

Integration of SatCom / SatNav Technologies for Environmental Monitoring and Management of Emergencies

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International Committee on
Global Navigation Satellite Systems

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Research Objectives

- Integration of **satellite communication and satellite navigation solutions** with space based observing systems for **prevention and management of emergencies**, occurring inside or outside Europe.
- The target of this Activity is the development of a User Platform in order to validate the technological concepts and acknowledge the benefits of an **integrated communication/ navigation/observation infrastructure with the users**.

Evolution

- Complementarities of the satellite capabilities with the terrestrial capabilities will be assessed on the basis of a medium to long term view.
- Foreseeable evolution of spaceborne and terrestrial communication and navigation technologies will be taken into account .
- In particular the relevant developments in the GALILEO System.

TAM TAM Project

TAM TAM (Transmission of Alert Messages Through SBAS for Disaster Management)



Evolution and implementation of the ESA ALIVE Concept in GMES (Global Monitoring for Environment and Security)

- Prevision and Management of Emergencies

- Provision of emergency communication messages through SBAS: **the ESA ALIVE concept**
- **ALIVE is the ALert Interface Via EGNOS for Disaster Prevention and Mitigation.**
- It acts as an interface between the various Disaster Management Centers and the users in distress.

Disaster Prevention

✦ Importance of the prevention of disasters

Various types of disasters:

Natural disasters:

- Earthquakes, volcanic eruptions, tsunamis, etc.
- Land slides, rock avalanches, etc.
- Tornadoes, hurricanes, wild fires etc.



ESA

Disaster Prevention

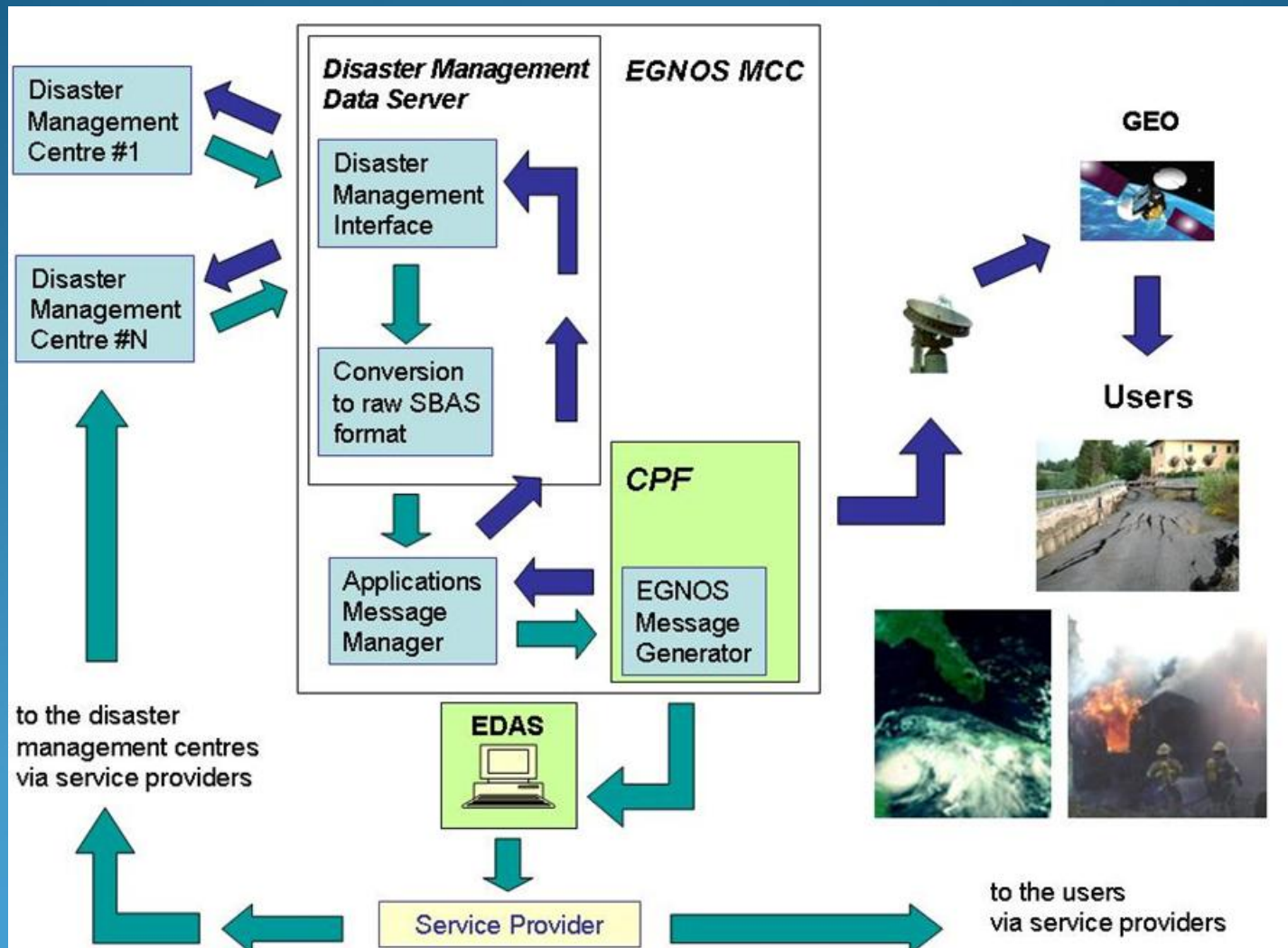
Anthropic disasters:

- Infrastructures collapses (bridges, buildings, etc.)
- Atmospheric/Earth/Marine dangerous pollutions, biological disasters
- Terroristic attacks, chemical and oil spills, etc.

