

# **TWSTFT Annual Report**

## **2006**

**Presented by**

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# Topics

- **Brief Introduction**
- **Summary of Working Group and Participating Stations Meetings**
- **Most Critical Issue faced this past year**
- **Future Efforts**



# Different SYSTEMS for Time Transfer

- **Loran-C**

- Precision (10-20 ns.)
- Accuracy (20-200ns.)
- Comment: Unpredictable variations in ground conductivity cause problems

## **GPS**

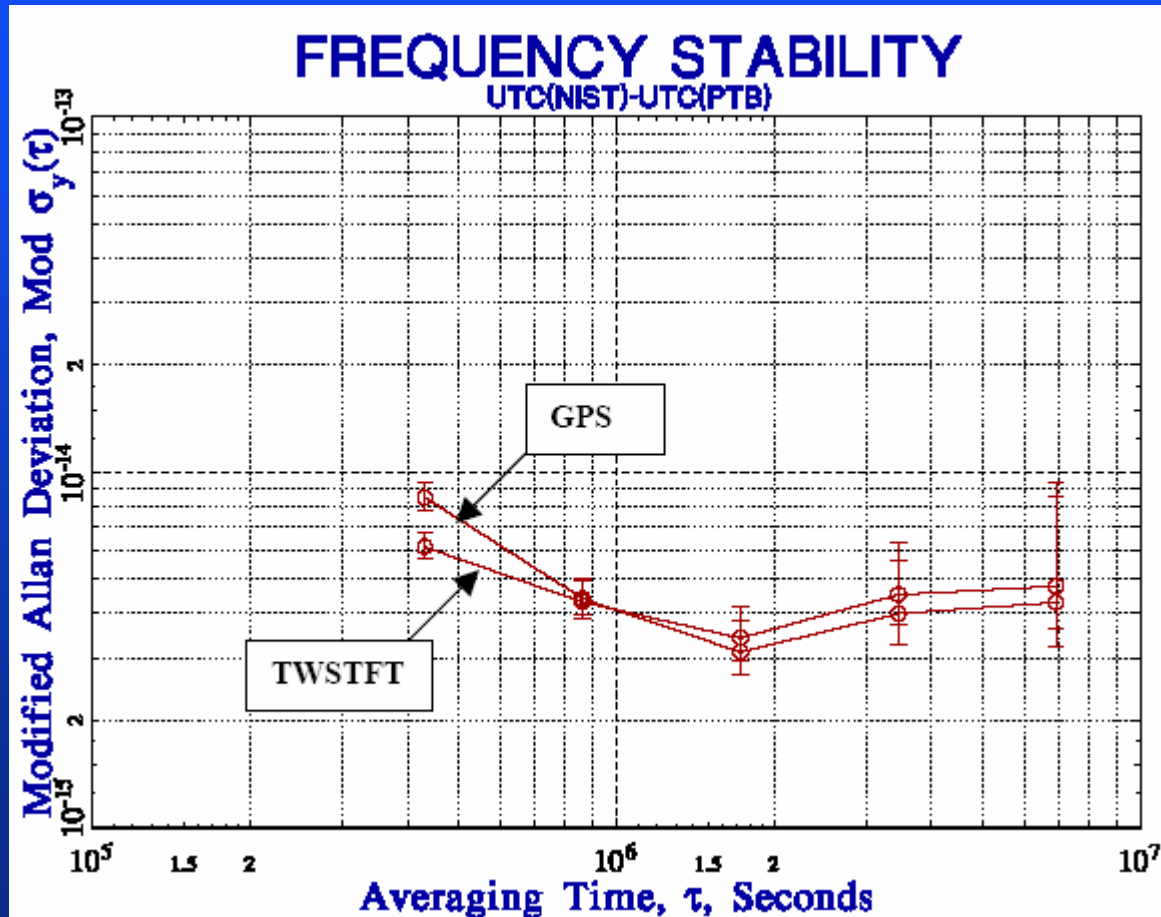
- Code (C/A)
  - Precision (5-15 ns.)
  - Accuracy (10-50 ns.)
  - Comment: Single Frequency model ionosphere
- Carrier Phase
  - Precision (500 ps. - 3 ns.)
  - Accuracy (1-3 ns.)
  - Comment: Dual Frequency - Carrier Phase

