Operationalization and performance of In-house Timescales for NavIC PTF

Aakanksha A Bhardwajan
T Subramanya Ganesh
ISTRAC/ISRO
Bangalore, India

Introduction to IRNWT

- One of the primary objectives of NavIC Ground Segment is to **generate**, **disseminate** and **maintain** precise time.

- IRNSS Network Timing (IRNWT-1/2) established at ISRO Navigation Centre (INC-1/2)

  – Serve as the **reference time** for the entire NavIC network

  – Ensemble of **Active Hydrogen Masers** and **Cesium/Passive Hydrogen Masers**

  – Traceable to **UTC(NPLI)** through GNSS CV, NavIC CV and TWSTFT

  – **Redundant** and **independent** Time scale chains

  – Provides 10MHz, 5 MHz, 1 PPS, NTP, PTP and IRIG-B

First generation time scales were turnkey solutions procured from foreign vendors.

In-house Timescale at INC-2

- First in-house developed time scale operational at INC-2
  - Operational since **January 2017** without any issues
  - Acted as reference timescale when INC-2 was primary and IRNWT-2 (turnkey time scale) was unavailable

IRNWT-1 reference

In-house Timescale (INC-2) reference

In-house Timescale at INC-1

ITS-BLR

287 09:49:15
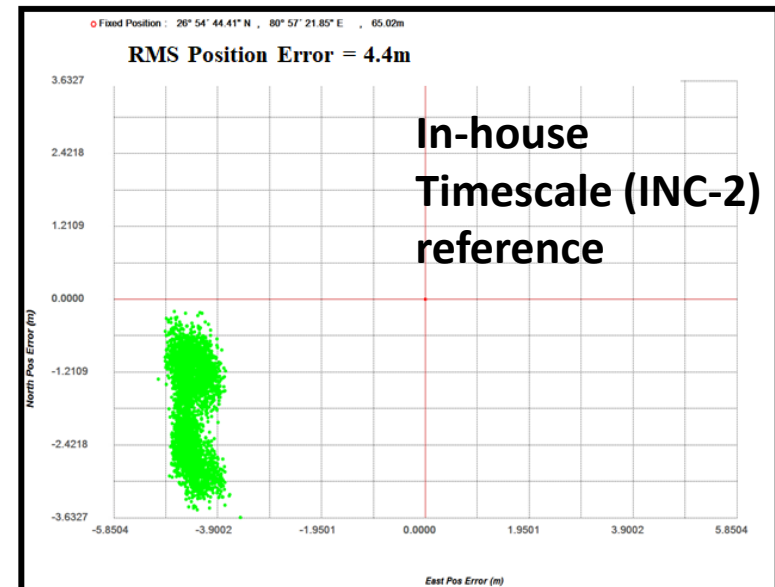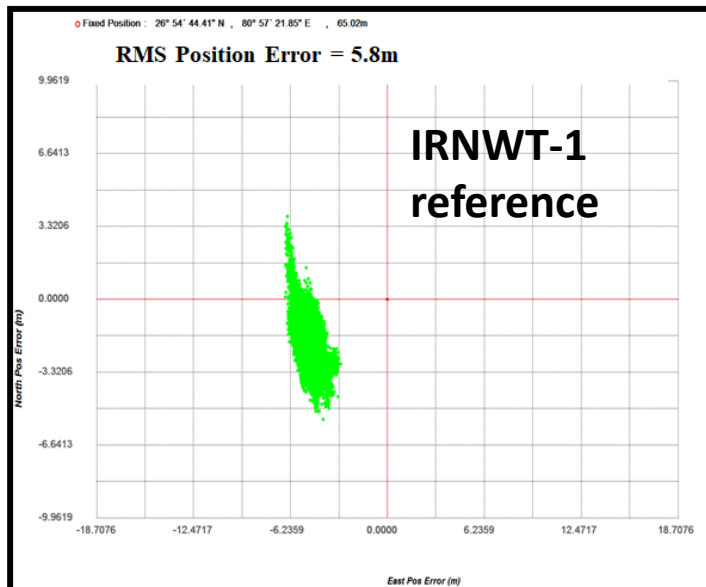
Second in-house Timescale at INC-1
- Cleared for operations in March 2020 by an ISRO inter-center committee
- Acting as NavIC Reference since February, 2021