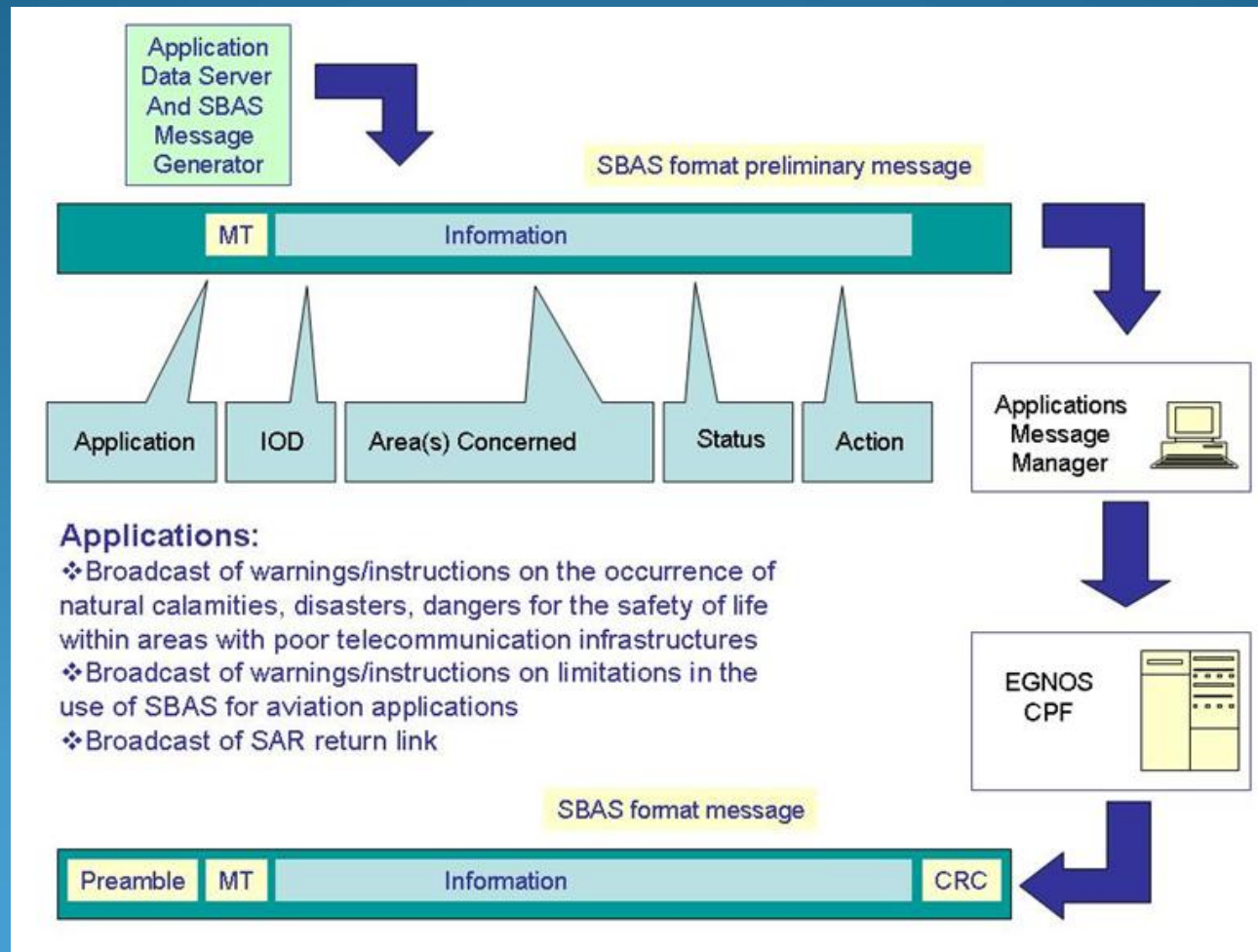
High Potential Advantages

- Works in places with no infrastructure or where infrastructure is not operational
- SBAS receivers get alert message and also have their position simultaneously. Only users concerned need to act;
- SBAS operated with all guarantees:
Safety of Life, Institutional control, 24hour non Stop;
in time broadcasting confirmation message.

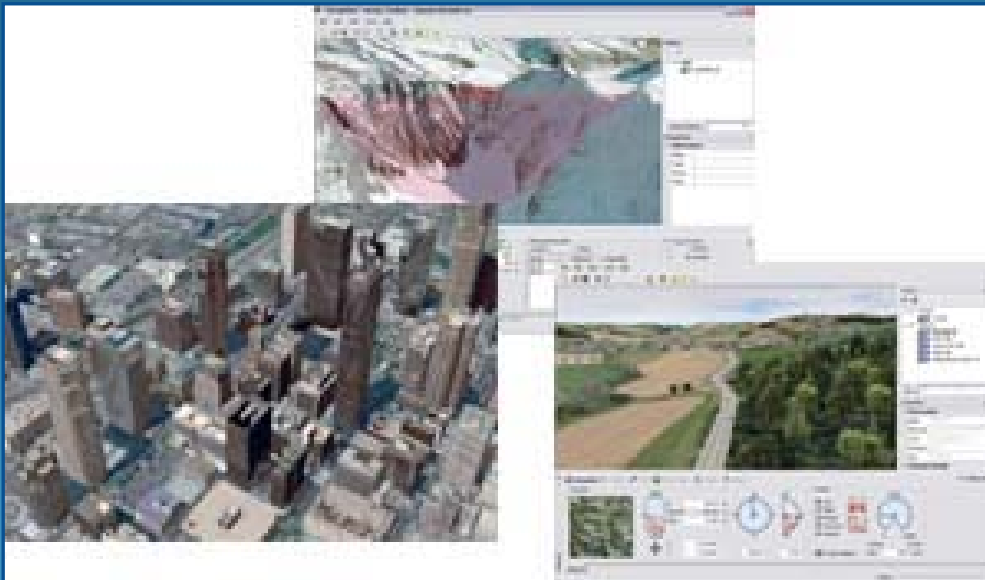
ESA ALIVE Architecture



SBAS format message



3D real time visualization at End User Terminals



<http://www.google.com/mobile/default/maps-demo.html>



SATNAV Technologies

Real time Kinematic Applications

**Development and Applications of an Experimental Data
Server hosting EGNOS and RTCM /RTK messages**

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Correction Data Generation using EGNOS/SISNeT Technology

