

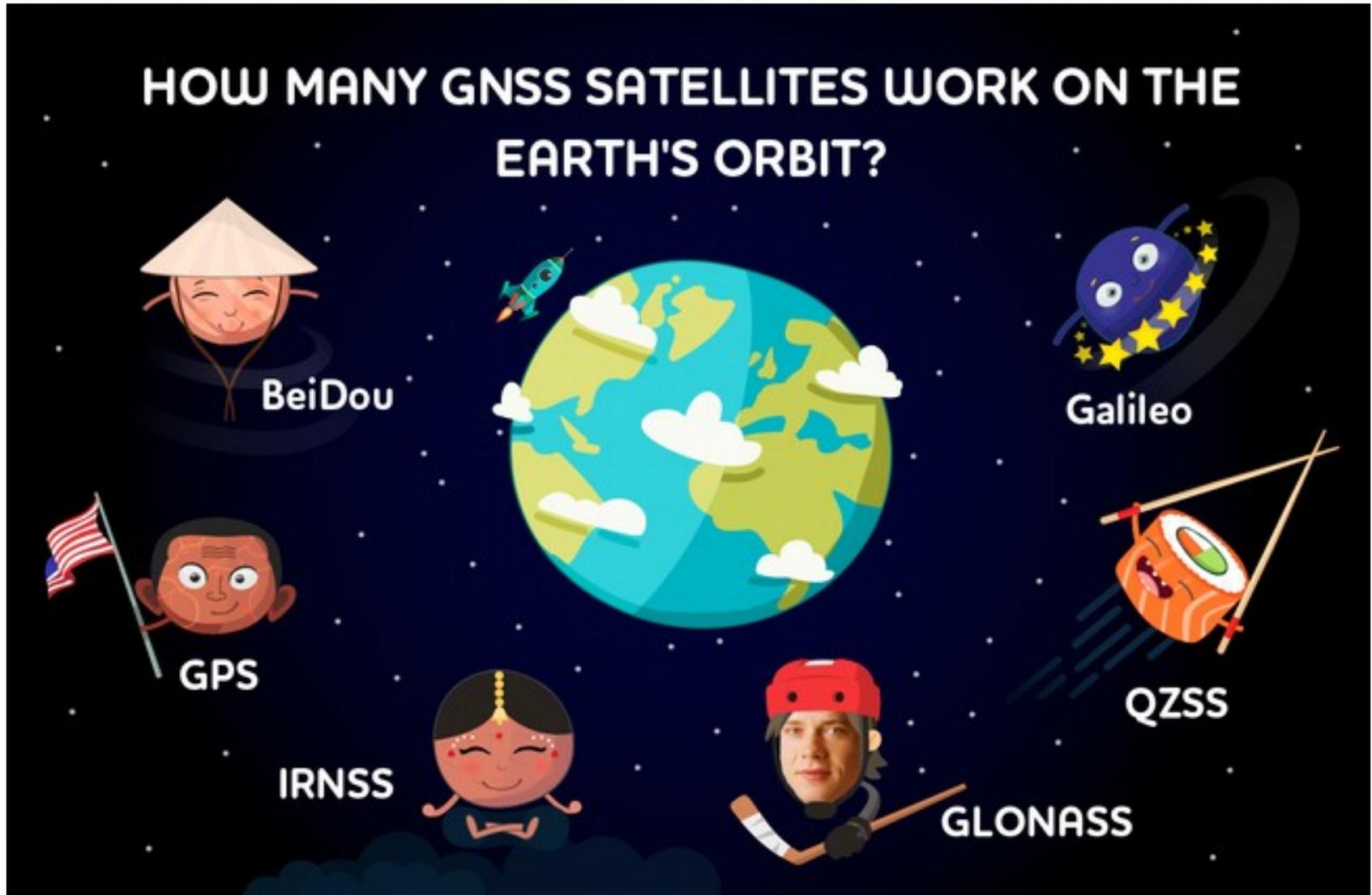
ReNEP

Estado, Produtos e Utilizadores

Manuela Vasconcelos

Ana Carla Bernardes

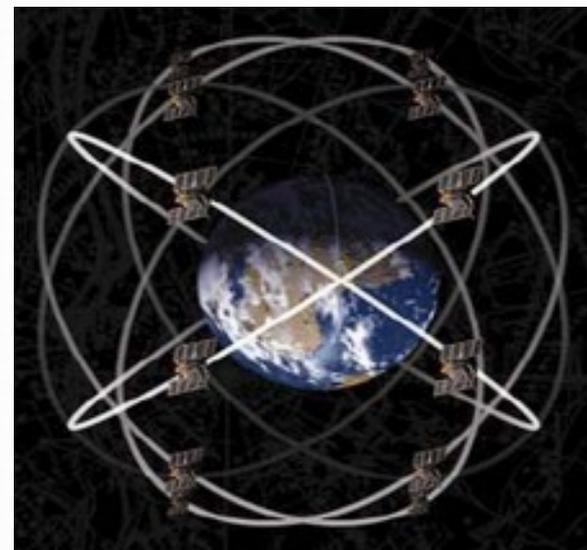
03 de Dezembro de 2018



[<https://www.telematics-talks.com/trends/in-depth/how-many-gnss-satellites-work-on-the-earths-orbit/>]

NAVSTAR GPS

- Criado e desenvolvido em 1973 pelo *Department of Defense* dos EUA com o objectivo de garantir navegação de precisão, contínua e globalmente, em tempo real e sob quaisquer condições atmosféricas
- Totalmente operacional em 17/07/1995
- Inicialmente: 24 satélites em 6 órbitas, a 26500km
- Actualmente: 31 satélites operacionais





GPS CONSTELLATION STATUS FOR 11/27/2018

Plane	Slot	SVN	PRN	Block-Type	Clock	Outage Date	Nanu-Type	Nanu-Subject
A	1	65	24	IIF	CS			
A	2	52	31	IIR-M	RB			
A	3	64	30	IIF	RB			
A	4	48	7	IIR-M	RB			
B	1	56	16	IIR	RB			
B	2	62	25	IIF	RB			
B	3	44	28	IIR	RB			
B	4	58	12	IIR-M	RB			
B	5	71	26	IIF	RB			
C	1	57	29	IIR-M	RB			
C	2	66	27	IIF	RB			
C	3	72	8	IIF	CS			
C	4	53	17	IIR-M	RB			
C	5	59	19	IIR	RB			
D	1	61	2	IIR	RB			
D	2	63	1	IIF	RB			
D	3	45	21	IIR	RB			
D	4	67	6	IIF	RB			
D	5	46	11	IIR	RB			
D	6	34	18	IIA	RB	17 NOV 2018	UNUSUFN	2018053 - SVN34 (PRN18) UNUSABLE JDAY 321/1701 - UNTIL FURTHER NOTICE
E	1	69	3	IIF	RB			
E	2	73	10	IIF	RB			
E	3	50	5	IIR-M	RB			
E	4	51	20	IIR	RB			
E	6	47	22	IIR	RB			
F	1	70	32	IIF	RB			
F	2	55	15	IIR-M	RB			
F	3	68	9	IIF	RB			
F	4	60	23	IIR	RB			
F	5	41	14	IIR	RB			
F	6	43	13	IIR	RB			

GLONASS

- Sistema Russo análogo ao GPS
- Primeiro lançamento em 1982
- 24 satélites em 3 órbitas circulares a 19100km
- Actualmente: 24 satélites operacionais

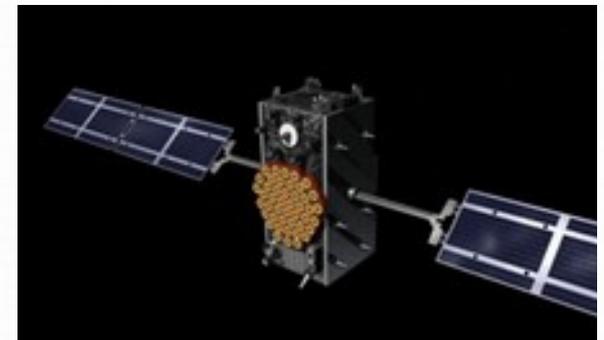
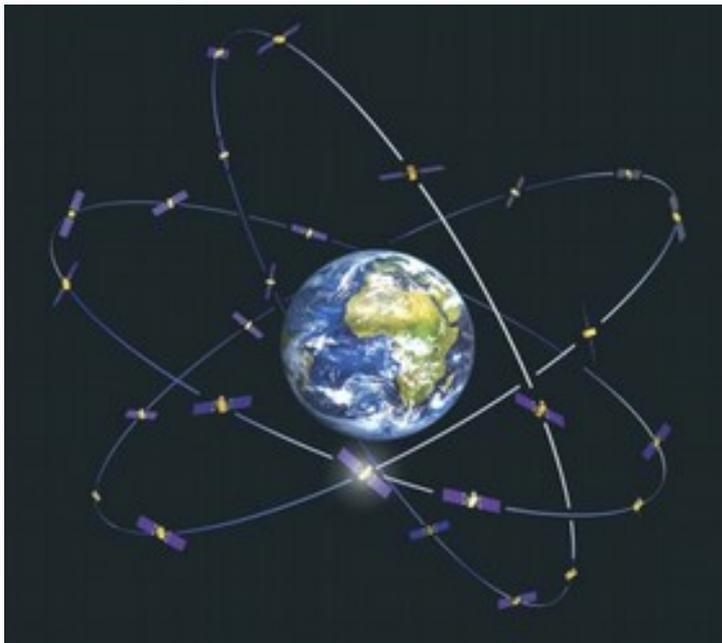




GLONASS CONSTELLATION STATUS AT 27.11.2018 BASED ON BOTH THE ALMANAC ANALYSIS AND NAVIGATION MESSAGES RECEIVED AT 10:00 27.11.18 (UTC) IN IAC PNT TSNIMASH

Orb. slot	Orb. pl.	RF chnl	# GC	Launched	Operation begins	Operation ends	Life-time (months)	Satellite health status		Comments
								In almanac	In ephemeris (UTC)	
1	1	01	730	14.12.09	30.01.10		107.5	+	+ 10:32 27.11.18	In operation
2	1	-4	747	26.04.13	04.07.13		67.1	+	+ 10:32 27.11.18	In operation
3	1	05	744	04.11.11	08.12.11		84.8	+	+ 10:32 27.11.18	In operation
4	1	06	742	02.10.11	25.10.11		85.9	+	+ 10:32 27.11.18	In operation
5	1	01	756	17.06.18	29.08.18		5.4	+	+ 10:32 27.11.18	In operation
6	1	-4	733	14.12.09	24.01.10		107.5	+	+ 10:32 27.11.18	In operation
7	1	05	745	04.11.11	18.12.11		84.8	+	+ 10:32 27.11.18	In operation
8	1	06	743	04.11.11	20.09.12		84.8	+	+ 10:32 27.11.18	In operation
9	2	-2	702	01.12.14	15.02.16		47.9	+	+ 10:32 27.11.18	In operation
10	2	-7	717	25.12.06	03.04.07		143.2	+	+ 10:32 27.11.18	In operation
11	2	00	753	29.05.16	27.06.16		30.0	+	+ 10:32 27.11.18	In operation
12	2	-1	723	25.12.07	22.01.08		131.2	+	+ 10:32 27.11.18	In operation
13	2	-2	721	25.12.07	08.02.08		131.2	+	+ 10:32 27.11.18	In operation
14	2	-7	752	22.09.17	16.10.17		14.2	+	+ 10:32 27.11.18	In operation
15	2	00	757	03.11.18	27.11.18		0.8	+	+ 10:32 27.11.18	In operation
16	2	-1	736	02.09.10	04.10.10		98.9	+	+ 10:32 27.11.18	In operation
17	3	04	751	07.02.16	28.02.16		33.7	+	+ 10:32 27.11.18	In operation
18	3	-3	754	24.03.14	14.04.14		56.2	+	+ 10:32 27.11.18	In operation
19	3	03	720	26.10.07	25.11.07		133.2	+	+ 10:32 27.11.18	In operation
20	3	02	719	26.10.07	27.11.07		133.2	+	+ 10:32 27.11.18	In operation
21	3	04	755	14.06.14	03.08.14		53.5	+	+ 10:32 27.11.18	In operation
22	3	-3	731	02.03.10	28.03.10		104.9	+	+ 10:32 27.11.18	In operation
23	3	03	732	02.03.10	28.03.10		104.9	+	+ 10:32 27.11.18	In operation
24	3	02	735	02.03.10	28.03.10		104.9	+	+ 10:32 27.11.18	In operation
15	2		716	25.12.06	12.10.07	24.11.18	143.2			Spares
20	3	-5	701	26.02.11			93.1			Flight Tests

- Sistema Europeu
- Primeiros lançamentos: Dez2005, Abr2008
- Previsto: 30 satélites em 3 planos orbitais a 30000km
- Actualmente: 18 satélites em órbita



Comparação das órbitas de satélites

Comparison_satellite_navigation_orbits.svg

GNSS	Coverage	First Launch	Status	Current Number	Planned Number
GPS	Worldwide	1974	Completed	30 (+2)	24
GLONASS	Worldwide	1982	Completed	24 (+2)	24
Galileo	Europe	2005	In progress	18 (+8)	30
Beidou	China	2000	In progress	17 (+21)	35
QZSS	Japan, Australia, New Zealand	2006	In progress	4	4
IRNSS	India, Pakistan, Afghanistan	2013	In progress	8	7



[Adaptado de: <https://www.telematics-talks.com/trends/in-depth/how-many-gnss-satellites-work-on-the-earths-orbit/>]

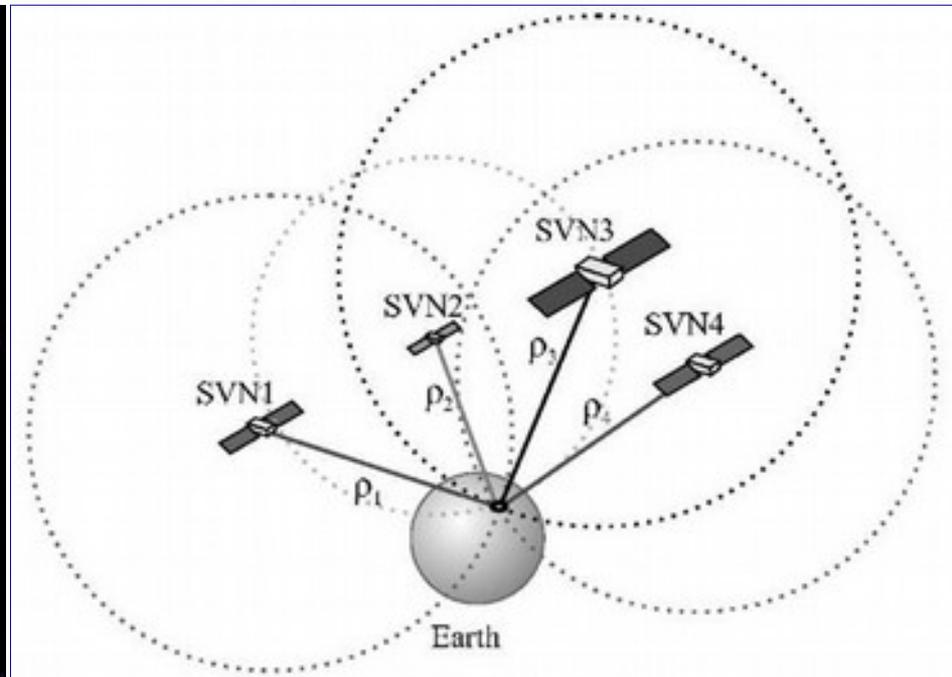
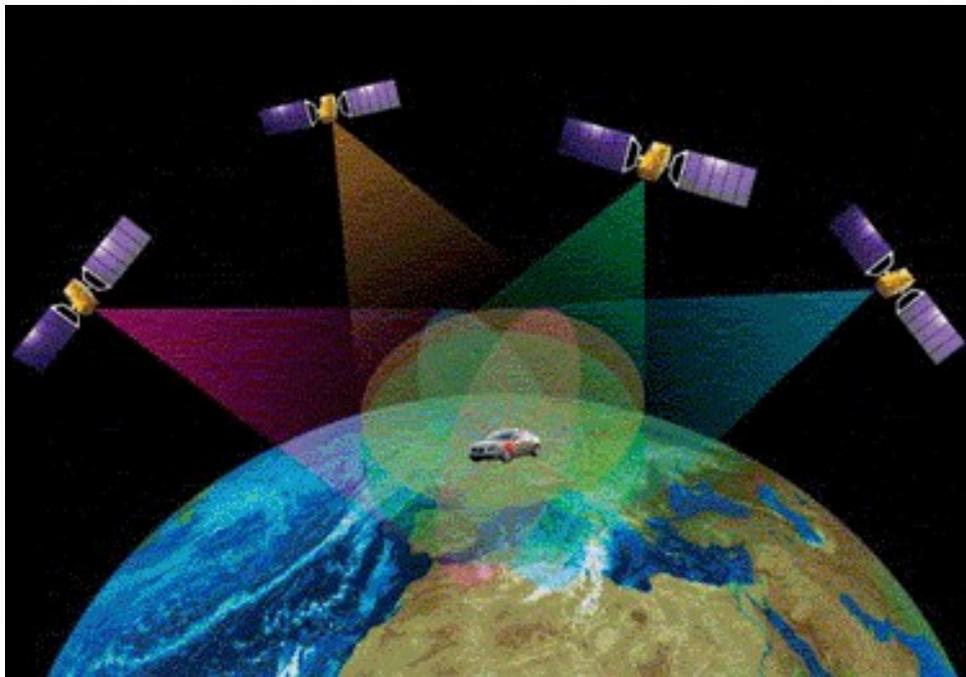
A Beehive of Satellites



[https://www.nasa.gov/multimedia/imagegallery/image_feature_1283.html]

Modo de Funcionamento

As coordenadas de um ponto à superfície da Terra são obtidas através da medição das distâncias desse ponto a vários satélites



Modo de Funcionamento

How GPS Works

If the GPS receiver only obtains signals from 1 Satellite, then it "knows" that it is located somewhere on this sphere...

