Protecting GPS with Resilient PNT Solutions

Introduction to Broadcast Positioning System (BPS) Ground-based Time Transfer

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Critical Infrastructure Timing Needs

Energy & Power Grid	Communications	Financial Transactions	Transportation (Aviation, Maritime, Rail, Surface, Pipeline)	First Responders
Chemical	Dams	Information Technology	Critical Defense Manufacturing	Healthcare and Public Health
		Food and Agriculture		

Critical Infrastructure Timing Requirements

Name of Industry	Timing Requirements
Mobile Wireless Networks	**1.1 µsec** traceable to UTC
Equity Trading Systems	**1 µsec** within UTC NIST (SEC Section 613 rules, MifID II EU)
Power Grid	**1 µsec** to UTC, IEEE 37-238, (Synchro-phasors)
Other CI Industries	**200 ns** satisfies all requirements

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ATSC 3.0 Standard
NextGen TV

ATSC The Broadcast Standards Association

nextgenTV™

- Standardization completed in 2018
- U.S. deployment started in 2019
- Can deliver data with television
- Works inside buildings

BPS → Broadcast Positioning System

A system and method of estimating time and position at a receiver using ATSC 3.0 broadcast signals

ATSC

Compliant with ATSC 3.0 standard

Uses datacasting feature

Independent and stand-alone

- GPS, Internet or cellular connectivity not required

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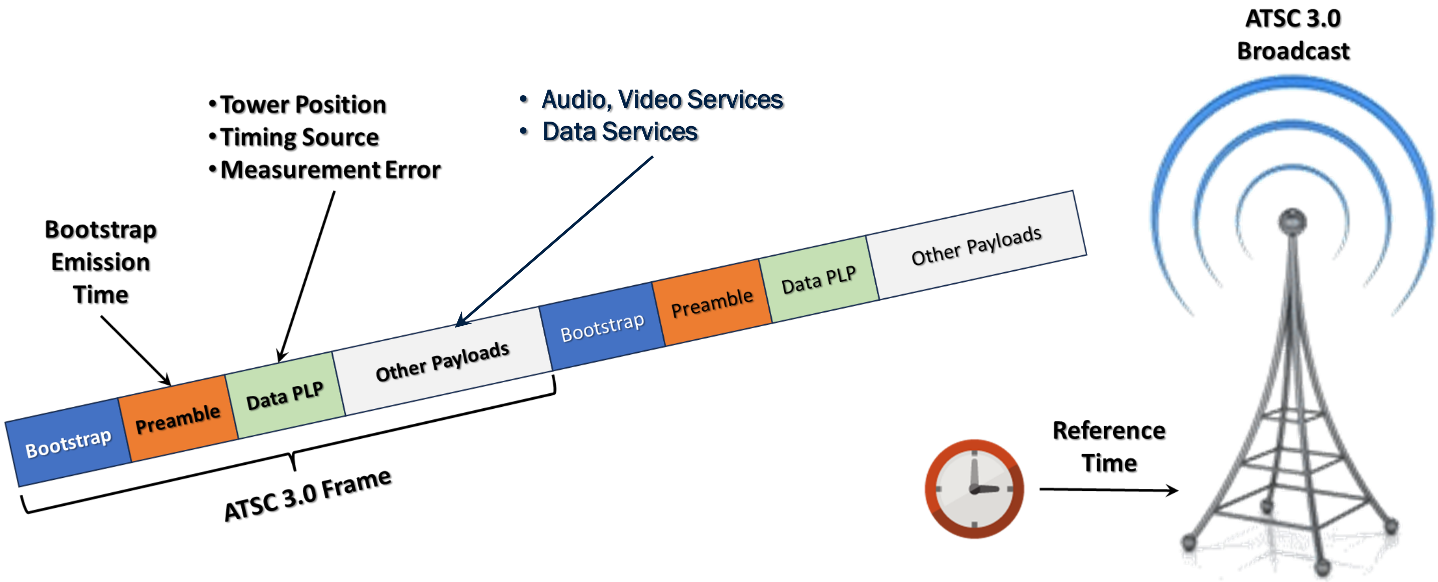
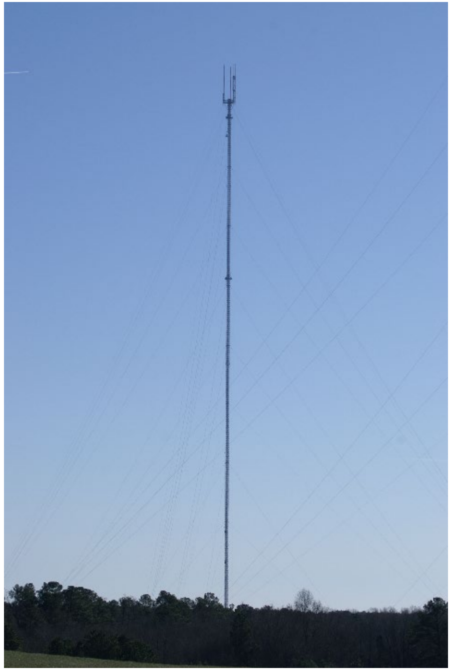
BPS Time Delivery



BPS PNT Capabilities



One TV tower can provide accurate time at a known position

- 100 ns, 95% of the time

Four TV towers can provide both time and position estimation

- 70 m positioning accuracy 50% of the time

Can detect GPS spoofing

Can enable GPS-BPS hybrid location

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BPS Advantages

- Infrastructure is already built
- Global standard
- Passive consumer service
- Independent
- Frequency diversity
- Nationwide coverage

