U.S. DEPARTMENT OF ENERGY

Advanced Synchrophasor Protocol – DE-OE-859

Project Overview

ASP Advanced Synchrophasor Protocol

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GRID PROTECTION ALLIANCE

ASP Project Scope

- For the demanding requirements of synchrophasor data:
  - Document a vendor-neutral publish-subscribe streaming time-series data protocol
  - Develop test and validation tools
  - Create multiple reference implementations
  - Report on protocol efficacy and performance as it's demonstrated at scale
  - Present the protocol to standards bodies
- Candidate protocol name:
  Streaming Telemetry Transport Protocol

Large-scale ASP Project Demonstrations

- WSU Demos
  - TVA
  - SPP
  - OG&E
  - SDG&E
- EPG Demos
  - Dominion
  - PJM

ASP Project Participants

Project Collaborators	Project Financial Partner	Vendor	Utility	Demonstration Host
Bonneville Power Administration *	♦*		♦	
Bridge Energy Group				
Dominion Virginia Power	♦		♦	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		♦		
TigerEye Software / Utilicast		♦		
Tennessee Valley Authority	♦*		♦	WSU
University of Southern California *				
V&R Energy		♦		
Washington State University	♦	♦		
	26	10	11	12	6

Background

Recognized Phasor Protocols

- IEEE C37.118-2005 (most widely used)
- IEEE C37.118.2-2011
- IEC 61850-90-5
- IEEE 1344-1995
- BPA PDCstream
- SEL Fast Message
- Macrodyne Streaming Data Protocol
- UTK F-NET Streaming Data Protocol

Commonalities of Phasor Protocols

- Each protocol is frame-based
  - A time-stamp
  - A block of data for one or more devices
- Electric industry specific content includes:
  - Voltage and Current phasors (complex type)
  - Frequency
  - Rate of Change of Frequency (dF/dt)
  - Analog values
  - Digital values
- Returning data from measurement devices is a priority of protocol design

Limitations of Phasor Protocols

- Protocol data formats are fixed
- Large data frames require a sizable number of network packets
  - Increasing opportunity for UDP loss
  - Increasing TCP latency
- Data frame will include “place keepers” for data that did not arrive within the lag-time
- Volume of data per frame has a fixed upper limit -- typically 64K

Why a new protocol?

sttp

Streaming Telemetry Transport Protocol

STTP Design Objectives

- Perform at high volume / large scale
  - Minimize losses
  - Lower bandwidth requirements
- Optimized for the performant delivery of individual data types via TCP
- Automated exchange of metadata
- Detect and expose communication issues
- Security and availability features that enable use on critical systems to support critical operations
- Pub/Sub – Measurement Based

… and for the API software included in the project, to be implementable in multiple languages, on multiple platforms with the ability to effectively utilize the hardware presented to it

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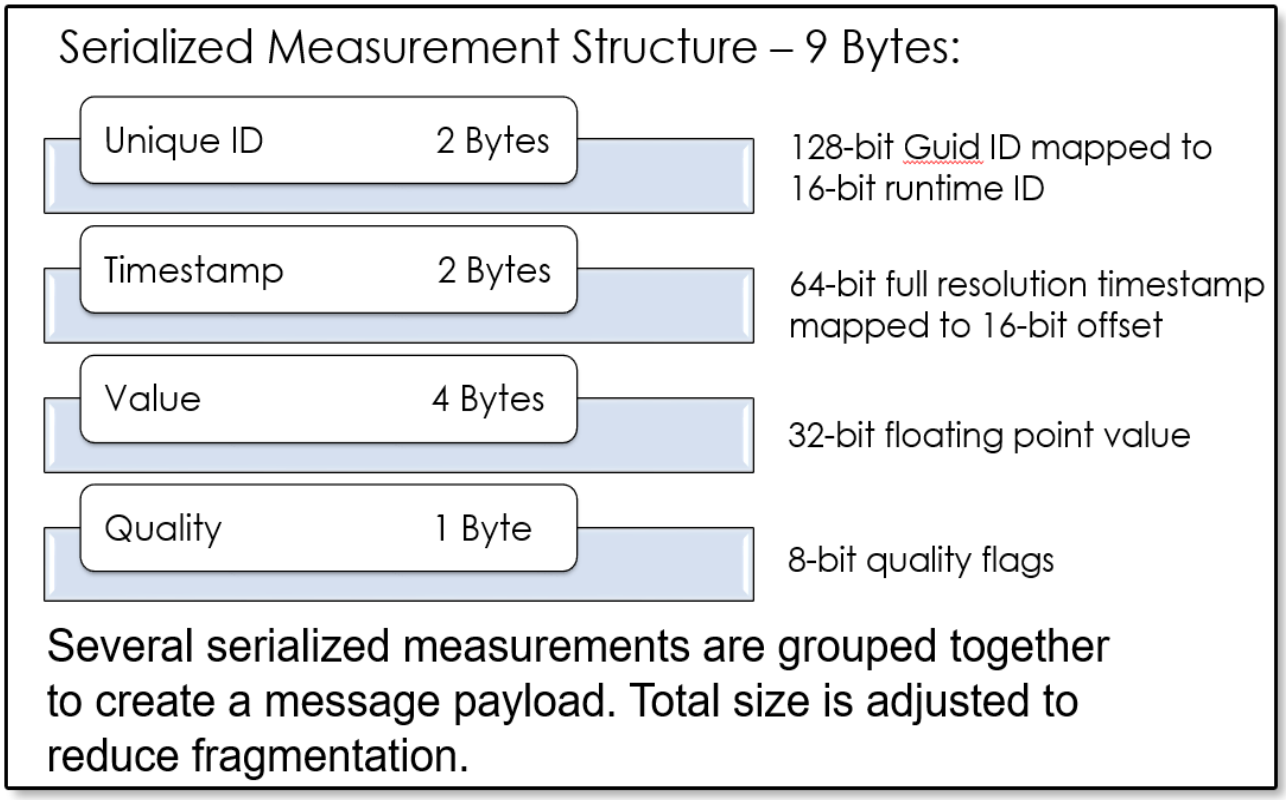
- Works Better
- Saves Money