- **TWSTT**

- Precision (200 ps.)
- Accuracy (500 – 750 ps.)
- Comment: Data reduction relatively simple



# Comparison of TWSTT and GPS Carrier Phase





# Relation of TWSTT and GPS Carrier Phase

- **Efforts can not be considered as competitive or adversarial**
  - **Each technique can and does complement the other**
- **GNSS are dependent on TWSTFT**
  - **Galileo**
  - **QZSS**
  - **GAGAN ?**



# Participating Stations

<b>North America</b>	<b>Europe</b>	<b>Pacific Rim</b>
<b>NIST</b>	<b>TUG</b>	<b>NICT</b>
<b>USNO</b>	<b>VSL</b>	<b>TL</b>
	<b>PTB</b>	<b>NTSC</b>
	<b>OCA</b>	<b>AUS</b>
	<b>ROA</b>	<b>SPRING</b>
	<b>OP</b>	<b>NMIJ</b>
	<b>SP</b>	<b>KRIS</b>
	<b>CH (METAS)</b>	
	<b>AOS</b>	
	<b>IPQ</b>	
	<b>INRIM</b>	
	<b>NPL</b>	
	<b>ESA</b>	



# PS MEETINGS

Date	Meeting	Place
<b>3/06</b>	<b>EFTF</b>	<b>Braunschweig</b>
<b>9/05</b>	<b>FCS/PTTI</b>	<b>Vancouver</b>
<b>3/05</b>	<b>EFTF</b>	<b>Besancon</b>
<b>4/04</b>	<b>EFTF</b>	<b>Guildford</b>



# WG MEETINGS

Year	Meeting #	Place
1993	1	NPL
1994	2	TUG
1995	3	PTB
1996	4	NIST
1997	5	ROA
1998	6	USNO
1999	7	BIPM

Year	Meeting #	Place
2000	8	BIPM
2001	9	NTSC
2002	10	PTB
2003	11	NPL
2004	12	NICT
2005	13	VSL
2006	14	OP





# Calibration of TWSTT Stations

- **Use of a Portable Station**
  - **USNO Portable X-Band antenna**
  - **Use of TUG Transportable Ku-Band Station**
- **Satellite Signal Simulator**
- **Calibration via GPS Common View**
  - **3 times per year**



# Calibration Efforts – Ku-band

<b>Date</b>	<b>Type</b>	<b>Stations</b>
<b>6/97</b>	<b>Ku Portable</b>	<b>TUG-DTAG-PTB-TUG</b>
<b>5/03</b>	<b>Ku Portable</b>	<b>INRIM-PTB-INRIM</b>
<b>7/04</b>	<b>Ku Portable</b>	<b>PTB - OP - NPL - VSL - PTB</b>
<b>10/05</b>	<b>Ku Portable</b>	<b>PTB - SP - VSL - NPL - OP - INRIM - PTB</b>
<b>5/06</b>	<b>Ku Portable</b>	<b>TUG - PTB - METAS(CH) - TUG</b>



# Calibration Efforts – X-band USNO - PTB

Date
<b>JUN 02</b>
<b>JAN 03</b>
<b>JUL 03</b>
<b>MAR 04</b>
<b>SEP 04</b>
<b>MAY 05</b>
<b>JAN 06</b>



# Most Critical Issue

- **Switching from R&D to Commercial Use of INTELSAT**
  - **Resolution**
    - **5 year contract**
    - **PS contributions**
  - **Benefits**
    - **Same satellite – do not have to move antenna**
    - **No cost increases during contract**
    - **No immediate Calibration Trip**
    - **No Interruption of Service**



# **Future Areas of Interest**

- **Carrier Phase TWSTFT**
- **Link Pacific Rim to Europe and North America**
  - **Several possibilities**
    - **QZSS link to USNO-GPS**
    - **GAGAN (ISRO – INPL) link to Galileo**
    - **Through Existing Dedicated links**