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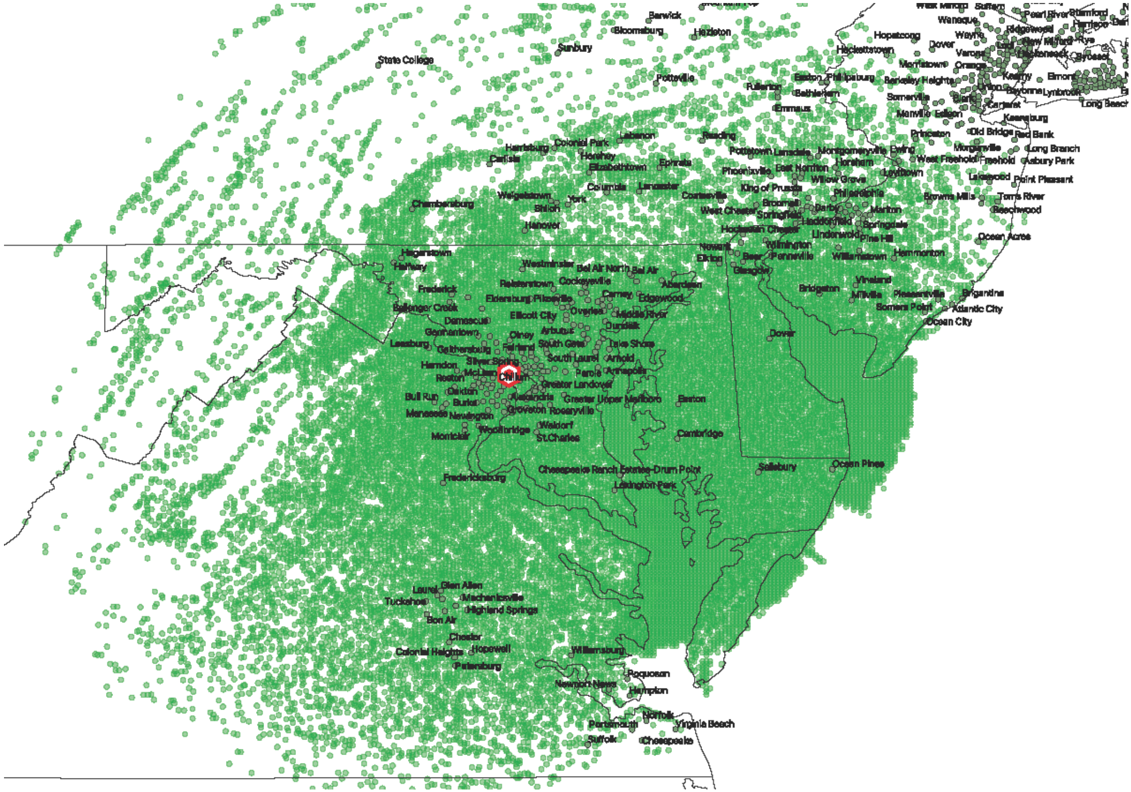
Typical Predicted BPS Coverage (50/50) of a TV Station

- WHUT-TV, Howard University
- 833 ft antenna height (HAAT)
- 416 kW ERP
- Channel 32, 587 MHz (center)
- On Air Now
- Received at NAB 1M Lab



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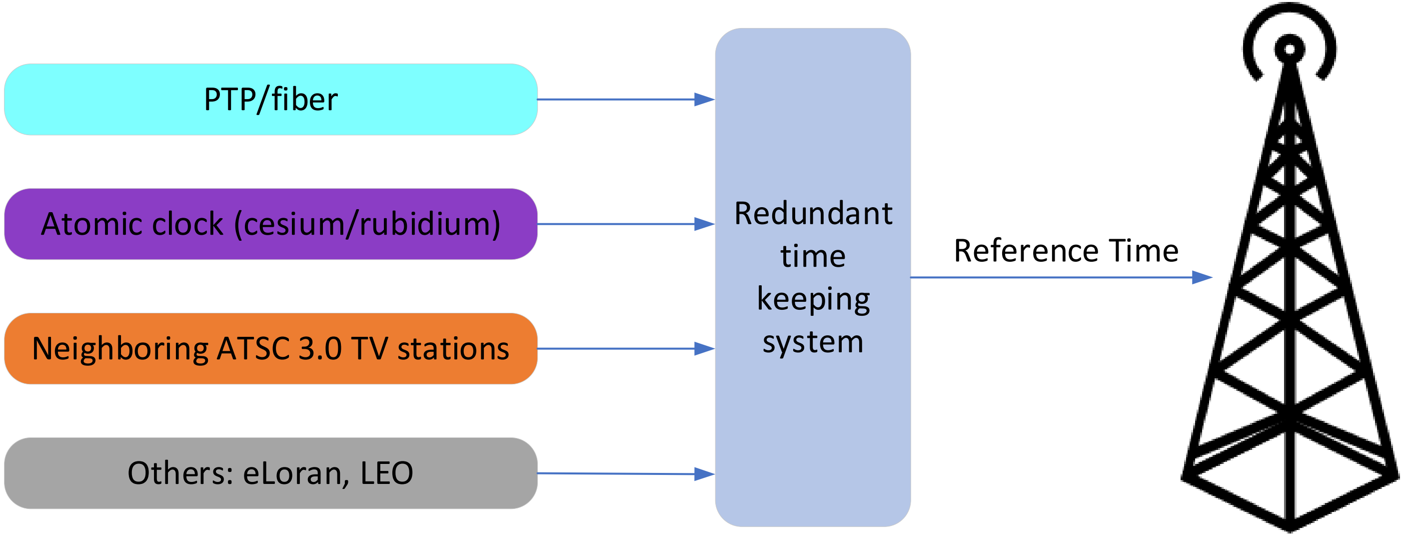
Reliable, Resilient, Traceable Timing Source



