

#### Tomasz Widomski

# It Is Time For Time

From ultra precision sub-nanosecond synchronization until "Trusted time distribution systems with audit and verification facilities" Building Robust Synchronization Systems that are resistant to falsification of time





#### Four Groups Of Risk Of Possible Time Gaps In Time Transfer

1) GNSS (Internal Err, Jamming/Spoofing)



2) Network (e.g. Time Delay Attack)



3) Leap second support











#### **GNSS Jamming & Spoofing**

### The Economist

https://www.economist.com/news/international/2 1582288-satellite-positioning-data-are-vitalbutsignal-surprisingly-easy-disrupt-out





Picture available courtesy of company Chronos



#### True Time is born inside GNSS receiver

- UTC, TAI output TIME calculated on Earth (not in space) based on GNSS stream data
- GPST, GLONASST, BEIDOUT, GALILEOT time differences to UTC/TAI counted in tens of seconds
- GPS SVN#23 13.5 μs error 26/01/2016 BBC
   <u>http://www.bbc.com/news/technology-35491962</u>





- What is a weighted average of GPS, GLONASS, BEIDOU ?
- How does it (if at all ...) correspond to XYZ organization ?



#### Examples of problems associated with commercial GNSS receiver

- One of leading GPS timing receivers claim for 1s period a 24hour error at midnight, November 29, 2003 (leap second – group 3)
- Another leading GPS t-receiver has reported on December 31, 2005
   23:59:59 instead 23:59:60. Then it rolled over to 00:00:00 on Jan 1, 2006, bringing back in line with UTC (leap second group 3)
- Today at least 4 different modern brands of GNSS receivers that use data from GPS along with the BeiDou were found to implement leap seconds one day to early, because BeiDou (leap second – group 3, but also internal GNSS RCV firmware bug):
  - counts numbers the "days of the week" from 0 to 6
  - while GPS/GALILEO/GLONASS number them from 1 to 7





#### **Examples of time problems associated with systems**

**ELPROMA** 

- On February 25, 1991, during the Gulf War, an American Patriot Missile battery in Dharan, Saudi Arabia, due to time error 0.34s at speed 1676m/h. Round-off error was a result of 24-bit fixed point register arithmetic computation
- On August 14, 2003, a Northeast blackout occurred. One of reasons was a software bug known as a "race condition" (effect is ahead of the cause) existed in Unix-based energy management system
- February 2017, a "Time Synchronization Attack" to power distribution and Smart Grid systems has been discussed and it reminds under consideration of DG-ENERGY (EU) experts





New York 2003, August the 14<sup>th</sup>





#### **Mythbusters**

- GNSS receiver is not operating like a Network Interface Card
- Output time at Time Server is not same as input time at Client (Slave) Saying in other words: "Timeservers know nothing about client side time"





- ✓ Autonomous Time Scale
   UTC/TAI Systems
- ✓ Dedicated Solutions

   e.g. DEMETRA TSI#2
   Trusted Time Distribution
   w/ Audit & Verifications





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#### ITSF 2017 "It is time for time "



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European Global Navigation Satellite Systems Agency







#TSI	Description
1	Time broadcasting
	(TV & Radio)
2	Trusted Time Distr.
	(incl. authenticated NTP
	and cryptographic TSP)
3	Time dissemination (PTP-
	White Rabbit ext.)
4	Time broadcasting using
	geostationary satellite
5	Calibration Service for User
	GNSS Receivers
6	Certified Time Steering
7	Time monitoring based on
	the IGS time products
8	Time integrity
	(GNSS satellites clock and
	timescales monit.).
9	Time synchronisation
	service for a scalable
	network of atomic clock

nodes ("SynchroNet")

## <u>Consortium</u>:

- 1) INRIM (Italy)
- 2) TAS-F (France)
- 3) TAS-I (Italy)
- 4) ELPROMA (Poland)
- 5) **DEIMOS** (Spain)
- 6) AIZOON (Italy)
- 7) ROB (Belgium)
- 8) ANTARES (Italy)
- 9) METEC (Italy)
- 10) VTT (Finland)
- 11) Politecnico di Torino(Italy)
- 12) VEGA (UK)
- **13) NPL** (UK)



#### **DEMETRA TSI#2 BY ELPROMA**



During DEMETRA INRIM-NPL-GUM International tests, the TSI#2 has demonstrated:

#### Functionality:

- 1. UTC DISTRIBUTION
- 2. CLIENT TIME AUDIT
- 3. RETROSPECTIVE TIME VERIFICATION (VALID/INVALID)
- Accuracy 100 us for LAN (SHORT LOOP TEST)
- Accuracy 10 ms with Internet (END-TO-END TEST)

The synchronized **QKD** ("Synchronized" Quantum Key Distribution) – a QPPS is under considerations to replace modern NTP protocol for UTC distribution /expecting large accuracy & security improvement in the future/





# Thank You

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