

#### **Prepared by Dr. Javier Ventura-Traveset**

EGNOS Project Office. Toulouse (France). European Space Agency. January 22, 2003



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## **Presentation Outline**

- The EGNOS Project: Fundamentals and Status
- EGNOS Pre-operational signal: The EGNOS Test Bed
- Merging EGNOS, WIRELESS and INTERNET technologies: the ESA SISNET technology
- Potential EGNOS evolutions
- ✓ Summary





## THE EUROPEAN STRATEGY in GNSS

**Step 1**: EGNOS to provide civil and safe complement to GPS (and GLONASS), into operations in 2004

EGNOS is an initiative of the European Commission, Eurocontrol and the European Space Agency (ESA)

Step 2: GALILEO is to achieve European sovereignty through dedicated system under civil control: into operations by 2008





GALILEO is an initiative of the European Commission and ESA



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#### **GALILEO** Constellation

#### Walker 27/3/1 + 3 in-orbit spares (1/plane)

altitude 23616 km inclination 56 deg Period: 14 hr 22 min Ground track repeat about 10 days

Dimensions: 2.7 x 1.2 x 1.1 m<sup>3</sup> 13 m length with SAs Overall Spacecraft: 680 Kg / 1.6 kW class Launcher Options: Ariane, Proton, Soyuz, Zenit



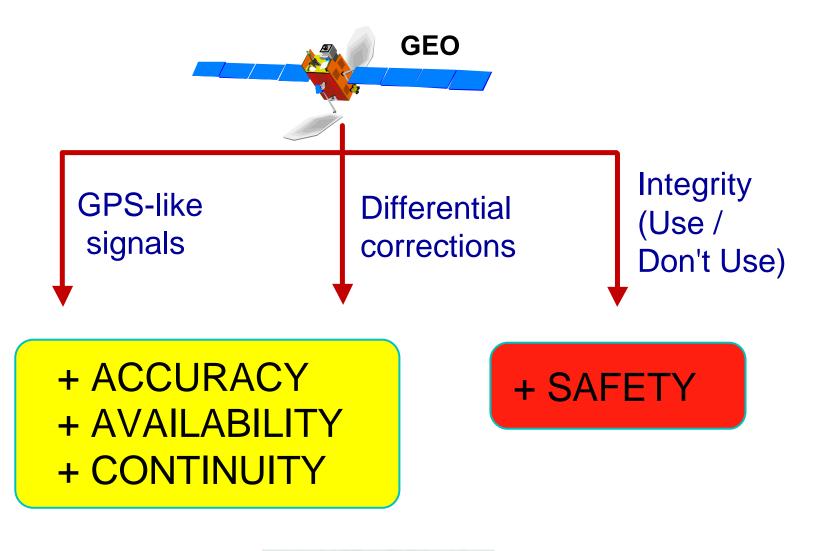


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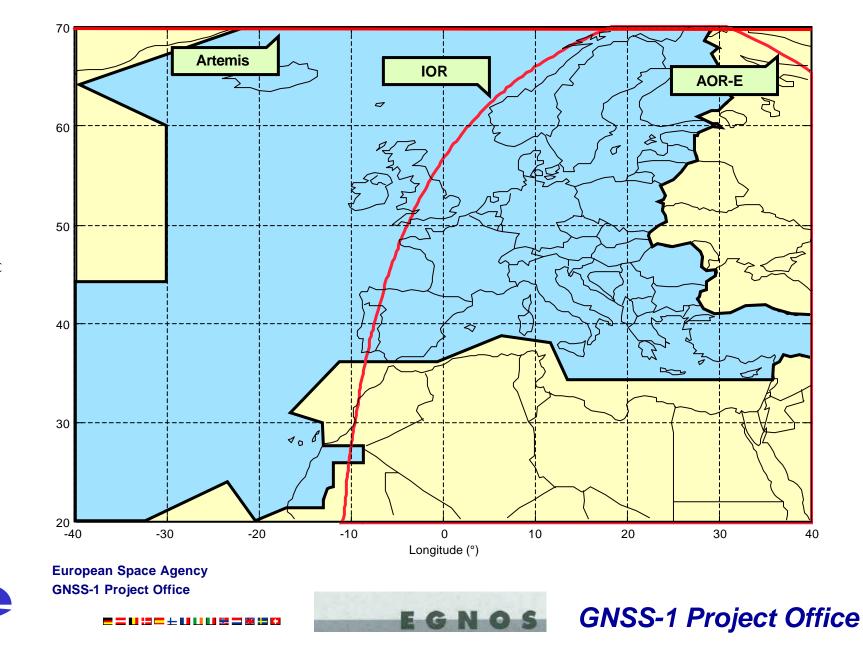
Navigation payload: 115 Kg / 780 W SAR transponder: 20 kg / 100 W