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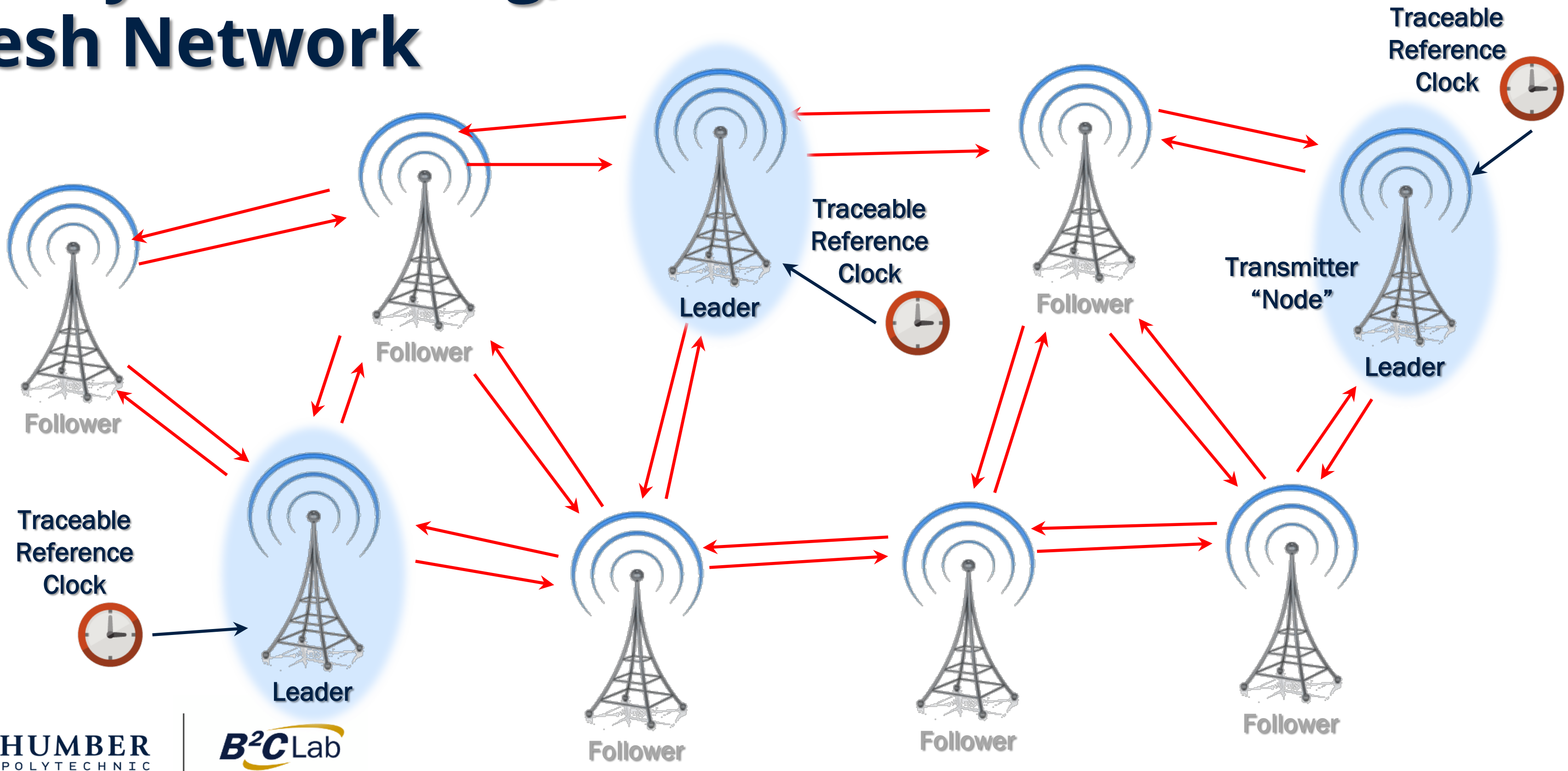
Self-Synchronizing, Traceable Time Mesh Network



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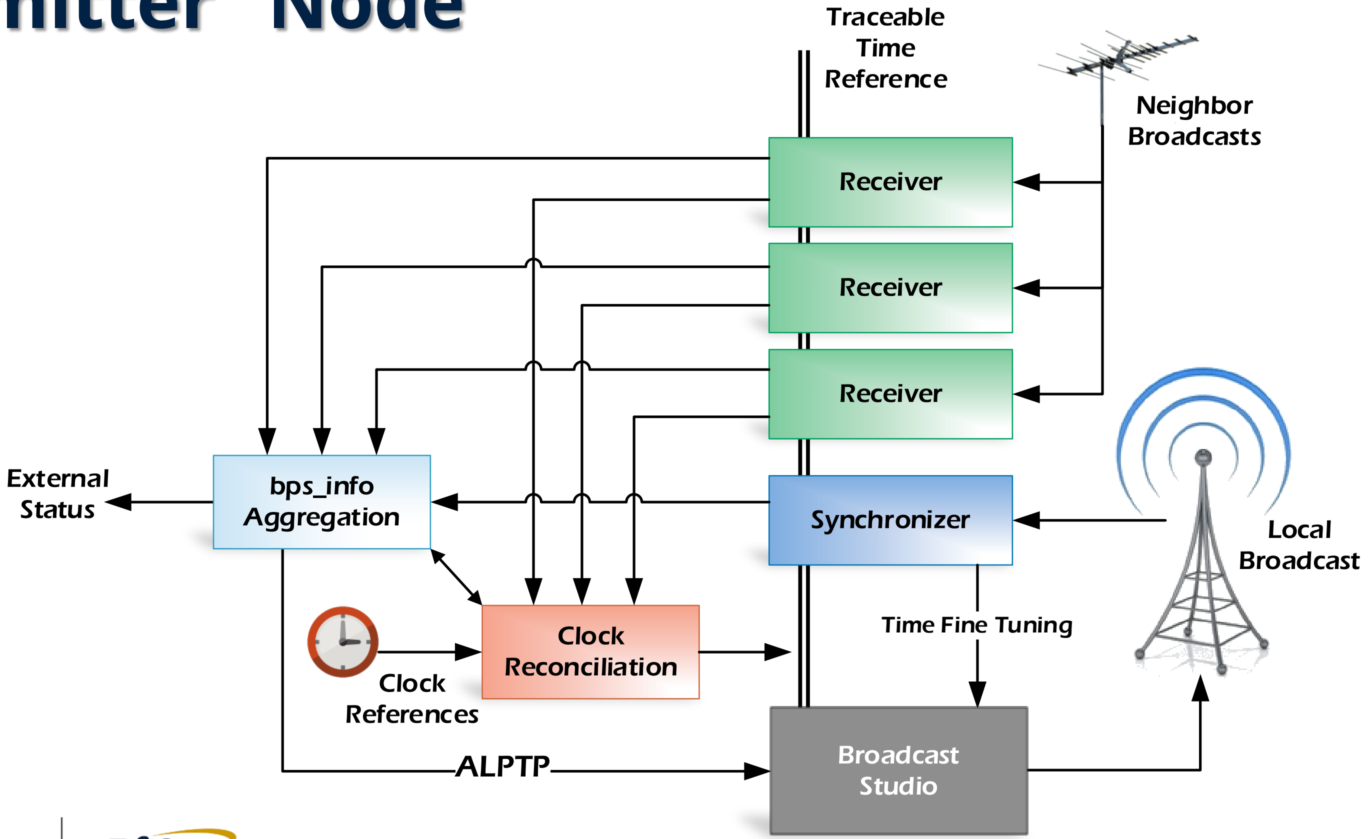
Transmitter “Node”



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BPS Equipment

AVQ1050 BPS Receiver & Synchronizer

AVQ1050 is a comprehensive tool designed for the deployment, monitoring, and troubleshooting of ATSC 3.0 SFN and MFN based BPS networks. It supports full synchronization of the ATSC 3.0 BPS Transmitter system time and in-field BPS signal validation, including reception and redistribution of BPS information. This versatile device offers a range of measurements for effective network monitoring and features a range of Avateq's proprietary algorithms and tools.