*Performance at par with turnkey timescales*

- Two methods of **Ensemble**:
  - Kalman plus weights
  - Multi-scale Ensemble Timescale
- Two methods of **steering**:
  - Linear Quadratic Gaussian (LQG)
  - Proportional-Integral Control (PIC)
- Seamless integration of **any type and any number of clocks**
- **Auto Steering** using Time transfer data via GNSS/NavIC Common View, TWSTFT and **Manual steering** using user inputs
- **Flywheel Mode** in case of loss of reference

- Automatic and manual **weight assignment** for physical clocks

- Seamless **addition** or **removal** of a physical clock

- Automatic **Clock anomaly detection** and **corrective** action

- **Isolating the faulty clo**ck from timescale ensemble

- **UTC Measurement anomaly detection** and corrective action

- **Protection of user** in case of timescale output non-availability
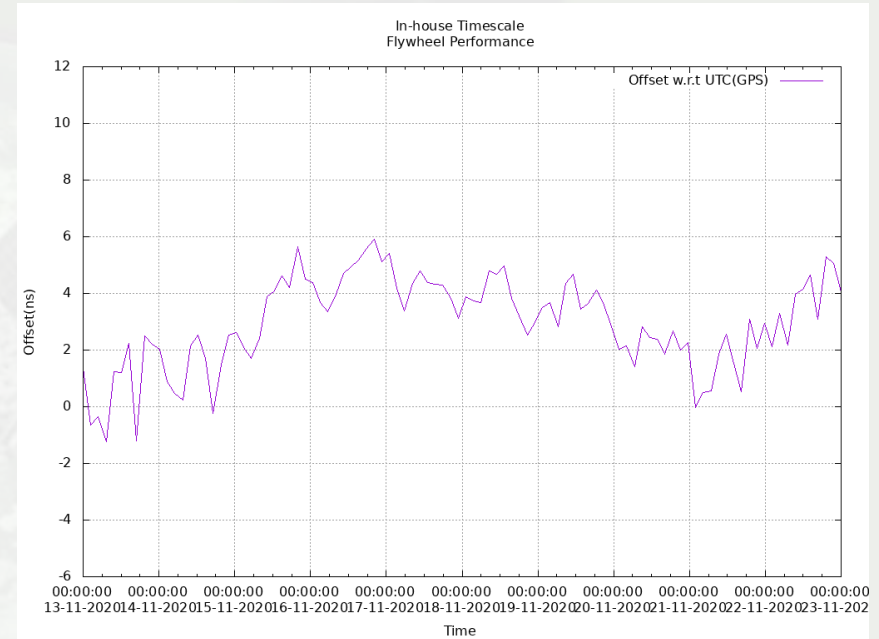
Performance of In-house Timescale
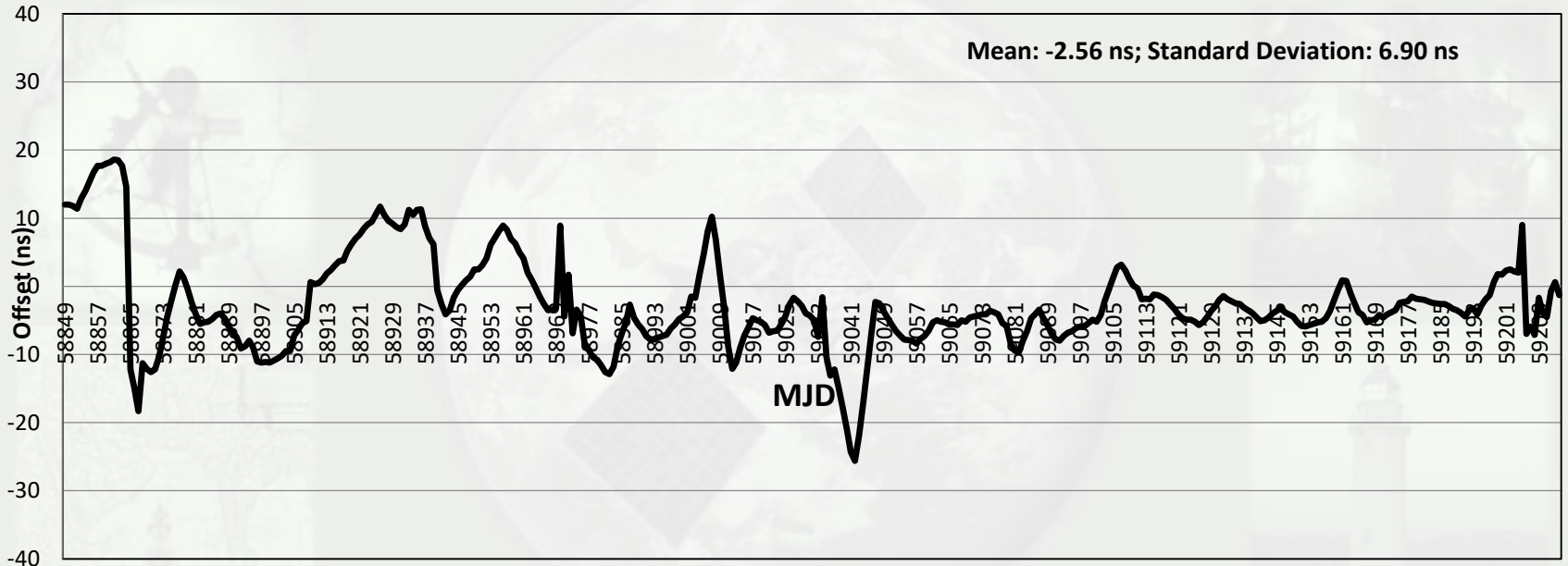
Offset between In-house Timescale and UTC(NPLI) over a year

