Project Demonstration by TVA and SPP

STTP Project Update
Demo of STTP over EIDSN

NASPI Workshop

April 15, 2019

DOE FOA 1492
DE-OE-859

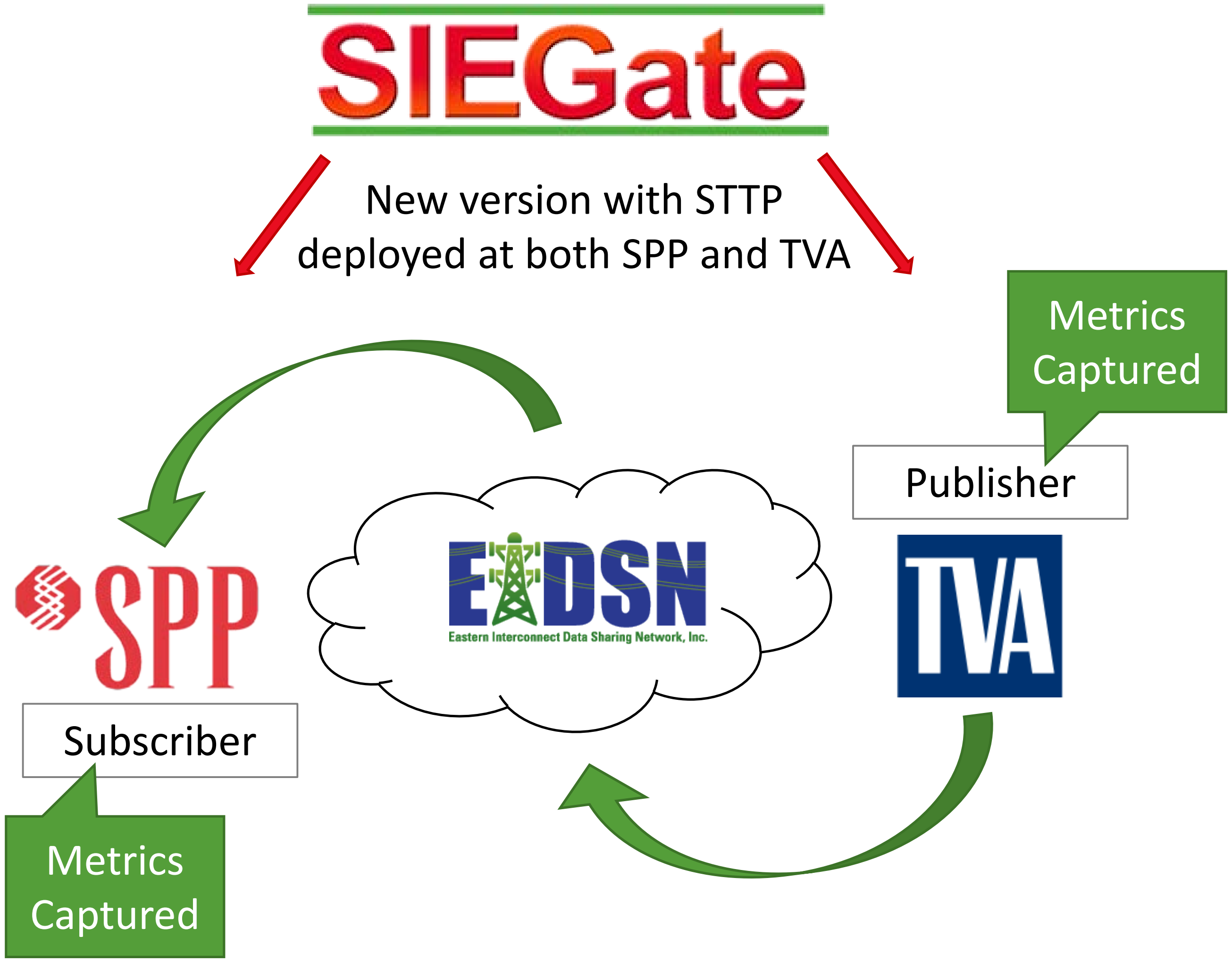
STTP over EIDSN Demonstration Overview

- **Purpose**

  To compare STTP protocol performance to IEEE C37.118

  https://www.osti.gov/search/semantic:1504742
  https://github.com/sttp/dotnetapi

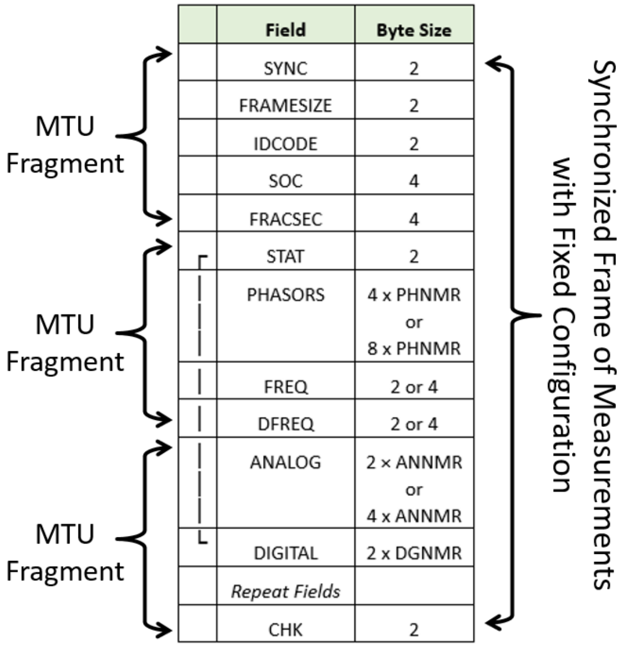
- **Approach**
  - Use the EIDSN as the transport layer