- *The implementation of the EGNOS Message Server (EMS) and the opportunities offered by the SISNeT (Signal-In-Space through the Internet) technology have encouraged the development of a number of applications within the GNSS users community.*
- *One possible application is to provide GNSS users with the best available correction data for their GPS measurements within the area of operations.*
- *Corrections can be based on: SBAS, RTCM and RTK data.*

Real Time Data transmission

- *The research idea is to make all the correction data available on a Data Server, allowing the GNSS users to access this server through a communication link and download the desired corrections.*
- *In this way GNSS users, depending on the application and on the operation area, can always benefit of the best available corrections.*

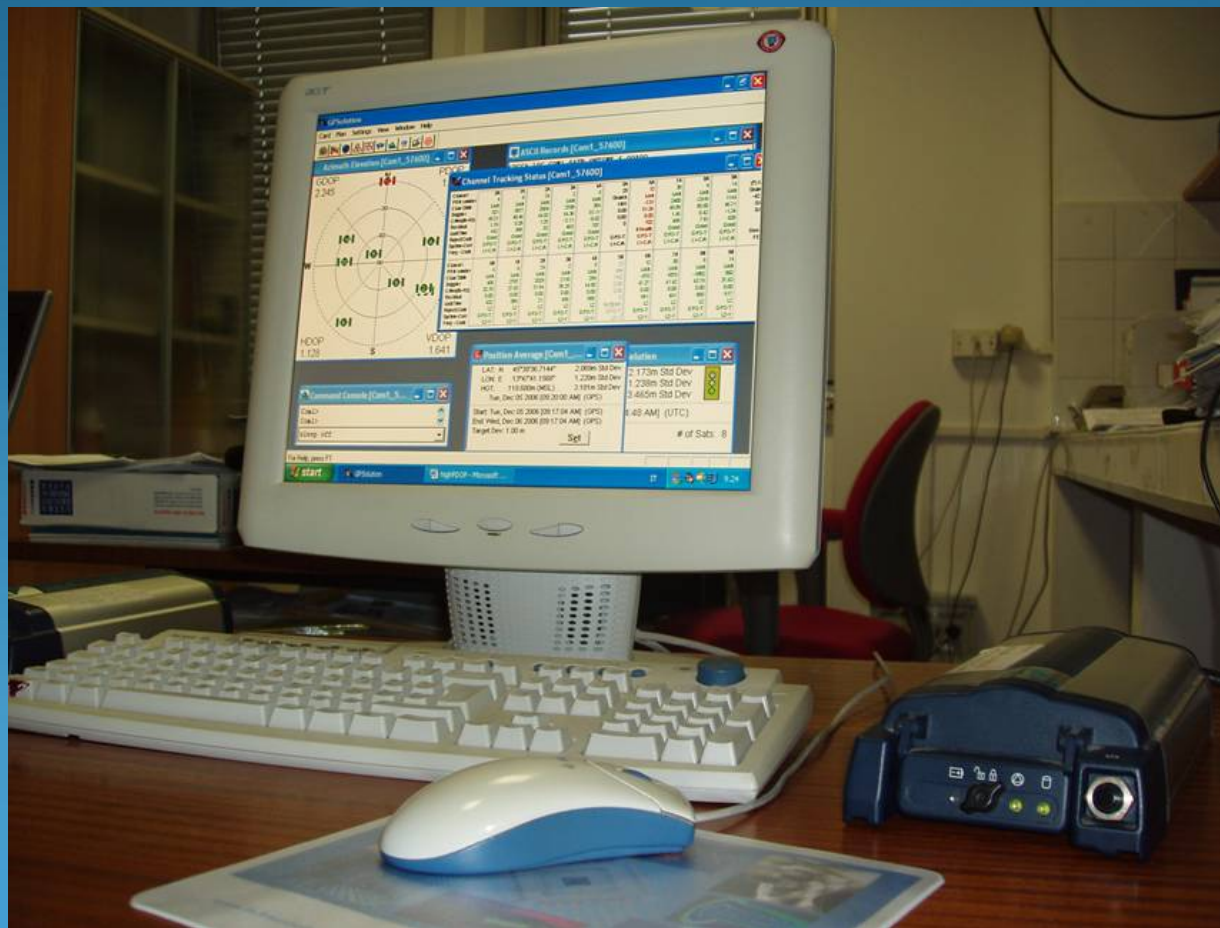
End User Terminals

- *All the corrections available on the Data Server are made accessible via **VPN (Virtual Protected Network)** through the Internet to authorised users equipped with an **integrated GPS/EGNOS/GPRS terminal**.*

