



THE TRANSMISSION OF GNSS DATA IN THE DISTART NETWORK FOR REAL TIME KINEMATIC POSITIONING

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TOPICS

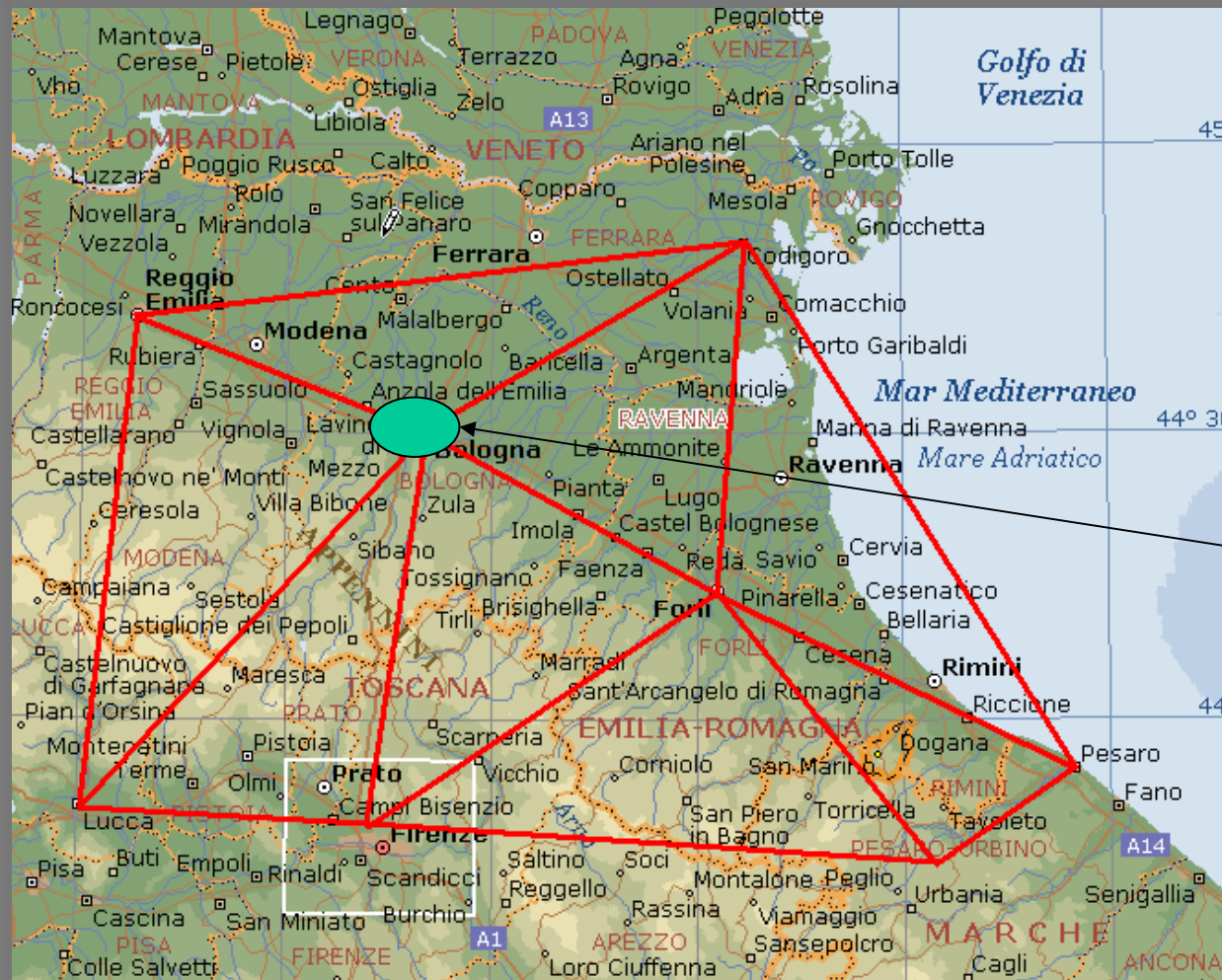
**A NRTK can be seen under two aspects:
topographic and data transmission**

- ✓ state of art of NRTK in Italy
- ✓ DISTART Network
- ✓ building of the Network both in the topographic aspect and in the data transmission aspect
- ✓ analyze: NAP
 - latency time
 - baudrate (not strictly necessary)