AVQ1051 BPS Multichannel Receiver

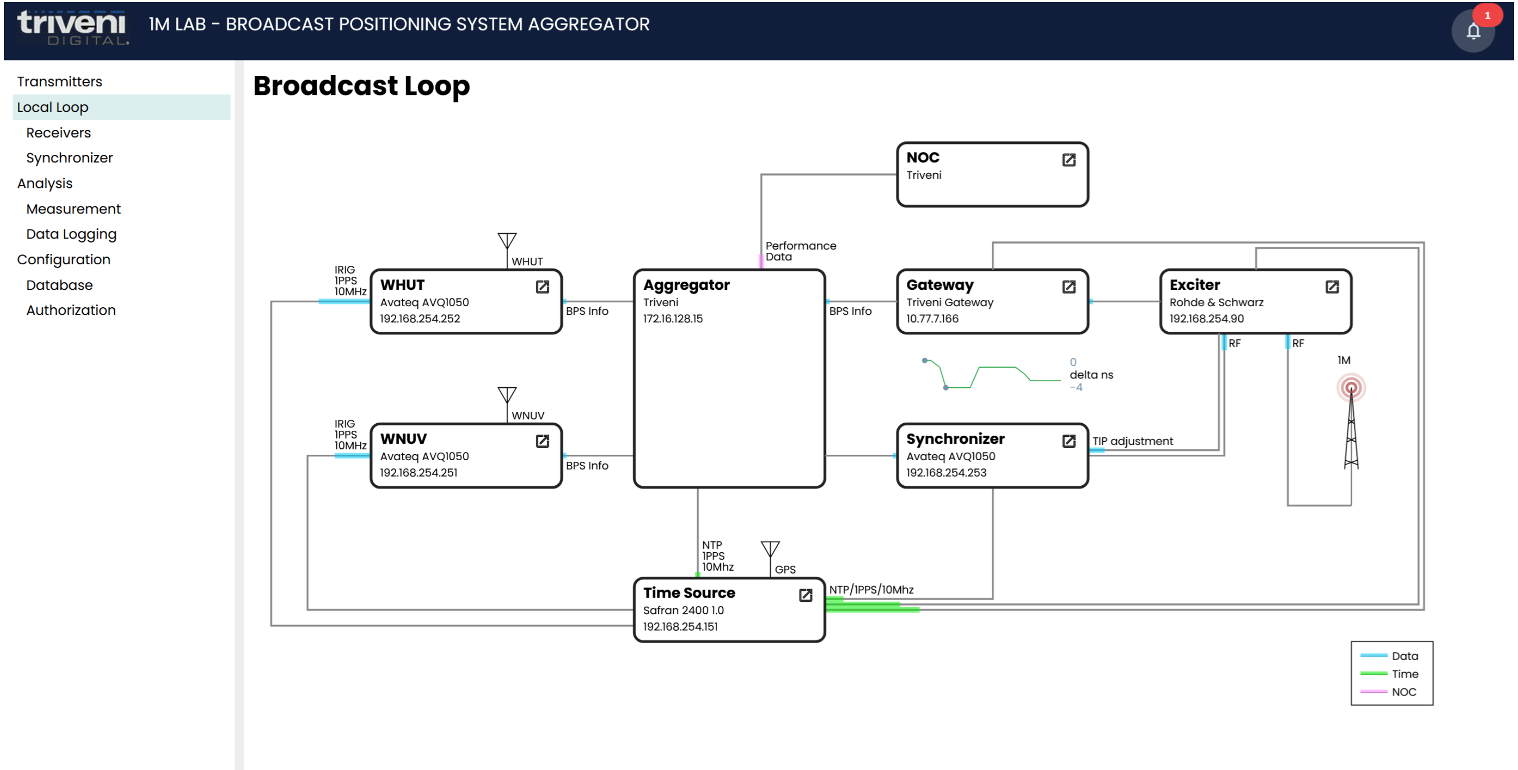
The **AVQ1051** - ATSC 3.0 BPS Multichannel Receiver is designed for applications requiring reliable timing delivery and serves as a key component for ATSC 3.0-based High-Precision Time Delivery Terrestrial Networks. It features a configurable architecture with up to four independent BPS information processing channels, making it a redundant solution for critical infrastructure sectors. The receiver provides precise timing information, including 1PPS and 10MHz reference signals.

AVQ1052 BPS In-Field Receiver

The **AVQ1052** - ATSC 3.0 BPS In-Field Receiver is a compact device with an external power supply, designed for applications requiring reliable timing delivery. It features **BPS Ephemeris** for statistical estimations of signal and timing quality, enhancing network reliability and management. The receiver includes spoofing and jamming detection with signal integrity analysis and delivers precise timing information, including 1PPS and 10MHz reference sources.

