International Committee on Global Navigation Satellite Systems

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Development of Timing GPS/GLONASS/Galileo Receivers at Astrogeodynamical Observatory in Borowiec

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DEVELOPMENT OF TTS-1, TTS-2, TTS-3, and TTS-4 RECEIVERS

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TTS-1 RECEIVER

- 1989-92 SINGLE CHANNEL, C/A CODE GPS RECEIVER
- HARDWARE & SOFTWARE DEVELOPED IN POLAND
- UNCERTAINTY OF MEASUREMENTS ~50 NS (SELECTIVE AVAILABILITY AT THAT TIME)
- 1993-1995 FIRMWARE & SOFTWARE IMPROVED, RMS~10NS, ACCURACY OF THE RECEIVER LIMITED BY THE HARDWARE

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TTS-2 RECEIVER

- 1997-1999

  INVITATION FROM BIPM TO WORK ON THE DEVELOPMENT OF NEW RECEIVER, MULTI-CHANNEL, C/A CODE GPS RECEIVER, IDEA OF W.LEWANDOWSKI
- MOTOROLA HARDWARE, SOFTWARE DEVELOPED IN POLAND BY J.N.
- UNCERTAINTY OF MEASUREMENTS ~1.5 NS FOR EUROPEAN BASELINES

  STILL SA

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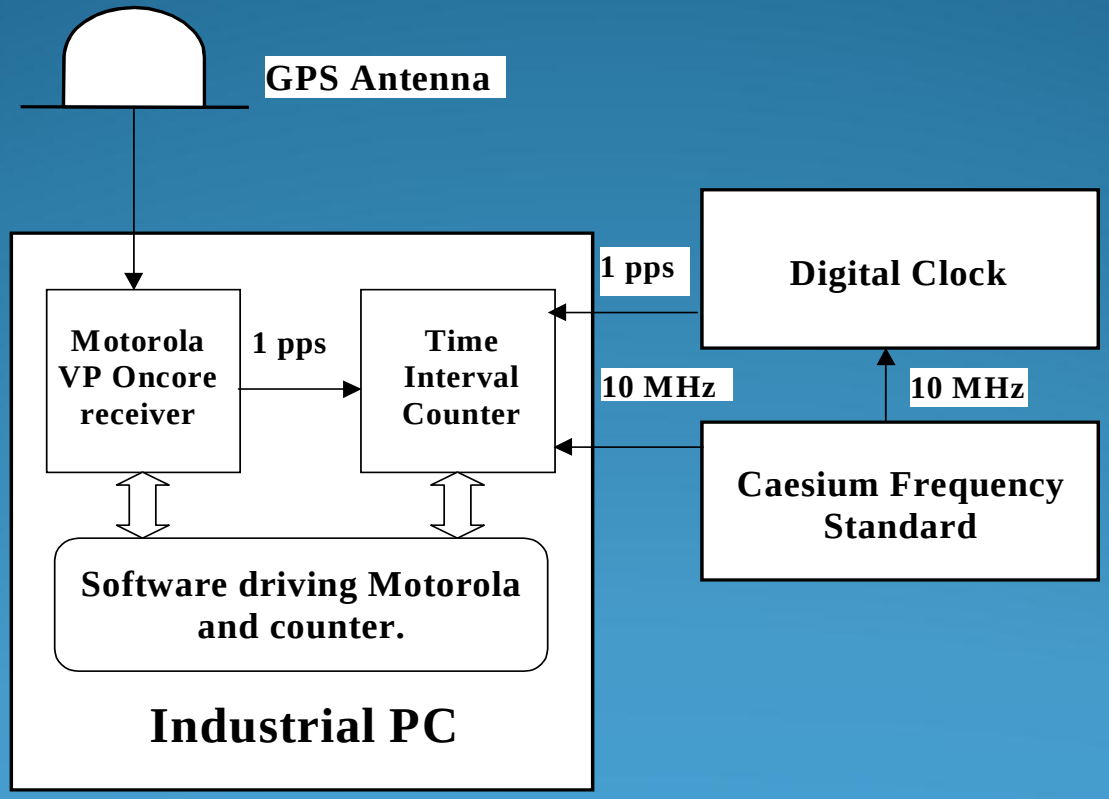
TTS-2 – BLOCK DIAGRAM



TIME TRANSFER SYSTEM TTS-3

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GATHERED EVERY SECOND:

- RAW PSEUDO-RANGES, L1,L2
- CORRECTIONS OF RECEIVER CLOCK
- 1PPS CORRECTIONS
- SATELLITE EPHEMRIDES

RINEX DATA

COMMON VIEW DATA

OTHER DATA FORMATS

- GPS C/A-code results

RMS ~1.5-2.0 ns,

- reonstructed GPS P-code:

RMS ~0.6 ns,

- GLONASS P-code:
- RMS~0.5 ns, with differential frequency delay calibration,
- WAAS/EGNOS,

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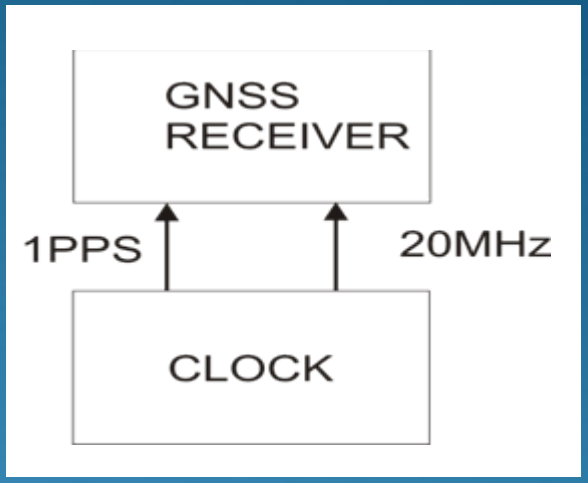
TIME TRANSFER SYSTEM TTS-3