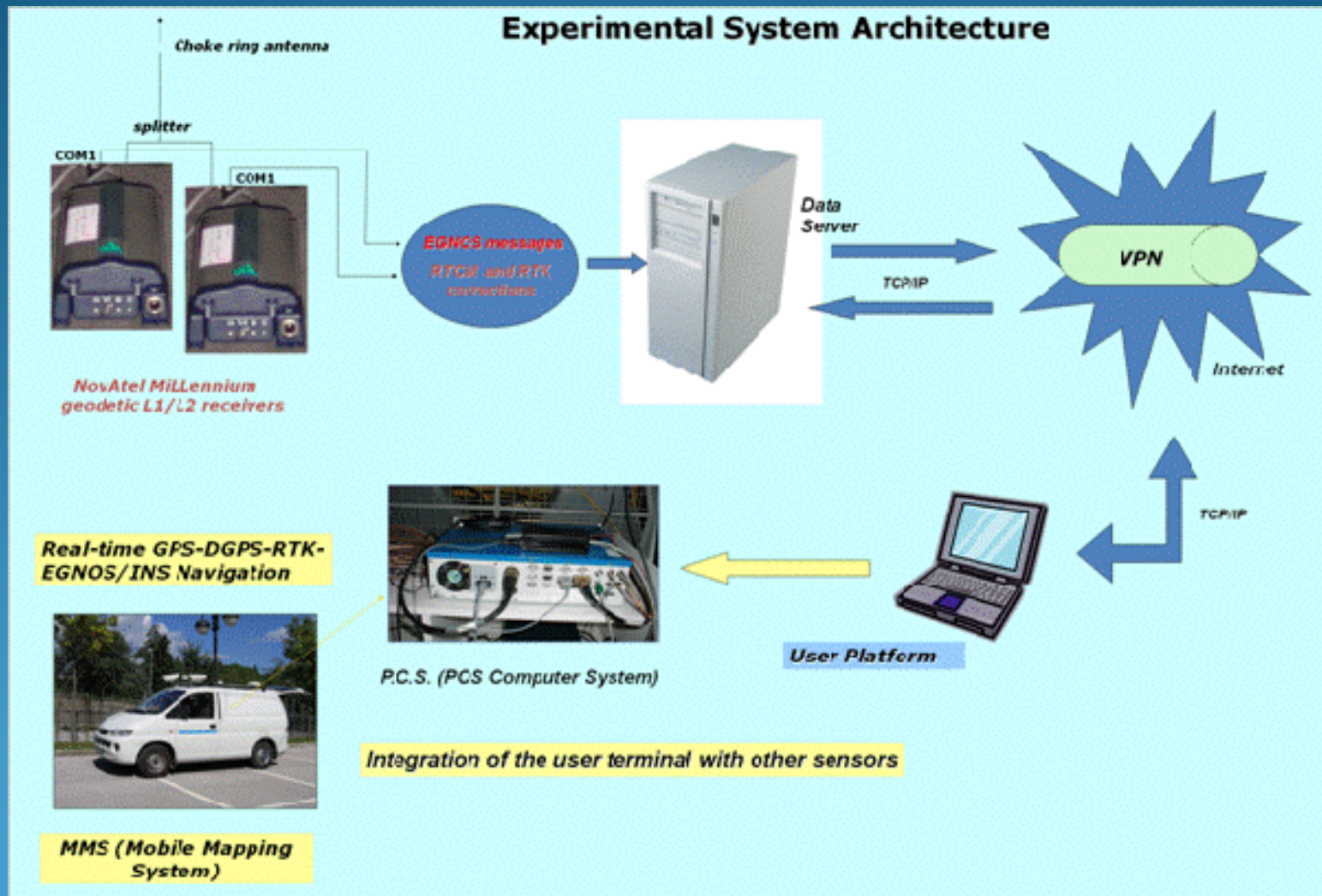
Experimental Data Server

- *An experimental Data Server making available at the same time EGNOS augmentation messages as well as RTCM and RTK differential corrections, computed by dedicated receivers located at a known reference position, has been set up at **GeoSNav Laboratory**, Department of Civil Engineering University of Trieste, ITALY.*