# EGNOS ADDED VALUE



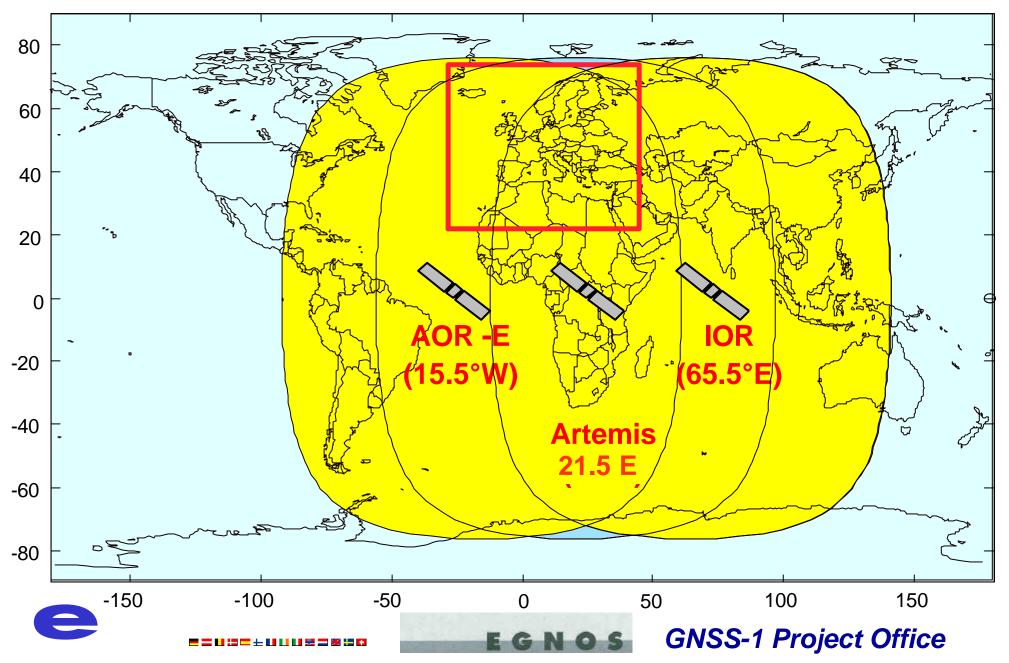


**ECAC** Area

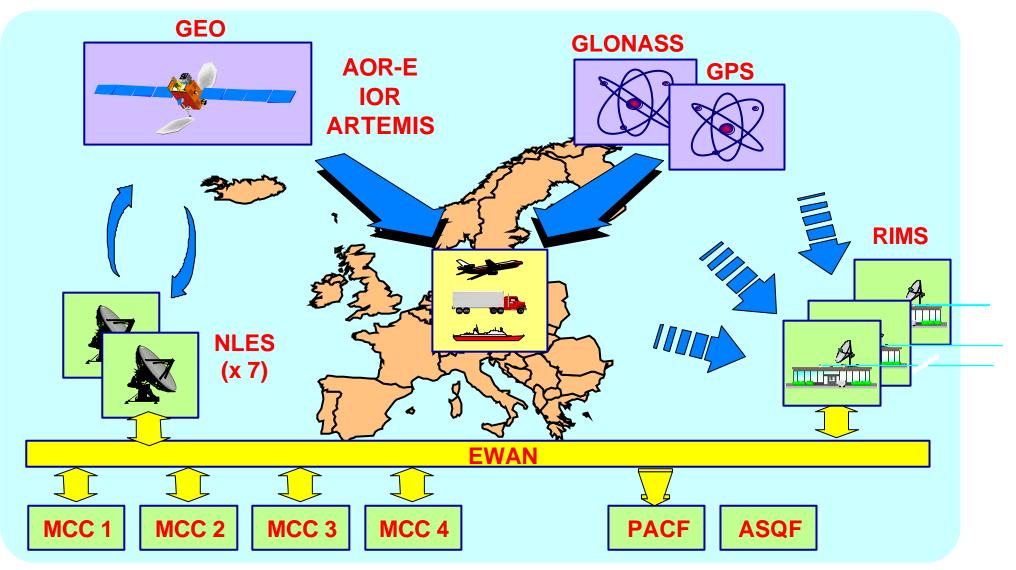


Latitude (°)