A diagram showing a single satellite (represented by a small airplane icon) and a red circle representing a sphere. A dashed line connects the satellite to the center of the sphere, indicating that the receiver is somewhere on the surface of this sphere.

How GPS Works

If the GPS receiver only obtains signals from 2 satellites, then it "knows" that it is located somewhere where these 2 spheres intersect

A diagram showing two overlapping red circles representing spheres. Two satellite icons are shown, each with a dashed line connecting it to the center of its respective sphere. The intersection of the two spheres is shaded in light blue, representing the possible location of the receiver.

How GPS Works

If the GPS receiver obtains signals from 3 satellites, then it "knows" that it is located somewhere where these 3 spheres intersect (2 points)

A diagram showing three overlapping red circles representing spheres. Three satellite icons are shown, each with a dashed line connecting it to the center of its respective sphere. The intersection of all three spheres is shaded in light blue, representing the possible location of the receiver.

How GPS Works

A fourth satellite is required to determine the exact location and elevation.

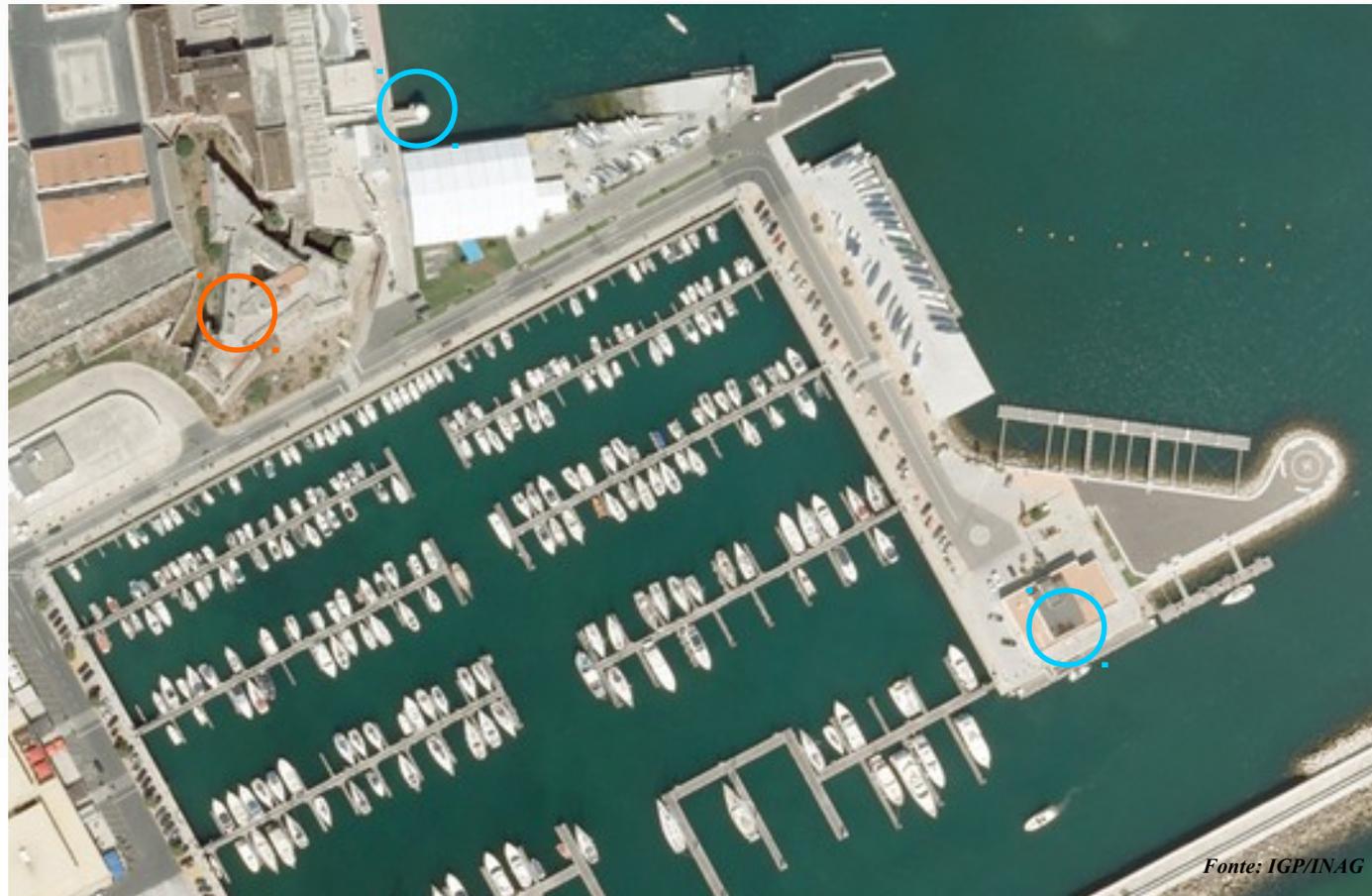
A diagram showing four overlapping red circles representing spheres. Four satellite icons are shown, each with a dashed line connecting it to the center of its respective sphere. The intersection of all four spheres is shaded in light blue, representing the exact location and elevation of the receiver.

Modo de Funcionamento

https://www.youtube.com/watch?v=FU_pY2sTwTA

ReNEP - Início

- 1997: Primeira Estação Permanente (EP) GPS instalada em Cascais, nas imediações do Marégrafo



Fonte: IGP/INAG

1999 - 2000



V.N. de Gaia



Lagos



Ponta Delgada

Funcionamento:

- Pós-processamento
- Ficheiros diários a 30 s
- Recolha “manual” dos ficheiros

Objectivos:

- Manutenção do Referencial Geodésico
- Apoio a trabalhos de posicionamento
- Contribuição para os Sistemas de Referência Globais e Regionais



Até 2005



Motivação

- A configuração da rede não permitia a cobertura eficaz de todo o território nacional
- Tornava-se fundamental a transmissão de dados em tempo real para dar resposta ao crescente número de utilizadores destas técnicas de posicionamento

Objectivos:

- Manutenção do **Referencial** Geo-espacial Nacional
- Posicionamento em **Tempo Real**



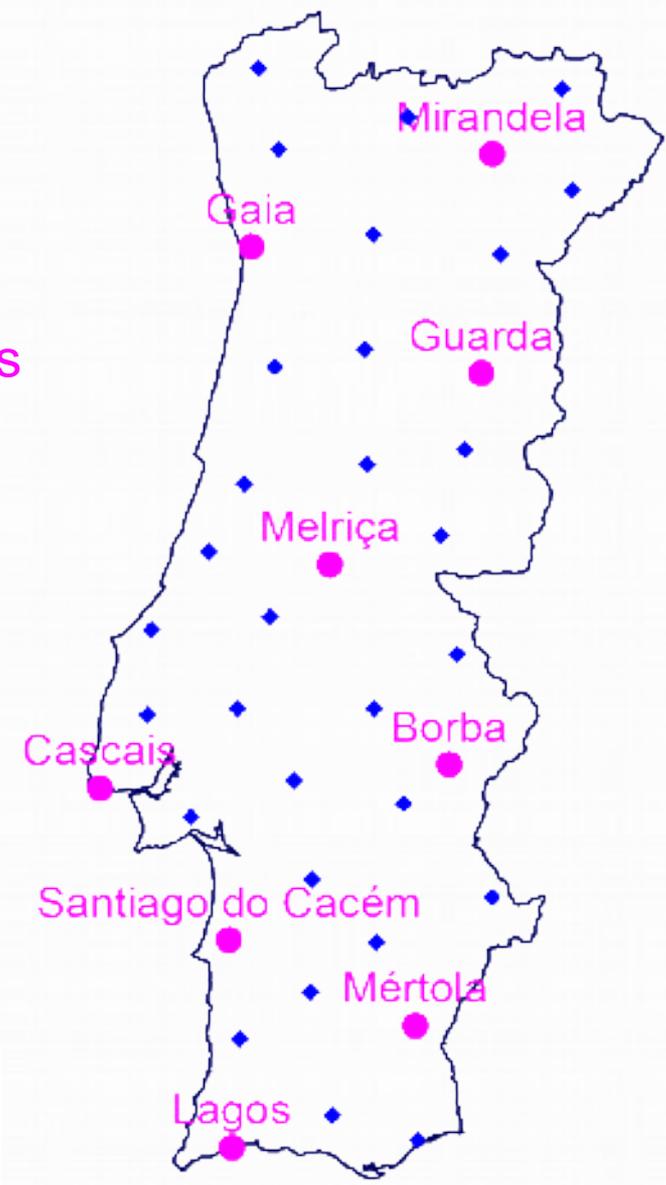
2006 – Projecto de Expansão da ReNEP

- **Serviço Público:** Dados Disponibilizados Gratuitamente
- **Projecto Cooperativo:** Colaboração com outras instituições públicas ou privadas
- **Transmissão de Dados:** centralizada pelo IGP
- **Funcionamento:**
 - RTK “cobertura em rede”
 - Distribuição homogénea, com uma distância entre estações inferior a 80 km, por forma a garantir uma sobreposição eficaz
 - *Streaming* contínuo
 - Distribuição dos dados em formatos *standard*

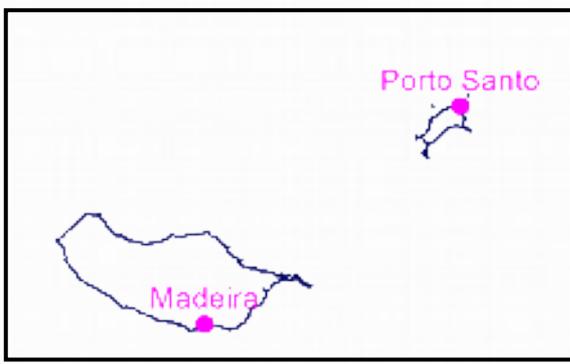
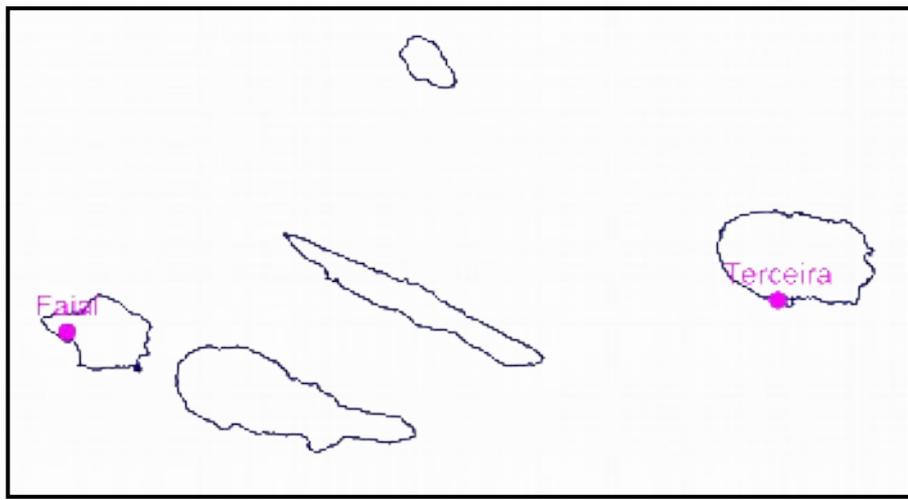
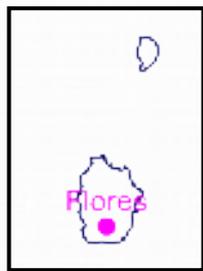