The Experimental Local Data Server at GeoSNAV Laboratory



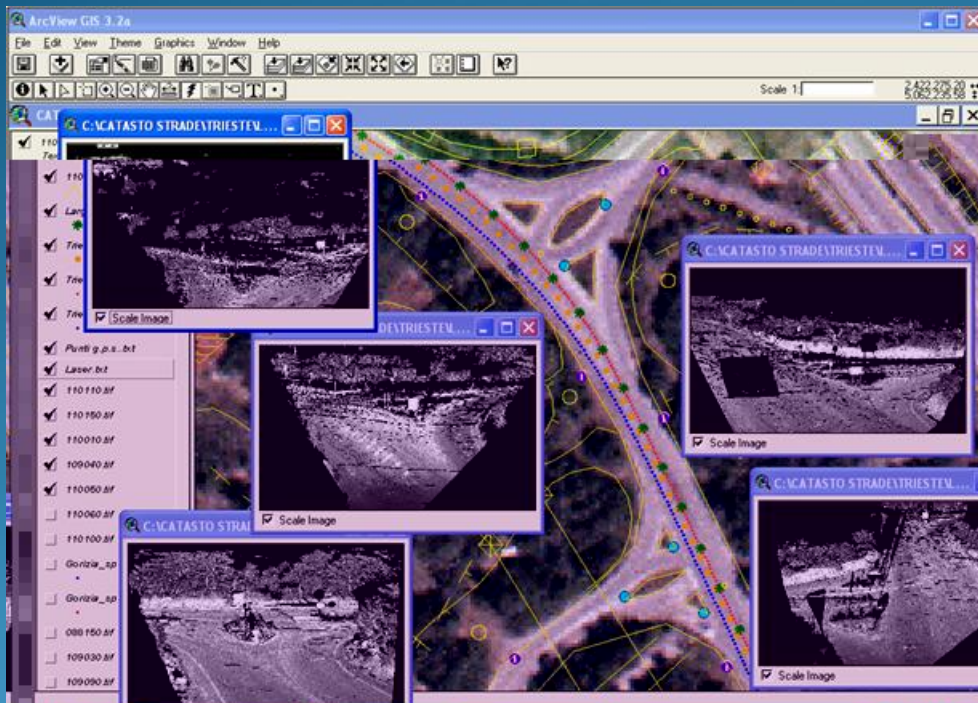
The Experimental System Architecture



Kinematic Applications - examples

Research in TeleGeomatics
Examples

Road Cadaster



**Integration with Laser
Scanner data**



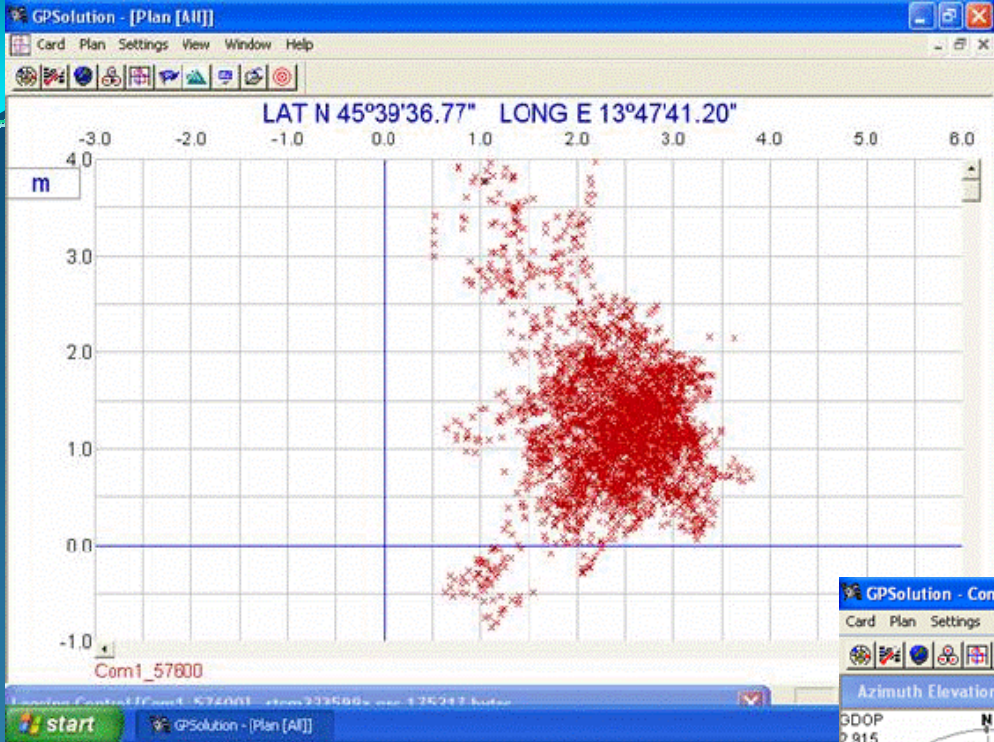
Some examples of available Message Types

\$RTCM59,665D7F557679694C67537241484B7D6A457B7F675F68786D6A5E757F775D724476407B7
F7F5F41547F6B56687651464C69717540606E696157445665676E787F52684E667F5974535D58447C
7F7B4F4B5B6E5048624C5540405E41525E63426E704D434B40604D65447075704777547D7F536475
5D707A5A6756547F79606A7E7F47*2F
\$RTCM59,665D7F557679494567674D7E77744255664741645F6878655E714E4048676D70497F747F
7F7F41477F6B5B697851465C4C665D40606E7946574456524C4C4C4077576E5D406D4B6C5A68684
34044627567516F774346597F7F7E416D615C795167687F737F5F7A54447075705E4C7740405C6857
5F707A464741757F7A606A447F4E*22
\$RTCM59,665D7F557679714967507241484B7D6A71767D7B5F687869
40607D407F6B55686351467C734E667F5F71664A5744564E625B4C4C
4044746E64516F4F575F487F7F4861625E6378516B7B7F5340604D6F
634F45437B796A7F5B5F4547405F*27
\$RTCM59,665D7F5553466E7E58517241484B7D6A41757F625F687861
40407D7640547A55486E795D697E45406076724D574456427A7E4940
7F7B614F596E507046717A7F7F6C7E53615C7C515355714B40607366
634F457A6452444072605A717F71*56

\$GPGGA,131723.00,4539.6123860,N,01347.6873391,E,9,05,
1.6,116.67,M,,,,*04
\$GPGGA,131724.00,4539.6122935,N,01347.6872930,E,9,05,
1.6,116.82,M,,,,*08
\$GPGGA,131725.00,4539.6122765,N,01347.6872205,E,9,05,
1.6,117.01,M,,,,*05
\$GPGGA,131726.00,4539.6122583,N,01347.6871378,E,9,05,
1.6,117.35,M,,,,*03
\$GPGGA,131727.00,4539.6122169,N,01347.6871607,E,9,05,
1.6,117.59,M,,,,*05
\$GPGGA,131728.00,4539.6121151,N,01347.6871835,E,9,06,
1.6,118.04,M,,,,*09
\$GPGGA,131729.00,4539.6121016,N,01347.6872149,E,9,05,
1.6,118.35,M,,,,*0A
\$GPGGA,131730.00,4539.6120948,N,01347.6872013,E,9,06,
1.6,118.91,M,,,,*02

\$FRMA,379,479700.127,120,80811EA4,250,53023FB8003FE80
FE8003B97B913B93BB88EC3EC0*3B
\$FRMA,379,479701.127,120,80811EA4,250,9A60000008000000
00003F7400000000425625800*42
\$FRMA,379,479702.128,120,80811EA4,250,C66A48108084042
FF7FFBFFDFEFFF780128D4E00*39
\$FRMA,379,479703.128,120,80811EA4,250,530E0003FE800BFF4003FF0000010003FF00000
0000391FBBB9393BBBE212BC0*3E
\$FRMA,379,479704.128,120,80811EA4,250,9A003FC4003FE8000003FFBFE8000003FD0003
FE8003B97B913B93BBA0ADA1C0*35