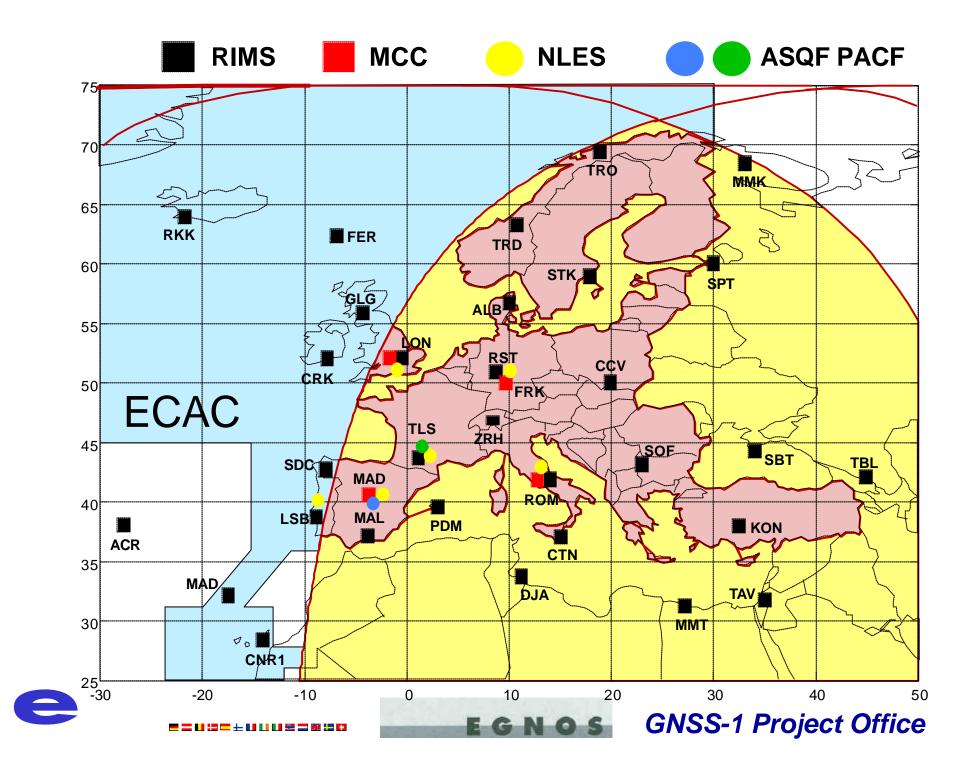
#### **INMARSAT and Artemis GBAs**



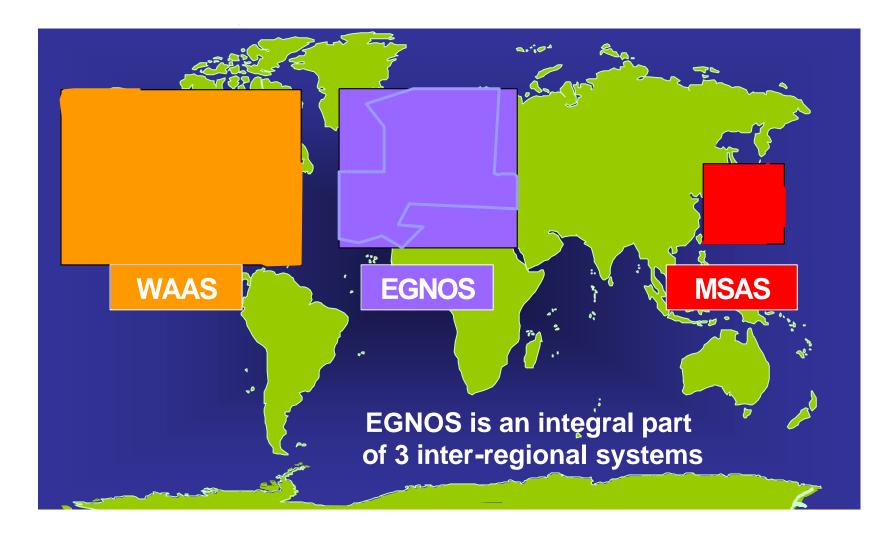
## **EGNOS AOC Architecture**







## **SBAS Interoperability**





## EGNOS Multimodal Performance Objectives

**Civil Aviation:** 

 Primary means of navigation down to Precision Approach (APV-1 and APV-2) with a 99% availability for APV-2 (VAL=20m) over ECAC.

