Analysis of dynamic generation and real time transmission of RTCM 3.1 geodetic transformation messages

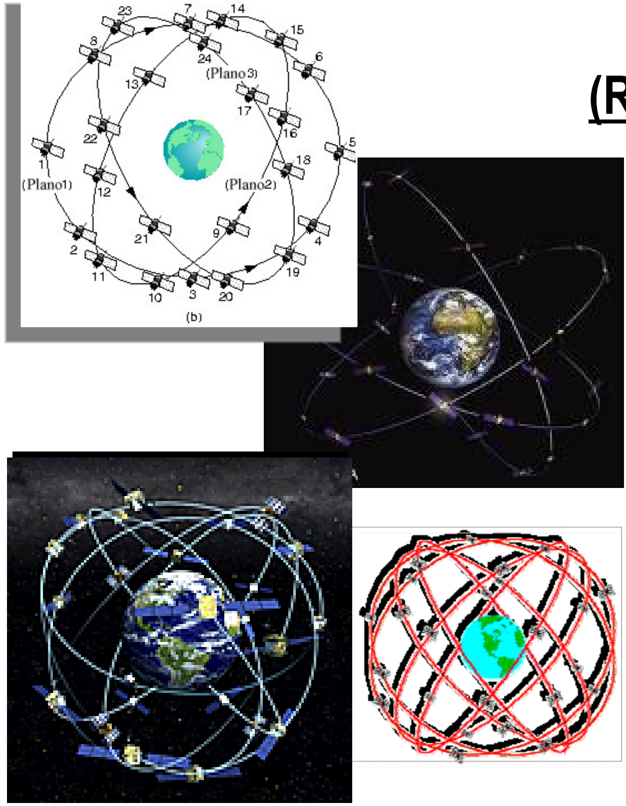
Análisis de la generación dinámica de transformaciones geodésicas en forma de mensajes RTCM 3.1 y su emisión en tiempo real

Capilla R., Martin A., Anquela A., Zaragoza M.

8th International Geomatic Week, March 3-5, 2009, Barcelona

GNSS Positioning in real time and RTCM SC-104 standards

(RTCM: Radio Technical Comission for Maritime Services)



-**DGPS/RTK, VRS, MAC, FKP**

-Interoperability between **GNSS networks**

-Standard streams with corrections and data in multi-constellation context (GPS+GLONASS+….GALILEO+…COMPASS.)

Standardization of geodetic transformation messages - RTCM 3.1

RTCM Working Group:

RTCM 3.1 Standards
RTCM Paper
100-2007-SC104

Geodetic Transformation Messages

NTRIP PROTOCOL stream with:

Corrections RTCM 3.1

+

Amendment 1-2007-2008

New 7 messages RTCM 3.1 with geodetic transformations

1021
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.
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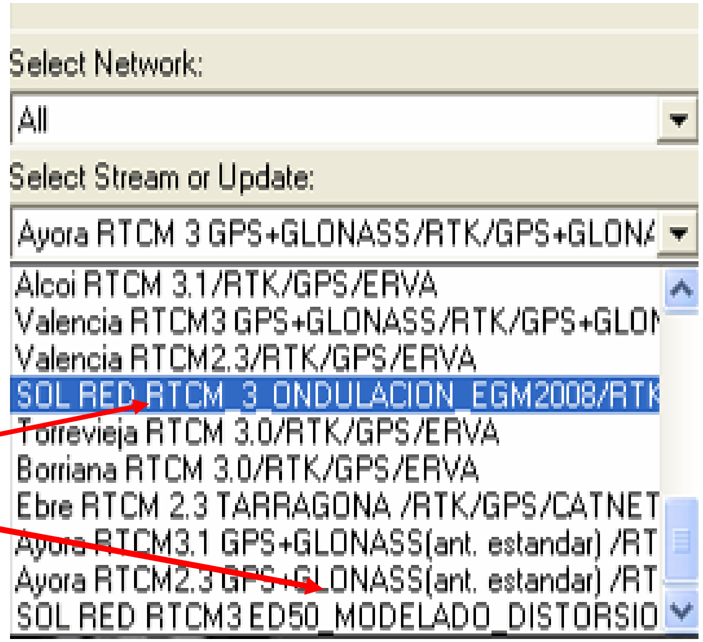
1027

Standardization of geodetic transformation messages - RTCM 3.1

Analysis topics and potential advantages.

For GNSS services providers:



-**Administration, centralized implementation of transformations following RTCM 3.x standards:**

-Geoid Undulations
-SGR ETRS89-ED50 parameters transport
-Definitions of CRS and projection for the final user
-It allows sending *offsets* between solutions of the network aligned with different frames (**ITRFyy –ITRFxx/ETRFxx**)

Analysis topics and potential advantages.

For final users:

-Analysis of final accuracy when setting up geodetic transformation in GNSS control center, NTRIP real time transport, and finally, due to interpolation in GNSS rover decoders.

-Final users could choose between different ***streams or Mountpoints*** with different transformation between CRS (Coordinate Reference Systems)***,*** is it not necessary set up transformation parameters or grid models in field controller?