Current Performance

NAB 1M Lab Transmitter Test Node



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Live Trials and Demos

PILOT
NAVIGATING BROADCASTING'S FUTURE

1M Lab
Washington, DC

BALTIMORE CW

WNUV-TV,
Baltimore, MD

B²C Lab

Humber
Polytechnic
Toronto, Canada

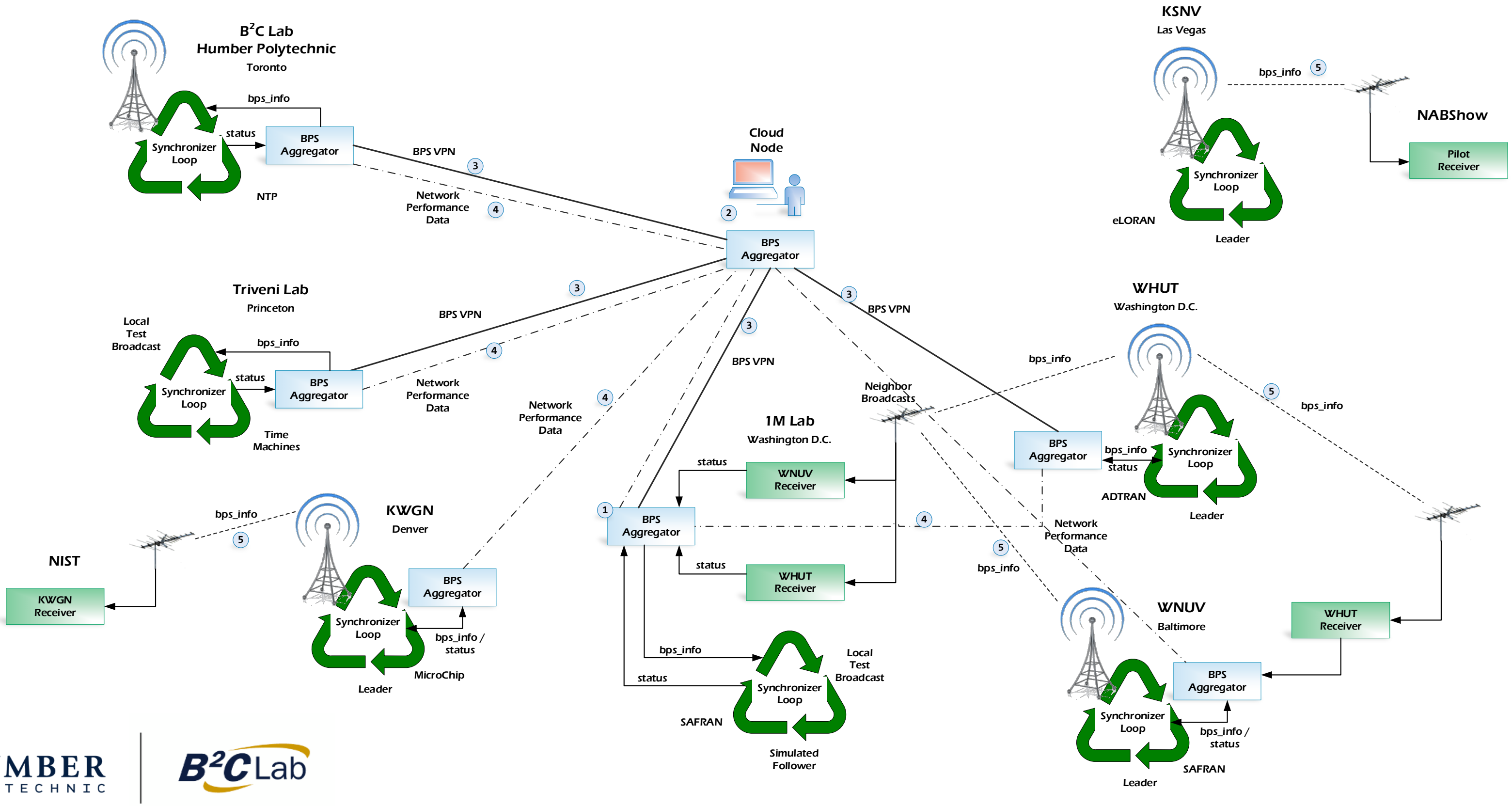