Maritime:

- Specified to be better than 4 meters in European Coastal waters
- Expected performance around 1 meter horizontal accuracy

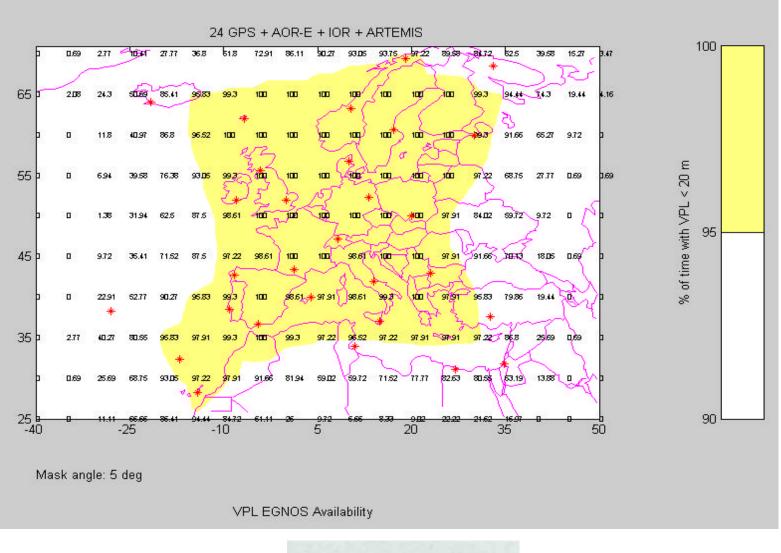
Land Applications (Road community, agriculture, ...) :

- Specified to be better than 4 meters in continental Europe
- Expected performance around 1 meter horizontal accuracy





### EGNOS APV-2 (VAL=20m) availability performances over ECAC



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### **EGNOS AOC Program Status**

	2002	2003	2004
EGNOS HW/SW ProductionChDesign & Production1Sub-system Integration & Tests	FQR	FQR V	
EGNOS System Level Activities System Design Phase System Factory Integration & Tests On-Site Deployment & SIS Tests System Technical Qualification Phase	CDR	FQR SIS 0 SIS1 SIS 2	ORR
EGNOS Sites Site Preparations Site Installations			
<b>EGNOS Operations</b> Operational Framework Formalisation Operation Preparation Phase Initial Operations Phase		V	



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### **All EGNOS S/S under Final qualification status**



**Central Processing Facility** 

CPF



**RIMS A, B and C** 



#### Land Earth Station HW



Central Control Facility (CCF)

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#### **EGNOS Factory Integration in Langen (Germany)**



All Sub-Systems delivered to Factory Integration (ID)

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First functional communications established



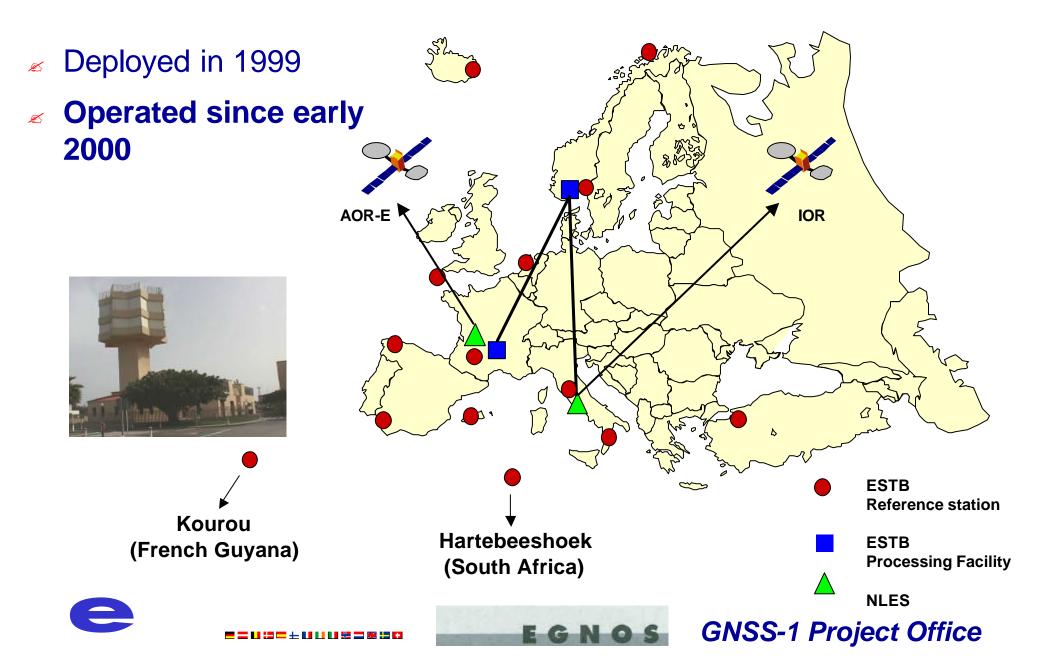
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## EGNOS Test Bed and GNSS Promotional Activities