THE STATE OF ART OF THE NRTK IN ITALY



THE DISTART NETWORK



EMILIA ROMAGNA



Control Centre

GNSS PERMANENT STATION



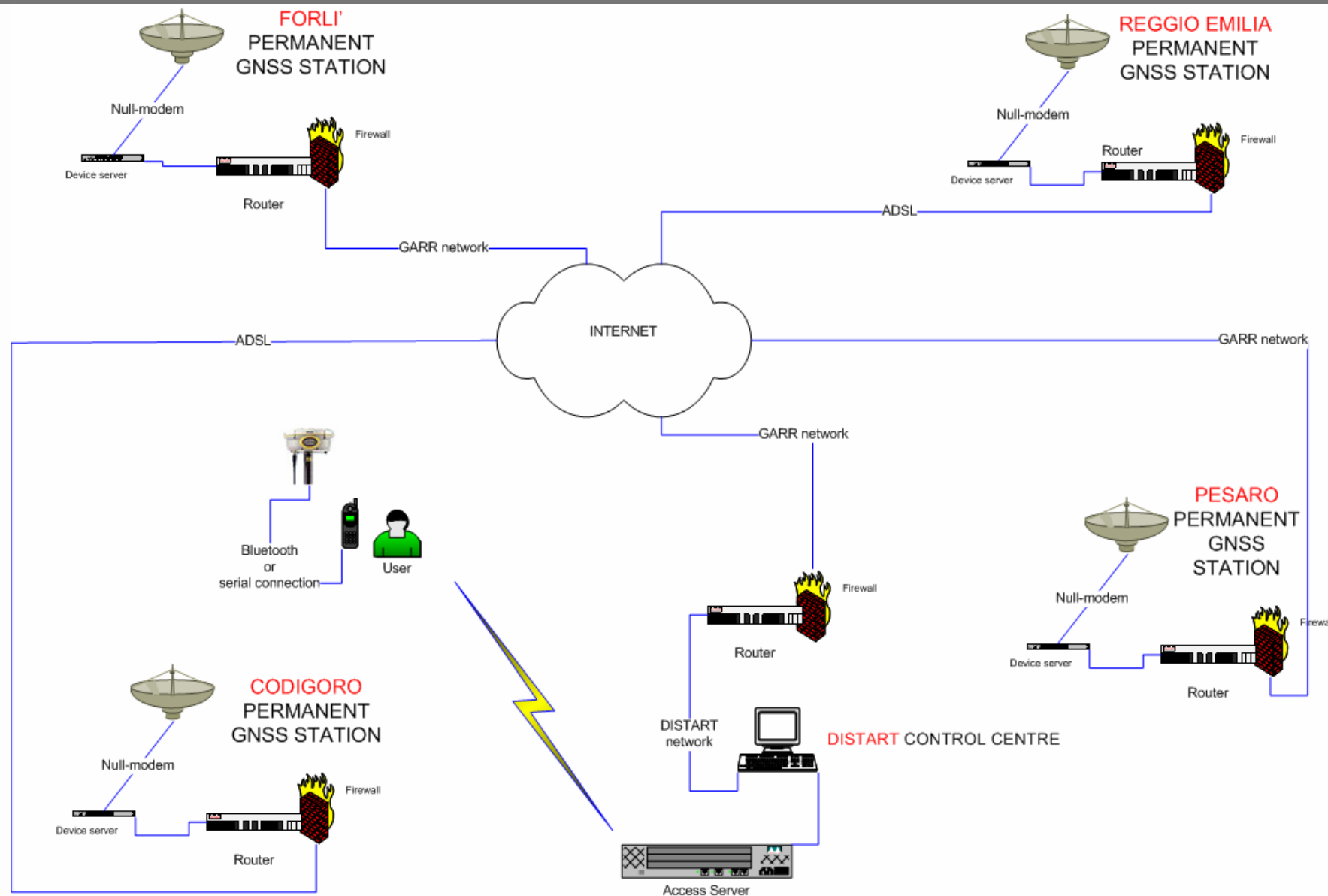
Reggio Emilia

CONTROL CENTRE nearby Univ. of BOLOGNA



- 10/01/2003 – 02/02/2004: GPSNet
- 07/04/2004 – 31/03/2005 : Geo++® GNSMART
- 05/04/2005 – now: GPS Spider installed on Intel(R) Pentium(R) 4 with CPU of 2.60GHz and 512MB RAM with OS Win XP
- 3 GSM modems and NTRIP

DATA TRANSMISSION NETWORK SCHEME



NAP - Neutral Access Point

PERMANENT STATION - CONTROL CENTRE

ADSL/GARR

Hop	%Loss	IP Address	Node Name	Location	Tzone	ms	Graph	Network
0		137.204.144.4	bedin	*			0	Universita' di Bologna
1		137.204.58.252	-	Bologna, Italy	+01:00	120	1209	Universita' di Bologna
2		137.204.2.17	alga11.unibo.it			1		Universita' di Bologna
3	30	193.206.128.125	ru-unibo-rt1-bo1.bo1.garr.n	Bologna, Italy	+01:00	1		GARR-B Backbone and POPs
4	10	193.206.134.237	rt1-bo1-rt-bo1.bo1.garr.net	(Italy)	+01:00	1		GARR-B Backbone and POPs
5	10	193.206.134.49	rt-bo1-rt-rm1.rm1.garr.net	(Italy)	+01:00	5		GARR-B Backbone and POPs
6		193.206.134.118	rt-rm1-rt-rm2-2.rm2.garr.net	(Italy)	+01:00	5		GARR-B Backbone and POPs
7		193.201.29.10	telecomitalia2-nap.namex.it	(Italy)	+01:00	5		Nautilus Mediterranean Exchange
8		82.184.8.177	host177-8.pool82184.interb	(Italy)	+01:00	7		Telecom Italia SPA
9		151.99.29.152	r-rm199-vl3.opb.interbusin			7		InterBusiness Backbone
10		80.20.8.250	host250-8.pool8020.interb	(Italy)	+01:00	12		Telecom Italia SPA
11		80.17.212.211	-	(Italy)	+01:00	267		Telecom Italia SPA
12	40	82.104.0.133	host133-0.pool82104.interb			314		82.104.0.133

Roundtrip time to 82.104.0.133, average = 314ms, min = 312ms, max = 323ms -- 08-Feb-2006 17:03:28 (Collapse Table)

NAP - Neutral Access Point

PERMANENT STATION - CONTROL CENTRE

ADSL/GARR

Hop	%Persi	Indirizzo IP	Nome nodo	Localazione	F.Ora	ms	Grafico	Rete
0		137.204.61.215	distart215.ing.unibo.it	*			0	RIPE Network Coordinatic
1		137.204.61.254	almr06_ing_61.ing.unibo.it	(Italy)	+01:00	0		RIPE Network Coordinatic
2		137.204.2.17	alga11.unibo.it	(Italy)	+01:00	0		RIPE Network Coordinatic
3		193.206.128.125	ru-unibo-rt1-bo1.bo1.garr.net	Bologna, Italy	+01:00	0		GARR-B Backbone and P
4		193.206.134.237	rt2-bo1-rt1-bo1.bo1.garr.net	Bologna, Italy	+01:00	2		GARR-B Backbone and P
5		193.206.134.21	mi-bo-g.garr.net	Milan, Italy	+01:00	27		GARR-B Backbone and P
6		193.206.134.18	rtg2-rtg1.mi.garr.net	Milan, Italy	+01:00	7		GARR-B Backbone and P
7		217.29.66.44	eplanet.mix-it.net	(Italy)	+01:00	0		Milan Internet eXchange
8		217.19.145.37	-	(Italy)	+01:00	0		ePlanet SPA
9								
10		217.18.208.15	access02.quesse.it	(Italy)	+01:00	10		Q&S Srl Internet Service P
11								
12		217.18.211.250	re-0007.dsl-38.a2-10-104.adslm	(Italy)	+01:00	68		Q&S Srl Internet Service P