  - Use GPA's secure gateway, SIEGate as the test application
  - Test performance at differing data volumes



Protocol Difference: Frames vs. Atomic Packets

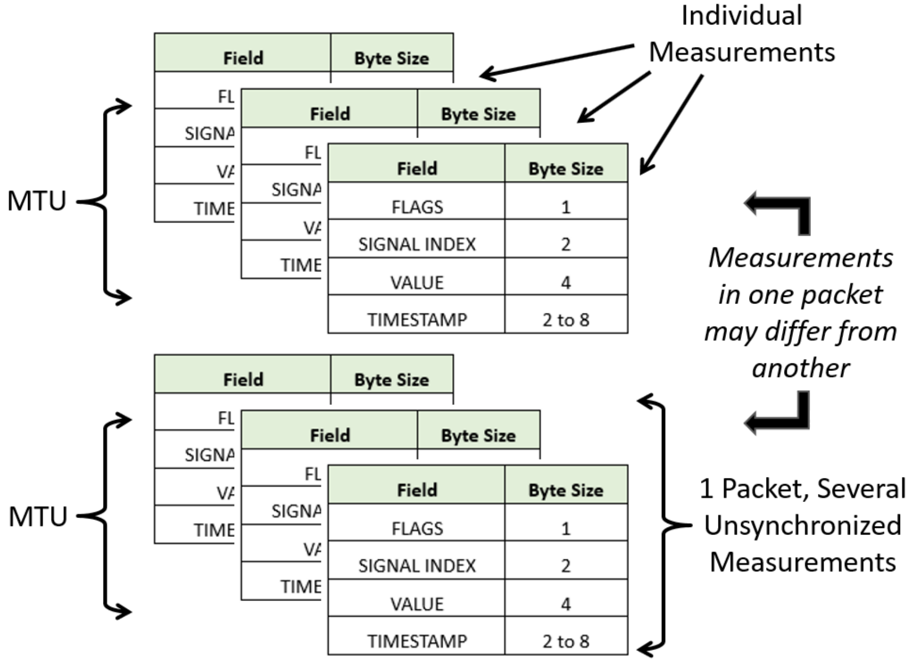
IEEE C37.118

- Created to support substation to control center phasor data communications
- Frame-based protocol where the frame size is a function of the number of measurement points
- Efficient data exchange, i.e., small number of bits per point
- Widely used -- The standard for phasor data communication for 15+ years