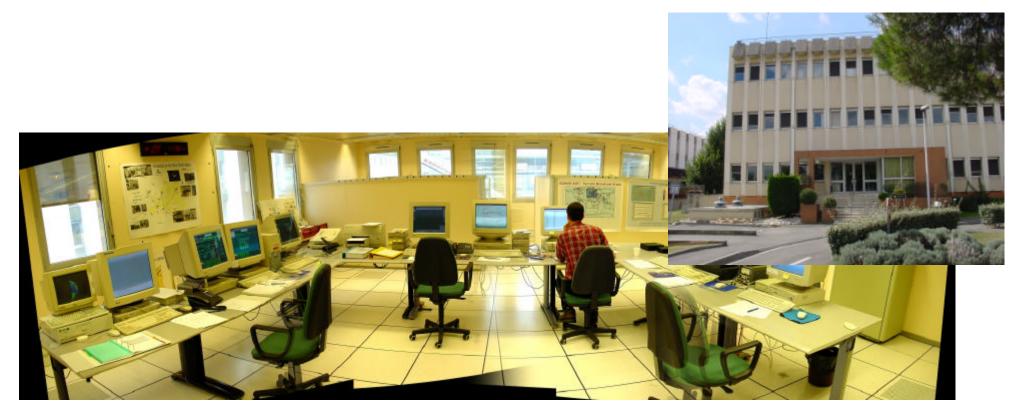


## EGNOS System Test Bed (ESTB)



## **ESTB Operations**

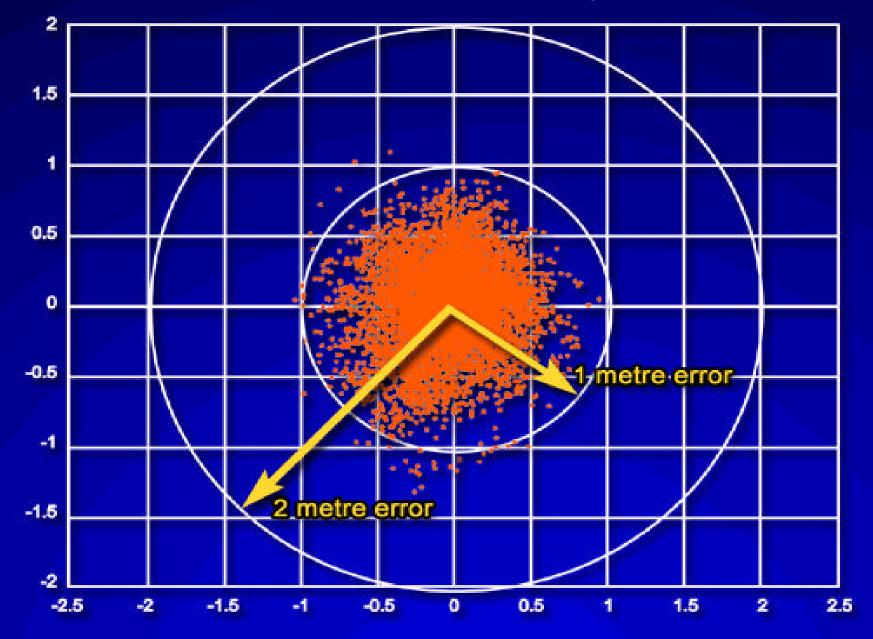
#### ESTB Operational Centre in Toulouse