Features of TTS-3 system:

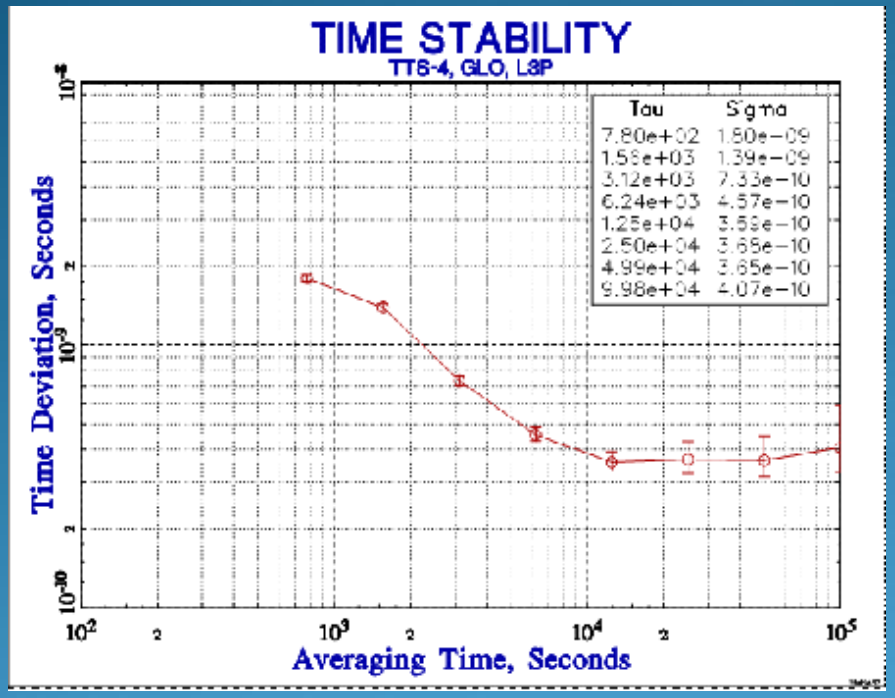
- GPS and GLONASS C/A-code, GPS and glonass P- code modes,
- integrate observations of all available navigation satellites: GPS, GLONASS, WAAS and EGNOS, and in the future Galileo (TTS-4)
- precision in multi-channel reconstructed GPS P-code mode, when using measurements of ionospshere and precise ephemerides may reach 1 ns for intercontinental time links and below 1 ns for continental time links,
- the system is working under LINUX, providing multitasking and integration with networks,
- P3 data available in real time (GPS, GLONASS)
- RINEX data format

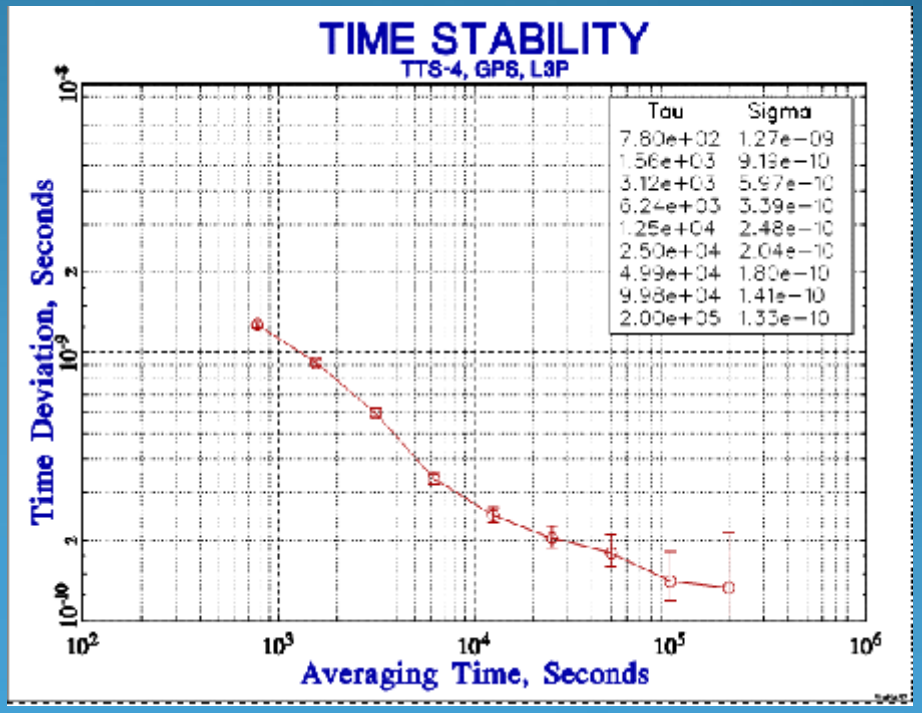
TIME TRANSFER SYSTEM TTS-4



- Driven by external 20 MHz , synchronized to external reference 1PPS signal
- Features of TTS-3 system + Galileo
- AOS waiting for full SIS (Signal in Space)

Performance, GLONASS and GPS





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PTF - APPLIED TIME TRANSFER METHODS

- The primary way of computation of [*PTF1-PTF2*] will be TWSTFT allowing time transfer at a level better that 1 ns. GPS and Galileo CV P3 will be used as back-up methods

- Calibration of the TWSTFT and CV P3 equipment crucial!

THANK YOU