2006 – Projecto de Expansão da ReNEP

- Estações Fundamentais
- ◆ Estações de Tipo 2



2006 – Projecto de Expansão da ReNEP



● Estações Fundamentais

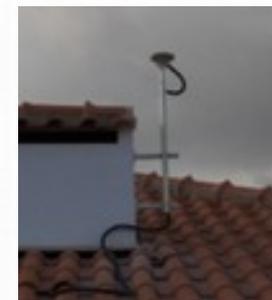
Projecto de Expansão da ReNEP

- **Nov 2006:** Início da distribuição de correcções diferenciais



- **Jul 2007:** Primeira estação de um Parceiro

- **2007 a 2009:**
 - 28 EP Instaladas
 - 4 EP Parceiros



- **Abr 2007:** Ficheiros horários a 5s

- **Mar 2009:** Novos Produtos para RTK



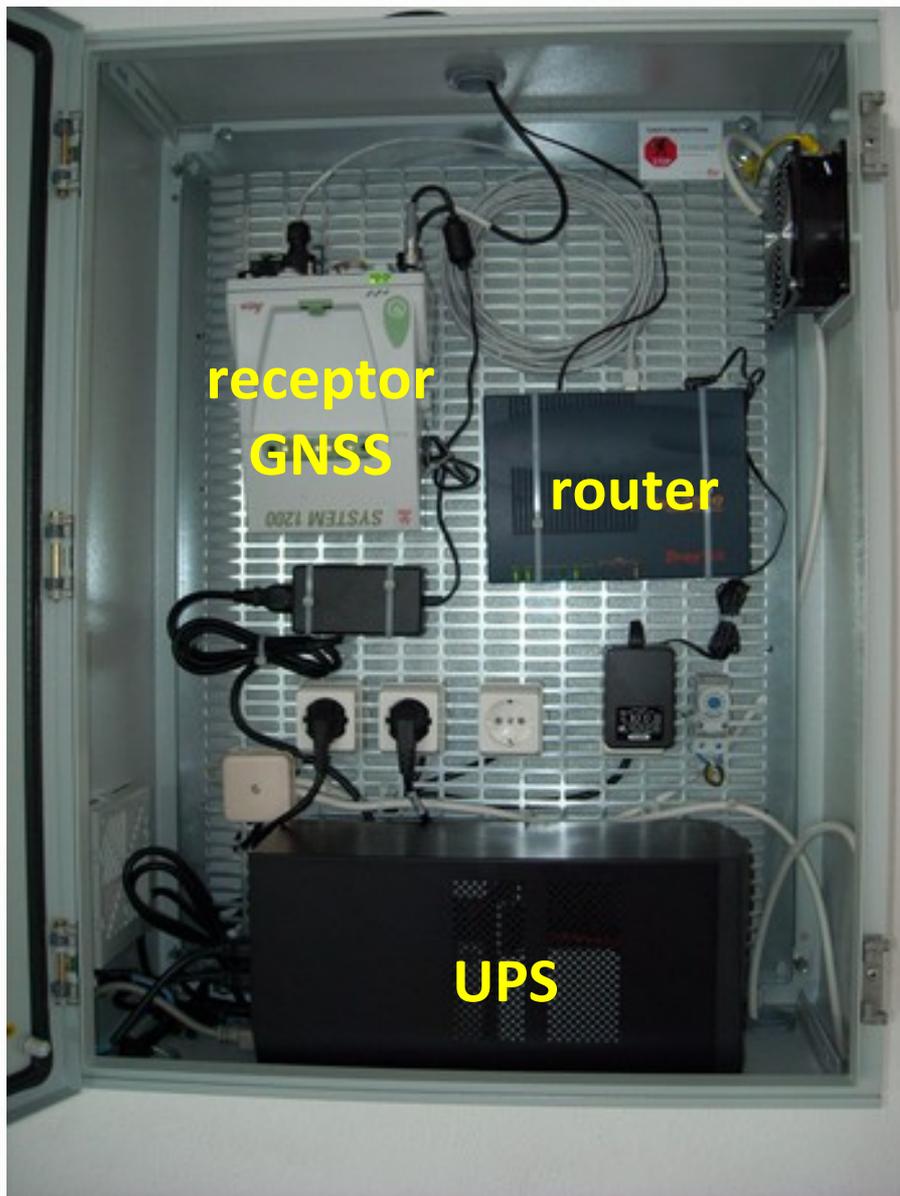
- **2015:** Conclusão da Rede



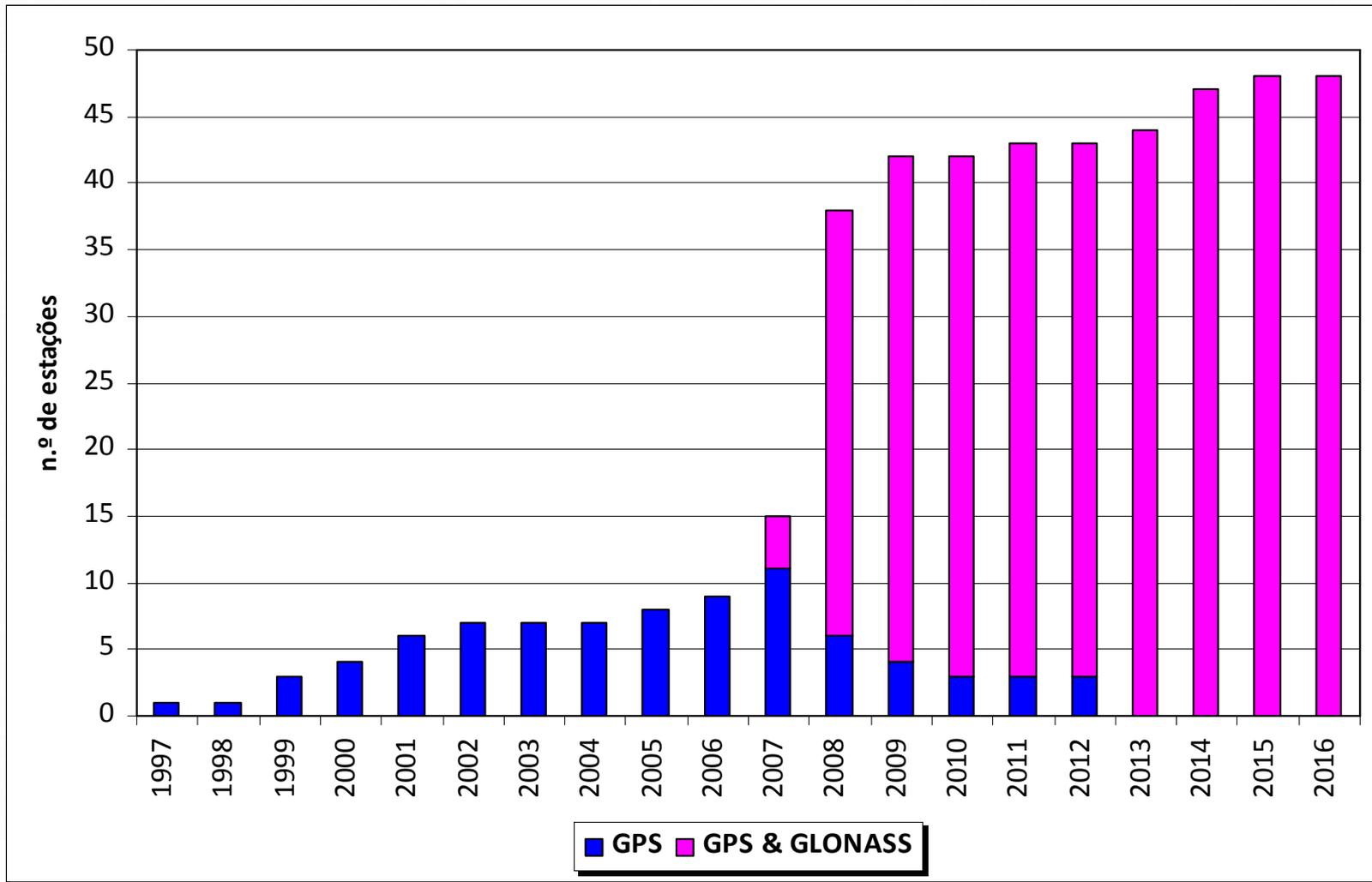
Composição de uma Estação



antena GNSS



Evolução do Número de Estações



Instalação



Instalação



Estado Actual



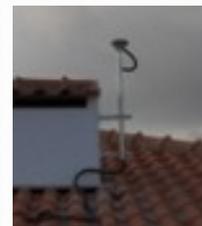
- ReNEP**
- DGT
 - Parceiros

Funcionamento

48 Estações: 42 Continente + 4 R. A. Açores + 2 R. A. Madeira



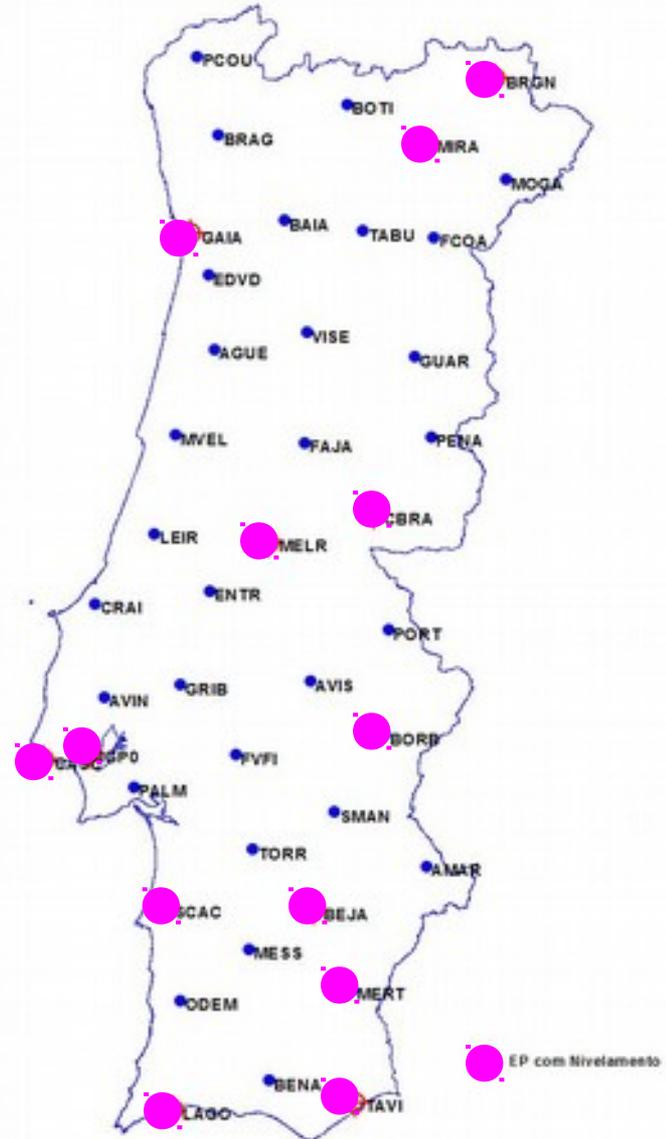
- 42 DGT + 6 Parceiros
- GPS&GLONASS



- Modo RTK “cobertura em rede”
- *Streaming* contínuo
- Mensagem RTCM (*Radio Technical Commission for Maritime Services*) sobre protocolo NTRIP (*Networked Transport of RTCM via Internet Protocol*)
- Ficheiros RINEX (*Receiver Independent Exchange Format*) com taxa de recolha de 5 segundos

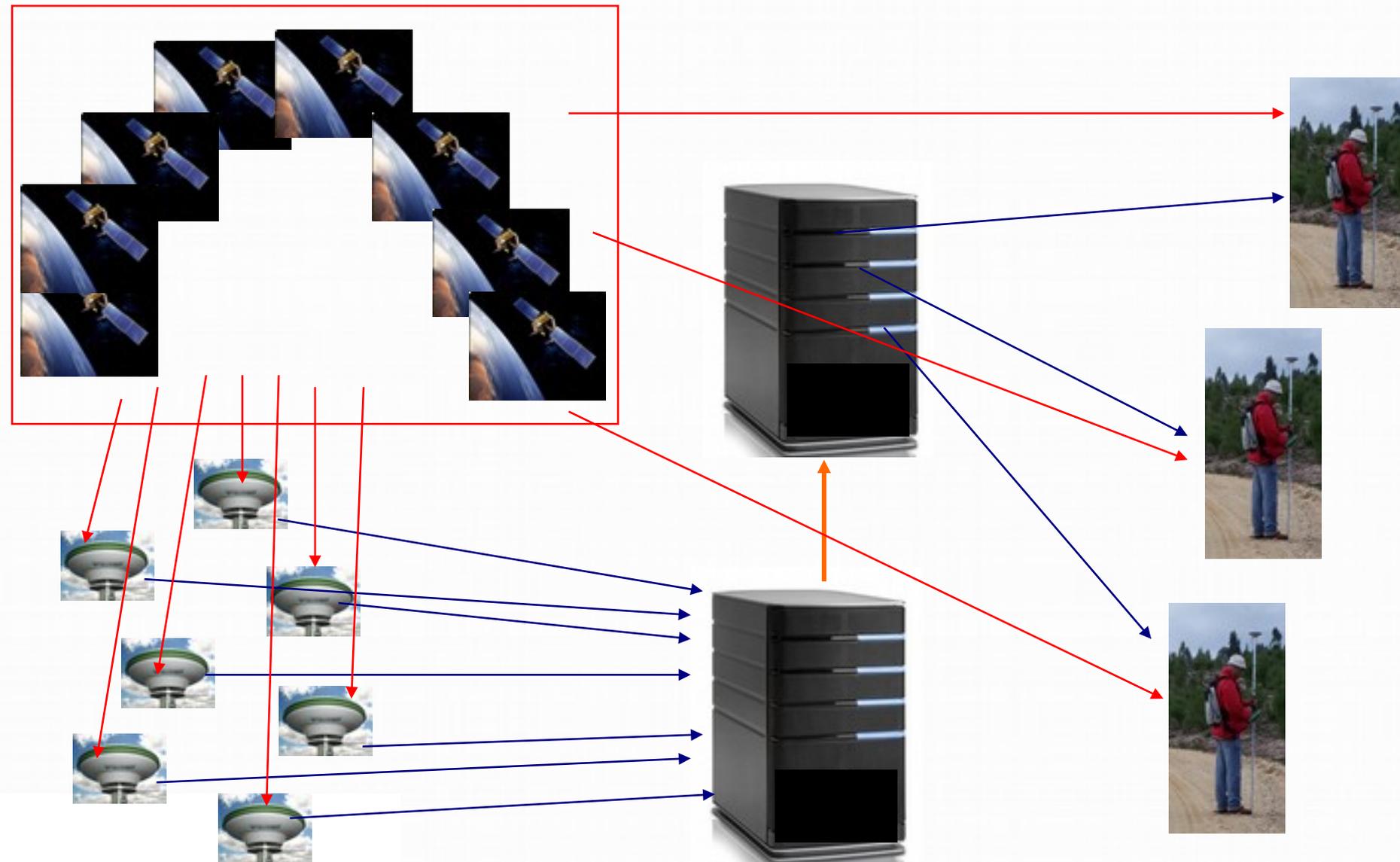
- **Sistemas de Referência:**
 - Continente: ETRS89
 - Regiões Autónomas: ITRF93

EP com Nivelamento Geométrico



PDEL

Funcionamento RTK



Produtos

➤ Pós-processamento:

- Ficheiros horários a 5s
- Outras taxas de recolha a pedido
- Formato RINEX 2.11
- Estações EPN & IGS: ficheiros horários e diários a 30s

➤ Tempo Real:

- Base Única Manual
- Estação mais próxima
- Rede
- Mensagens RTCM 3.1 (e 2.3)