#### CURRENT ESTB PERFORMANCES (HNSE(95%) close to 1 m accuracy !!)



#### **ESTB APV-2 SERVICE AREA**

Last 24 hours of ESTB data. 02-Oct-2002 12:38:05 (CET)

Bound Bound2 scale 28 GPS + AOR-E 100 100 -925 80.62 8.12 3.12 0 13.12 37.6 61.87 75.62 91.87 100 100 100 100 41.25 60.82 75 65 100 100 / 100 44.37.9.37 0 100 100 100 100 95 100 100 100-100 NDB 57.49 22.5 0 % of time with VPL < 20 m 24.37 40 72.5 75 100 100 100 100 100 -100 55 21.25 51.87 75 100. 100 tin. 100 100 93.75 31.25 22.5 97.5 100 100 100 100 000 100 31.25 71.87 71.5 94.37 100 100 \* 100 100 100 100 100 100 100 96 39.57 0 90 45 þ 25.62 68.12 80 21.87 61.25 80 35 31,25 38,12 96 87 96 87 96 87 96 87 96 87 100 100 4400 1002/100 100 100 100 7/1.87 21.87 9687 9687 9687 9687 9687 9687 9687 80 80 97.5 100 100 9687 93.78 4628 11.87 15.62 70 25 b 80 65.62 63.12 71.87 62.6 61.87 0 -25 35 -40 -10 5 20 50 Mask angle: 5 deg VPL EGNOS Availability





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#### The EC/ESA on-going GNSS application projects (not complete list)

- Aviation domain
  - EMS Eurocopter
  - Delta Hybridisation
- Road domain
  - EGNOS through DAB
  - EGNOS through RDS



- GALLANT
- NAVOCAP SISNET
- Intelligent Car Navigation (\*)
- General
  - ESA SISNET Technology
  - ETRAN CCN SISNET
  - Special Applications (\*)

• Info-mobility



- *⊯* INSTANT
- 🗷 Nav-Com



- - 🖉 ETRAN-2
  - K Waterways Applications(\*)
- Rail domain

  - LOCOLOC/LOCOPROL

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⊯ ECORAIL ⊯ RUNE

Local Elements

 ETRAN-1





## Merging SBAS, WIRELESS and INTERNET technologies

## **The ESA SISNET Project**











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#### EGNOS Signal In Space over the interNeT in real time

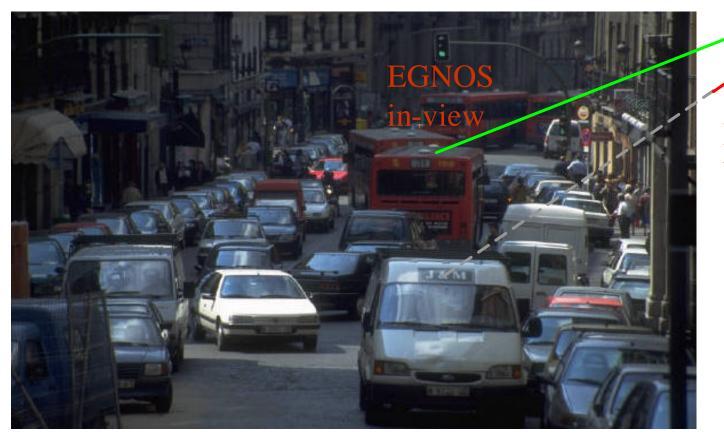


Together, these technologies are stronger than the sum of the parts





Excellent complement to satellite transmission In urban and canyon areas.



EGNOS GEO satellite

## EGNOS blocked by buildings

WHY?