STTP – IEEE 2664

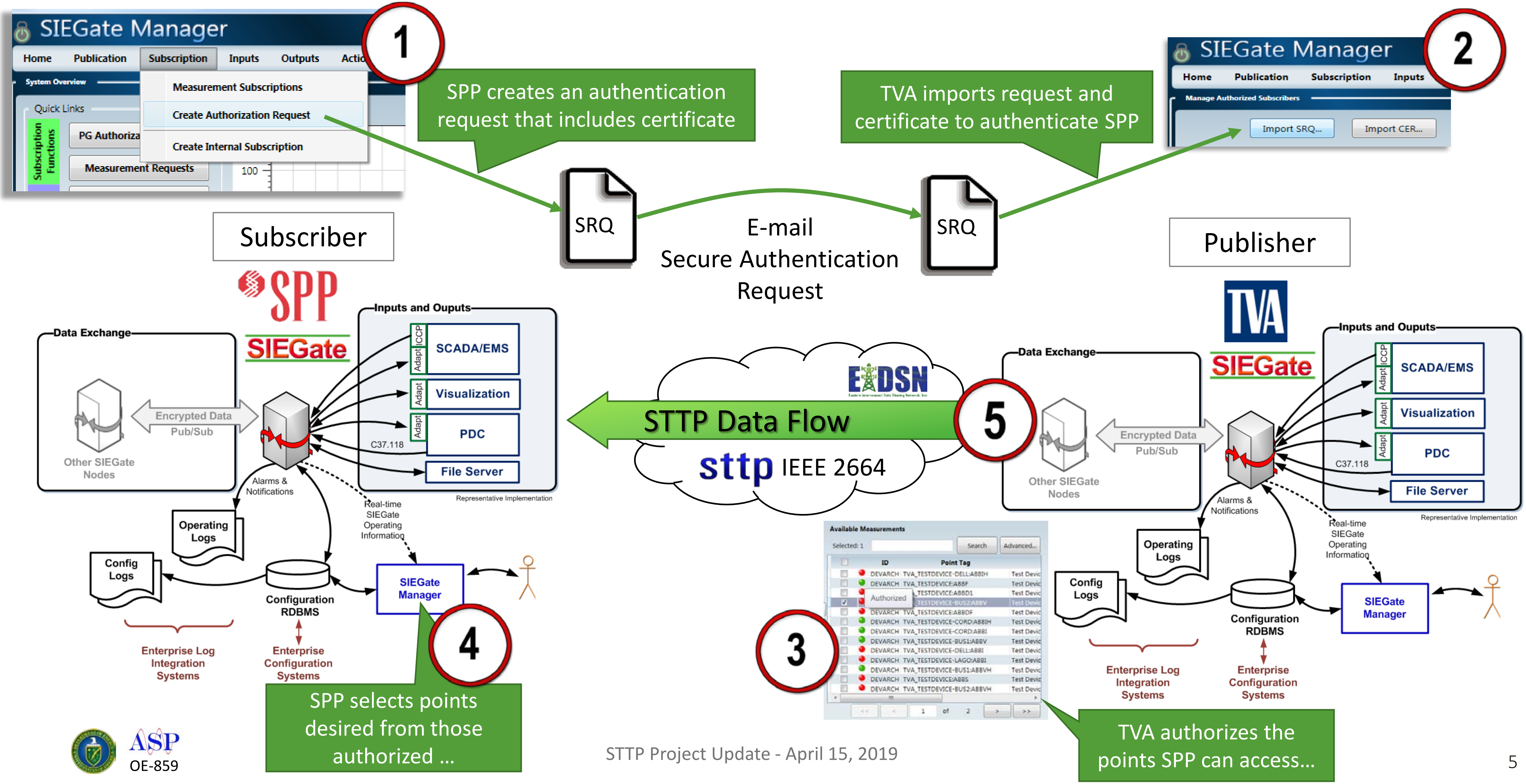
- Created to support control center to control center phasor data communications (as well as other high-fidelity, high-volume streaming data use cases.)
- Network MTU packet size optimized for efficient communication
- Intrinsically reduces losses by removing stress of large frame-size on networks
- Allows the safe co-mingling of phasor data with other operational data network traffic rather than having to isolate phasor data on purpose-provisioned networks
- Metadata exchanged as part of protocol significantly simplifies configuration management
- Includes lossless compression to reduce bandwidth use over C37.118
- Security-first design with strong authentication and option for encryption