Base Única Manual



Estação Mais Próxima

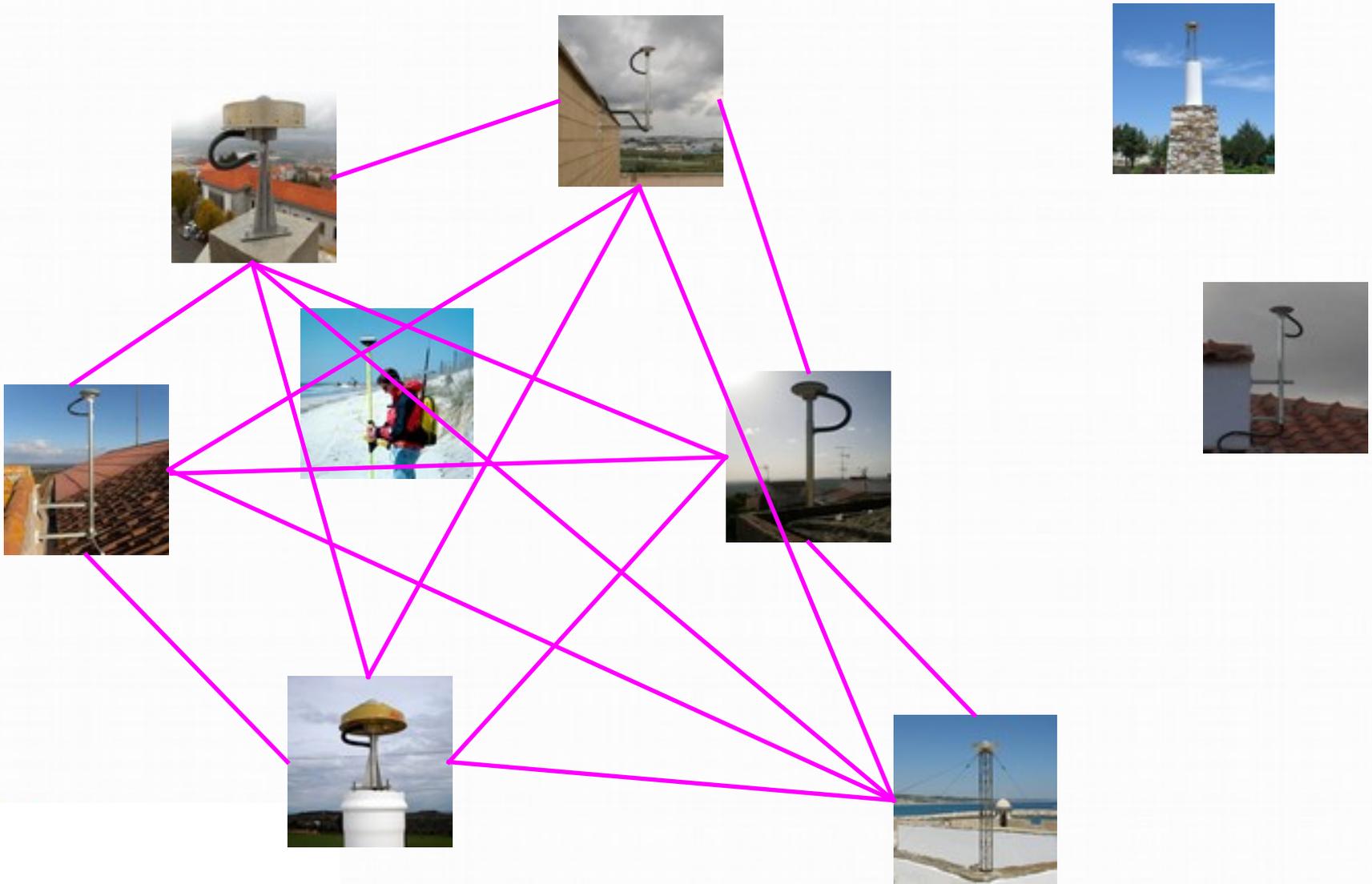


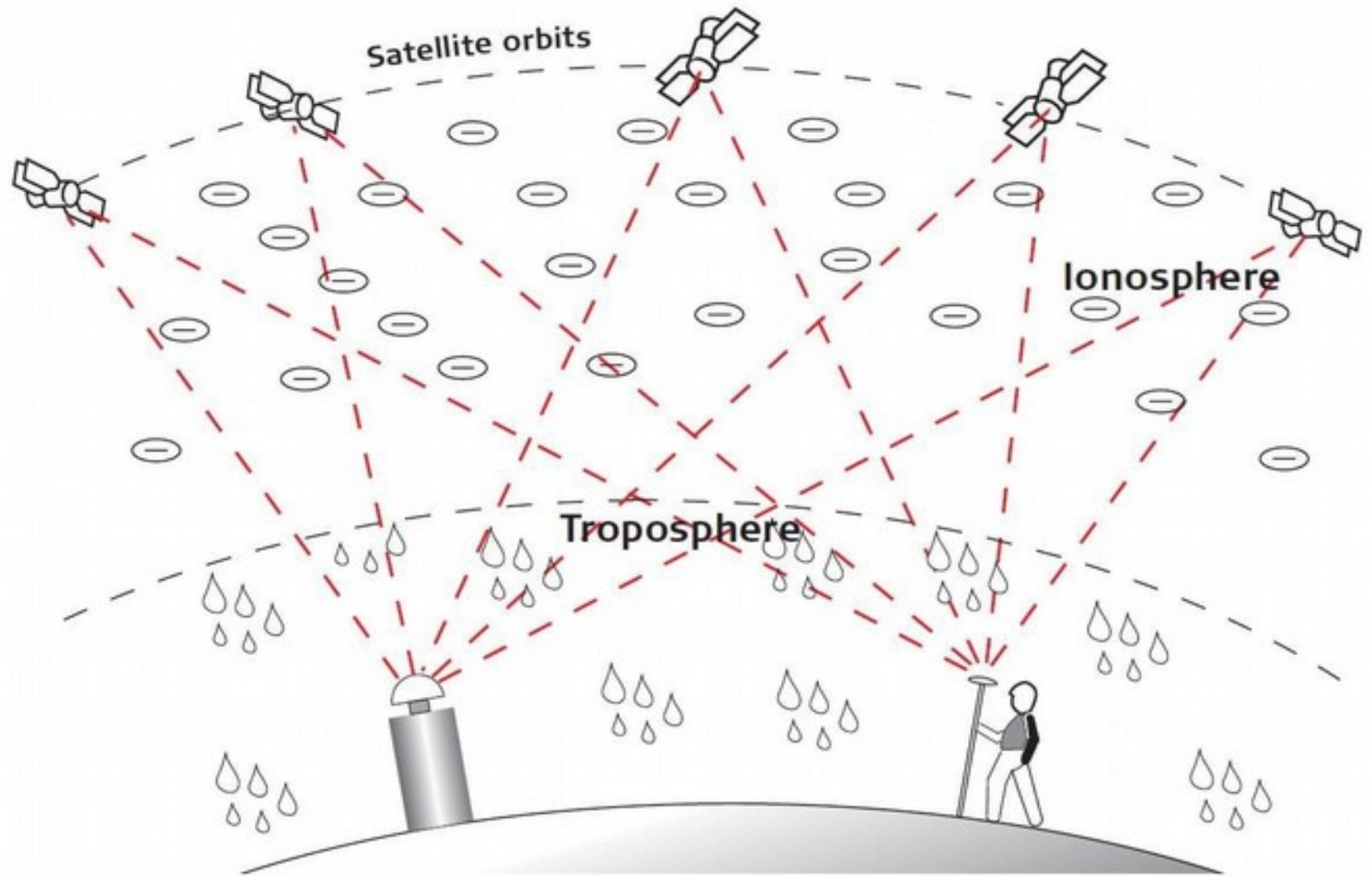
Estação Mais Próxima

X

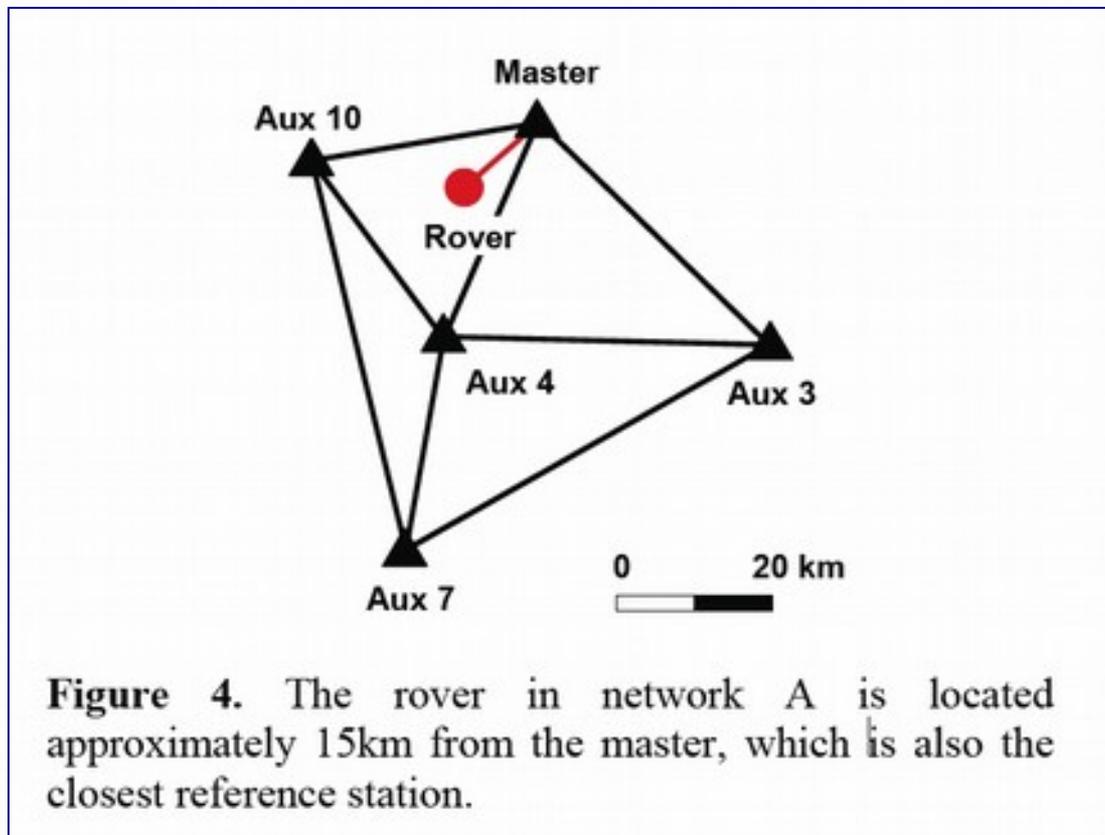


Rede





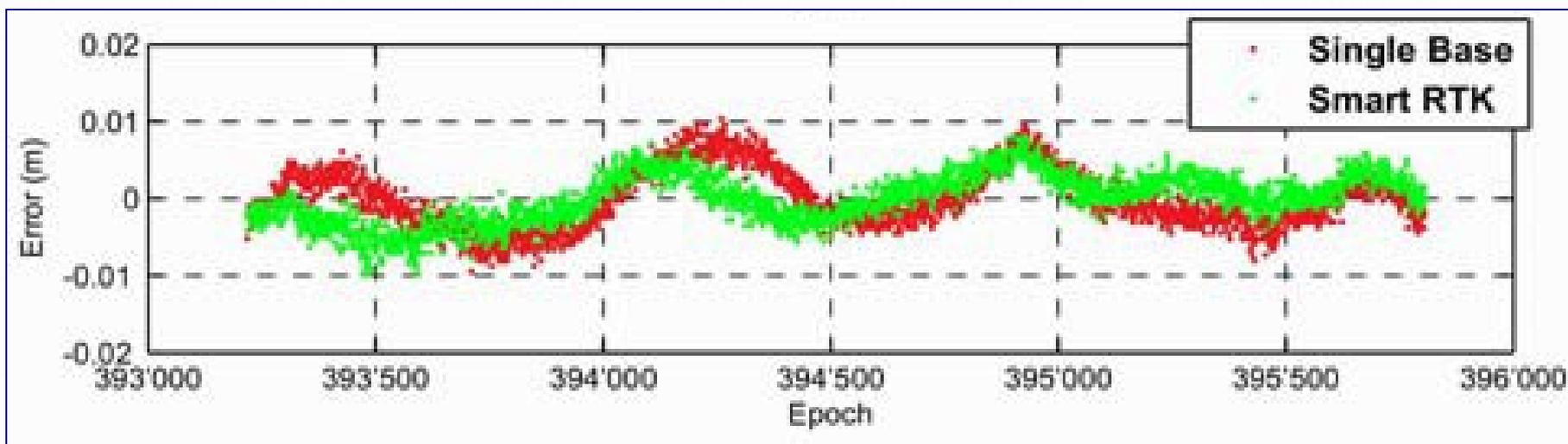
Comparação entre os diferentes métodos



[Takac, F. and Lienhart, W., (2008)]

Comparação entre os diferentes métodos

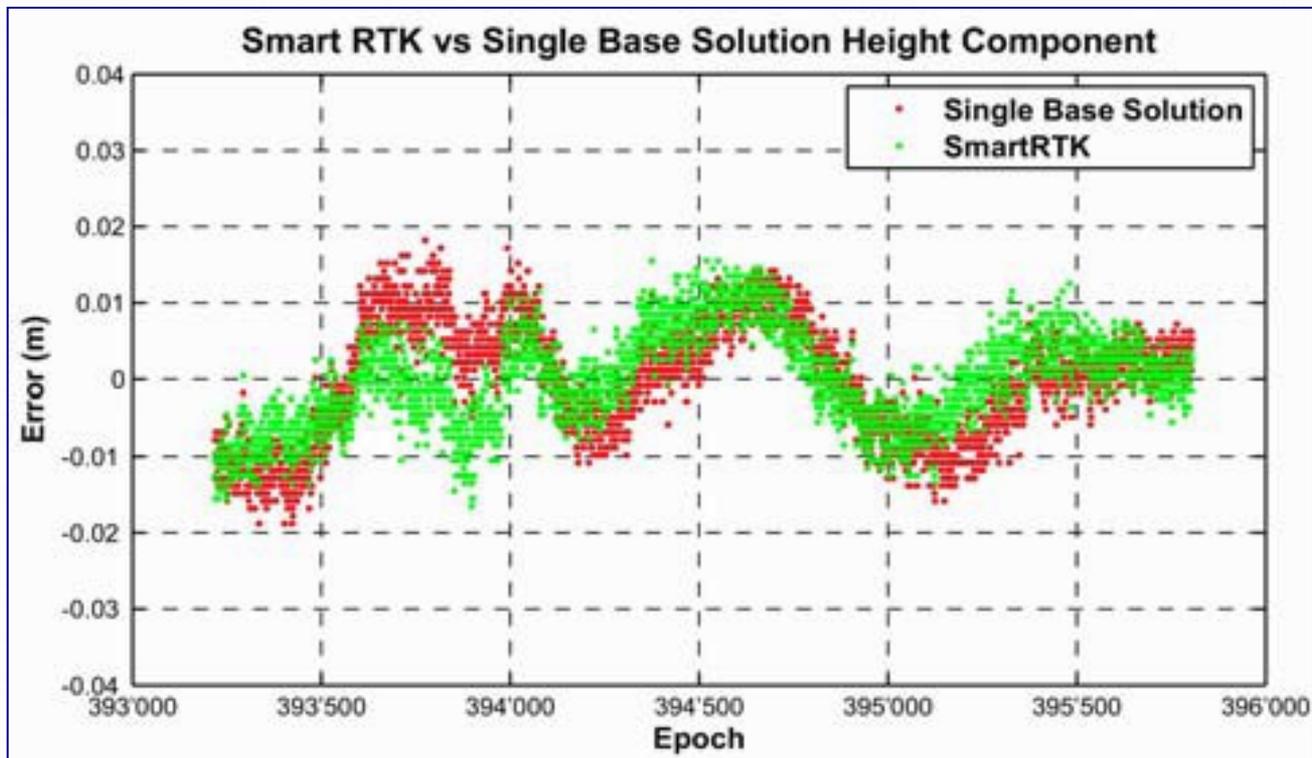
Planimetria



[Takac, F. and Lienhart, W., (2008)]

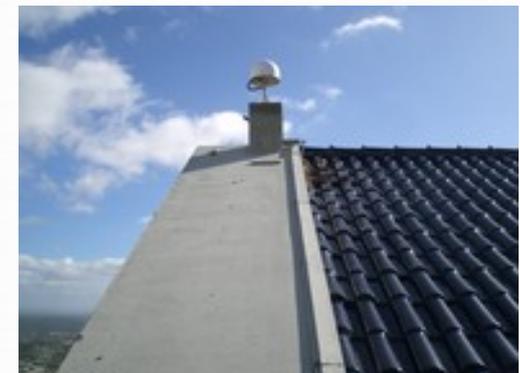
Comparação entre os diferentes métodos

Altimetria



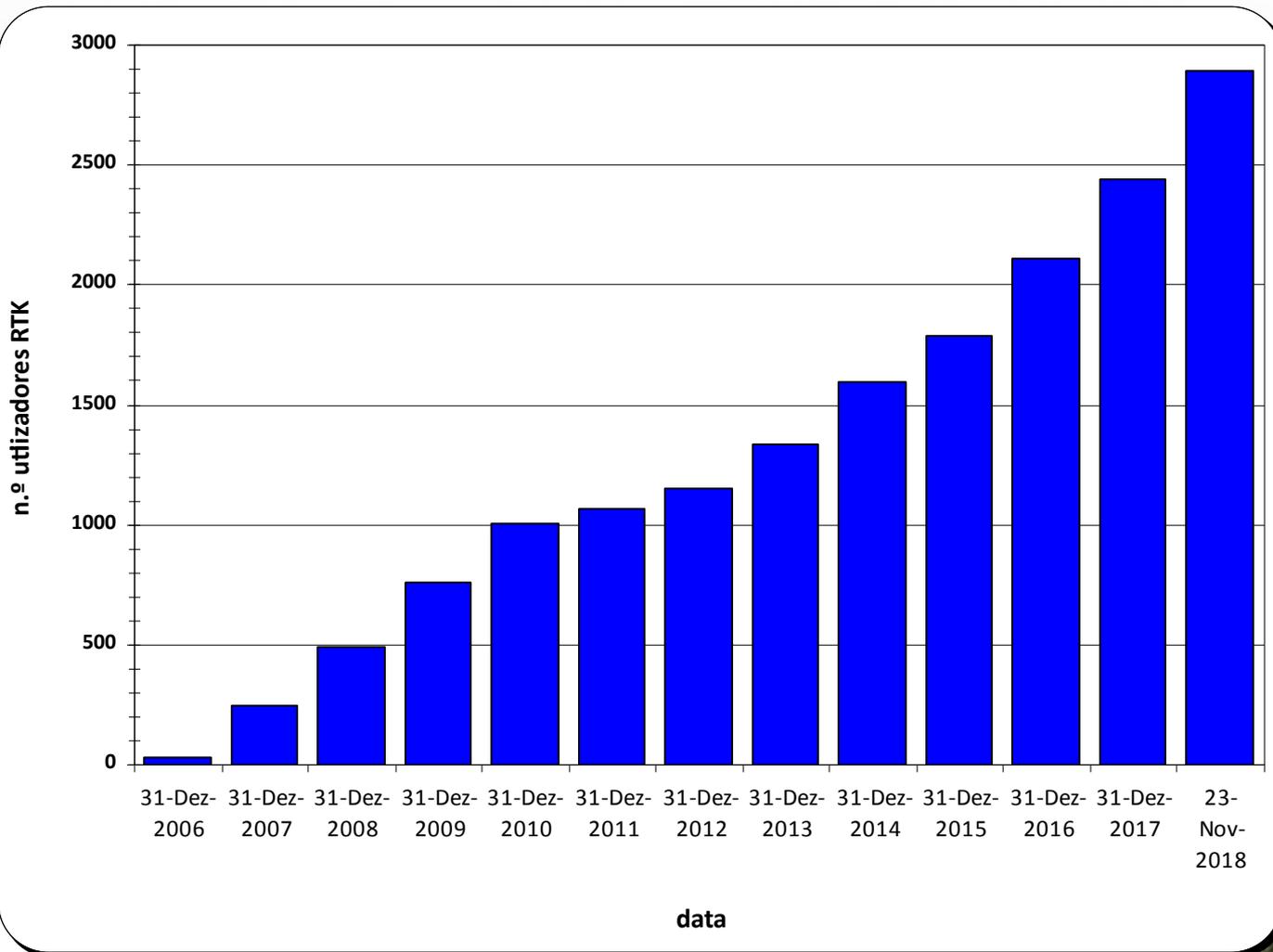
[Takac, F. and Lienhart, W., (2008)]