Stand Alone GPS



Position [Com1_57600] - Good Solution

LAT: N 45.66024103° 2.788m Std Dev
 LON: E 13.79476326° 1.591m Std Dev
 HGT: 113.639m (MSL) 4.143m Std Dev

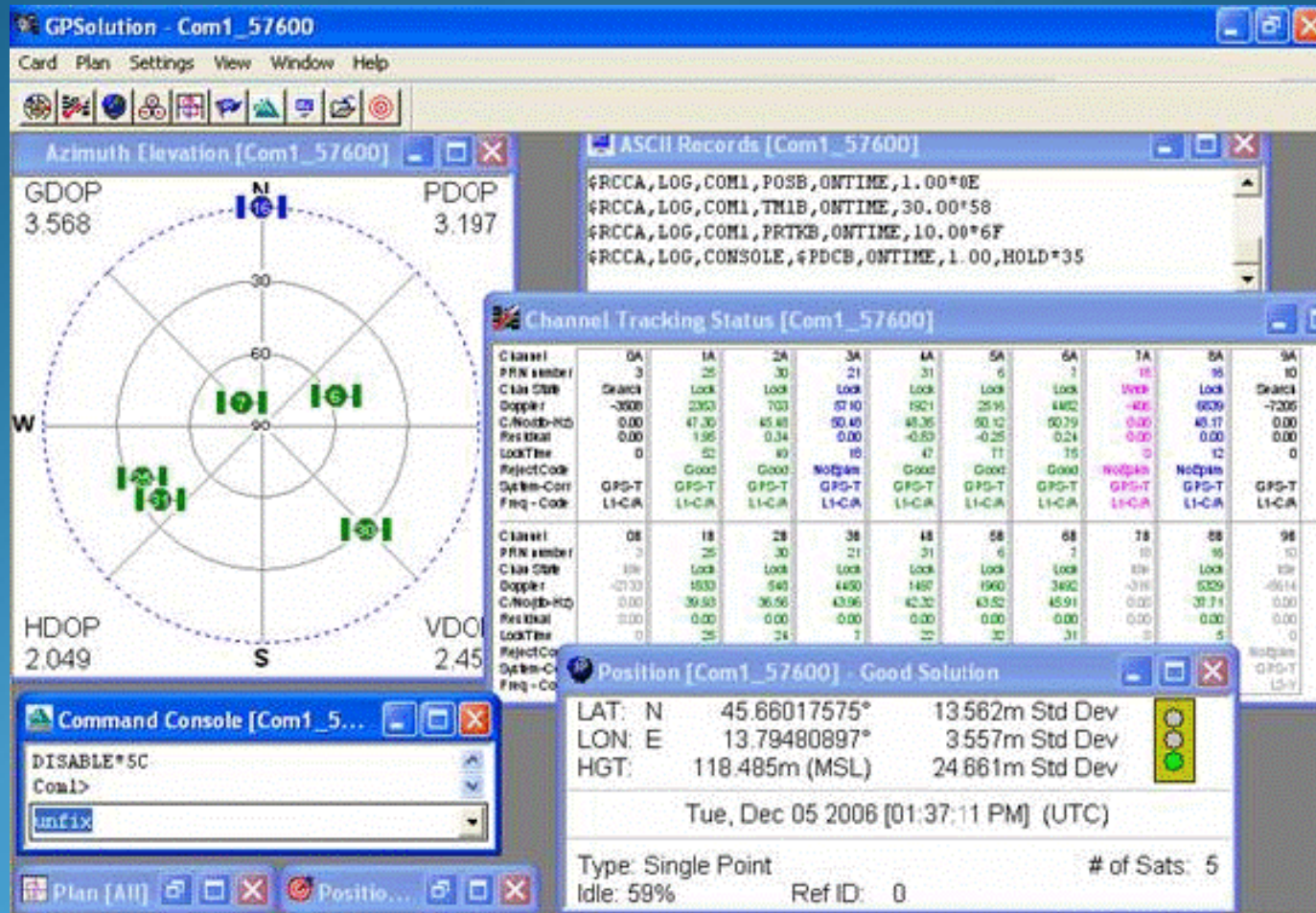
Fri, Dec 01 2006 [03:29:02 PM] (UTC)