Test Process

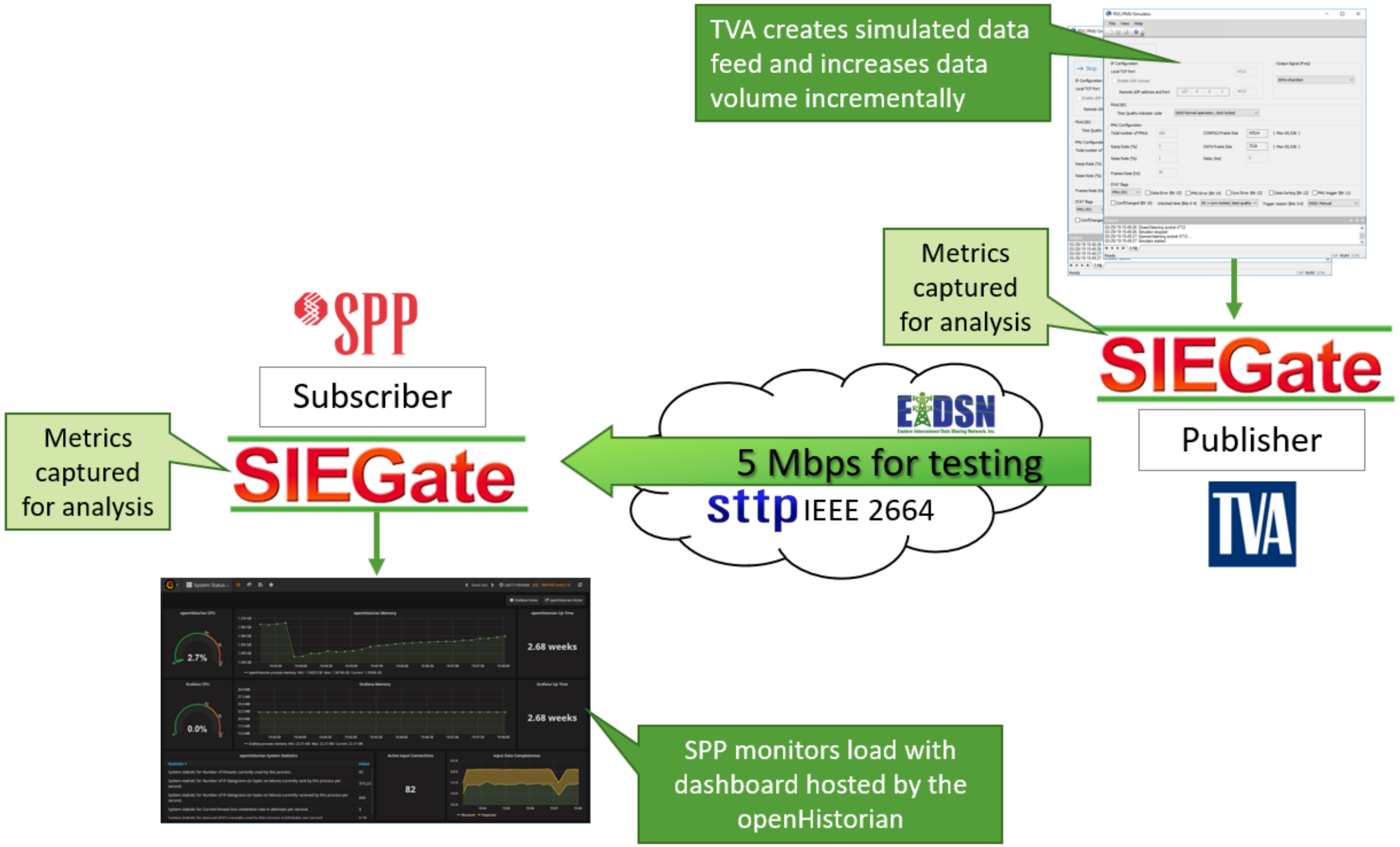
- SPP increases provisioned EIDSN bandwidth from 2 to 10 Mbps to facilitate testing
- 5 Mbps is allocated for this test to avoid impact to production TVA and SPP processes
- SIEGate nodes placed on EIDSN by TVA and SPP
- SIEGate nodes configured for testing *(and will be left in production following testing)*
- GPA PMU Simulator used to create repeatable "test cases" at varying load levels
- For testing, TVA is the phasor data publisher and SPP is the subscriber
- Data recorded by both TVA and SPP during testing
  - 4 Test Cases C37.118
  - 3 Test Cases for STTP