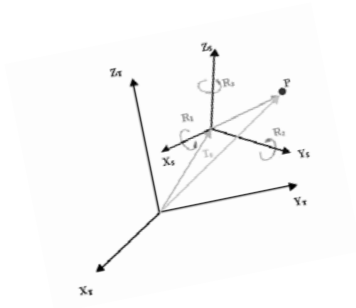
-All users that choose same Mountpoints with transformations set up in GNSS control center use same models or GRIDS.

Standardization of geodetic transformation messages - RTCM 3.1

Supported CRS operations

Messages:

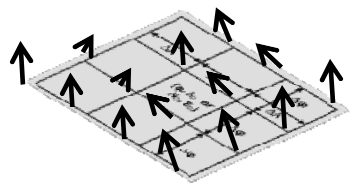
1021-1027

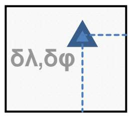


-1021: 5p Molodensky, 7p Bursa-Wolf

-1022: Badekas-Molodensky parameters

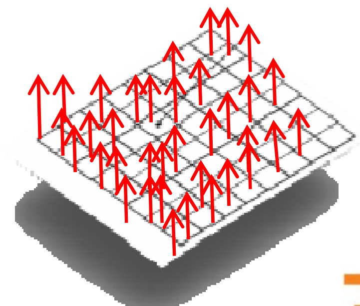
$$\begin{bmatrix}X_T\\Y_T\\Z_T\end{bmatrix} = M * \begin{bmatrix}1 & +R_Z & -R_Y\\ -R_Z & 1 & +R_X\\ +R_Y & -R_X & 1\end{bmatrix} * \begin{bmatrix}X_S\\Y_S\\Z_S\end{bmatrix} + \begin{bmatrix}dX\\dY\\dZ\end{bmatrix}$$





-1023 φ_0 λ_0 / 1024 N_0 E_0 :GRID

- δλ,δφ o δN, δE
- δNgeoid



Standardization of geodetic transformation messages - RTCM 3.1
Supported CRS operations

Projection definition:

- -1025: Support of 7 projections
- -1026: Lambert conformal conic projection
- -1027: Oblique Mercator .....

-False northing

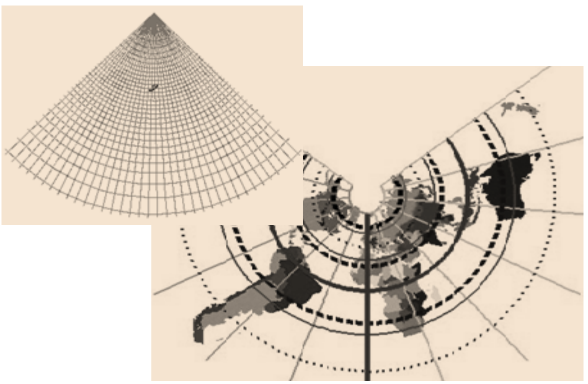
-False easting

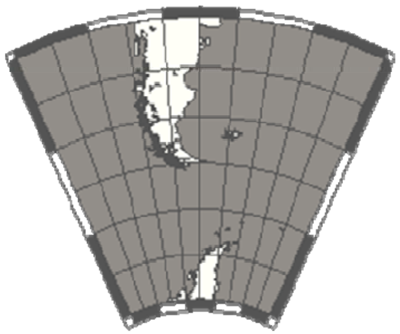
-Prime meridian

-Scale factor at prime meridian

-Standard parallel 1,2 ….

……..





……..

IMPLEMENTATION AT GNSS CONTROL CENTER ESPECIFICATIONS ABOUT MESSAGES CONTENTS

Id. *CRS* Source/ EPSG code → ***Operation between Coordinate Reference System (CRS)*** → **Id. *CRS* Target/ EPSG code**

System **I**dentification **N**umber 1 (**Alias** of first set of parameters

System **I**dentification **N**umber n (**Alias** of n-set of parameters)

Range ***RTCM 3.1***

1021 -> **Id. Technique of Transformation**
- -Origin ***φ λ*** *area of validity*
- *-N,S -EW* area dimensions
- **-Id. Expected accuracy**
- **-Tx,Ty,Tz,Ds,Rx,Ry,Rz** → **Height Indicator**

1022

.
.
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.
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1023
1024
- -Origin ***φ λ /N E*** **GRID**
- -GRID Dimensions
- ….

.

1027

GRID *φ λ /N E*
- **-Id. Interpolation Technique**
- **-Id. Expected accuracy**
- -GRID values ***δφi,δλi/ δNi, δEi***
- *i=1 to 16*

….

GRID N GEOID
- **-Id. Interpolation technique**
- **- Id. Expected accuracy**
- - GRID values ***δNigeoid***
- *i=1 to 16*

→ **Height Indicator**

Range ***RTCM 3.1***
1021 …..
…….
…….
1027…………..