WHUT
HOWARD UNIVERSITY TELEVISION

WHUT-TV
Washington, DC

COLORADO'S OWN 2
KWGN-TV

KWGN-TV,
Denver, CO

BPS Network – April 2025



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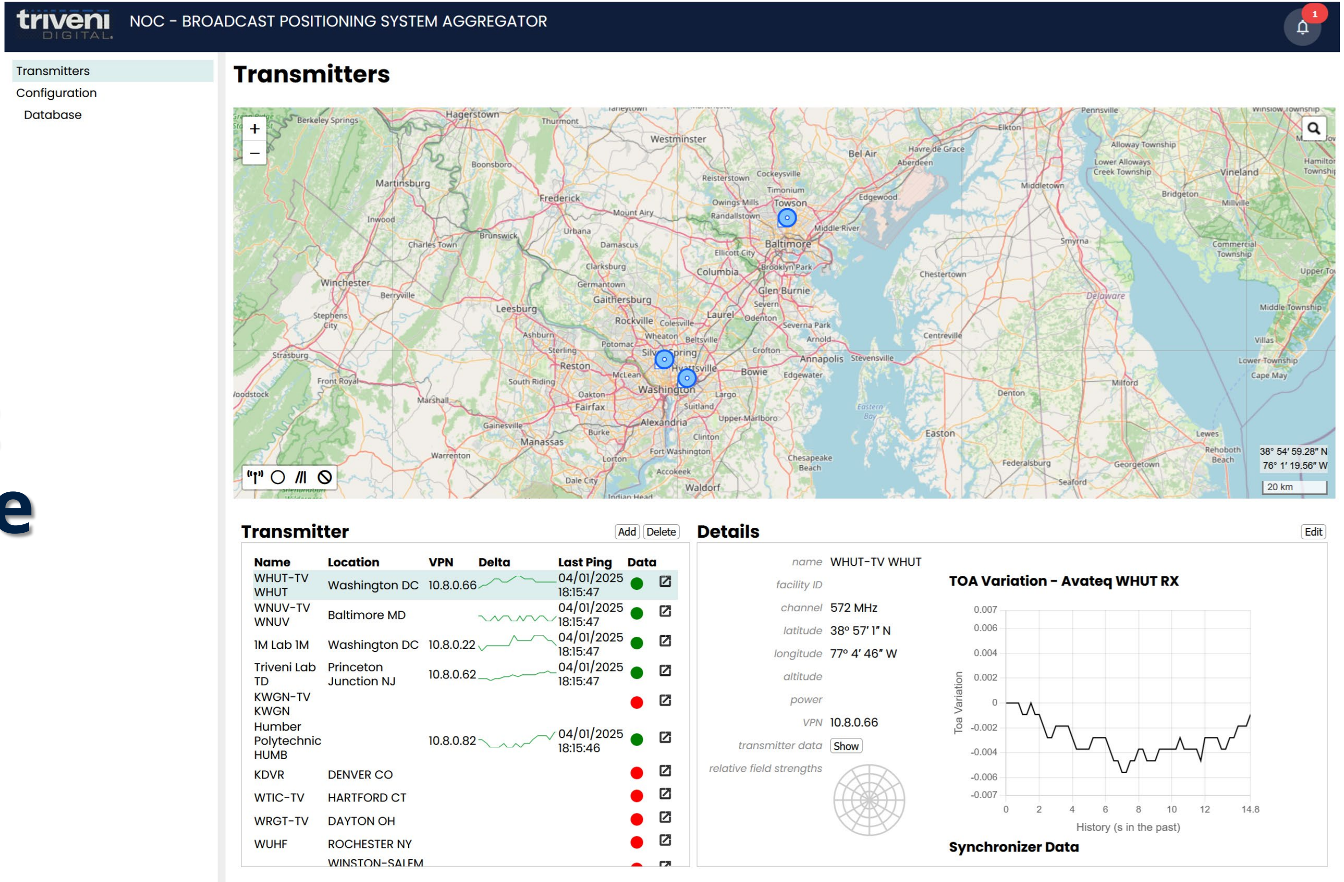
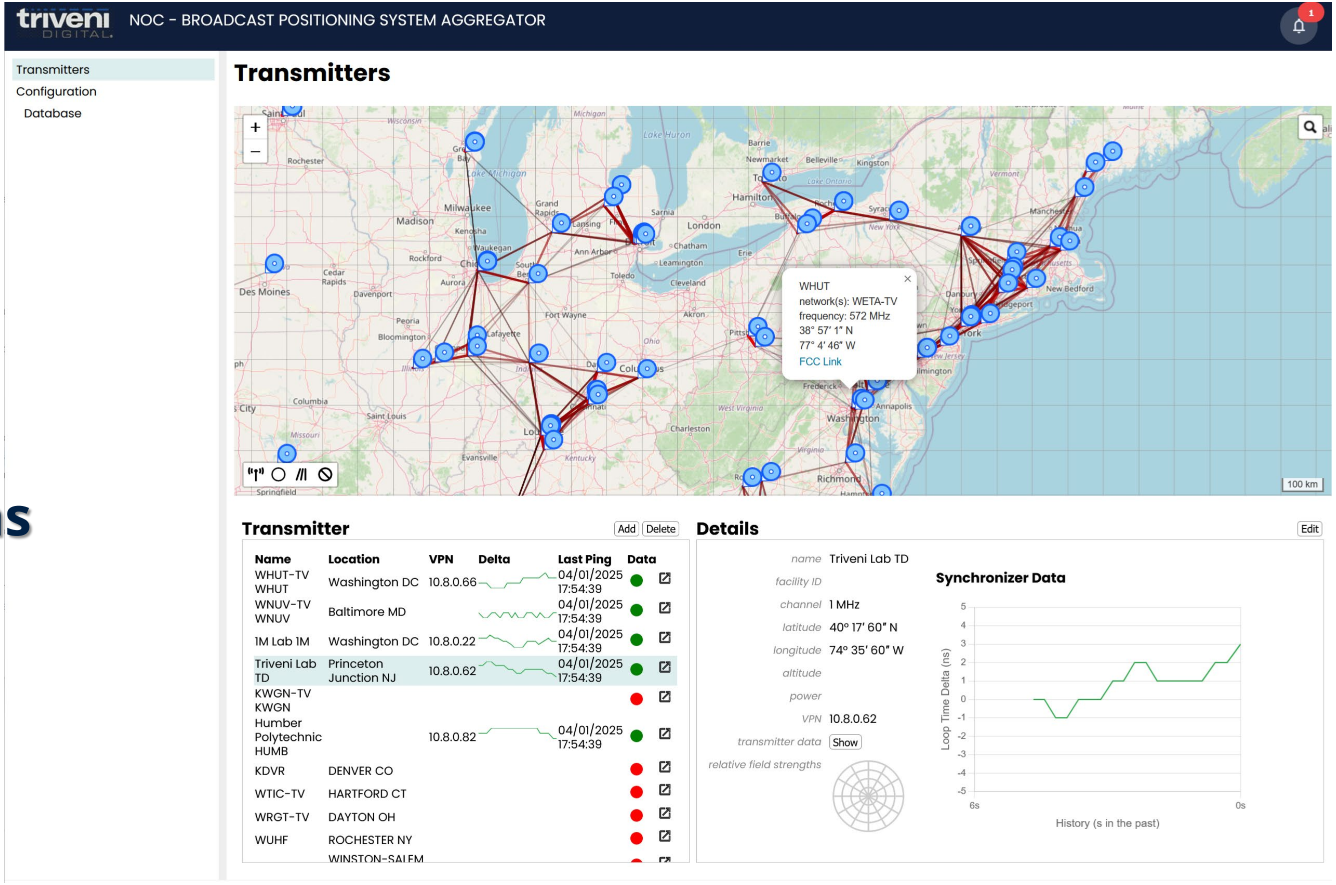
Network Management User Interface