STTP Configuration Steps for TVA → SPP Data Flow



ASP
OE-859

Test Set Up



- TVA is data publisher
- SPP is data subscriber
- Phasor data for testing produced by a phasor data simulator
- Limit of 5 Mbps allocated for testing
- All testing uses TCP/IP
- Multiple tests run with both TVA and SPP capturing test statistics

Test Cases / Phasor Data Loading Levels

- Number of measurement points is the best factor for protocol comparison
- STTP test inadvertently included more points per PMU
  - C37.118 – 15 measurements per PMU
  - STTP – 19 measurements per PMU
- GPA phasor data simulation tool maxed-out at 139 PMUs per instance
- Multiple simulator instances used for the larger test cases

IEEE C37.118

TEST	Points	PMUs
1	450	30
2	1,125	75
3	2,085	139
4	5,085	339

sttp IEEE 2664

TEST	Points	PMUs
1	2,641	139
2	6,441	339
3	8,341	439

Demonstration Test Results

- STTP has greater throughput
- More server CPU cycles are required for STTP
- Server memory use is about the same

IEEE C37.118

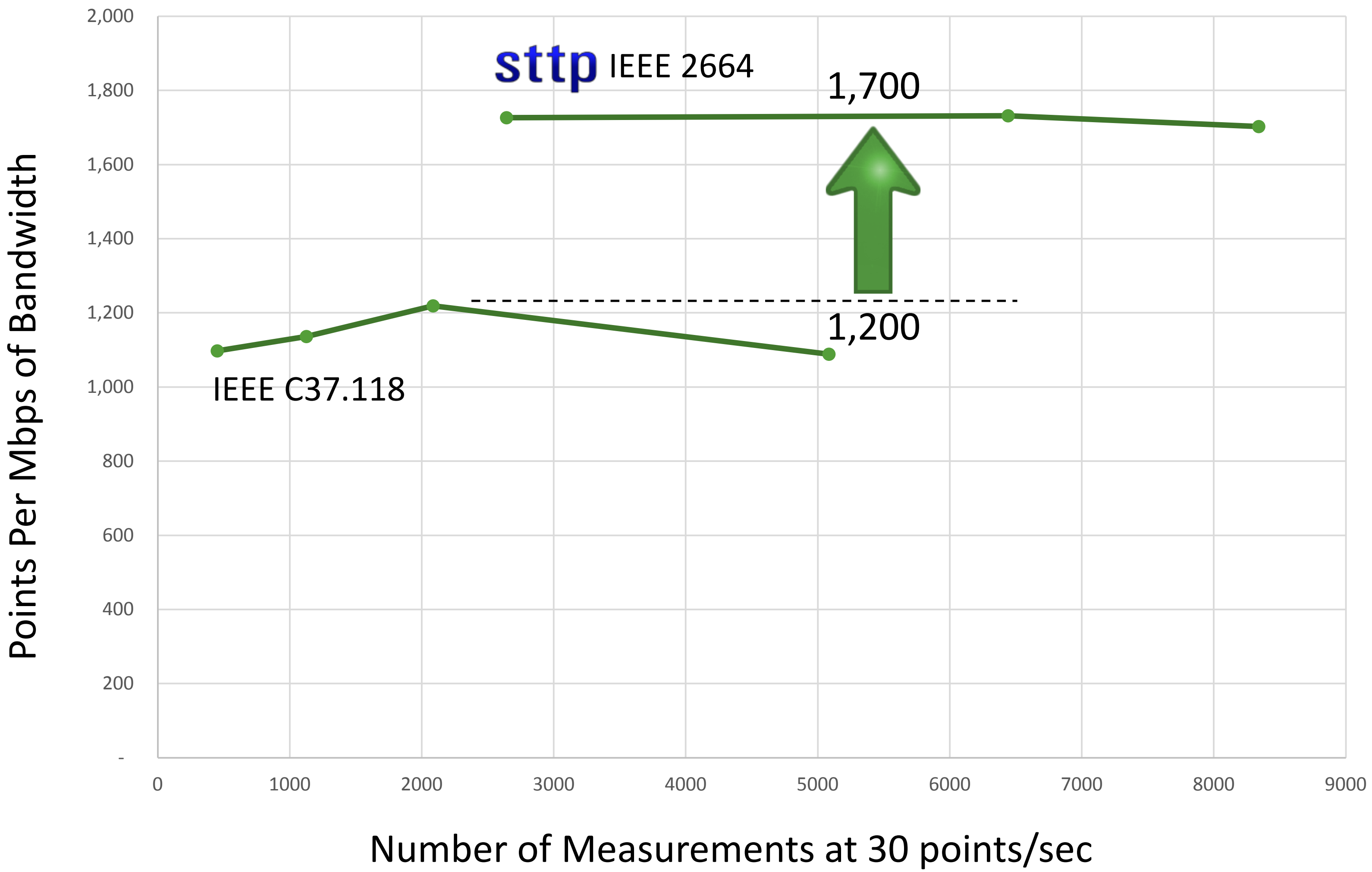
TEST	Points	Bandwidth	CPU_{SPP}	Mem_{SPP}
1	450	0.41 Mbps	3.3%	2.1GB
2	1,125	0.99 Mbps	3.6%	2.1GB
3	2,085	1.71 Mbps	4.1%	2.1GB
4	5,085	4.67 Mbps	5.0%	2.0GB