Manutenção

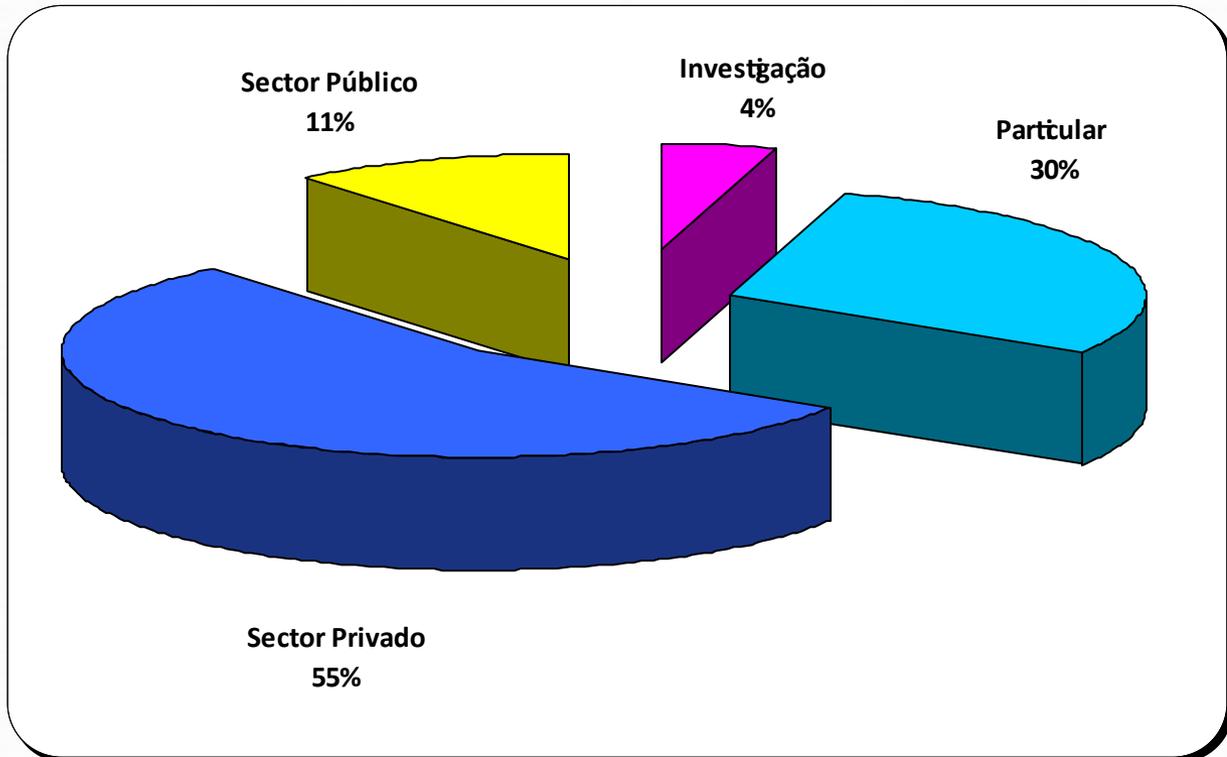
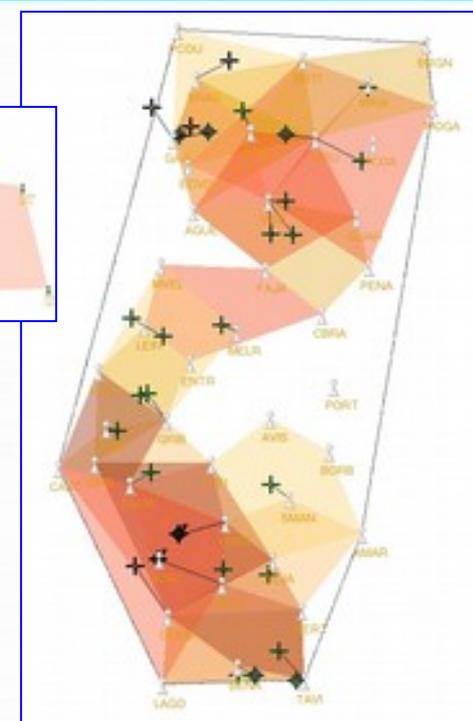
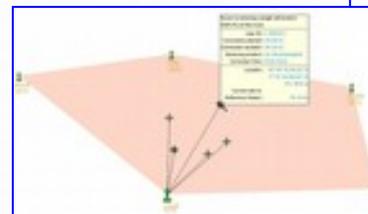