………

IMPLEMENTATION AT GNSS CONTROL CENTER
ESPECIFICATIONS ABOUT MESSAGES CONTENTS

1023 : GRIDS {δλ,δφ (δN, δE en 1024) δNgeoid

RTCM Paper 100-2007-SC104-STD

DATA FIELD	DF NUMBER	DATA TYPE	NO. OF BITS
Message Number	DF002	uint12	12
System identification number	DF147	uint8	8
Horizontal shift indicator	DF190	bit(1)	1
Vertical shift indicator	DF191	bit(1)	1
φ0	DF192	int21	21
λ0	DF193	int22	22
Δφ	DF194	uint12	12
Δλ	DF195	uint12	12
Mean Δφ	DF196	Int8	8
Mean Δλ	DF197	Int8	8
Mean ΔH	DF198	Int15	15

DATA FIELD	DF NUMBER	DATA TYPE	NO. OF BITS
Three shifts for 16 grid points (i=1,16)			*16*(9+9+9)*
$\delta\varphi_i$	DF199	int9	
$\delta\lambda_i$	DF200	int9	
δh_i	DF201	int9	
Horizontal interpolation method indicator	DF212	uint2	2
Vertical interpolation method indicator	DF213	uint2	2
Horizontal Grid Quality Indicator	DF216	uint3	3
Vertical Grid Quality Indicator	DF217	uint3	3
Modified Julian date	DF051	Uint16	16
TOTAL			***578***

IMPLEMENTATION AT GNSS CONTROL CENTER
ESPECIFICATIONS ABOUT MESSAGES CONTENTS

Residual grid generation in RTCM 3.1 standard : **GZTRAC –GZTRAS TOOL (JÄGER et al 2008)**

[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Latitude Residual P1 [”]: 0.0000000000**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Longitude Residual P1 [”]: 0.0000000000**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P1 [m]: 0.12600**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P2 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P2 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P2 [m]: 0.09000**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P3 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P3 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P3 [m]: 0.06500**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P4 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P4 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P4 [m]: 0.03900**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P5 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P5 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P5 [m]: 0.06600**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P6 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P6 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P6 [m]: 0.02900**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P7 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P7 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P7 [m]: 0.00500**
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Latitude Residual P8 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	Longitude Residual P8 [”]: 0.0000000000
[24.01.2009 - 20:21:11][INFO]	[RTCMMessage1023]	**Height Residual P8 [m]: -0.01300**

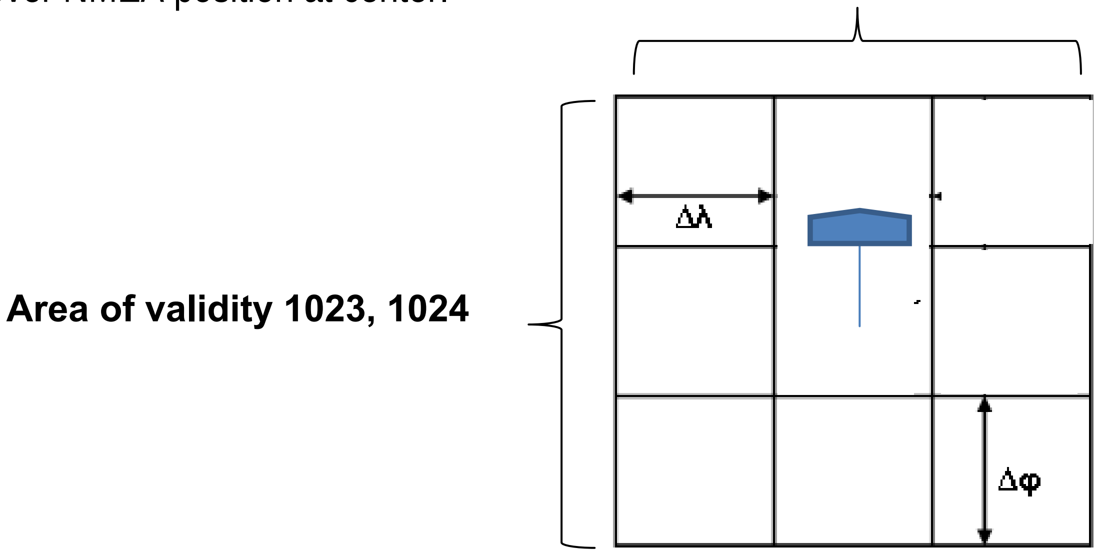
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P9 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] **Height Residual P9 [m]: 0.01600**
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P10 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P10 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] **Height Residual P10 [m]: -0.01900**
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P11 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P11 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Height Residual P11 [m]: -0.04700
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P12 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P12 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Height Residual P12 [m]: -0.06700
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P13 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P13 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Height Residual P13 [m]: -0.02800
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P14 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P14 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Height Residual P14 [m]: -0.06100
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P15 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P15 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Height Residual P15 [m]: -0.09000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Latitude Residual P16 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] Longitude Residual P16 ["]: 0.0000000000
[24.01.2009 - 20:21:11][INFO] [RTCMMessage1023] **Height Residual P16 [m]: -0.11100**

IMPLEMENTATION AT GNSS CONTROL CENTER ESPECIFICATIONS ABOUT MESSAGES CONTENTS

-1023, 1024 (GRIDS or models):

Link: Bi-directional

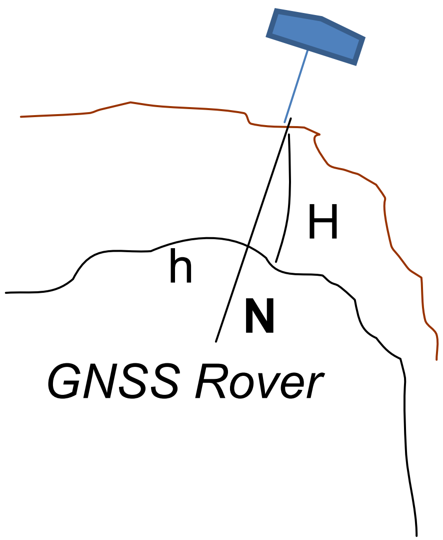
Area of validity = Every new dynamic grid (16 grid points) computed at control center is generated in real time with rover NMEA position at center.