sttp IEEE 2664

TEST	Points	Bandwidth	CPU_{SPP}	Mem_{SPP}
1	2,641	1.53 Mbps	5.1%	2.1GB
2	6,441	3.72 Mbps	8.9%	2.0GB
3	8,341	4.90 Mbps	10.6%	2.1GB

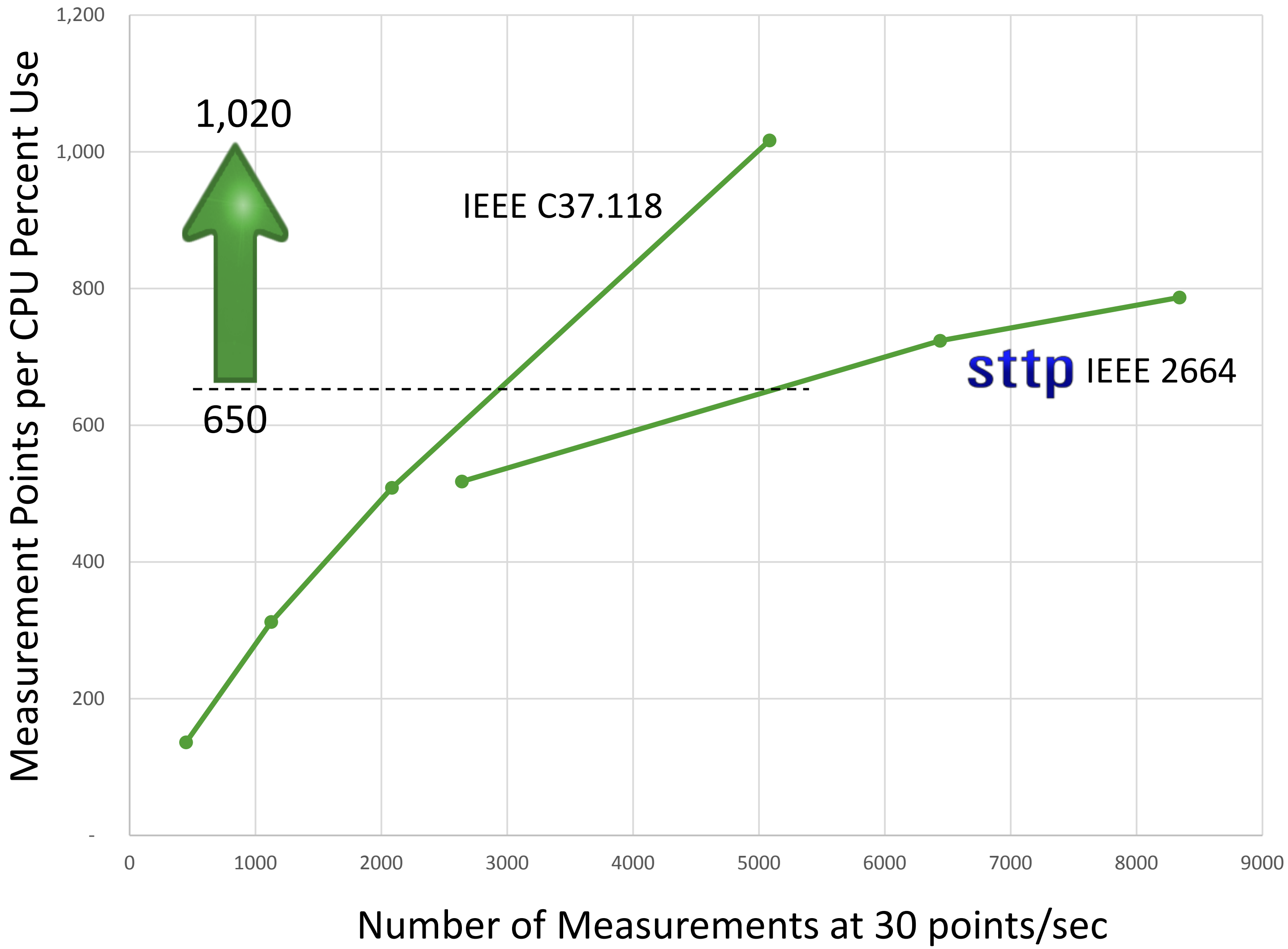
Demonstration Test Results

Lossless compression enables greater STTP throughput



Demonstration Test Results

Lossless compression requires more CPU cycles



Test / Demonstration Conclusions

- The 5 Mbps limit for the test was adequate to represent large phasor data flows between RCs over the EIDSN – 300+ PMUs in the case of C37.118 and 400+ for STTP.
- The STTP beta code performed well in both publication and subscription modes. No issues were discovered during the test.
- Setup and configuration worked smoothly and is significantly improved over C37.118 without the need for both parties to have the same namespace or share measurement point keys.
- STTP achieved desired bandwidth reductions with simple lossless compression techniques. *(STTP is designed to enable easy plug in of new compression methods.)*
- The measured additional server loading for STTP compression/decompression is acceptable.
- No other significant differences in the protocols were discovered during the testing.