Utilizadores

cerca de 2900 utilizadores registados para os serviços RTK

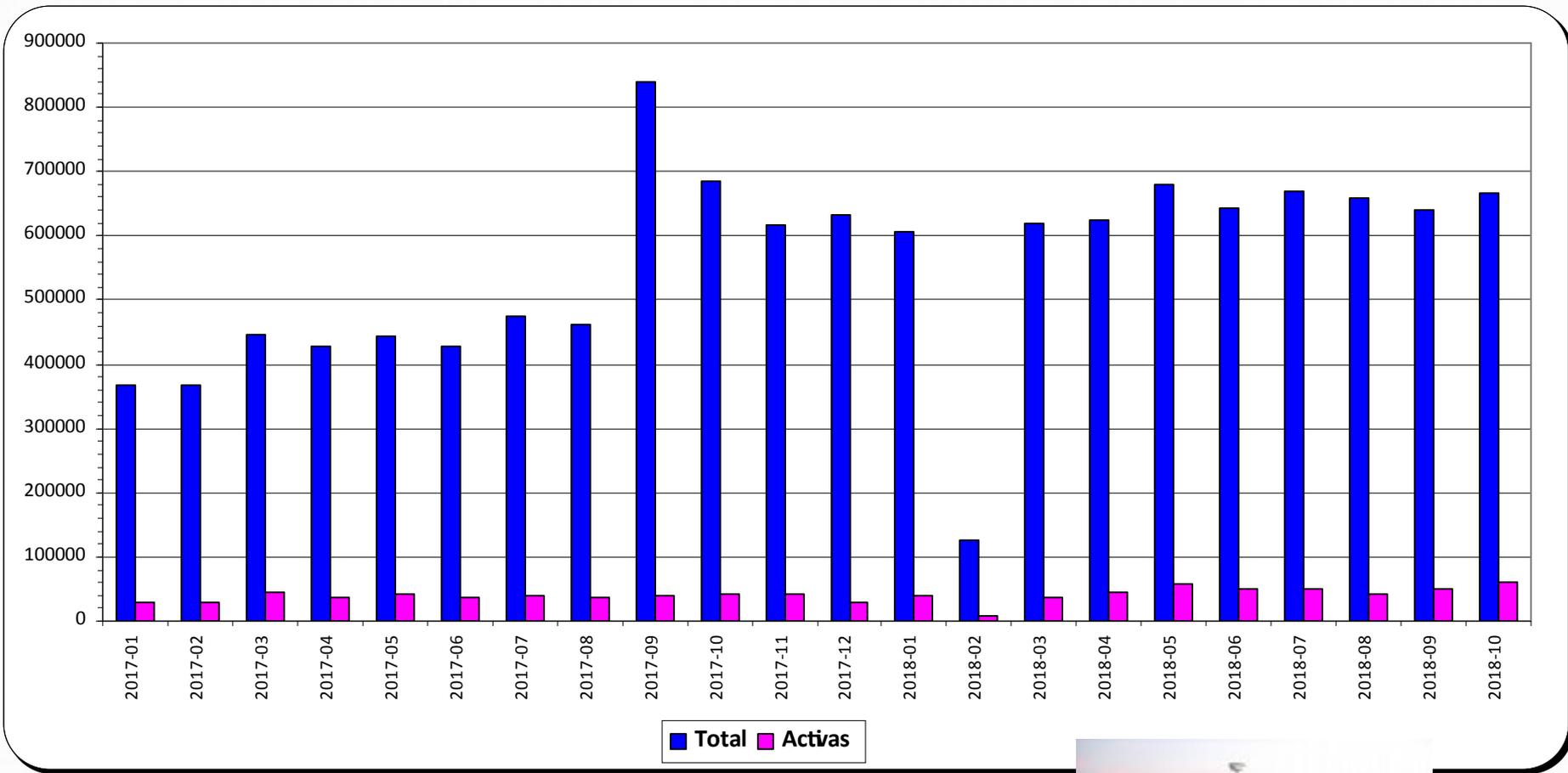


Utilizadores



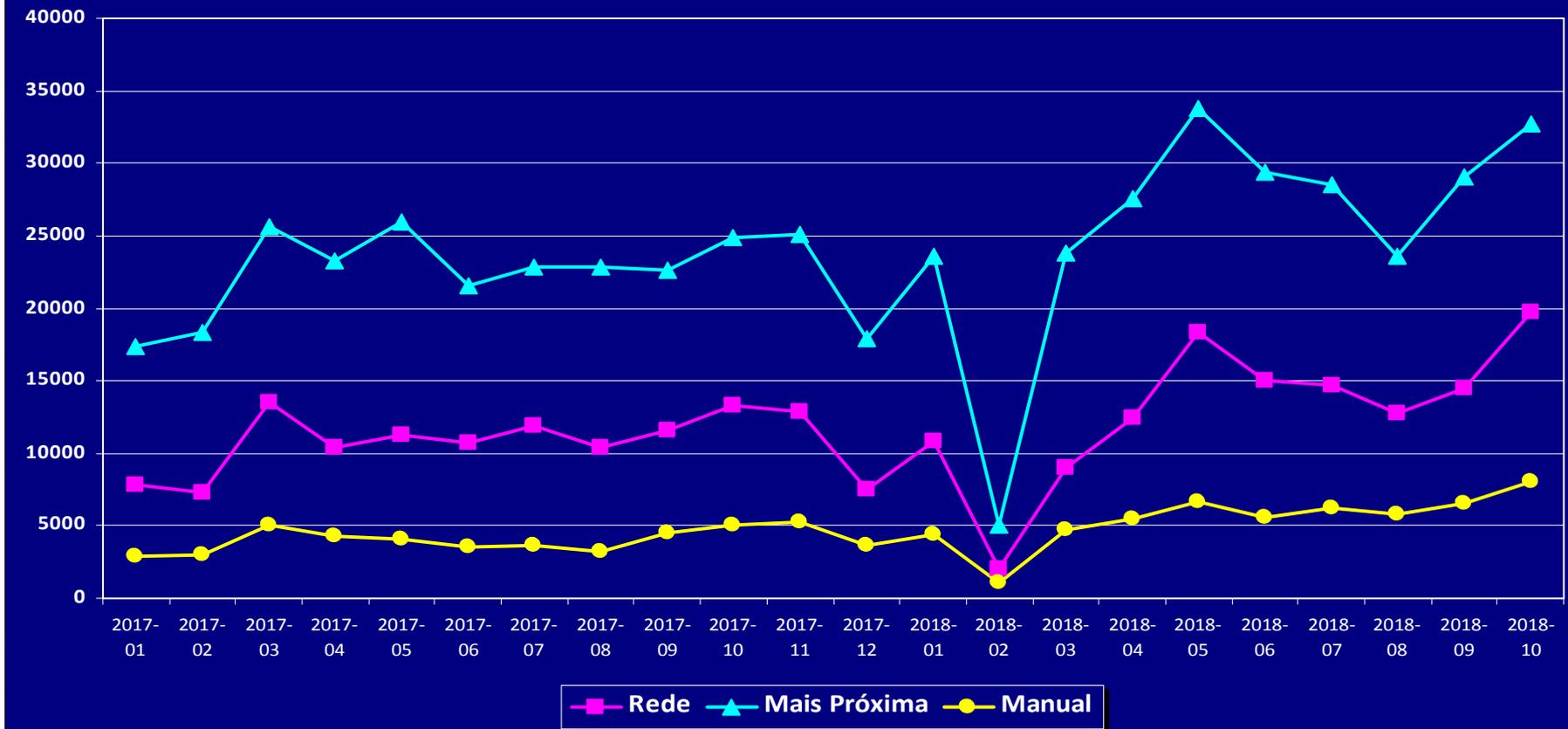
Utilizadores

Mais de 600 000 ligações mensais ao servidor

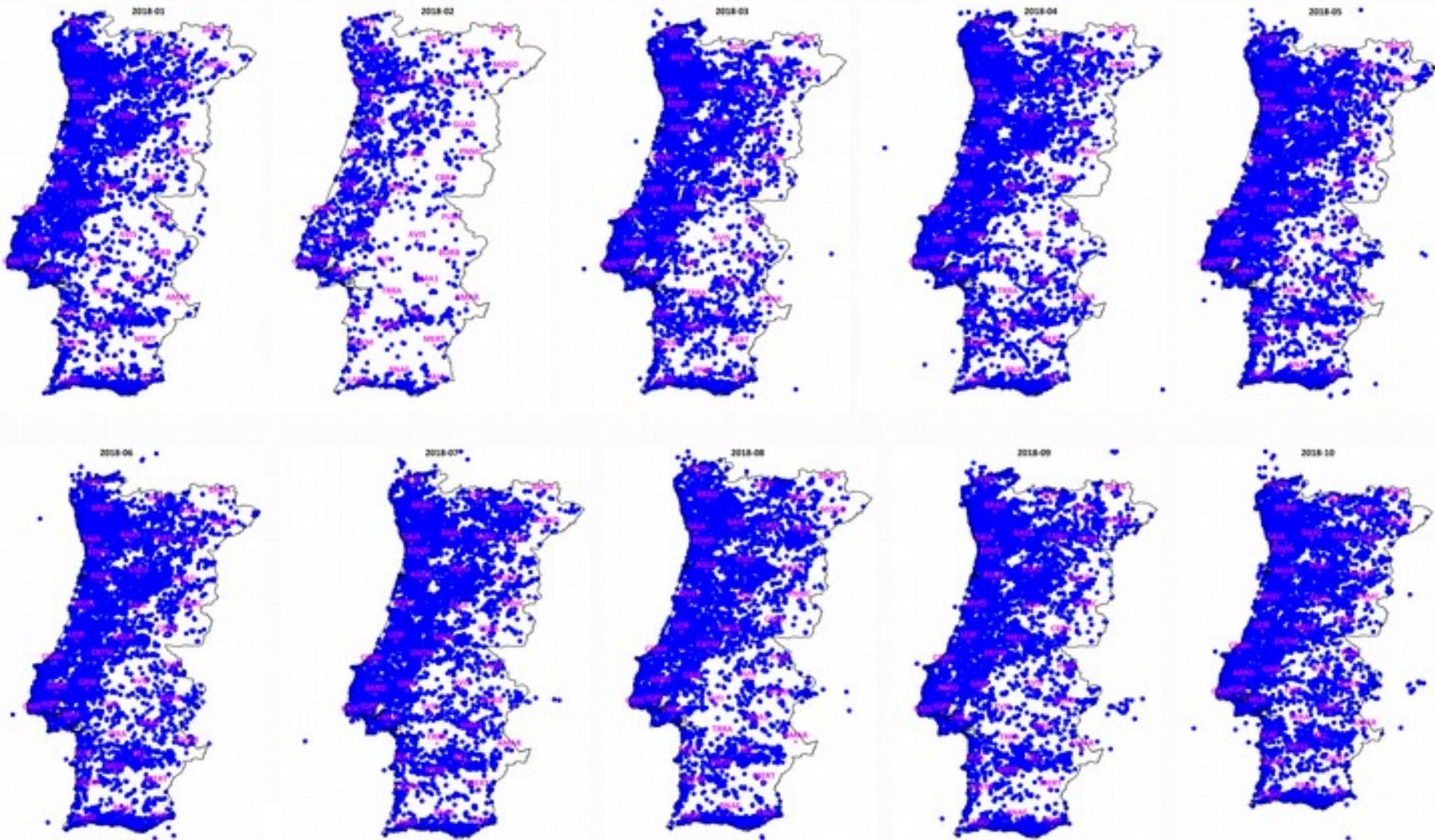


Utilização dos Produtos RTK

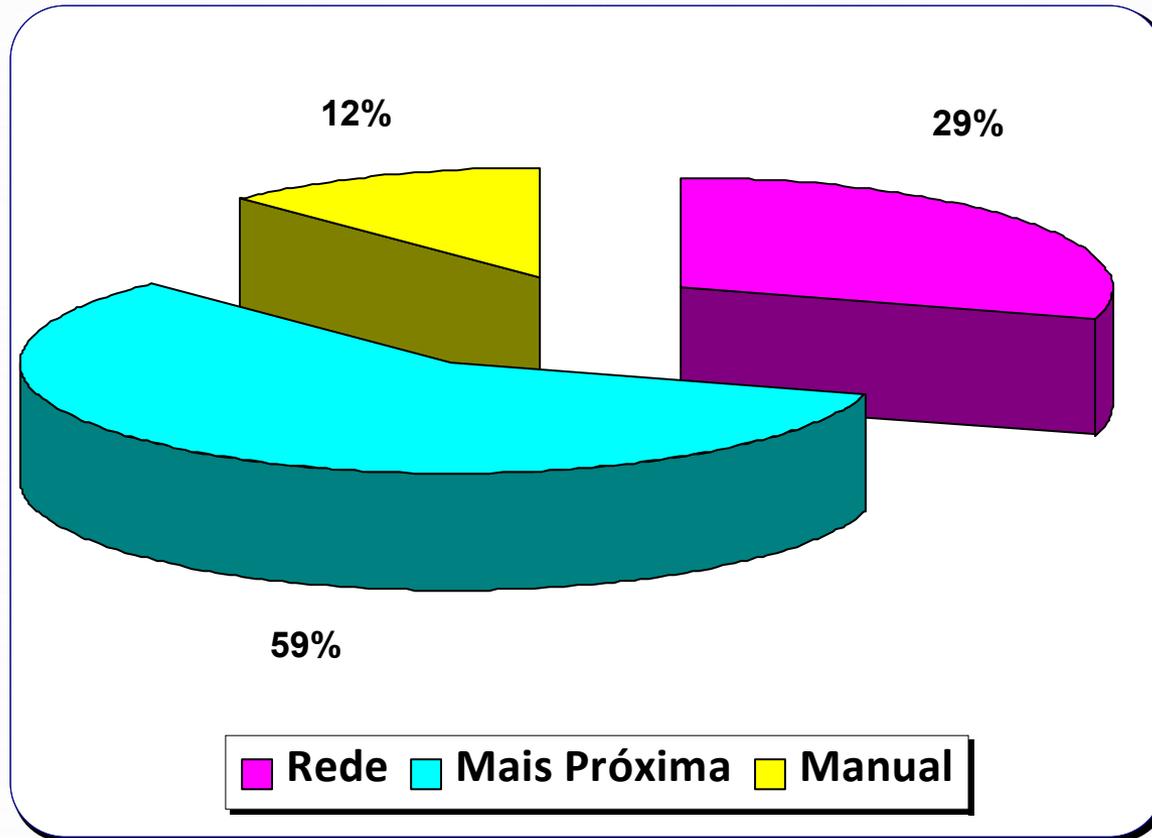
ligações mensais ao servidor_r



Utilização RTK - 2018



Produtos RTK - 2018



Tempo médio de ligação ao servidor: 31m03s

Exactidão RTK

Observações GNSS-RTK em VG

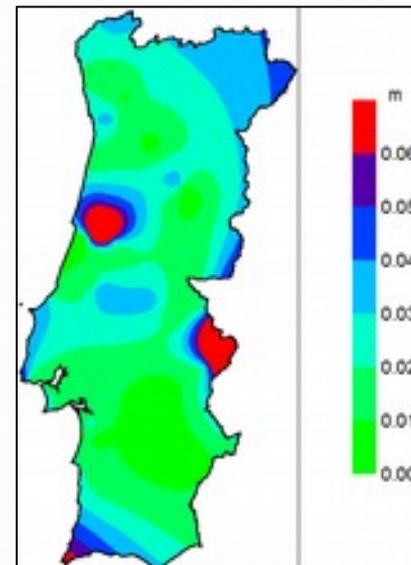


Resíduos (m)	M	P	2D	h
Máximo	0.033	0.045	0.068	0.134
Média	-0.003	0.006	0.019	0.001
Mínimo	-0.051	-0.055	0.004	-0.174
e.m.q.	0.015	0.017	0.023	0.051

Para 95% dos VG:

$\text{dif } 2\text{D} < 5 \text{ cm}$

$|\text{dif } h| < 10 \text{ cm}$



Transformação de Coordenadas – Continente

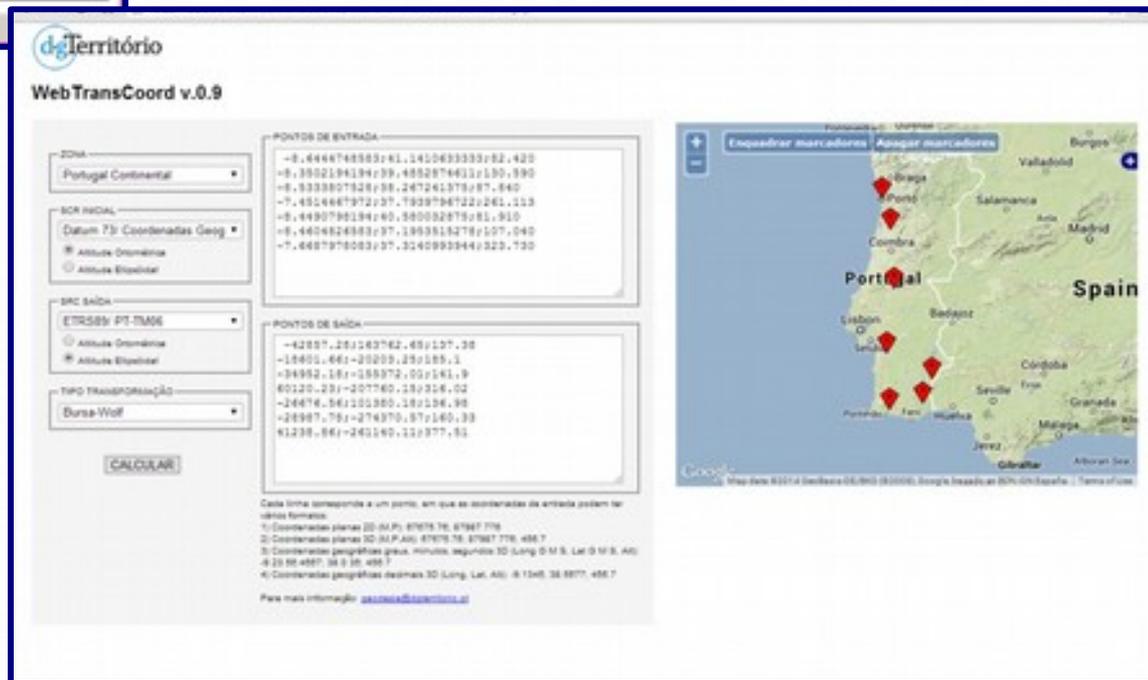
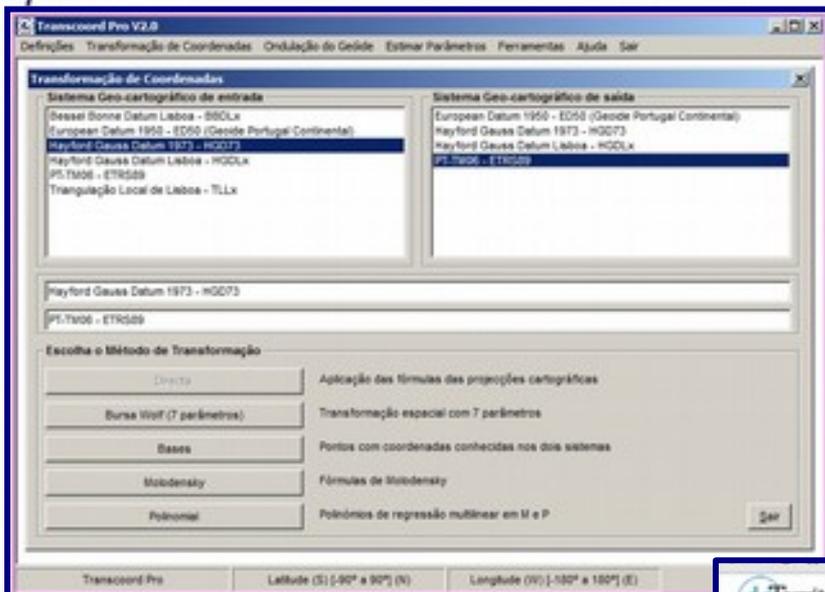
Comparação da Planimetria (vector)

HGD73 -> PT-TM06/ETRS89

Resíduos (m)	Molodensky	Bürsa-Wolf	Polinómios 2º grau	Grelhas
máximo	2.382	1.380	0.609	0.171
média	0.882	0.478	0.122	0.051
mínimo	0.007	0.019	0.003	0.001
e.m.q.	1.014	0.524	0.143	0.063

HGDLx -> PT-TM06/ETRS89

Resíduos (m)	Molodensky	Bürsa-Wolf	Polinómios 2º grau	Grelhas
máximo	5.611	5.109	4.199	0.779
média	2.160	1.868	0.994	0.162
mínimo	0.107	0.114	0.067	0.007
e.m.q.	2.331	2.049	1.166	0.200





FLRS Station Information - Site Page

SiteID	FLRS	Receiver	Antenna	Calibration	Clock	Collocation
Country	Portugal	LEICA	LEIAT504GG +	ROBOT	INTERNAL	None
Station Log	flrs_20161227.log	GRX1200GGPRO	NONE			
DOMES Number	31907M001					
Constellation	GPS GLONASS					
Data Center	BKG					



FLRS Quality



Station Configuration

Current station configuration: `cas_20141229-log-current` [View](#)
 CASCOOPRT is operated by DGT and integrated in the EPN since 20-09-1998.

RECEIVER : LEICA GRX1200GGPRO
 ANTENNA : LEIAT504GG NONE
 SET TO TRACK : GPS+GLO
 INDIVIDUAL CALIBRATION : NO
 Data routinely analysed by BEK, CODE, IGE, ION.

Data Provided

RINEX Data Quality

Daily tracking performances

Monthly snapshots of satellite tracking

Position, Velocity & Time Series

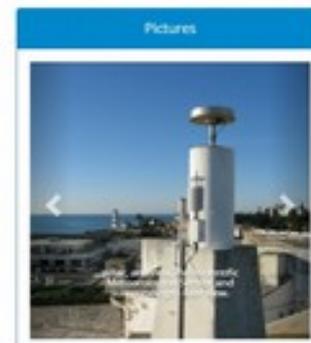
CASCOOPRT (Class A station)

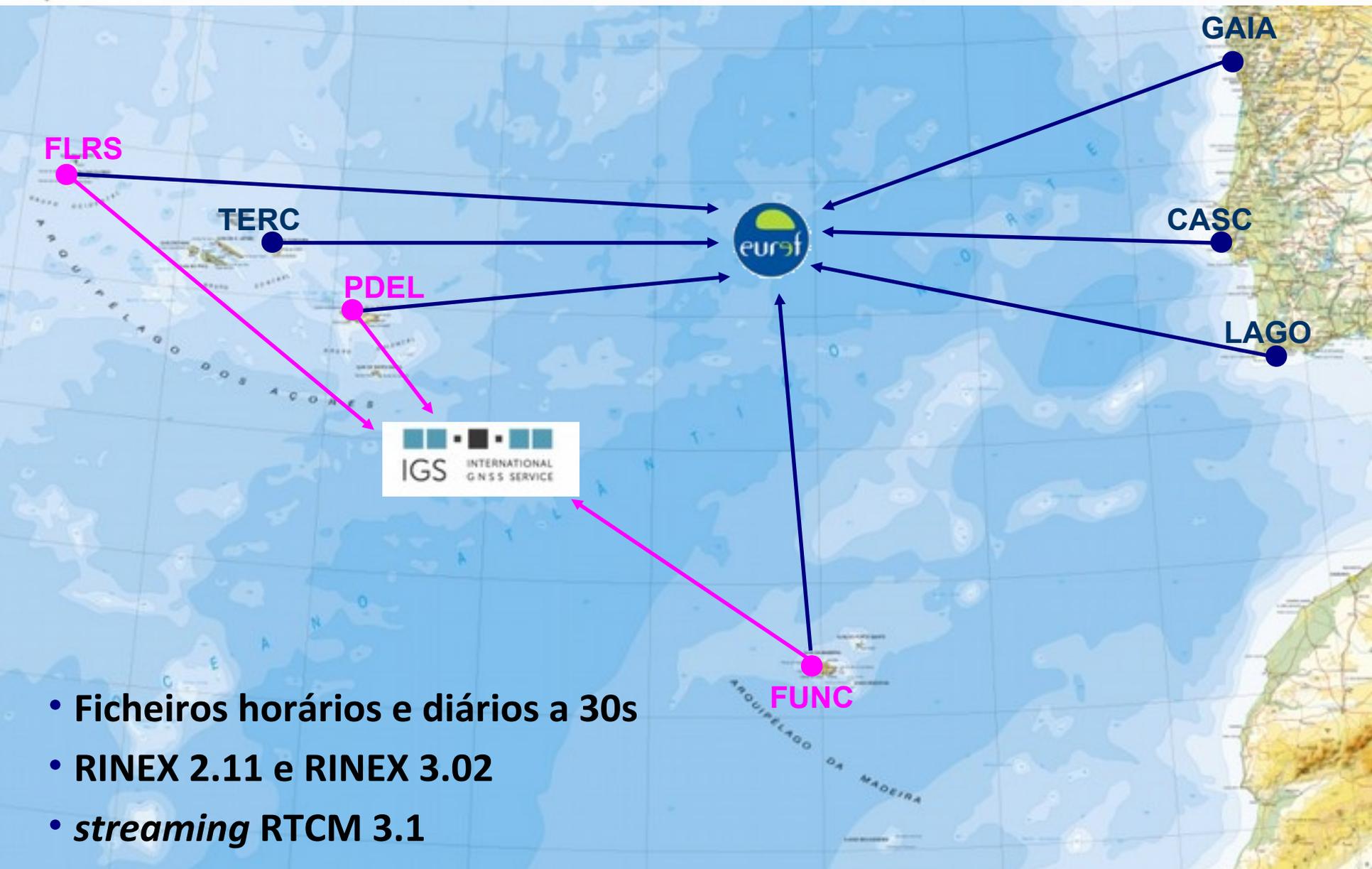
Last position valid from 06/2008 to 06/2016
 expressed at epoch 30/1/2005

X = 4077037.110 m	Vx = 0.0000 m/s
Y = 411726.487 m	Vy = 0.0000 m/s
Z = 3980857.135 m	Vz = 0.0000 m/s