NAP - Neutral Access Point

PERMANENT STATION - CONTROL CENTRE

GARR ROUTE

Hop	%Persi	Indirizzo IP	Nome nodo	Locazione	F.Ora	ms	Grafico	Rete
0		137.204.61.215	dstart215.ing.unibo.it	*			0	RIPE Network Coordinating Centre
1		137.204.61.254	almr06_ing_61.ing.unibo.it	(Italy)	+01:00	3		RIPE Network Coordinating Centre
2		137.204.2.17	alga11.unibo.it	(Italy)	+01:00	4		RIPE Network Coordinating Centre
3		193.206.128.125	ru-unibo-rt1-bo1.bo1.garr.net	Bologna, Italy	+01:00	3		GARR-B Backbone and
4		193.206.134.237	rt2-bo1-rt1-bo1.bo1.garr.net	Bologna, Italy	+01:00	1		GARR-B Backbone and
5		193.206.134.25	rt-bo1-rt-bo.bo.garr.net	Bologna, Italy	+01:00	4		GARR-B Backbone and
6		193.206.134.158	rc-rt-2.bo.garr.net	Bologna, Italy	+01:00	4		GARR-B Backbone and
7		193.206.128.134	unife-rc.bo.garr.net	Bologna, Italy	+01:00	8		GARR-B Backbone and
8								
9								
10		192.167.215.16	h16.ing.unife.it	Ferrara, Italy	+01:00	20	180	Universita di Ferrara

LATENCY TIME

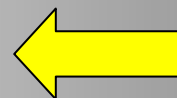
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Uncorrected Carrier Phase Measurement          FRAME 18
Freq.: L2          EXP-Time : 34816.000485 s
SV | PhErr  cycle|Loss| Wave | Code| Phase cycles | EXP-Time  s
---|-----|----|-----|-----|-----|-----
 5 | <= 0.00696 | 26 | FULL | P | 3669450.16 | 34816.000485
 6 | <= 0.00696 | 29 | FULL | P | -196245.08 | 34816.000485
15 | <= 0.00696 | 21 | FULL | P | 1303300.85 | 34816.000485
10 | <= 0.00696 | 6  | FULL | P | 1515385.14 | 34816.000485
30 | <= 0.00696 | 20 | FULL | P | -4236643.79 | 34816.000485
21 | <= 0.00696 | 18 | FULL | P | -7863784.46 | 34816.000485
 2 | <= 0.00696 | 24 | FULL | P | -2306178.03 | 34816.000485
16 | <= 0.00696 | 30 | FULL | P | 1742567.14 | 34816.000485
 1 | <= 0.00696 | 19 | FULL | P | -2459136.50 | 34816.000485
```

frame: 18 latency: -0.749