Type: Single Point # of Sats: 7
 Idle: 66% Ref ID: 0

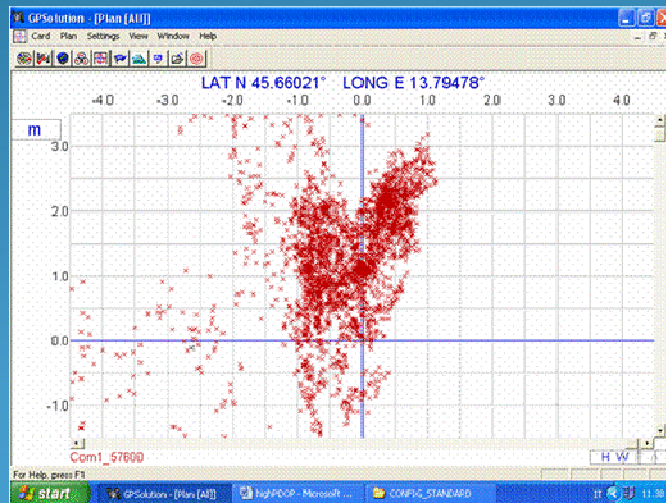
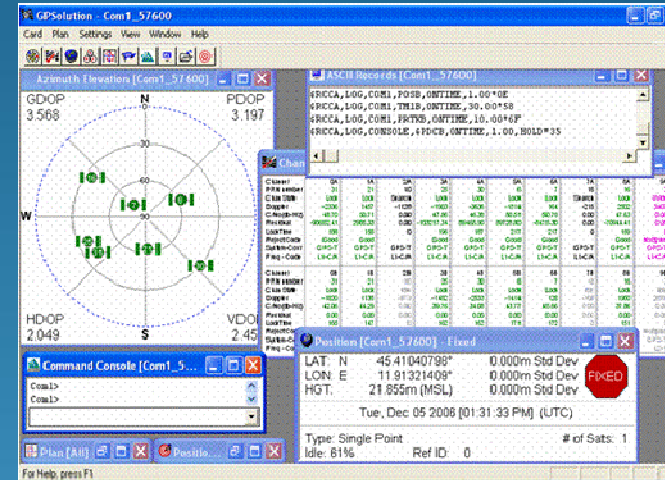
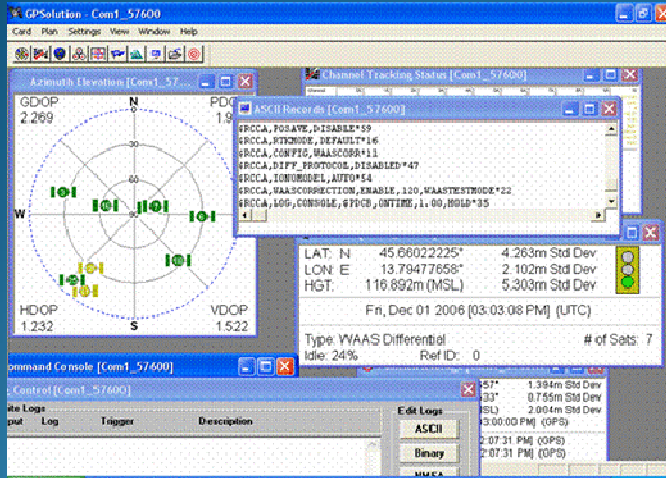
| Channel | PRN | PRN Index | Case | CDR | Doppler | C-MagB-Hz | Residual | LockTime | RejectCode | System-Code | Freq - Code |
|---------|-----|-----------|------|-----|---------|-----------|----------|----------|------------|-------------|-------------|
| 08 | 18 | 28 | 38 | 48 | 58 | 68 | 78 | 88 | 98 | 108 | 118 |
| 03 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 | 111 | 121 |
| 06 | 12 | 22 | 32 | 42 | 52 | 62 | 72 | 82 | 92 | 102 | 112 |
| 09 | 19 | 29 | 39 | 49 | 59 | 69 | 79 | 89 | 99 | 109 | 119 |
| 11 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95 | 105 | 115 |
| 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 | 114 | 124 |
| 16 | 16 | 26 | 36 | 46 | 56 | 66 | 76 | 86 | 96 | 106 | 116 |
| 17 | 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 |
| 19 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 |
| 22 | 1 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 |
| 24 | 5 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95 | 105 |
| 27 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 | 103 | 113 |
| 30 | 2 | 12 | 22 | 32 | 42 | 52 | 62 | 72 | 82 | 92 | 102 |
| 33 | 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 |
| 36 | 8 | 18 | 28 | 38 | 48 | 58 | 68 | 78 | 88 | 98 | 108 |
| 39 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 | 114 |
| 42 | 3 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 | 103 |
| 45 | 6 | 16 | 26 | 36 | 46 | 56 | 66 | 76 | 86 | 96 | 106 |
| 48 | 9 | 19 | 29 | 39 | 49 | 59 | 69 | 79 | 89 | 99 | 109 |
| 51 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 | 111 |
| 54 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95 | 105 | 115 |
| 57 | 1 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 |
| 60 | 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 |
| 63 | 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 |
| 66 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 |
| 69 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 | 103 | 113 |
| 72 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 | 117 |
| 75 | 1 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 |
| 78 | 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 |
| 81 | 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 |
| 84 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 |
| 87 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 | 103 | 113 |
| 90 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 | 117 |
| 93 | 1 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 |
| 96 | 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 |
| 99 | 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 |
| 102 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 |
| 105 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 | 103 | 113 |
| 108 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 | 117 |
| 111 | 1 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 |
| 114 | 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 |
| 117 | 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 |
| 120 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 |
| 123 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 | 103 | 113 |
| 126 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 | 117 |

Real Time Positioning Performances

Real Time Positioning Performances - Stand Alone GPS



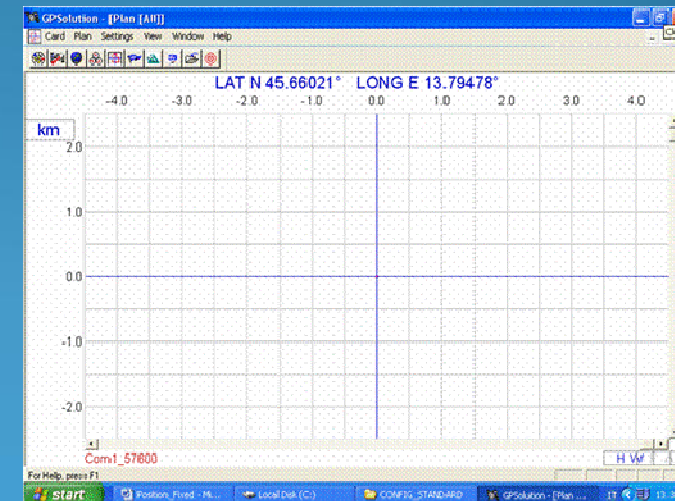
Real Time Positioning EGNOS Performances and RTCA corrections generation