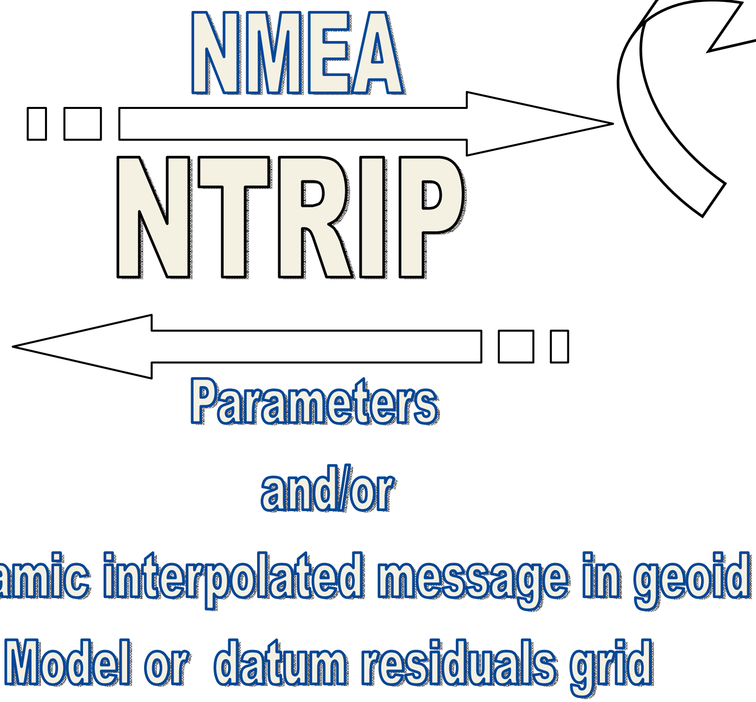


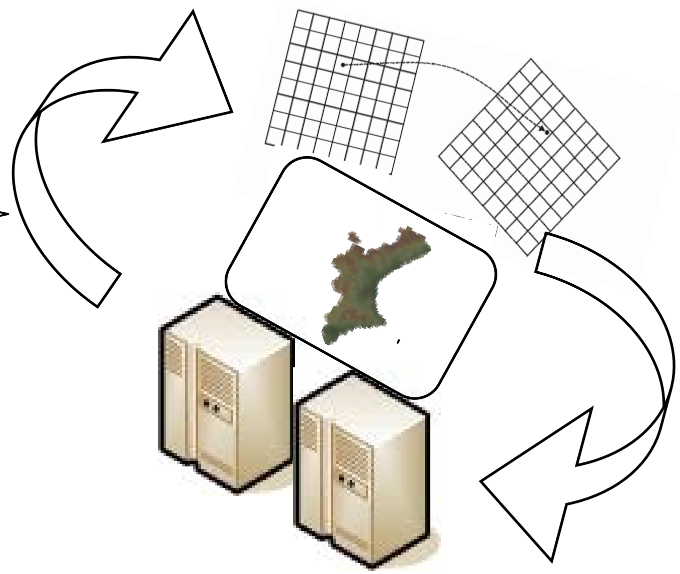
- 1021, 1022 (Parameters):

Link: Broadcast mode or bi-directional

IMPLEMENTATION AT GNSS CONTROL CENTER







<?xml version="1.0" encoding="utf-8" ?>
- <Undulation>
- <Model_information>
<Model_type>1</Model_type>
<Number_of_Grids>1</Number_of_Grids>
</Model_information>
- <Parameters>
- <Grid_Area>
- <Grid_Area_NW>
- <Latitude>
<Direction>N</Direction>
<Degree>39</Degree>
<Minute>40</Minute>
<Second>0</Second>
</Latitude>
- <Longitude>
<Direction>W</Direction>
<Degree>0</Degree>
<Minute>30</Minute>
<Second>0</Second>
</Longitude>
</Grid_Area_NW>
- <Grid_Area_SE>
- <Latitude>
<Direction>N</Direction>
<Degree>39</Degree>
<Minute>18</Minute>
<Second>0</Second>

RTCM 10403.1 – Amendment 1

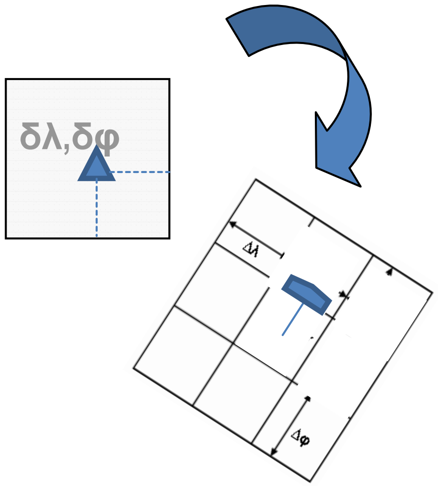
1021,1022 Bursa Wolf, Molodensky, Molodensky-Badekas
1023,1024 Grid with residuals in φ, λ and geoid undulations
1025-1027 Projections
….