```
Freq.: L2          EXP-Time : 34817.000485 s
SV | PhErr  cycle|Loss| Wave | Code| Phase cycles | EXP-Time  s
---|-----|----|-----|-----|-----|-----
 5 | <= 0.00696 | 26 | FULL | P | 3666846.49 | 34817.000485
 6 | <= 0.00696 | 29 | FULL | P | -196788.19 | 34817.000485
15 | <= 0.00696 | 21 | FULL | P | 1306146.71 | 34817.000485
10 | <= 0.00696 | 6  | FULL | P | 1516427.86 | 34817.000485
30 | <= 0.00696 | 20 | FULL | P | -4238550.27 | 34817.000485
21 | <= 0.00696 | 18 | FULL | P | -7861593.80 | 34817.000485
 2 | <= 0.00696 | 24 | FULL | P | -2309015.20 | 34817.000485
16 | <= 0.00696 | 30 | FULL | P | 1744919.03 | 34817.000485
 1 | <= 0.00696 | 19 | FULL | P | -2461230.47 | 34817.000485
```

frame: 18 latency: -0.947

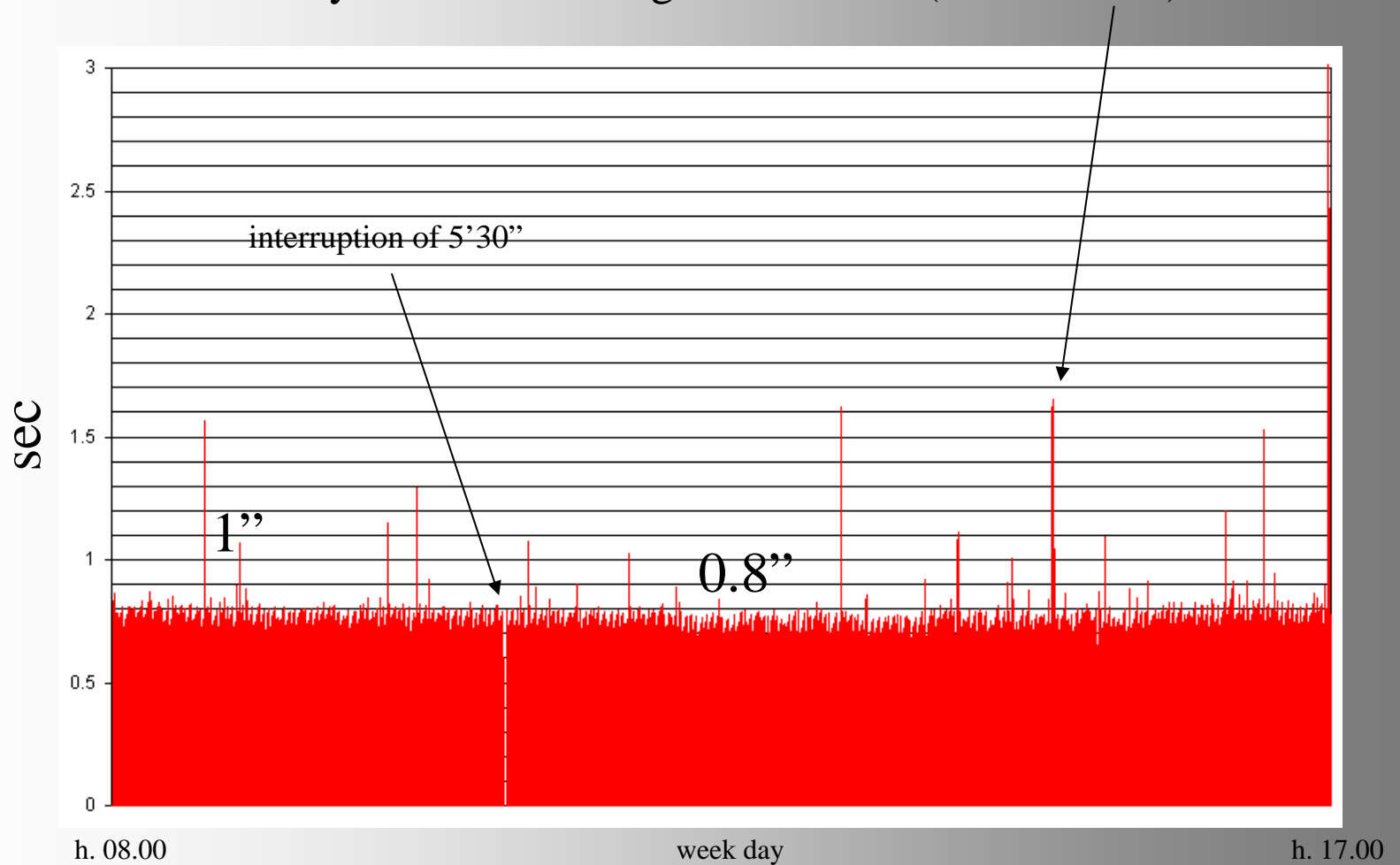
RTCM DECODER
SW (checked with
VisualPulse sw)



LATENCY TIME

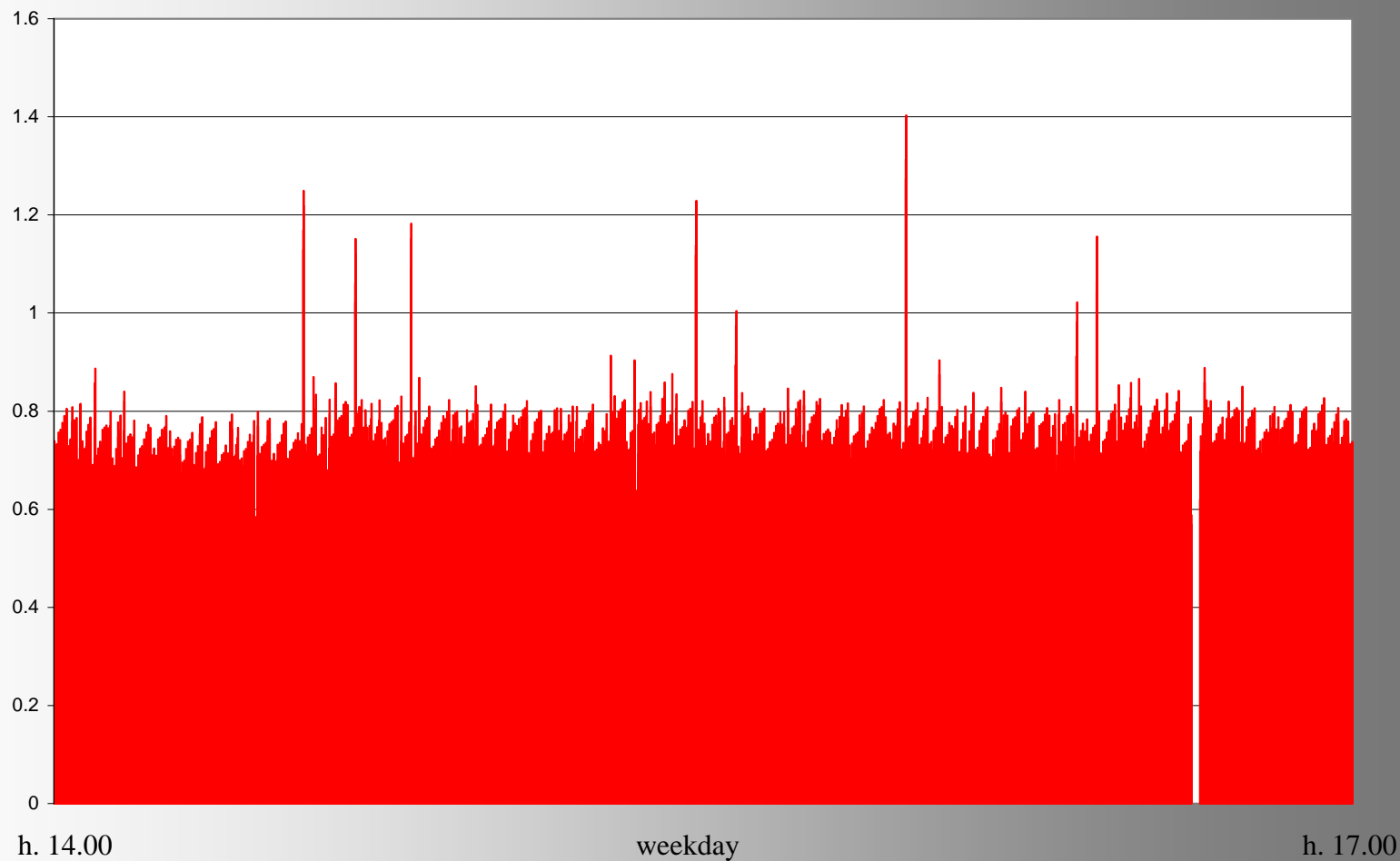
GARR route (Forlì-Bologna)

latency >1.5'' for average times of 3' (max time 6')



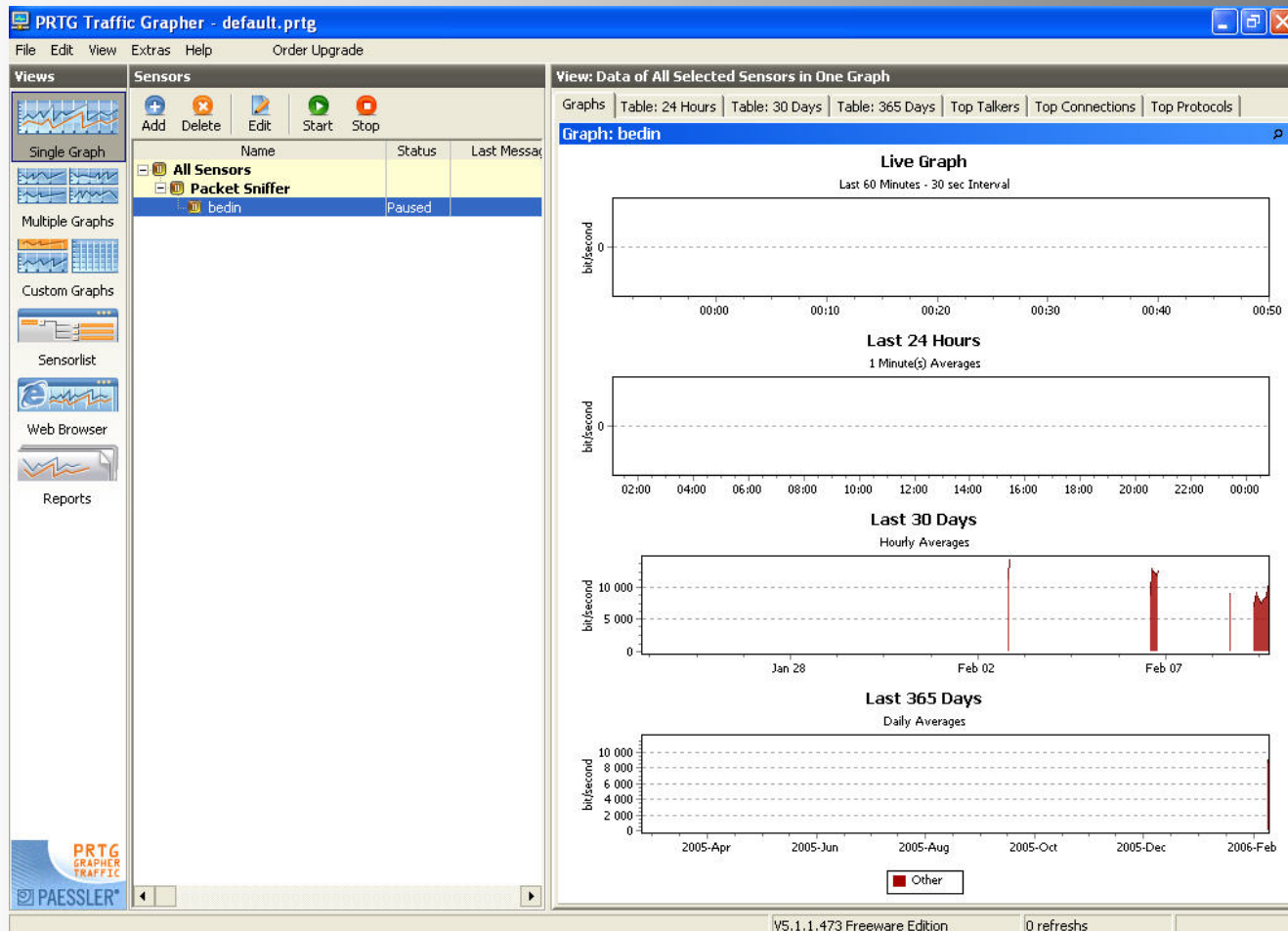
LATENCY TIME

ADSL/GARR route Reggio Emilia - Bologna



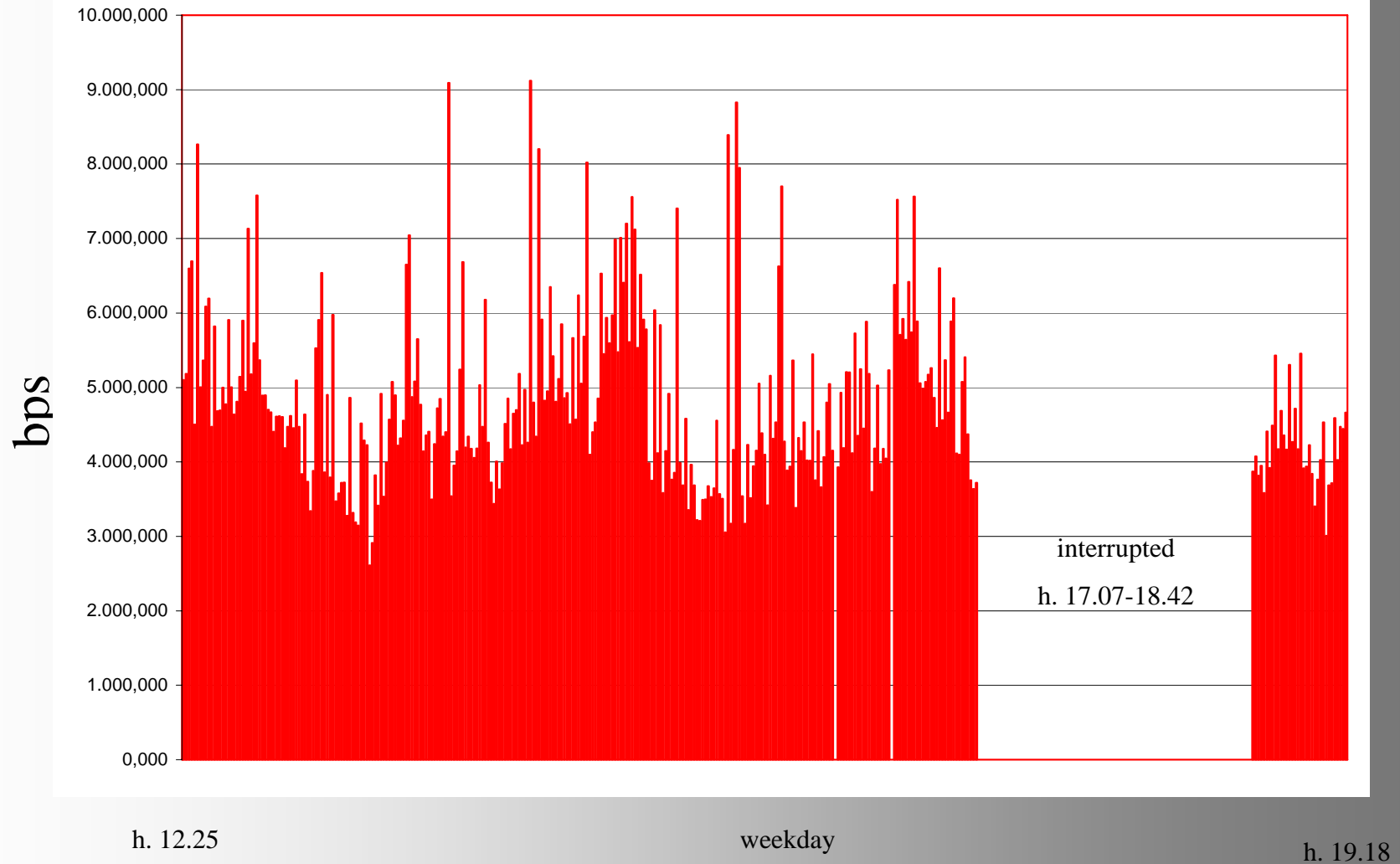
BPS ANALYSIS (not strictly necessary)

PRTG SW (check with NetLimiter sw)



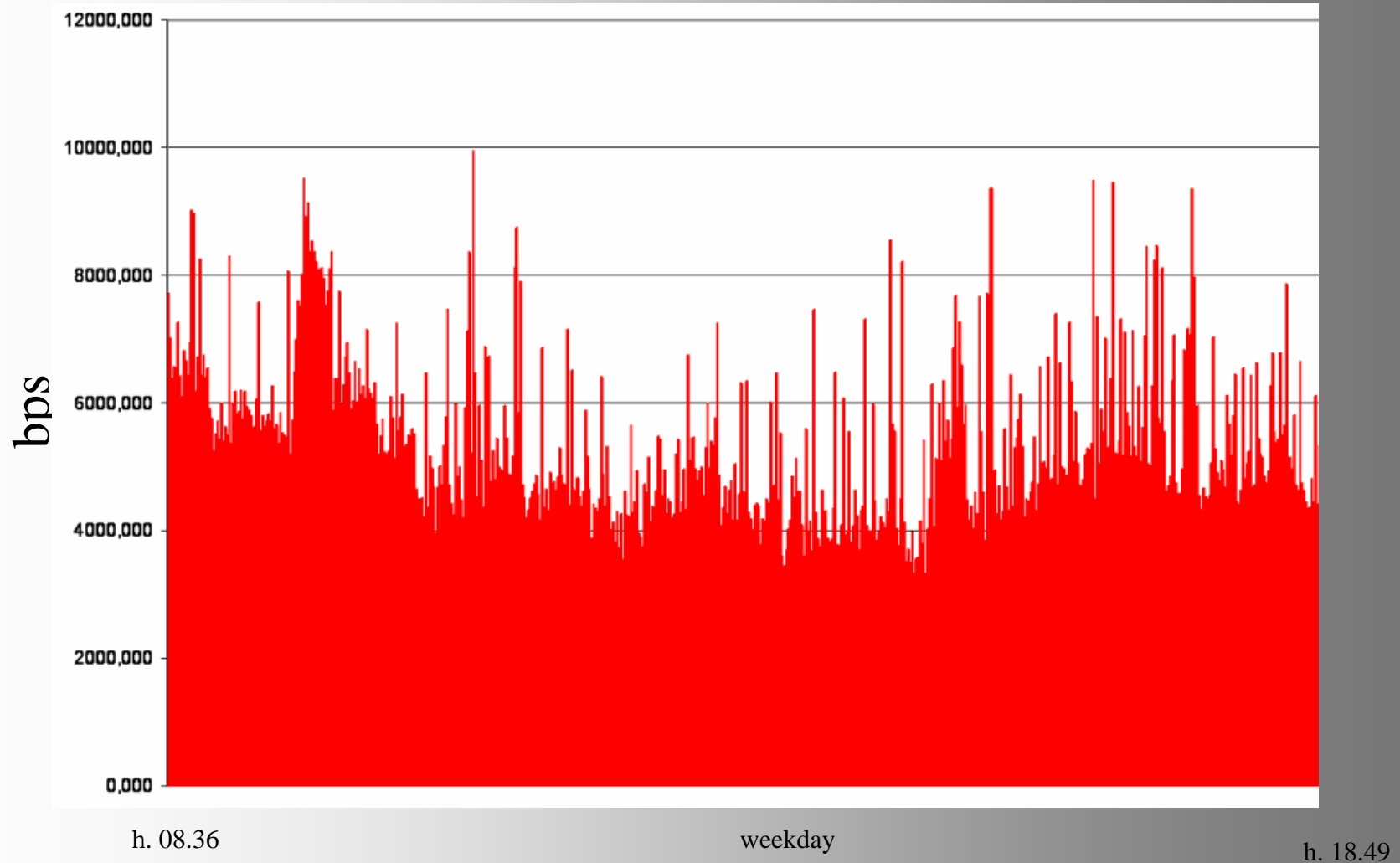
BPS ANALYSIS

GARR Network route Forlì - Bologna



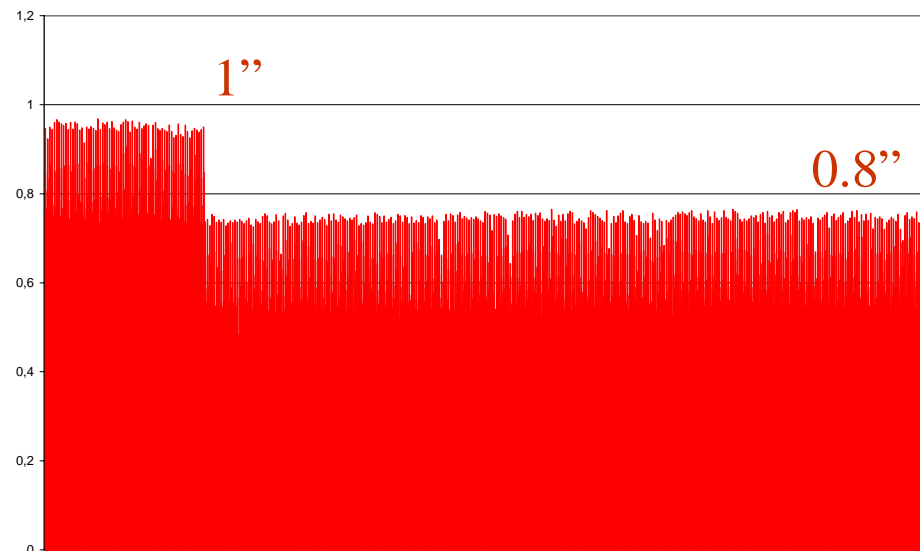
BPS ANALYSIS

ADSL/GARR Network route Pesaro - Bologna