Getting EGNOS corrections in these cases proves to be very useful

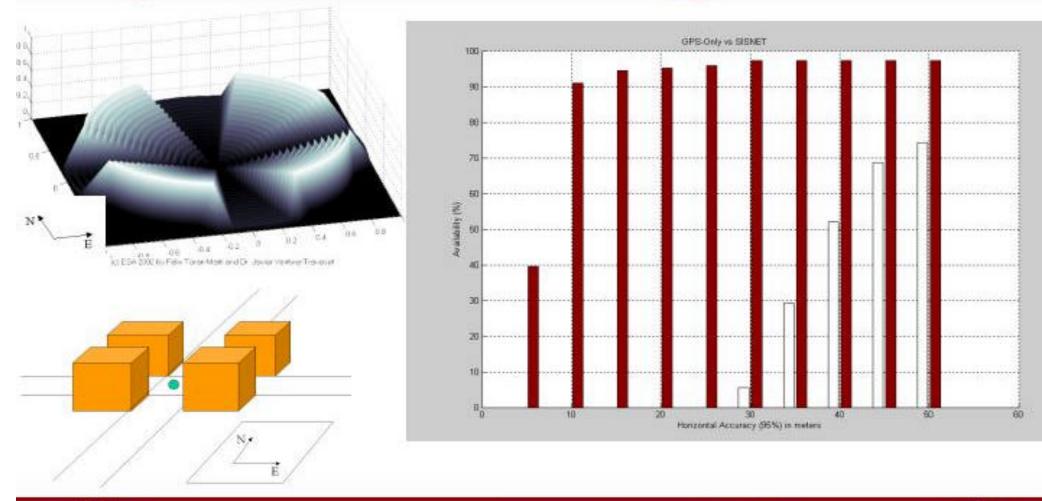


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## Preliminary Simulation Result: Scenario 1











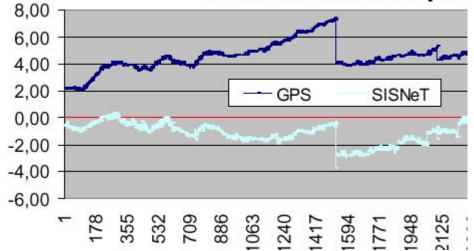








Errors in the North compone



First tests successfully performed in Finland During 2002 with SISNET PDA developed receiver.





# On-going SISNET technology application demonstrations

- EGNOS/SISNET for fleet management of public bus transportation (NAVOCAP)
- EGNOS dissemination through FM RDS (TDF)
- EGNOS dissemination through DAB (BOSCH/BLAUPUNKT)
- Full integration of EGNOS/SISNET receiver in mobile phones
- EGNOS/SISNET to support blind pedestrian (GMV)







## **EGNOS EVOLUTIONS**



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## **Possible EGNOS Evolutions**

#### ✓ Context

- On-going International Standards efforts towards SBAS L5 service definition in 2004.
- GEOs with L1/L5 capability will be available in Europe in 2004
- GPS modernization program: First GPS IIR-M (L2C) in 2003. 50% constellation in 2006. First GPS IIF (L5) in 2005.
- WAAS evolution plans

#### Possible EGNOS Evolution Objectives

- 1) Expansion of EGNOS Service coverage;
- 2) Introduction of SBAS L5 Broadcast service.
- 3) Longer term Integration of GNSS services (SBAS / Galileo) towards sole mean
- 4) Provision of service through other Broadcasting means (e.g. SISNET)



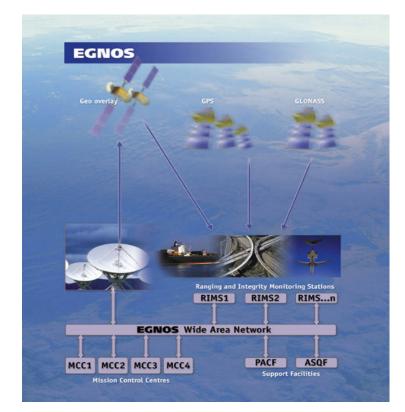


#### In response to the new Mission Requirements EGNOS V2 (2005/ 2008) could ... (I)

- Incorporate additional
   Expansion and Interoperability message
  - Type 28 as done by WAAS/MSAS.
- Provide SBAS service on L1 and L5 frequencies
  - full robustness to L1 loss/interference
- Include additional RIMS
  - for Service coverage expansion area
- Include additional GEOs