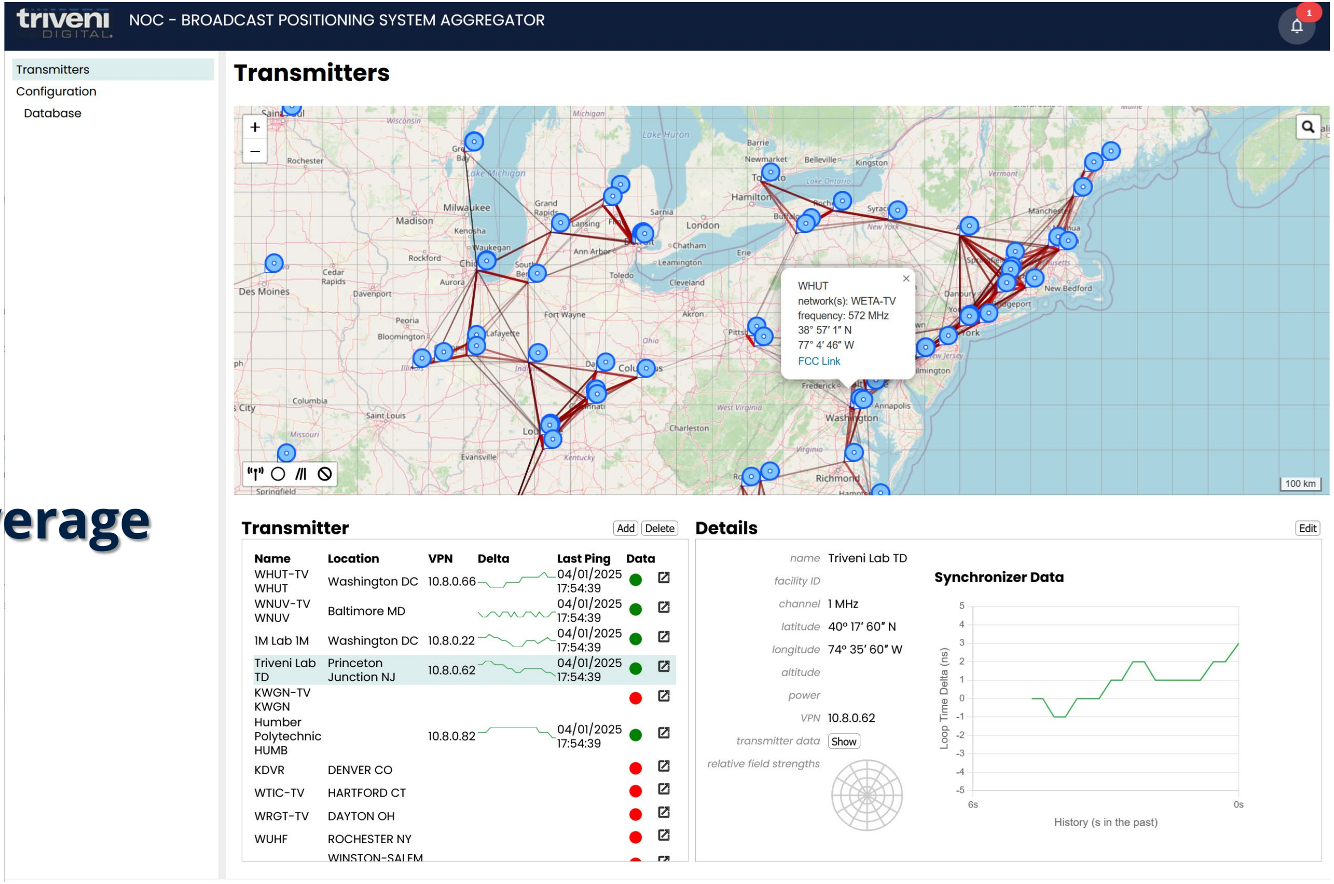
Network Management

- Mesh Connections



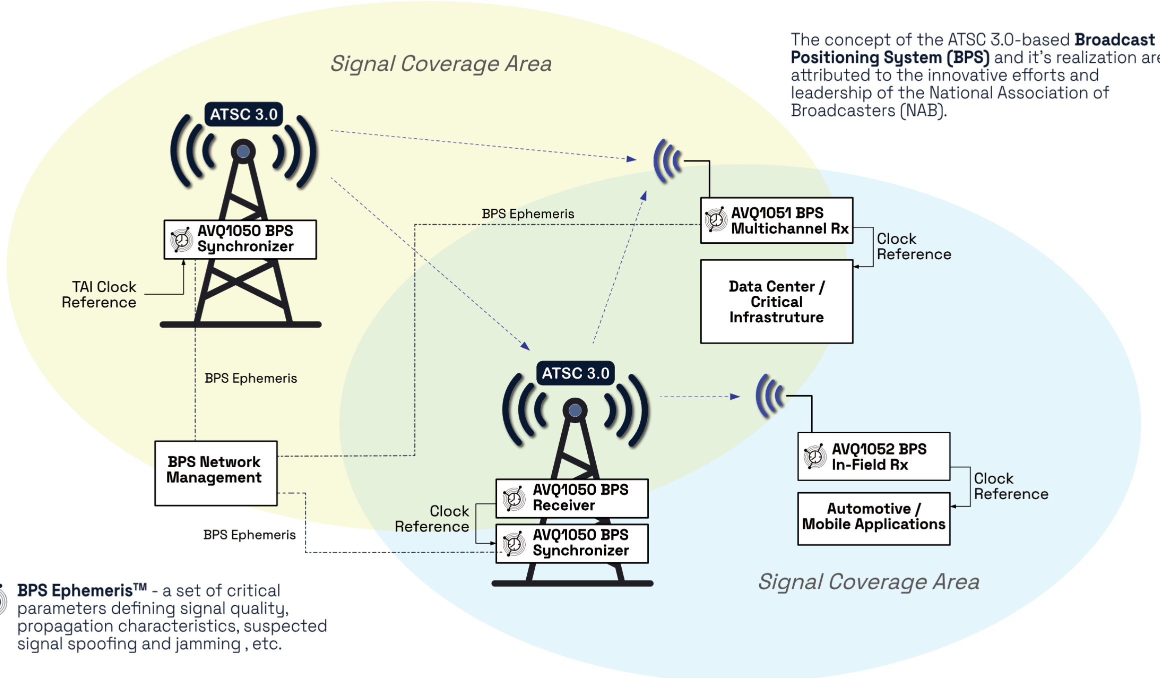
Network Management

- **75 & 200 mile Coverage**
- **Current ATSC 3.0 Deployments**



BPS Receiver

APPLICATION DIAGRAM



The concept of the ATSC 3.0-based **Broadcast Positioning System (BPS)** and it's realization are attributed to the innovative efforts and leadership of the National Association of Broadcasters (NAB).

BPS Ephemeris™ - a set of critical parameters defining signal quality, propagation characteristics, suspected signal spoofing and jamming , etc.

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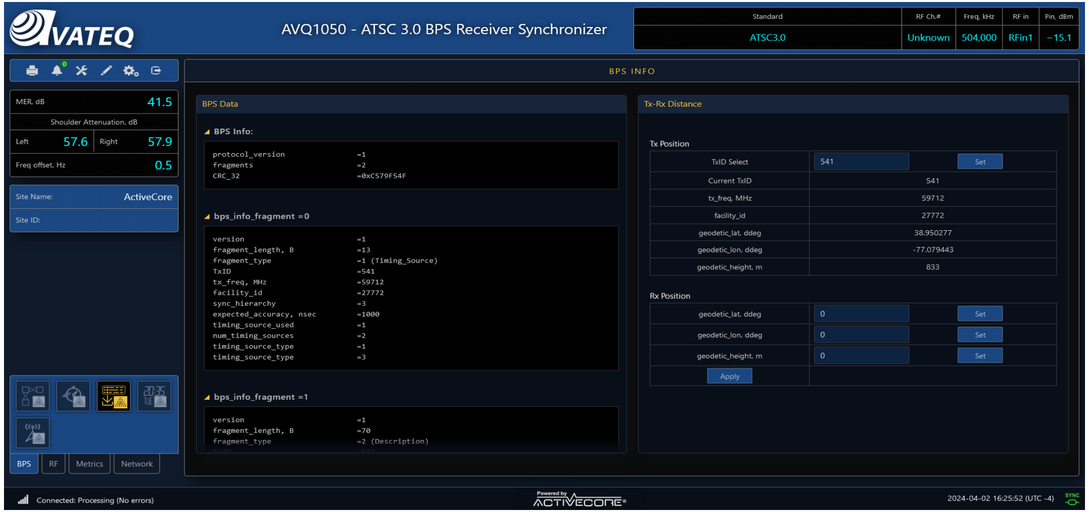
BPS Rx Almanac