Real time EGNOS positioning

12/9/2008

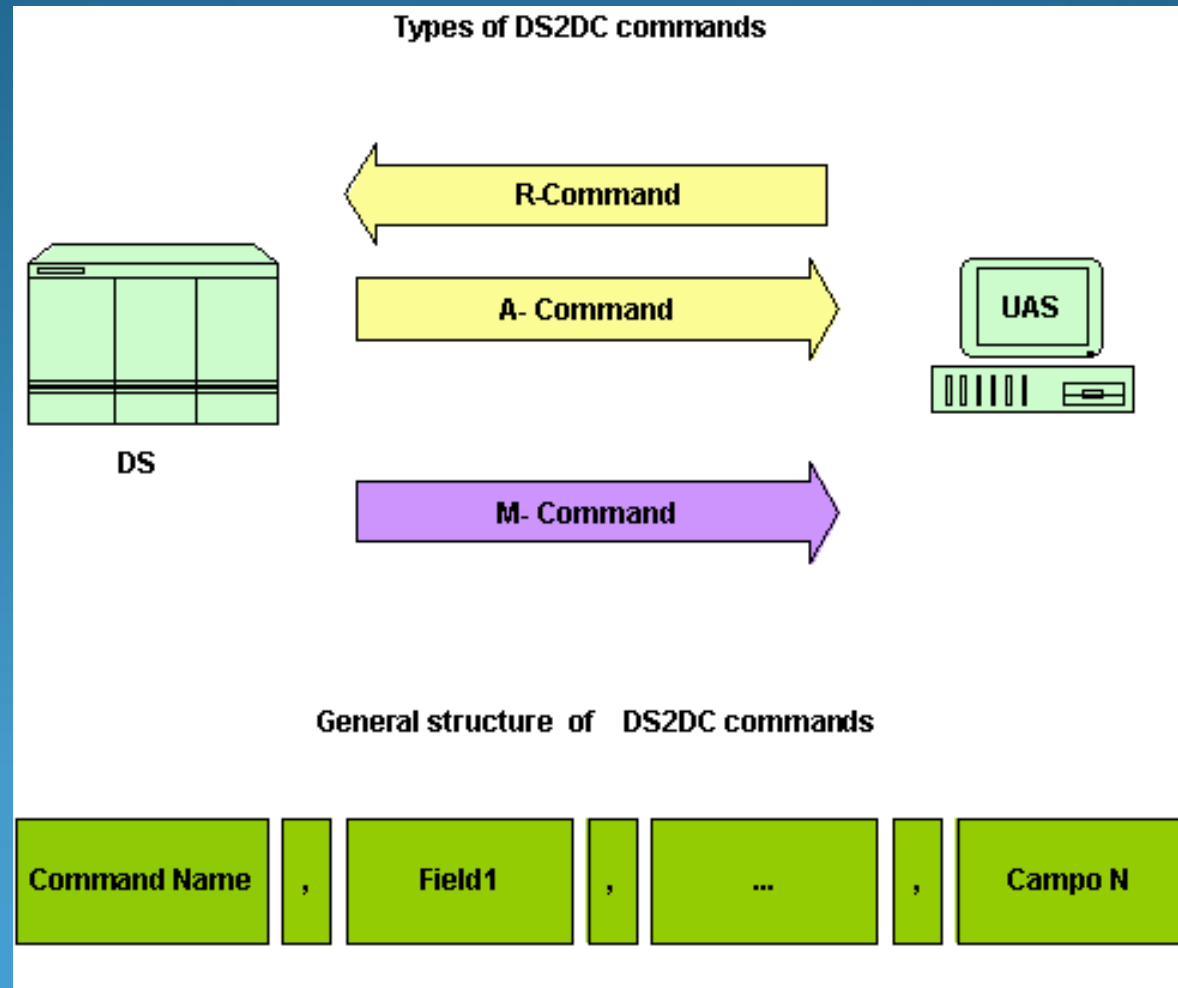
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RTCM/RTK corrections
generation

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UNITS UAS (User Application Software) Architecture



SISNeT UAS UNITS client

SISNet UniTS client

Messaggio spedito
MSG

Messaggio ricevuto
9A0E400001400000000000000000000005000000000380039FB88893B939ECE9800*35

MSG WEEK 194
MSG GPS TIME 580966.129
MSG TYPE 3

Salva su file
 Trasferisci su seriale

IP server 131.176.49.142
Porta server 7777
login rcefalo
password xxxxxxxx

Connetti
Disconnetti
Chiudi

GeoLab Trieste 2003 by M Calderan
Command received from the Data Server (7:21:54 PM)

Accuracy related to User Needs

- *Depending on the operational conditions and on the operation area (distance from reference station/visibility of EGNOS satellites), the **user can choose the augmentation** to be included in the computation of position, velocity and time.*
- *The research project has encompassed the following activities:*
 - ✓ ***Development of the Data Server***
(2 GPS/SBAS receivers + 1 PC + dedicated SW)
 - ✓ ***Development of the User Terminal***
(1 GPS/GPRS/UMTS terminal + dedicated SW)

Encompassed Activities

- ✓ *Tests on the availability/accessibility of augmentations on the data server*
- ✓ *Tests on the communication link between the server and the user terminal*
- ✓ *Static and dynamics tests to assess the navigation performance of the user terminal*
- ✓ *Integration of the user terminal with other sensors*

References

- *A. R. Mathur, J. Ventura – Traveset, C. Montefusco, F. Toran, H. P. Plag, L. Ruiz, I. Stojkovic, J.C. Levy , 2005*

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The ESA ALIVE concept , IAIN 2005,

<http://www.egnos-pro.esa.int/Publications/navigation.html>

- *M. Calderan , R. Cefalo, C. Montefusco, 2008*

Development and Applications of an Experimental Data Server
hosting EGNOS and RTCM /RTK messages, IIN Journal, in
printing

- <http://www.esa.int/esaNA/egnos.html>

- http://cordis.europa.eu/fp7/home_en.html

The Authors



Thank you for
your Attention!