IMPLEMENTATION AT GNSS CONTROL CENTER

GRID transport in NTRIP with **RTCM 3.1-1023/1024 standardization**

RTCM Paper 100-2007-SC104-STD

Element of message RTCM 3.1	**Máx./Min. displacement**
Data Field 205-206	**$\Delta\lambda$, $\Delta\varphi$ ± 0.127 ''**
Data Field 207	**ΔN_{geoide} ± 163.8 metros**



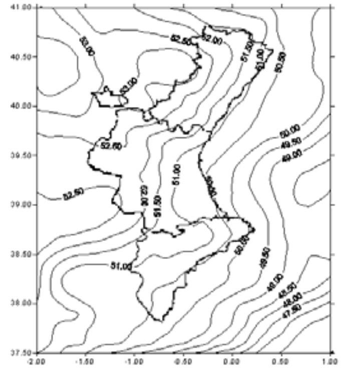
Element of message RTCM 3.1	**Tolerance in interpolation (standard RTCM 3.1)**	Description
Data Field (DF) 199	**$\delta\varphi i$ ± 0.00765 [arc seconds]**	Residuals in latitude
Data Field 200	**$\delta\lambda i$ ± 0.00765 [arc seconds]**	Residuals in longitude
Data Field 201	**δN_{geoid} ± 0.255 meters**	Residuals in N geoid interpolation

IMPLEMENTATION AT GNSS CONTROL CENTER

Geoid undulation transport

Geoid models of different resolution and cell dimensions.

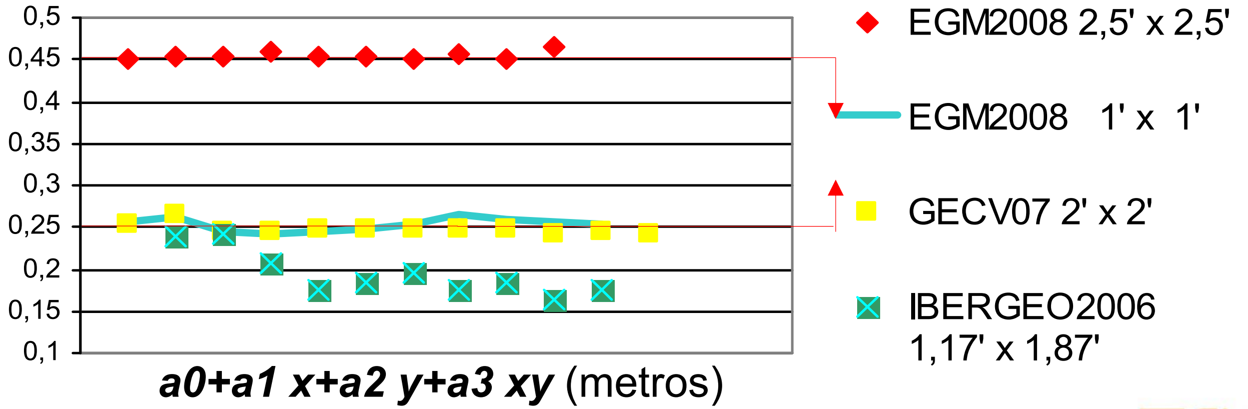
- -Earth Gravitational Model EGM2008-Global, Pavlis et al. 2008 (not locally scaled)
- -GECV07, Martin et al. 2007
- -IBERGEO2006, Sevilla 2006



Geoid of Comunidad Valenciana GECV07 (Martin et al. 2007)

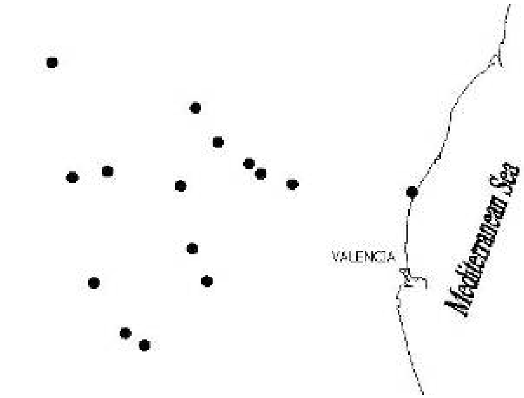
Data Field DF201 **value, tolerance in 1023/1024 for δN_{geoid}**

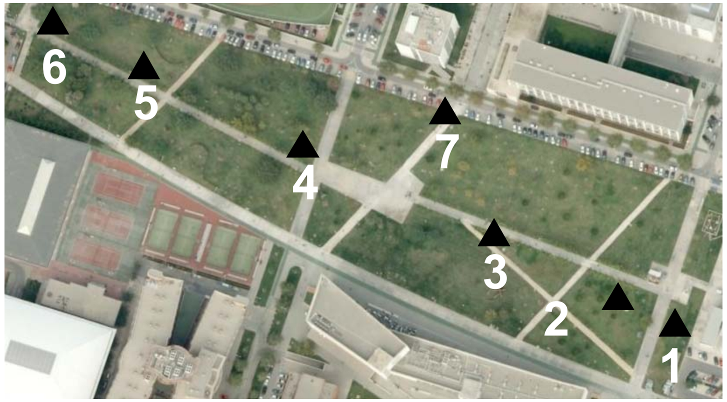
41º N > φ > 37º 42', -2º > λ < 1º



Broadcasting Geodetic transformation messages 1021-1023 ……
Applicability and first results:

Autonomic Geodetic Network

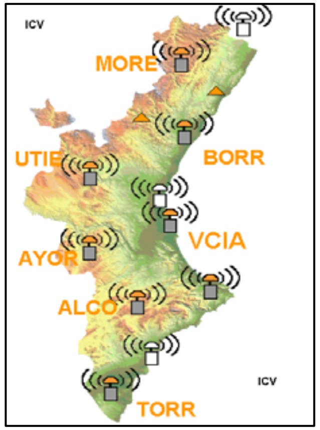




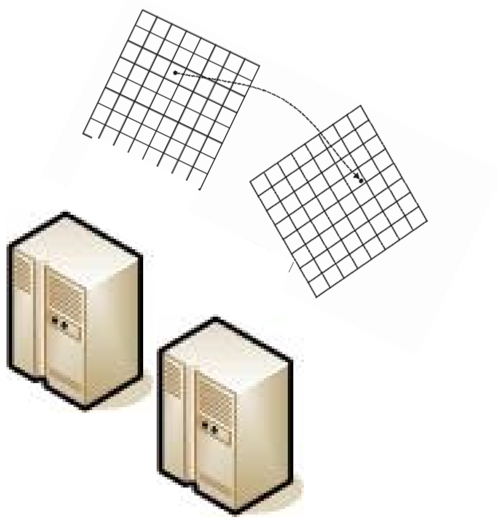
Calibration Network (UPV-Dep.ICGF)

Broadcasting Geodetic transformation messages 1021-1023 ……
Applicability and first results:

Tools for test and analysis at control centre:



ERVA-ICV



Client Software:

Tested Messages	1021	1022	GRID 1023/1024
Cliente A			
Cliente B			

…..

External tools or embedded moduls:

-**GZTRAS**, Jäger et al. 2008- Faculty of Geomatics, Hochschule Karlsruhe

-**Trimble Transformation Generator** (Courtesy of Trimble)

LAPTOP PC or Rover Controller:

-**GZTRAC**,(Jäger et al. 2008), **Leica, Trimble…**

INSTITUTO CARTOGRÁFICO VALENCIANO

instituto cartografico valenciano

Broadcasting Geodetic transformation messages between DATUM ETRS89-ED50 (CASE WITHOUT DISTORTION MODELLING) RTCM 3.1-1021

1021:7P real time broadcasting

φ λ GRS80 ↔ *φ λ ED50*

Transmission every five epochs

System Identification Number
(Alias of first set of parameters)

Range RTCM 3.1

1021 ->

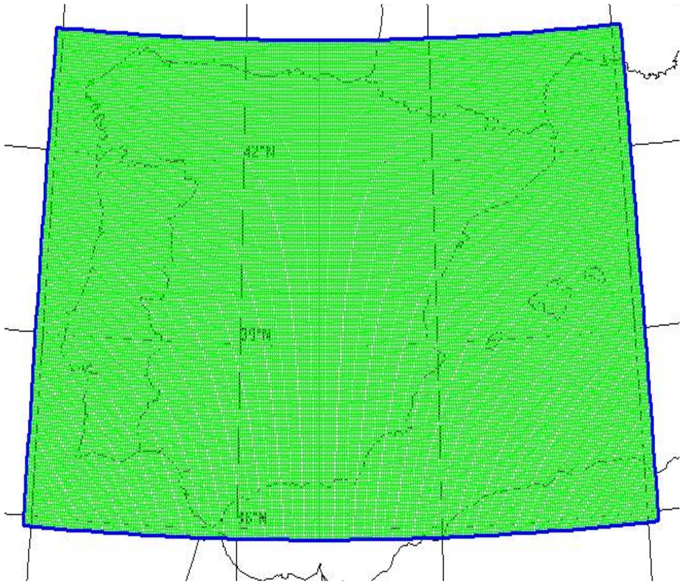
Id. Transformation Technique

- -Origin *φ λ area of validity*
- -*N,S -EW* area dimensions
- -Id expected accuracy
- **-Tx,Ty,Tz,Ds,Rx,Ry,Rz**

MEAN PDOP :1.6, mean Latency :0.7 segundos	μ	σ	2σ P95%	Max.	Min.
Accuracy with Network RTK solution	0.009	**0.002**	0.0043	0.014	0.006
Deviation broadcast transformation –computed transformation over network RTK solution point	0.003	**0.003**	0.0064	0.017	0.000
Deviation broadcast transformation –application of transformation in known ETRS89 coordinates : Accuracy of broadcast transformation + Accuracy in RTK position	**0.024**	**0.013**	**0.027**	**0.063**	**0.007**

Units in meters

Broadcasting Geodetic transformation messages between DATUM ETRS89-ED50 (CASE WITH DISTORTION MODELLING). Combined messages RTCM 3.1-1021+1023 GRID



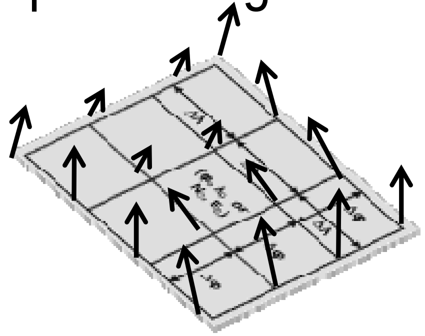
Treatment of recent "sped2et.gsb"