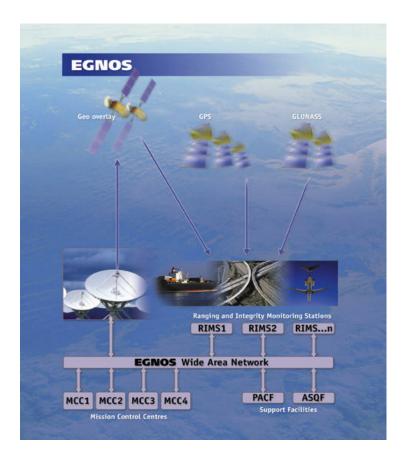






#### In response to the new Mission Requirements EGNOS V2 (2005/ 2008) could ...(II)

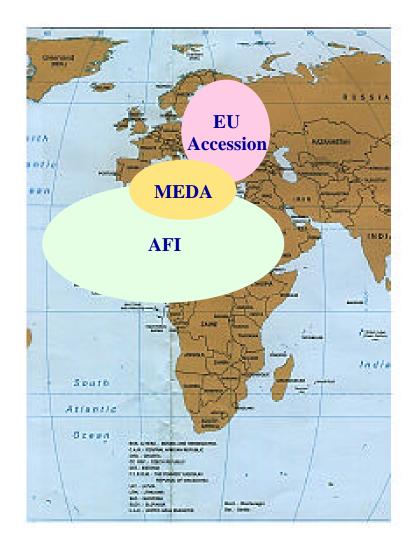
- Adapt Ranging Stations to GPS L2C
  - further robustness to interference, iono scintillation and improved coverage
- Provide additional EGNOS services
  - provision through non-GEO means
- Be implemented gradually
  - without EGNOS service interruption.





## **Service Coverage Extensions**

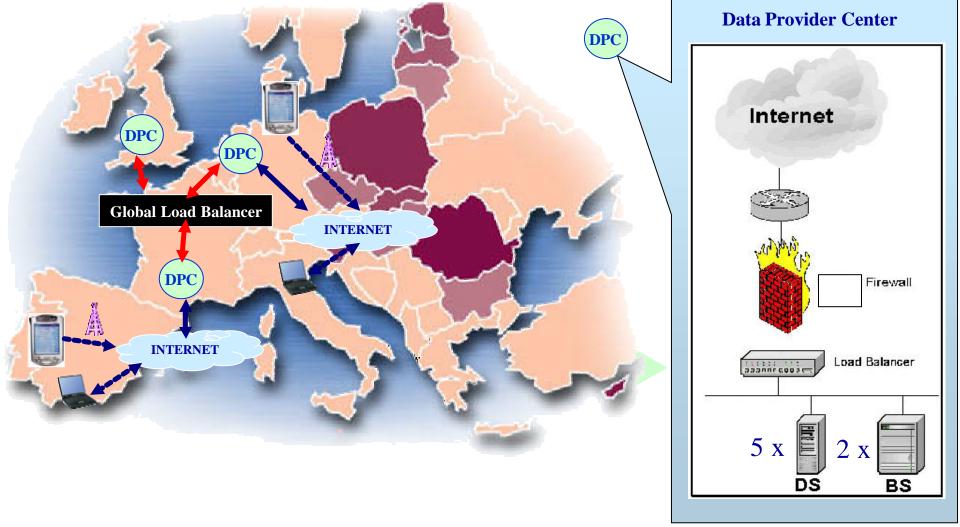
Thanks to built-in
 expansion capabilities,
 EGNOS service can
 easily expand coverage
 area via simple addition
 of extra Monitoring
 Stations







## THE ESA SISNeT PLATFORM can easily be expanded TO 100,000s/millions of USERS



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### SBAS /GALILEO combined use towards GNSS "Sole-mean" for Safety Of Life applications







#### SUMMARY

- EGNOS AOC development progress is in line with the target of delivering the first EGNOS signal in April 2003 and the final system (Operational Readiness Review) in April 2004.
- With the broadcasting of the EGNOS test bed since Feb 2000, SBAS has now become real in Europe for many users. This has allowed the development of a large number of GNSS multimodal applications which may now use EGNOS
- Interoperability with other SBAS (WAAS, MSAS) remains a key objective
- Next important Program Challenges:
  - Complete integration, deployment and verification activities within schedule (SIS0. SIS 1, SIS 2 and Final SIS)
  - Continue and finalize the preparation of the operational framework (operations to start in Spring 2004)
  - Consolidate EGNOS evolution and full integration into GALILEO



## Thank you for your attention

## **EGNOS Benefits to GNSS users**

- Recent Galileo Studies further demonstrate the huge Macro-economic benefit of Satellite Navigation Service development in Europe
  - Mobility, Telecom
  - Route guidance, info and emergency services
  - Aviation & Maritime Sector
  - Oil and Gas Sector
  - Public regulated services, Police and Fire Sector
- EGNOS now recognised as first step to Galileo and part of the European Satellite Navigation Strategy
- EGNOS System sole European source of GNSS Services in 2004-2008 timeframe
- EGNOS/GALILEO combined services may allow GNSS to become «sole means »