ITRS89 (ITRF2005) position & velocity

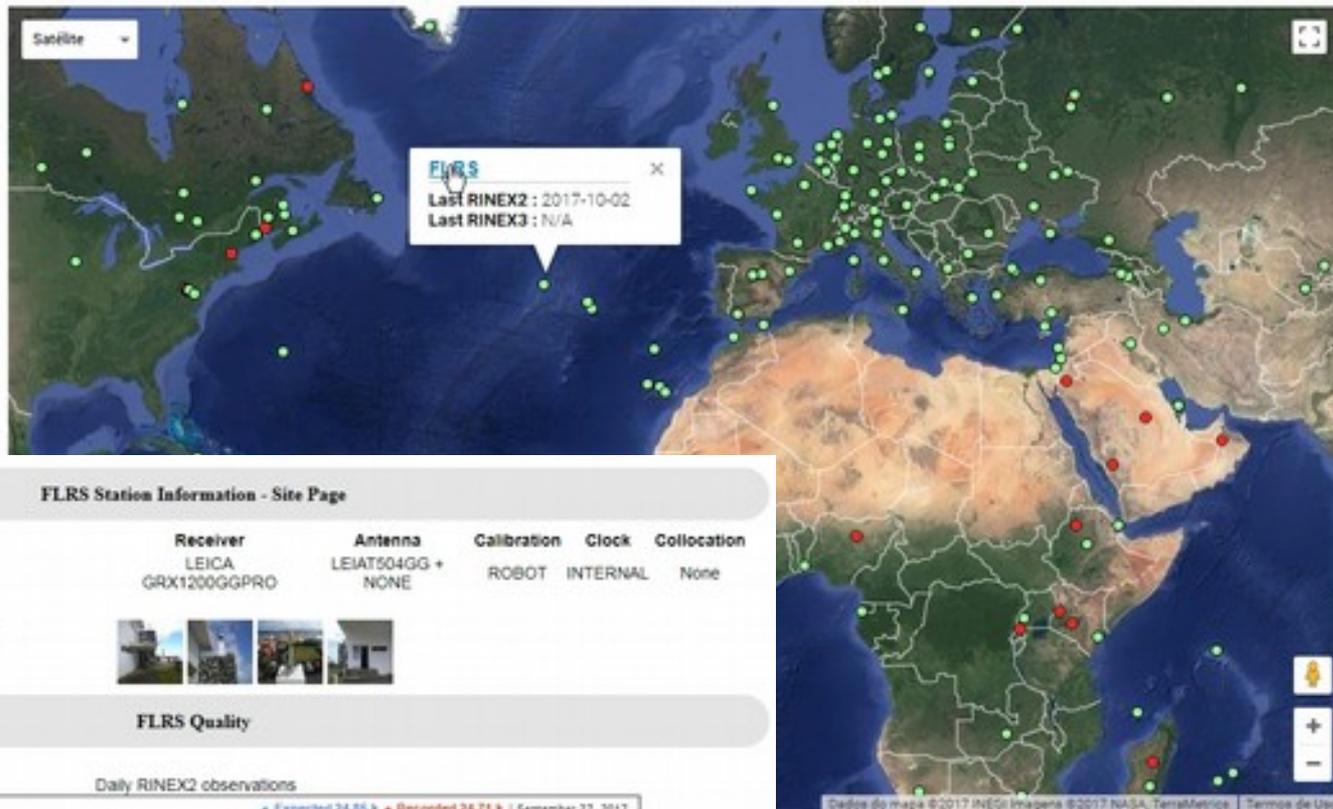
Position time series





- Ficheiros horários e diários a 30s
- RINEX 2.11 e RINEX 3.02
- *streaming* RTCM 3.1

ReNEP & Redes Internacionais



FLRS Station Information - Site Page

SiteID	FLRS	Receiver	LEICA GRX1200GGPRO	Antenna	LEIAT504GG + NONE	Calibration	ROBOT	Clock	INTERNAL	Collocation	None
Country	Portugal										
Station Log	flrs_20170420.log										
DOMES Number	31907M001										
Constellation	GPS GLONASS SBAS										
Data Center	BKG										



FLRS Quality



Receiver + Firmware

Antenna

2008-04-09 LEICA GRX1200GGPRO - 5.62/3.014

2008-08-18 LEICA GRX1200GGPRO - 6.00/3.015

2009-04-02 LEICA GRX1200GGPRO - 7.02/3.016

[Read More](#)

2008-04-09 LEIAT504GG NONE



Identification	Equipment	Tracking	Data flow
Marker Name:	DASCO0PRT		
Marker Number:	13909S001		
Location:	Cascais, Portugal		
Status:	active		
Networks:	IGS	ITRF2014	
	no	yes	
More details:	station information		

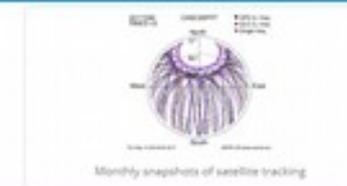
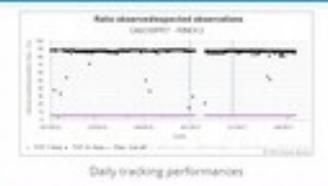


Station Configuration

Current station configuration: `casc_20170420.log` (current) [View](#)
 CASCO0PRT is operated by DGT and integrated in the EPN since 20-09-1998.
 RECEIVER : LEICA GRX1200GGPRO
 ANTENNA : LEIAT504GG NONE
 SET TO TRACK : GPS+GLO+SBAS
 INDIVIDUAL CALIBRATION : NO
 Data routinely analysed by BEK, COE, IGE, IGN.

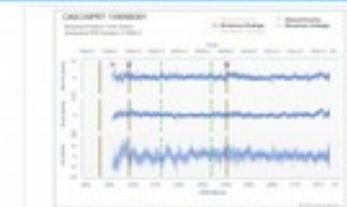
Data Provided

RINEX Data Quality



Position, Velocity & Time Series

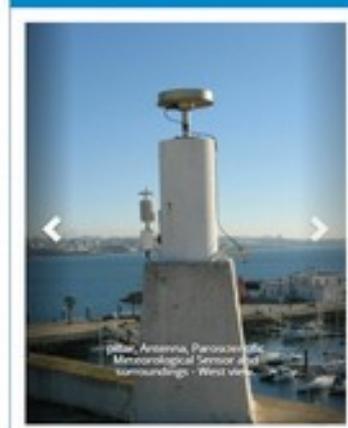
CASCO0PRT (Class A station)	
Least position varied from 2003-2008 to 2009/2017 expressed at epoch 001/2005	
X = 4917537.110 m	$\dot{x} = -0.0008$ m/y
Y = -815726.487 m	$\dot{y} = -0.0009$ m/y
Z = 3965857.135 m	$\dot{z} = -0.0003$ m/y
ETRS89 (ITRF2000) position & velocity	



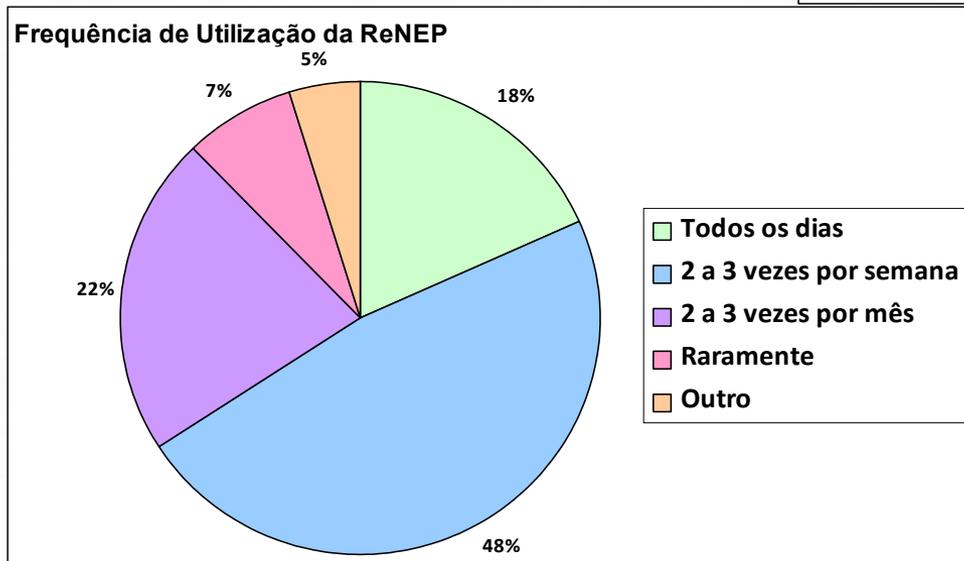
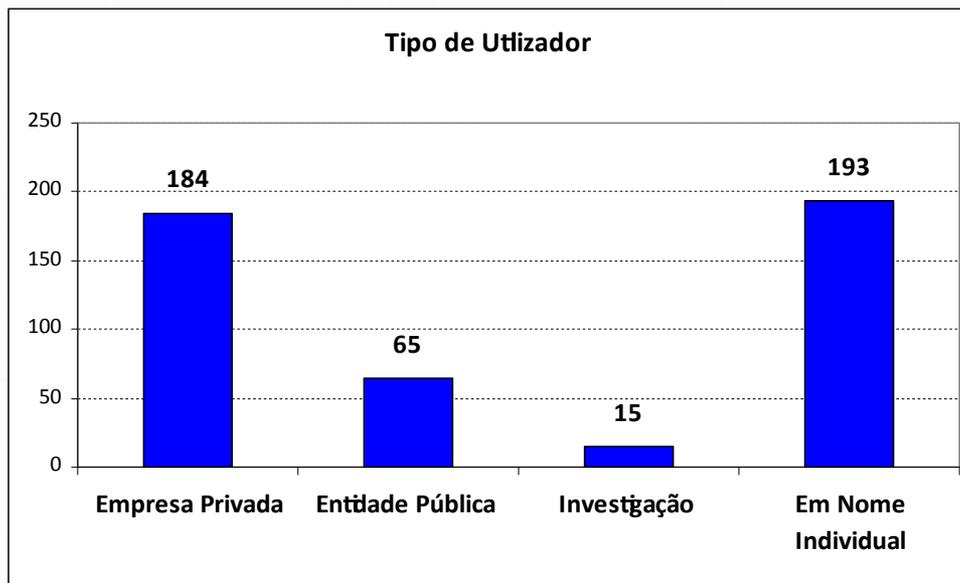
Location



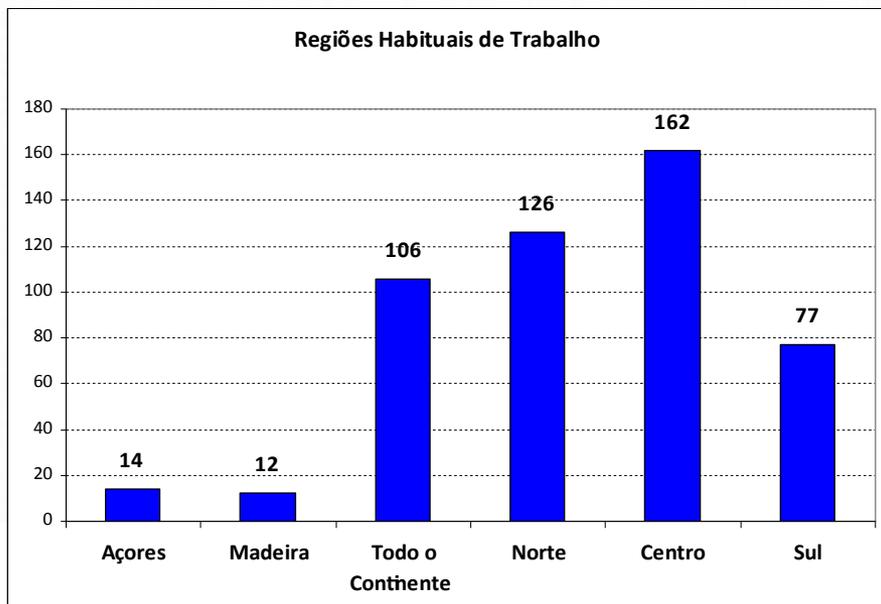
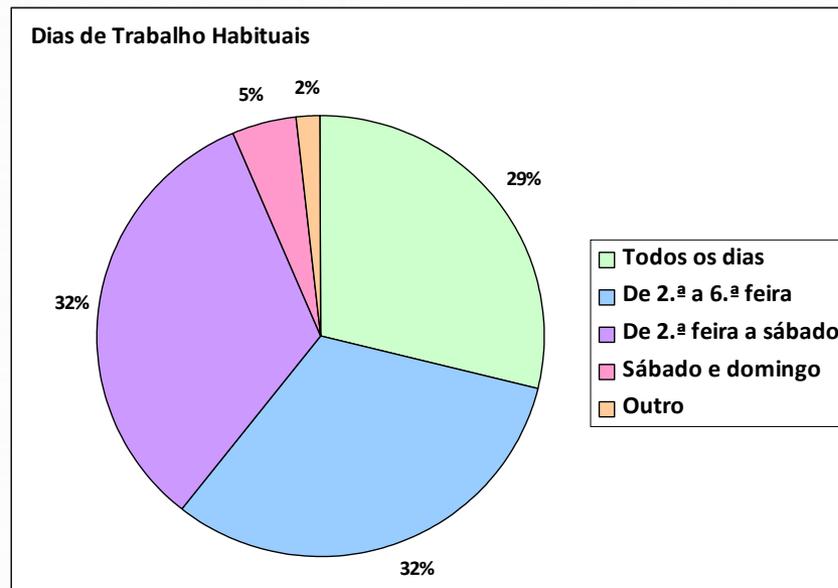
Pictures