BPS Info:
protocol_version = 1
fragments = 9
CRC_32 = 0x0F2672B8

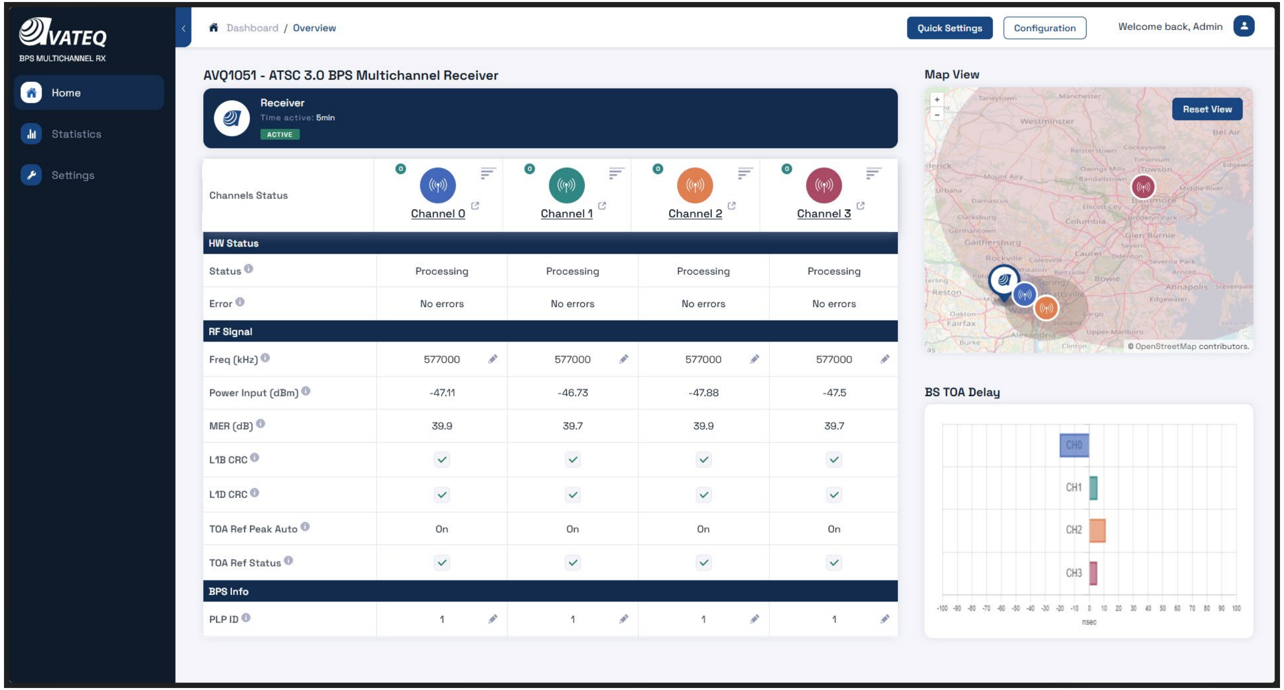
bps_info_fragment =0
- version = 0
- fragment_length, B = 13
- fragment_type = 1 (Timing_Source)
- TxID = 4153
- tx_freq, MHz = 123
- facility_id = 12345
- sync_hierarchy = 1
- expected_accuracy, nsec = 1000
- timing_source_used = 1
- num_timing_sources = 2
- timing_source_type = 0
- timing_source_type = 1

bps_info_fragment =1
- version = 0
- fragment_length, B = 13
- fragment_type = 1 (Timing_Source)
- TxID = 256
- tx_freq, MHz = 536
- facility_id = 7933
- sync_hierarchy = 3
- expected_accuracy, nsec = 1000
- timing_source_used = 1
- num_timing_sources = 2
- timing_source_type = 1
- timing_source_type = 3

bps_info_fragment =2
- version = 0
- fragment_length, B = 14
- fragment_type = 1 (Timing_Source)
- TxID = 31
- tx_freq, MHz = 572
- facility_id = 65670
- sync_hierarchy = 1
- expected_accuracy, nsec = 1000
- timing_source_used = 1
- num_timing_sources = 4
- timing_source_type = 0
- timing_source_type = 1
- timing_source_type = 3
- timing_source_type = 15

bps_info_fragment =3
- version = 0
- fragment_length, B = 21
- fragment_type = 0 (Measurement)
- TxID = 4153
- tx_freq, MHz = 123
- facility_id = 12345
- forward_flag = 0
- prev_bootstrap_time_sec = 1739317977
- prev_bootstrap_time_msec = 424
- prev_bootstrap_time_usec = 11
- prev_bootstrap_time_nsec = 547
- prev_bootstrap_time_error_nsec = -247344881

Multi-channel BPS Receiver



Achievements

Time Transfer Performance of the Broadcast Positioning System™ (BPS™)

Davi

SUMMARY

BPS time transfer stability is studied using signal from a live TV station and two baselines, one exceeding 100km. We show that the ns-level timing of BPS can support PNT services comparable to GPS or other GNSS. This is done using a BPS signal observed in common view at two different locations. After adjusting for the common sources of errors, it is observed that the stability of BPS time transfer is comparable to or better than GNSS, making BPS a viable complementary PNT solution when GNSS is unavailable.

National Institute of Standards and Technology.
Proceedings of the 2025 International Technical Meeting.
ION ITM 2025, January 27-30, 2025
(https://www.nab.org/bps/ITM25-0009.pdf)

NABSHOW 2025 PROJECT OF THE YEAR

Operations Category

Recognizing efforts to manage and move content in myriad formats to scale workflows and maxi across complex global environments.

Sinclair Broadcasting, Nexstar, Avateq and Triveni Digital: BPS Mesh Network Initial Deployment
Led by: Harvey Arnold of Sinclair Broadcast Group and Brett Jenkins, of Nexstar Media Group, Inc.
Technology Partners: Avateq and Triveni Digital

National Association of Broadcasters.
Project of The Year Award.
NABShow, Las Vegas, NV
April 9, 2025

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Thank You!

Questions?

https://nab.org/bps

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