Performance of In-house Timescale
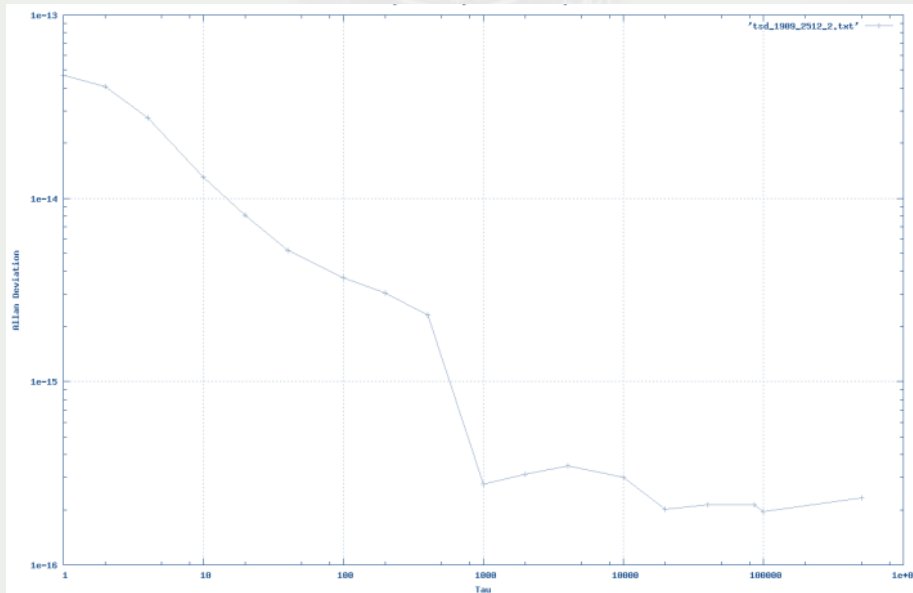
Allan Deviation of Timescale at 1 day
averaging : 1.95e-16

Timescale w.r.t UTC during flywheel
Net movement of ~4 ns in 10 days

Thank You