- Validation of operation in the demonstration was sufficient for TVA and SPP to begin longer term evaluation of STTP through its use as their production phasor data exchange protocol.

Project Partners

Advanced Synchrophasor Protocol Project

sttp

DOE FOA 1492
DE-OE0000859

ASP

Streaming Telemetry Transport Protocol

Project Collaborators	Project Financial Partner	Vendor	Utility	Demonstration Host
Bonneville Power Administration	◆		◆	
Bridge Energy Group				
Dominion Energy	◆		◆	EPG
Electric Power Group	◆	◆		
Electric Power Research Institute				
ERCOT			◆	
Grid Protection Alliance (Prime)	◆	◆		
ISO New England			◆	
MehtaTech		◆		
Oklahoma Gas & Electric	◆		◆	WSU
OSIsoft		◆		
Peak Reliability			◆	
PingThings		◆		
PJM Interconnection			◆	EPG
Southern California Edison			◆	
San Diego Gas & Electric	◆		◆	WSU
Schweitzer Engineering Laboratories	◆	◆		
Southern Company Services			◆	
Southwest Power Pool	◆		◆	WSU
Space-Time Insight		◆		
Trudnowski & Donnelly Consulting Engineers		◆		
Utilicast	◆	◆		
Tennessee Valley Authority	◆		◆	WSU
University of Southern California				
V&R Energy		◆		
Washington State University	◆	◆		
26	11	11	12	6