Example: National Geographic Institute of Spain –GRID SOLUTION

National Transformation Version 2 NTv2

Binary format – (Glez. Matesanz et al.**)**

-Encapsulated grid format



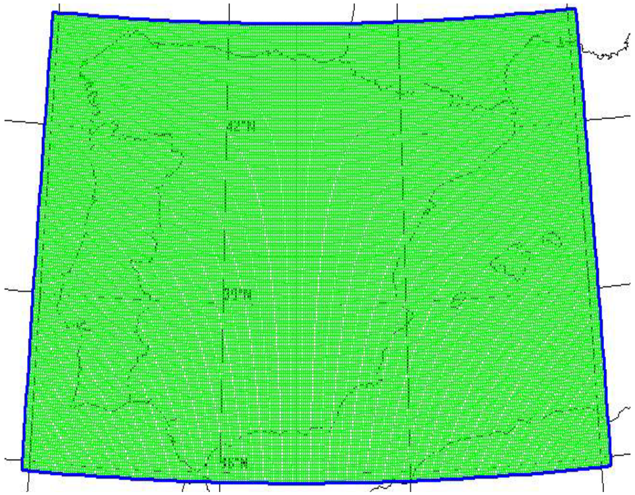
-Mean Displacement between nodes RTCM 3.1 :

Δλ, Δφ < ± 0.127 "

-Interpolation tolerance for residuals grid RTCM 3.1 :

δφi, δλi ± 0.00765" ±0.255 cm

Broadcasting Geodetic transformation messages between DATUM ETRS89-ED50 (CASE WITH DISTORTION MODELLING). Combined messages RTCM 3.1-1021+1023 GRID



Treatment

-Combined Messages 1021 (conformal transformation) + 1023 (residuals modelling).

1023 messages consist in "new grid" following standard RTCM 3.1 1023/1024 (not original sped2et.gsb)

-Mean displacement between GRS ETRS89 –ED50 in NTv2 sped2et.gsb

Δλ, Δφ= [4 "- 5 "] >Mean Value RTCM 3.1± 0.127 "

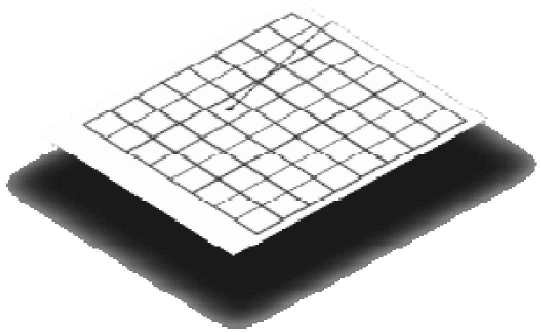
-Interpolation value or nodes residuals:

δφi, δλi = ± 0.01" - ± 0.009 "

> Tolerance RTCM 3.1 = 0.00765"

Broadcasting Geodetic transformation messages between DATUM ETRS89-ED50 (CASE WITH DISTORTION MODELLING). Combined messages RTCM 3.1-1021+1023 GRID

New GRID generation for NTRIP transport in GNSS control center.



Proposed Techniques:

A.Grid only with the values of the differences between conformal transformation and distortion modelling with minimum curvature surfaces technique (IGN):

Transformation with NTv2 minus Transformation with 7P

B. New GRID with the residual distortion computed in the original process of National GRID determination sped2et.gsb with minimum curvature surfaces technique

Broadcasting Geodetic transformation messages between DATUM ETRS89-ED50 (CASE WITH DISTORTION MODELLING). Combined messages RTCM 3.1-1021+1023 GRID

Source: ETRS89 → **Operation between *CRS*** → **Target:** ED50

System **I**dentification **N**umber (**Alias** of parameters set)

Range ***RTCM 3.1***

1021
- Origin ***φ λ***,
- Area … …
- **Tx,Ty,Tz,Ds,Rx,Ry,Rz**

+ 1023
- Origin ***φ λ*** */N E* GRID
- Dimensions ***NS -EW***
- …

GRID *φ λ* / *N E*
- **Id. Interpolation Technique**
- Id expected accuracy
- GRID values ***δφi,δλi/ δNi, δEi***
- *i=1 to 16*

GRID N GEOID
- Id. Interpolation Technique
- Id expected accuracy
- GRID values **δ*Nigeoid***
- *i=1 to 16*

Δλ, Δφ = [-0,03 '' - + 0,005 '']

Tolerance RTCM 3.1 δφi, δλi < 0.00765''

Broadcasting Geodetic transformation messages between DATUM ETRS89-ED50 (CASE WITH DISTORTION MODELLING). Combined messages RTCM 3.1-1021+1023 GRID

-Consistency in results in φ, λ

-Real time NTRIP broadcast :
Combined Messages 1021 (conformal transformation) + 1023 (residuals modelling) with GRID $\delta\varphi, \delta\lambda$, 1'x1'

	μ	σ	2σ P95%	Max.	Min.
Differences in real time transport of conformal+distortion modelling with *RTCM* 3.1 - computed position with NTv2 grid over network RTK solution point	0,0005	0,003	0,007	0,003	-0,002
Differences real time transport of conformal+distortion modelling with *RTCM* 3.1 –computed with *NTv2* grid over ETRS89 adjusted coordinates **Accuracy of broadcast GRID + RTK Position Accuracy**	**0,0016**	**0,007**	**0,016**	**0,0098**	**-0,002**

