, MD 20910-3282 email: LFoster@ngs.noaa.gov

CIVIL GPS SERVICE INTERFACE COMMITTEE
INTERNATIONAL INFORMATION SUB-COMMITTEE (IISC)
21ST MEETING RECORD - 17 SEPTEMBER 1996 - KANSAS CITY

1. Meeting agenda at Annex A, Attendee list at Annex B, and Action list located Annex C.

Item 1 - 20th Meeting Record Approval

2. After the Chair welcomed all attendees to the meeting, including for the first time, Henry Baird from the Department of State. The record was approved.

Item 2 - Matters Arising

a. 20th Meeting Record

3. Jerry Bradley advised through a third party his intention to quickly forward a summary of the L 1 frequency protection and interference issues. There were no reports about national local actions to protect the Il frequency band.

b. 28th CGSIC Meeting

4. The meeting acknowledged the five action items identified at the main meeting, i.e.

i. The timeliness and reliability of GPS information dissemination
ii. To determine the extent of L2 carrier phase use
iii. The need to establish links with the ISO TC211 committees
iv. To encourage the adoption of a common datum and timing system for GPS and GLONASS
v. To address the 1024 week problem anticipated in August 1999

Two related issues were identified:

vi. To assess the benefits by providing a second L5 frequency on the Block IIF satellites.
vii. The need to improve the performance of the system which disseminates GPS status and other information.

5. Issue vi. was subsequently discussed at the Executive panel meeting. The Radionavigation Policy Office committed to release a draft consultation letter for universal distribution regarding the needs and benefits of the propose L5 frequency. Copies of this letter would be distributed to IISC Points of Contact to obtain comment and feedback from civil users.

6. The discussion of issue vii. resulted in the decision for the IISC Chair to submit a formal letter to the CGSIC Chair. Hank Skalski is aware of this issue and already working on it. Furthermore, he is coordinating the US DOT work linked to interference issues particularly global information dissemination.

c. GPS Interference and Protection

7. Formal presentation delivered to the main meeting by Hank Skalski

d. Outstanding Issues submitted to **CGSIC**

8. None outstanding

e. Gothenburg meeting record

9. George Preiss stated that copies are available from him at a cost of $100 and thanked the IISC for their meeting support.

Item 3 - Executive Business Plan Issues

10. George Preiss described the background to the Executive Business Plan (subsequently adopted at the Executive Panel meeting). Significantly, the EBP is binding on the Subcommittee and requires the adherence to Standard Operating Procedures.

11. The Subcommittee wondered if the US authorities intended to recognise the CGSIC in any future BI-lateral agreements between the US and other countries. The US meeting representatives requested more time to address this issue before responding.

12. One of the Australian delegates described their approach to GPS related issues with the formation of a GPS Sub-group at government level, the military contact through NATO and also the BI-lateral agreement between the United States and Australia.

13. In response to a further question concerning the attendance of the US delegates to the ICAO Inter Sessional Working Group, Henry Baird stated this is an international forum to which a formal US position is presented.

a. National reports and presentations

14. The Chair described the responses and feedback received as a result of the newly created reporting form. Although, the initial form had proved satisfactory, there is a need to refine it.

15. The Executive Panel also discussed this item and it was decided to change the CGSIC meeting format by making the IISC agenda more attractive and using the main meeting room for the sub-committee. To recognise the effort and expense to attend CGSIC meetings, each national representative, delegate or official Point of Contact will receive ample time and opportunity to present a comprehensive national report.

16. Hiroshi Nishiguichi stated that this was the 9th meeting he had attended and as a result had improved his and others knowledge of GPS related issues. As secretary of the Japan GPS Industry Council, he represented the private Japanese sector and although the JPGSC had contributed to the recent meetings between the United States and Japan about GPS he expressed the concern of JPGSC at any actions to formalise CGSIC contact at government level. These actions could result in the exclusion of the JPGSC from any such meetings.

17. George Wiggers, the CGSIC chair, replied by emphasizing the open nature of CGSIC and recognizing the need for the Committee to be impartial and independent.

b. Sub-committee Industry **Affiliates**
c. Procedure to Change Sub-committee charter
d. Standard Operating Procedures **(SOPs)**

18. These topics will be covered by the Standard Operating Procedures associated with the Executive Business Plan.

Item **4 -** Meeting Arrangements

a. 1996 European - Frankfurt

19. **The** preparations for this meeting are well advanced and were described to the Subcommittee. An updated information package will be forwarded to registered delegates prior to the meeting.

20. 50 to 100 delegates are expected to attend the meeting and it is the IfAG intention to create a Web site for access to the meeting proceedings. George Weber also hopes to organise representative exhibition for the meeting.

21. The efforts of IfAG and in particular George Weber to support the meeting were acknowledged.

b. 1997 Asia - Belconnen, Australia

22. A lengthy discussion occurred about this meeting and several locations were suggested. After the meeting, the Australian Land Information Group based near Canberra notified their firm intention to host and fund this meeting either in June or July 1997. (delegates travel and accommodation costs to their own account). It is planned to hold the meeting coincident with another meeting for the expanding Pacific GNSS aviation group, CGSIC delegates will be encouraged to attend both meetings.

23. When further information becomes available, it will be communicated to IISC Points of Contact. All potential participants and presenters are requested to contact either John Manning or the Secretary before the next CGSIC March 1997 meeting.

Item **5** - Information Service Topics

a. Internet

24. **The** Subcommittee recognised the impact of Internet for GPS and GLONASS information acquisition and distribution. The present arrangements were satisfactory and proved reliable in operation.

b. E-mail

25. **The** Subcommittee considered that on the whole e-mail worked very well and improved the timeliness of communication between members. Both Rebecca Casswell and Mike Savill encouraged all IISC Points of Contact be they individuals, organisations or national representatives to forward their addresses to either of them for POC list entry.,

c. WWW implementation update

26. **The** meeting identified the need to create on the USCG Web pages a chapter which list links to other important services.

27. The subject of GLONASS information sources was raised and the need for separate sourcing of GLONASS for individual countries identified. Furthermore, GLONASS information sources should be discussed at the proposed meeting between the United States and Russia planned for December 1996.

d. Mirror Images of Information Services

28. This topic was not discussed but the IfAG Information Service does contain a near mirror image of the USCG Bulletin Board.