STTP Demonstration – April 2, 2019

Real-Time Results Capture

Real-Time Test Monitoring

C37.118 – 30 Devices

C37.118 – 75 Devices

Real-Time Test Monitoring

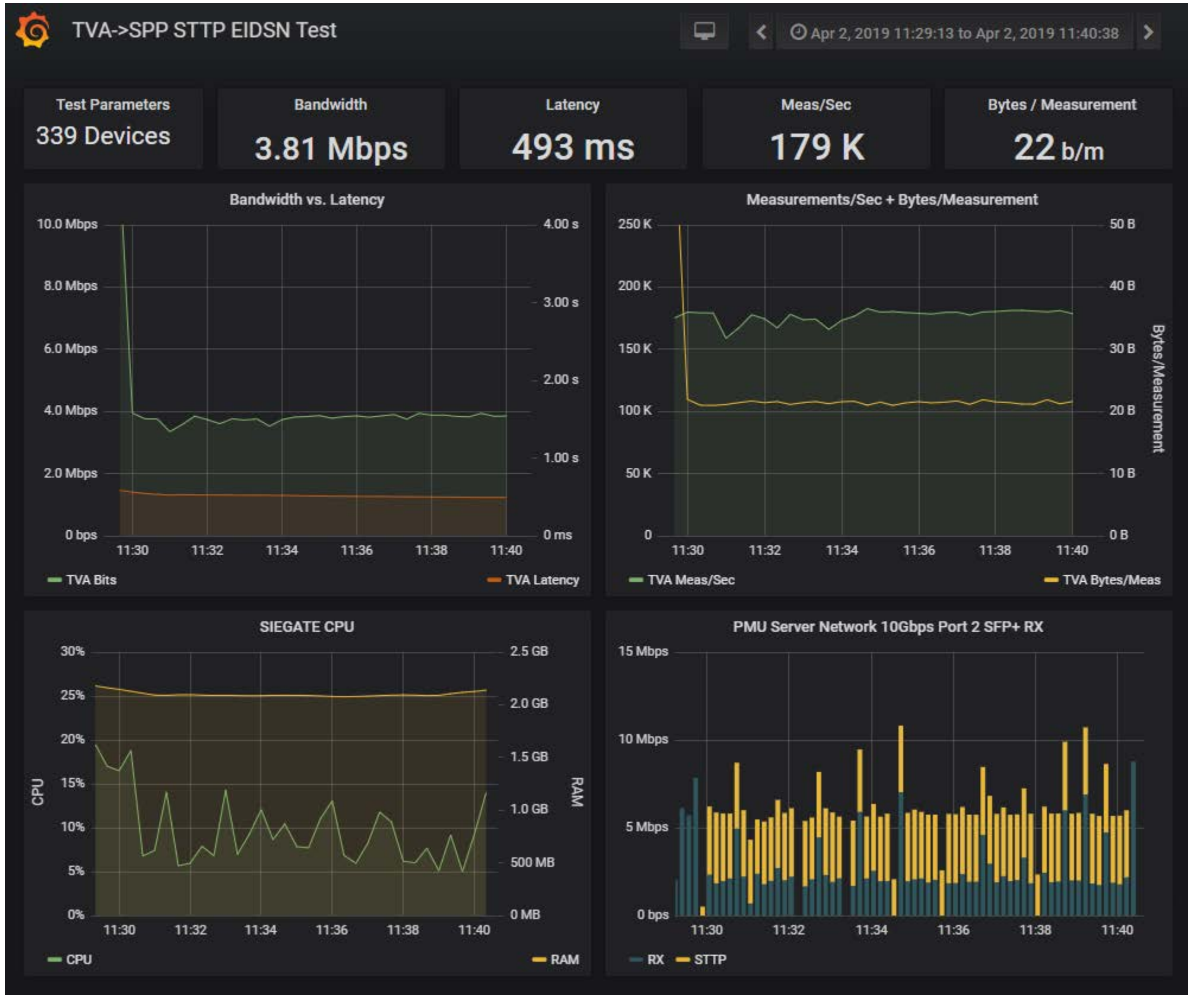
C37.118 – 139 Devices

C37.118 – 339 Devices

Real-Time Test Monitoring

STTP – 139 Devices

STTP – 339 Devices



Real-Time Test Monitoring

STTP – 439 Devices

STTP – All cases compared