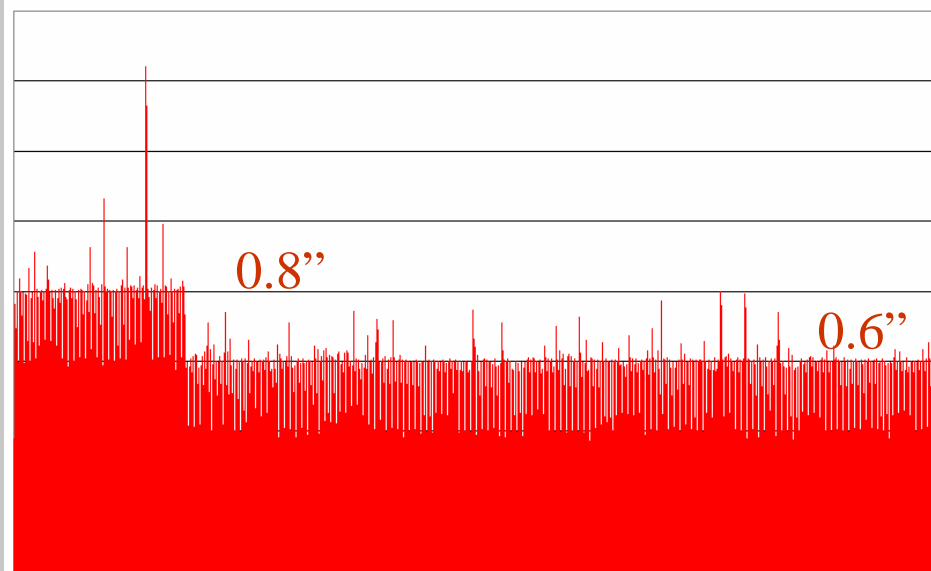
RTCM 3.0 FORMAT TRANSMISSION

RTCM 2.3



Latency Times (secs)
on Reggio Emilia-Bologna route
from 14.00 to 17.00 in weekdays
with 8-12 satellites (VisualPulse sw)

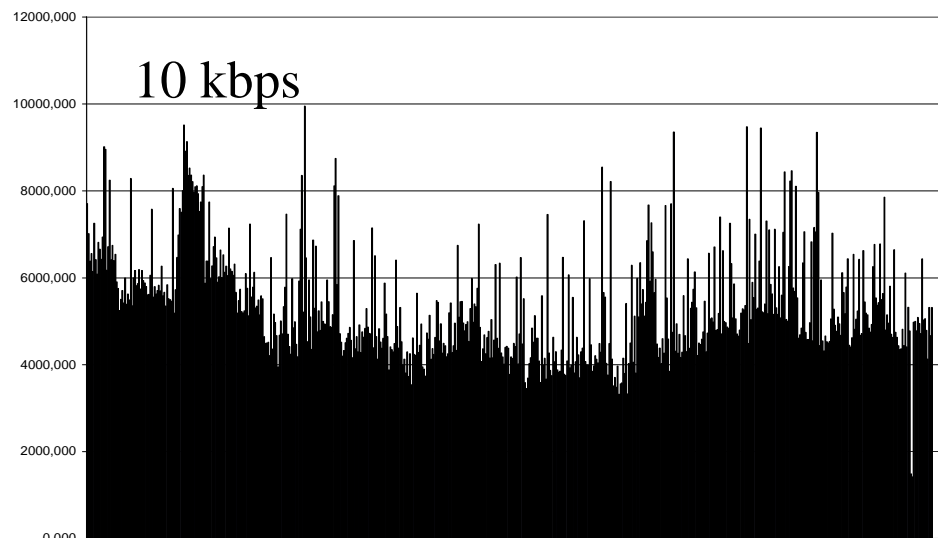
RTCM 3.0
(type 1003)



RTCM 3.0 FORMAT TRANSMISSION

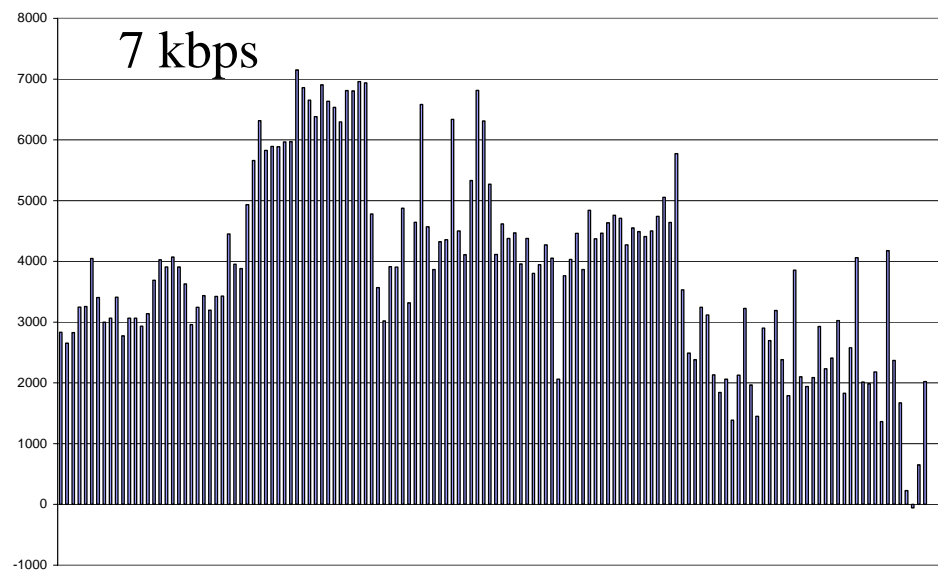
RTCM 2.3

bit rate (bps)
on Pesaro route
from 10.00 to 16.30 in weekday
with 8-12 satellites (PRTG sw)



RTCM 3.0 (type 1003)

bit rate (bps)
on Bologna route
from 14.00 to 17.00 in weekday
with 8-12 satellites (PRTG sw)



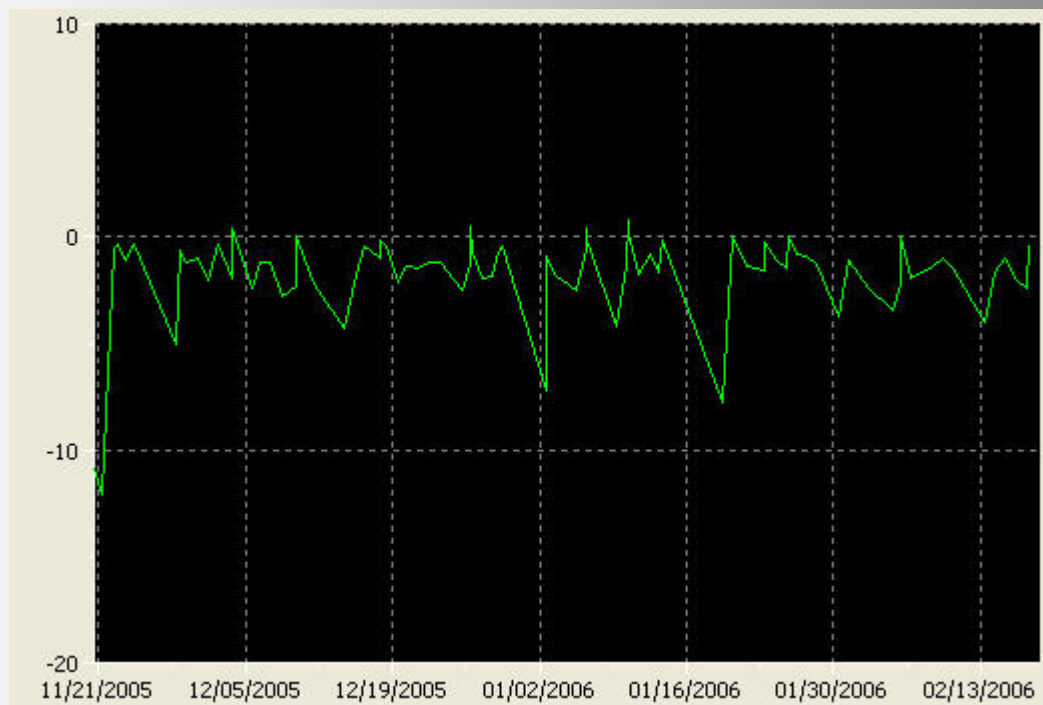
RTCM 2.3 vs. 3.0 ANALYSIS

THE TESTS VERIFIED:

- RTCM 2.3 (type 18,19 or 20,21 is equivalent): the baud rate for each satellite is 600 bps
- RTCM 3.0 (type 1003): the baud rate for each satellite is 150 bps
- RTCM 3.0 (type 1004): the baud rate for each satellite is 200 bps
- the latency time of RTCM 3.0 is lower than RTCM 2.3 of 0.2 “

**the latency time and the baud rate differences between
the two formats aren't significant concerning
data transmission**

TIME MACHINE SYNCHRONIZATION



Control Centre Computer
synchronized with a
NTP (Network Time Protocol) server:
ntp1.ien.it

ANTENNA CABLE SIGNAL ATTENUATION

RG-213 [dB]

<i>Frequency</i>	<i>20 [m]</i>	<i>30 [m]</i>	<i>40 [m]</i>
L1	7.04	10.56	14.08
L2	5.92	8.88	11.84

FSJ1-50A [dB]

<i>Frequency</i>	<i>20 [m]</i>	<i>30 [m]</i>	<i>40 [m]</i>
L1	4.9	7.35	9.8
L2	4.5	6.6	8.9

$$\text{sign} = 20 * \log_{10}(V1/V2)$$

CONCLUSIONS

WITH THIS STUDY *DISTART* PROPOSES A **STANDARD**,
POSSIBLY **CERTIFIED**, FOR THE **NRTK** INSTALLATION

1. TEQC + ELETTROMAGNETIC INTERFERENCE ANALYSIS
2. DATA TRANSMISSION ANALYSIS:
 - *traceroute* for the determination of NAPs and evaluation of the delay
 - latency times analysis
 - baud rate (bps) analysis on the route GNSS Permanent Station – Control Centre (not strictly necessary)
3. analysis of the components (e.g. antenna cables, antenna's calibration,...) of the GNSS Permanent Stations