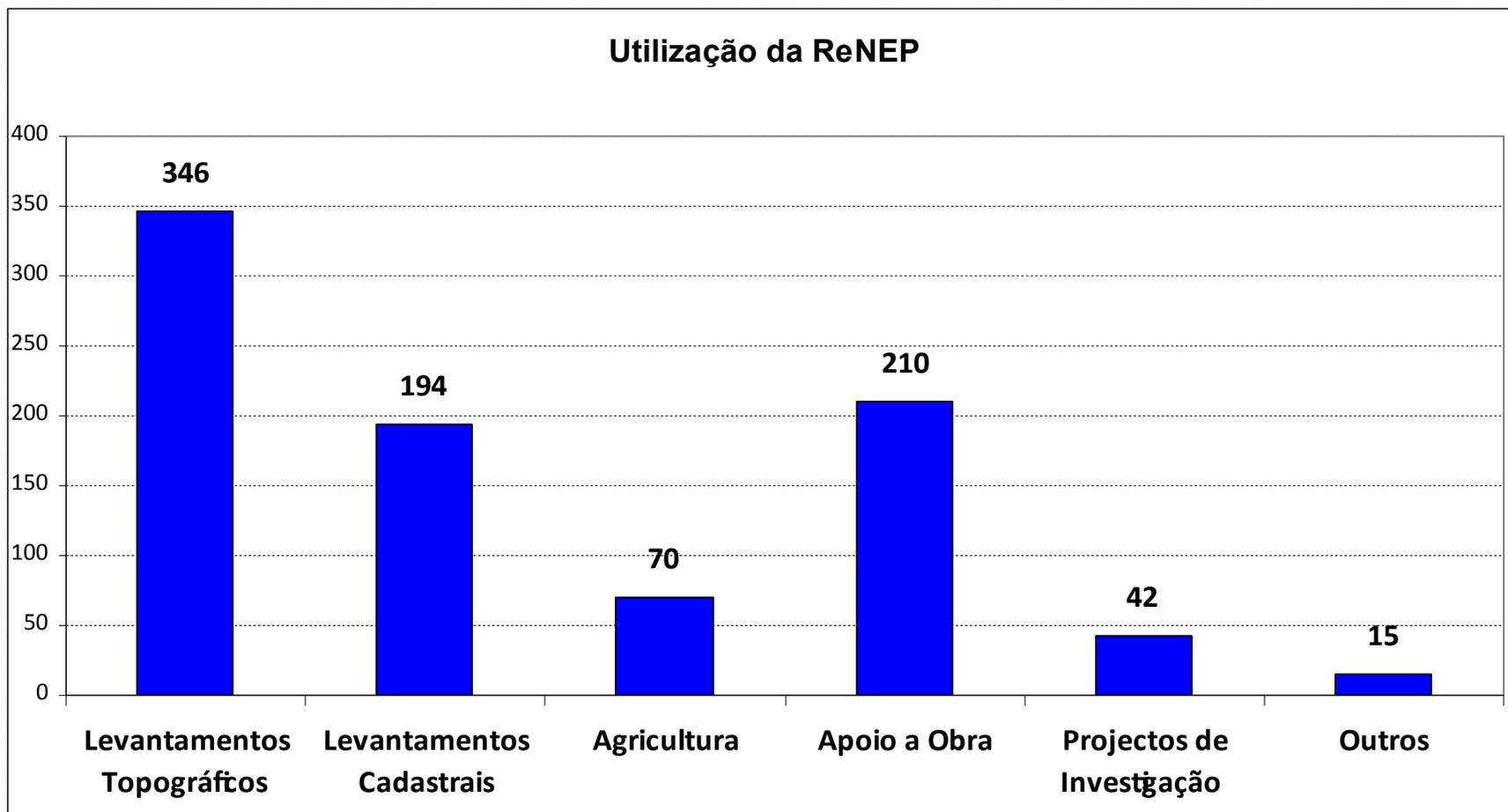
Características dos Utilizadores



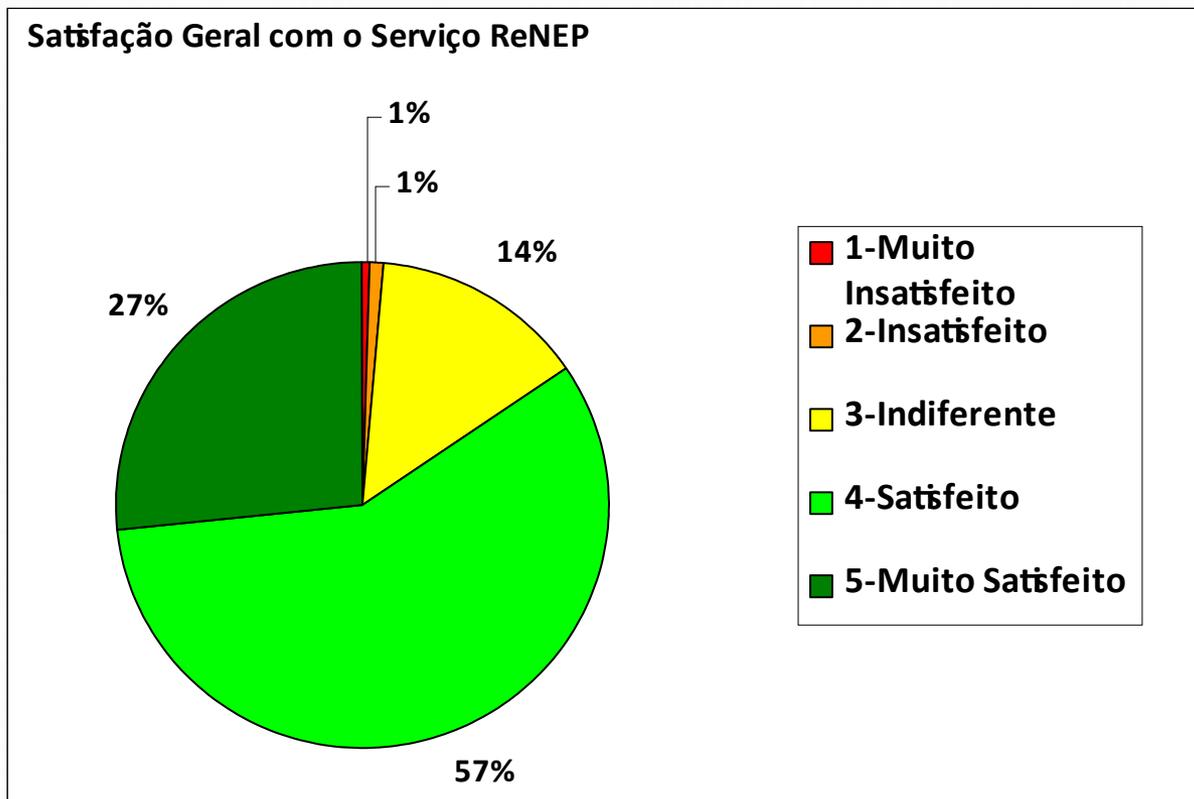
Características dos Utilizadores



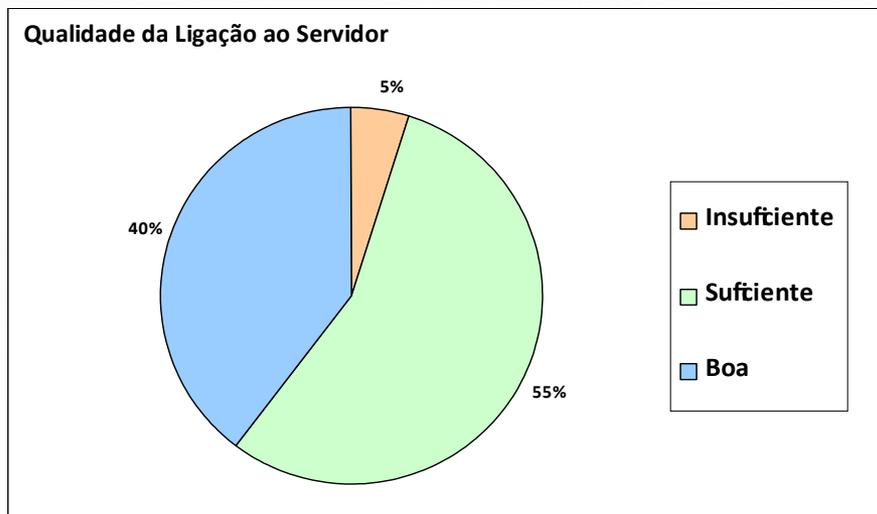
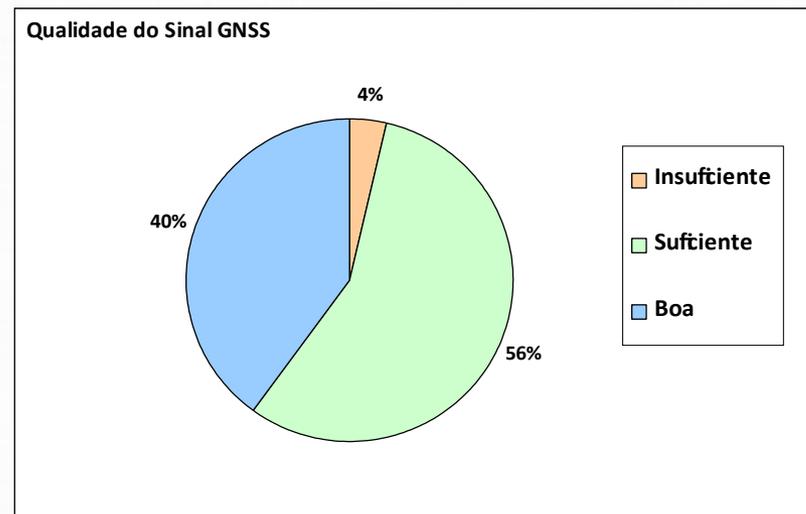
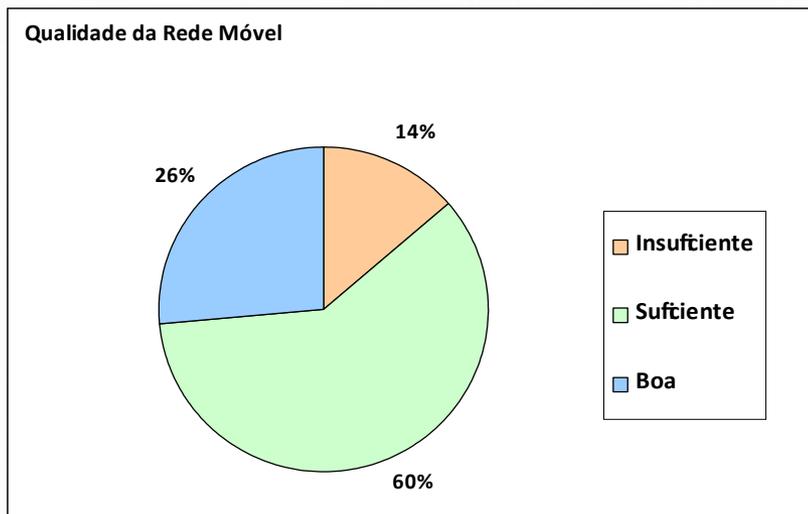
Inquérito aos Utilizadores (389 respostas)



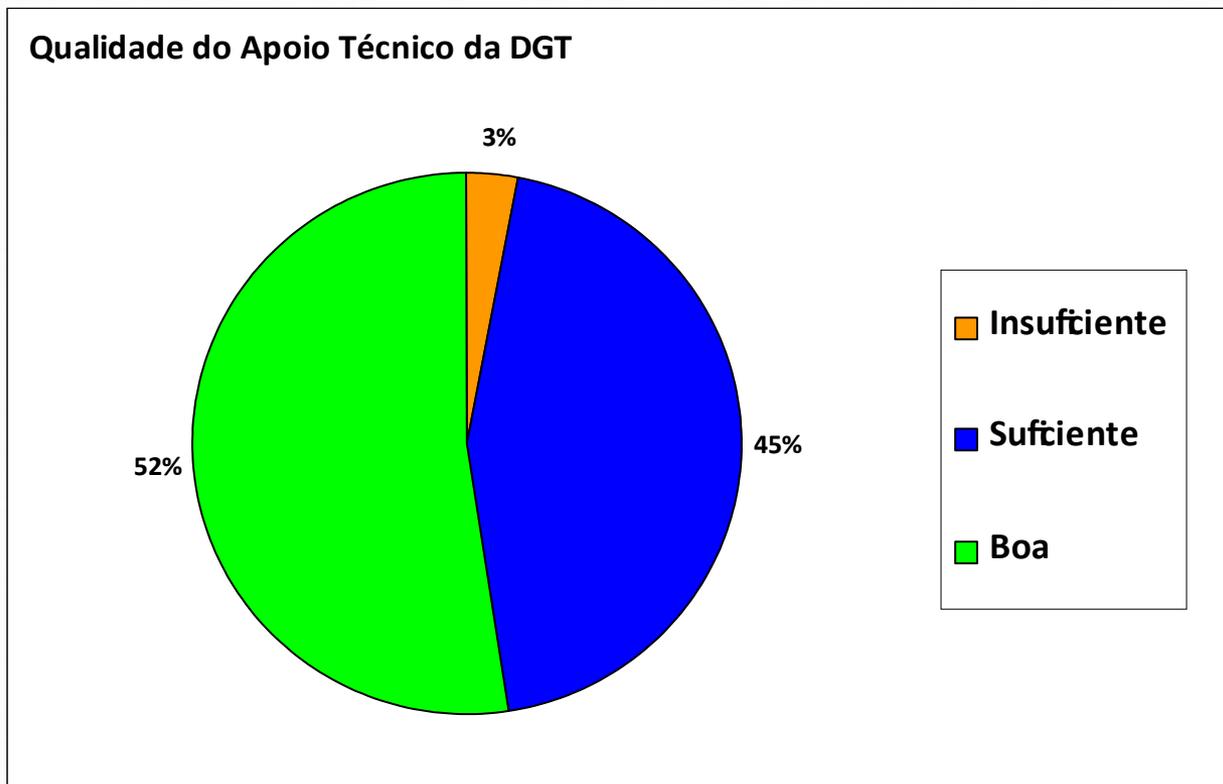
Satisfação com o Serviço

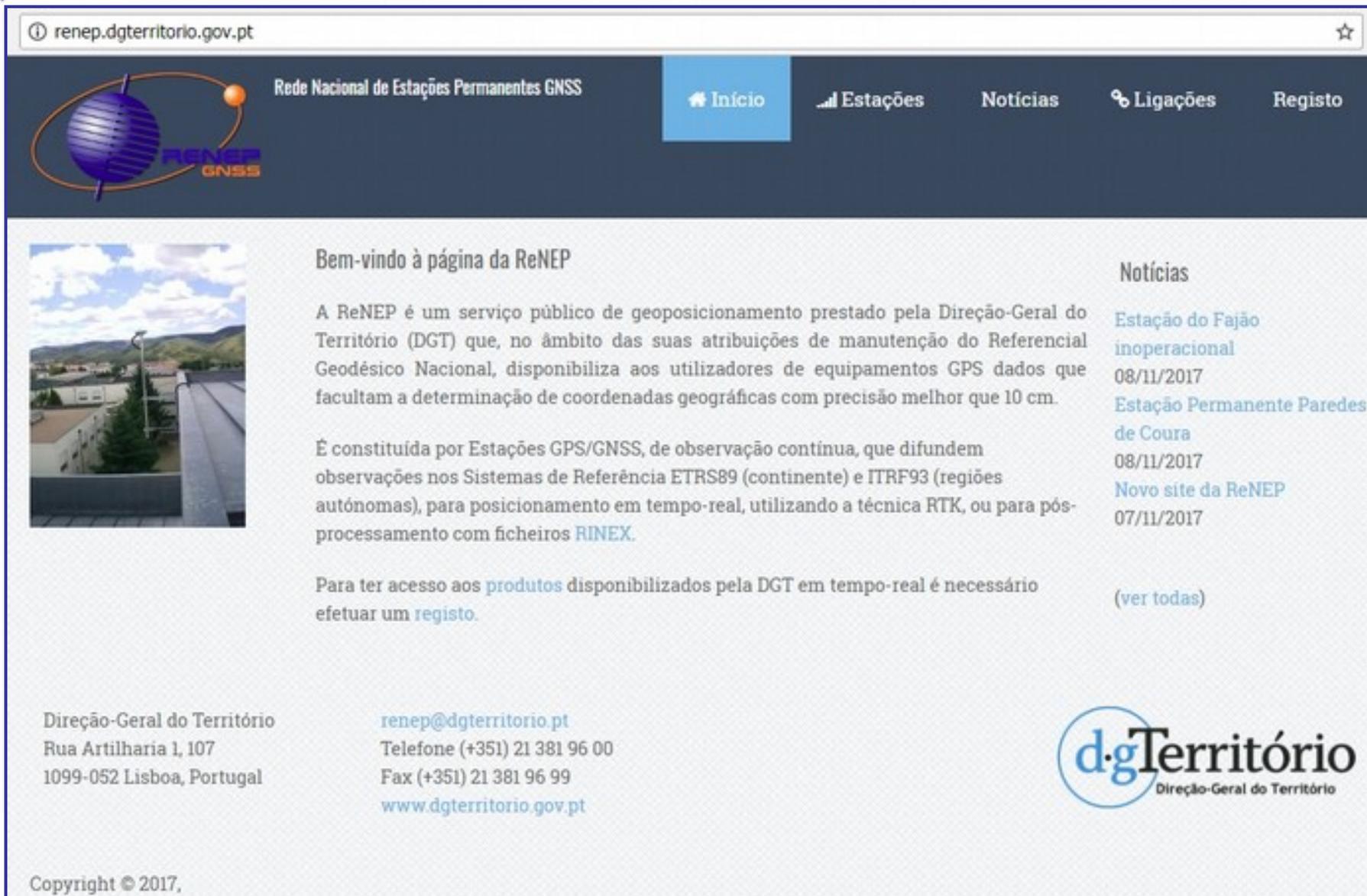


Satisfação com o Serviço



Satisfação com o Serviço





The screenshot shows the website interface for ReNEP (Rede Nacional de Estações Permanentes GNSS). The browser address bar displays 'rekep.dgterritorio.gov.pt'. The navigation menu includes 'Início', 'Estações', 'Notícias', 'Ligações', and 'Registo'. The main content area features a welcome message, a description of the service, and a list of news items. A sidebar on the left contains contact information for the Direção-Geral do Território.

renekep.dgterritorio.gov.pt

Rede Nacional de Estações Permanentes GNSS

Início Estações Notícias Ligações Registo



Bem-vindo à página da ReNEP

A ReNEP é um serviço público de geoposicionamento prestado pela Direção-Geral do Território (DGT) que, no âmbito das suas atribuições de manutenção do Referencial Geodésico Nacional, disponibiliza aos utilizadores de equipamentos GPS dados que facultam a determinação de coordenadas geográficas com precisão melhor que 10 cm.

É constituída por Estações GPS/GNSS, de observação contínua, que difundem observações nos Sistemas de Referência ETRS89 (continente) e ITRF93 (regiões autónomas), para posicionamento em tempo-real, utilizando a técnica RTK, ou para pós-processamento com ficheiros RINEX.

Para ter acesso aos produtos disponibilizados pela DGT em tempo-real é necessário efetuar um registo.

Notícias

- Estação do Fajão inoperacional 08/11/2017
- Estação Permanente Paredes de Coura 08/11/2017
- Novo site da ReNEP 07/11/2017

(ver todas)

Direção-Geral do Território
Rua Artilharia 1, 107
1099-052 Lisboa, Portugal

renekep@dgterritorio.pt
Telefone (+351) 21 381 96 00
Fax (+351) 21 381 96 99
www.dgterritorio.gov.pt



Copyright © 2017,