Units in meters

Geoid Undulation Transport GRID RTCM 3.1-1023

CRS Source
φ,λ,h ETRS89

Operation between CRS

CRS Target
φ,λ, ETRS89
H orthometric

System **I**dentification **N**umber 1 (Id or **Alias** Of the set of parameters)

1023

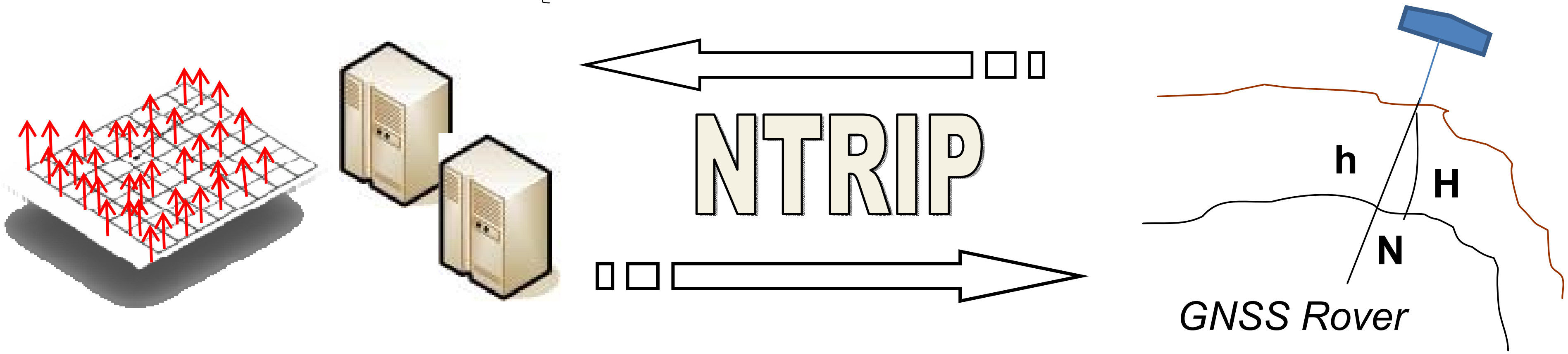
- -Origin ***φ λ / N E* GRID**
- -Dimensions ***NS -EW* GRID**
- …

GRID *φ λ*

- -Values **GRID *δφi,δλi = 0 , i=1 to 16***
- ….

GRID N GEOIDE

- -Id. Interpolation technique
- -Id expected accuracy
- -GRID values ***Φgrs80 λgrs80 Ngeoid*** *i=1 to 16*



Geoid Undulation Transport GRID RTCM 3.1-1023

Geoid model GECV07

Mean PDOP :1.6 Mean Latency : 0.7 seg.	μ	σ	2σ-P95	Max.	Min.
Accuracy with Network RTK solution (N,E)	0.009	0.002	0.0043	0.013	0.006
Accuracy with Network RTK solution (h)	0.014	0.004	0.008	0.025	0.008
Differences between transported undulations *RTCM* 3.1 and computed undulations for RTK position	**-0.002**	**0.011**	**0.023**	**0.015**	**-0.027**
Differences between transported undulations *RTCM* 3.1 and computed undulations for adjusted ETRS89 coordinates (Accuracy in real time broadcast undulation + position accuracy)	**-0.001**	**0.010**	**0.0214**	**0.018**	**-0.024**

Units in meters

Geoid Undulation Transport GRID RTCM 3.1-1023

Geoid model EGM2008

Mean PDOP :1.3 Mean Latency : 0.8 seg.	µ	σ	2σ - P95%	Max.	Min.
Differences between transported EGM2008 undulations *RTCM* 3.1 -computed undulations for RTK positions	-0.0033	0.0092	0.0212	0.0000	-0.0110
Differences between transported EGM2008 undulations *RTCM* 3.1 – computed undulations for adjusted ETRS89 coordinates **(Accuracy in real time broadcast undulation + position accuracy)**	**0.001**	**0.0094**	**0.0213**	**0.0058**	**-0.0017**

Units in meters

Apparently, there is not big differences in accuracy due to real time transport by NTRIP protocol of GRIDS with geoid undulations, GRS transformations or rover interpolation.

Offsets between frames transport
ITRFyy-ETRS89/ETRFyy + Geoid undulations

- 1021 : Tx,Ty,Tz,Ds,Rx,Ry,Rz which provides estimated offsets between alignment of the network with frames:

ITRF05-ETRS89/ETRF05 and ITRF00-ETRS89/ETRF00

-These offsets could imply jumps for users if they present mean values worse than real time positioning accuracy, for instance in reference station networks computed in different frames and also changing antenna calibration models (from relative to absolute antenna phase center calibrations).

-1023 : Undulation values (for example EGM2008)

	µ	σ	2σ P95%	Max.	Min.
Differences in broadcasted transformation – computed for RTK position	-0,0030	0,008	0,018	0,006	-0,014
Differences in broadcasted transformation – computed over adjusted ETRS89 coordinates	**0,0033**	**0,0097**	**0,022**	**0,015**	**-0,01208**

Application of mean translation between 2008-2005 station coordinates. Units in meters

Gracias por su atención

Thanks for your attention