… and for the API software included in the project, to be implementable in multiple languages, on multiple platforms with the ability to effectively utilize the hardware presented to it

Why not use an existing protocol?

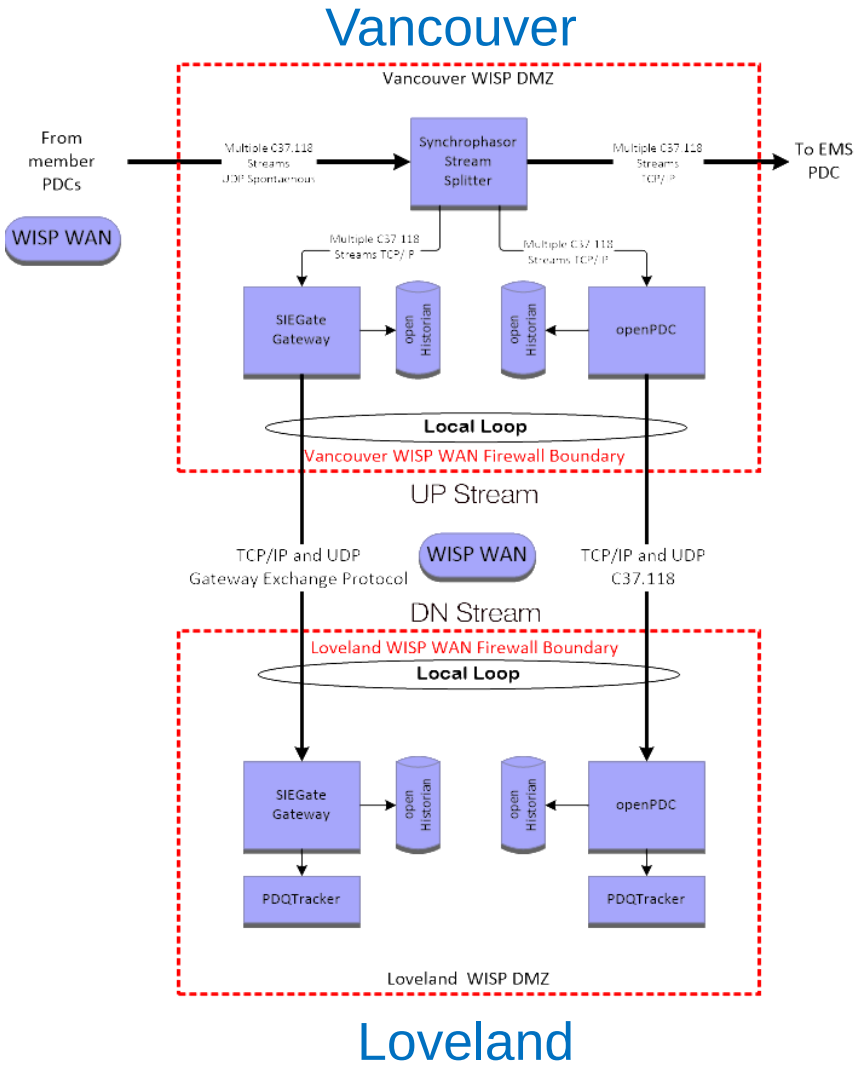
- Other standard protocols were evaluated for suitability
- Most were eliminated for one of the following reasons:
  - Request / Reply (i.e., non-streaming) nature
  - Insufficient specified limits on data throughput
  - Restrictive payload formatting, e.g., inability to send binary data
  - Forced transport specifications, e.g., HTTP
  - Limited opportunity to optimize bandwidth requirements

Foundational Experience for Design of STTP is the Gateway Exchange Protocol

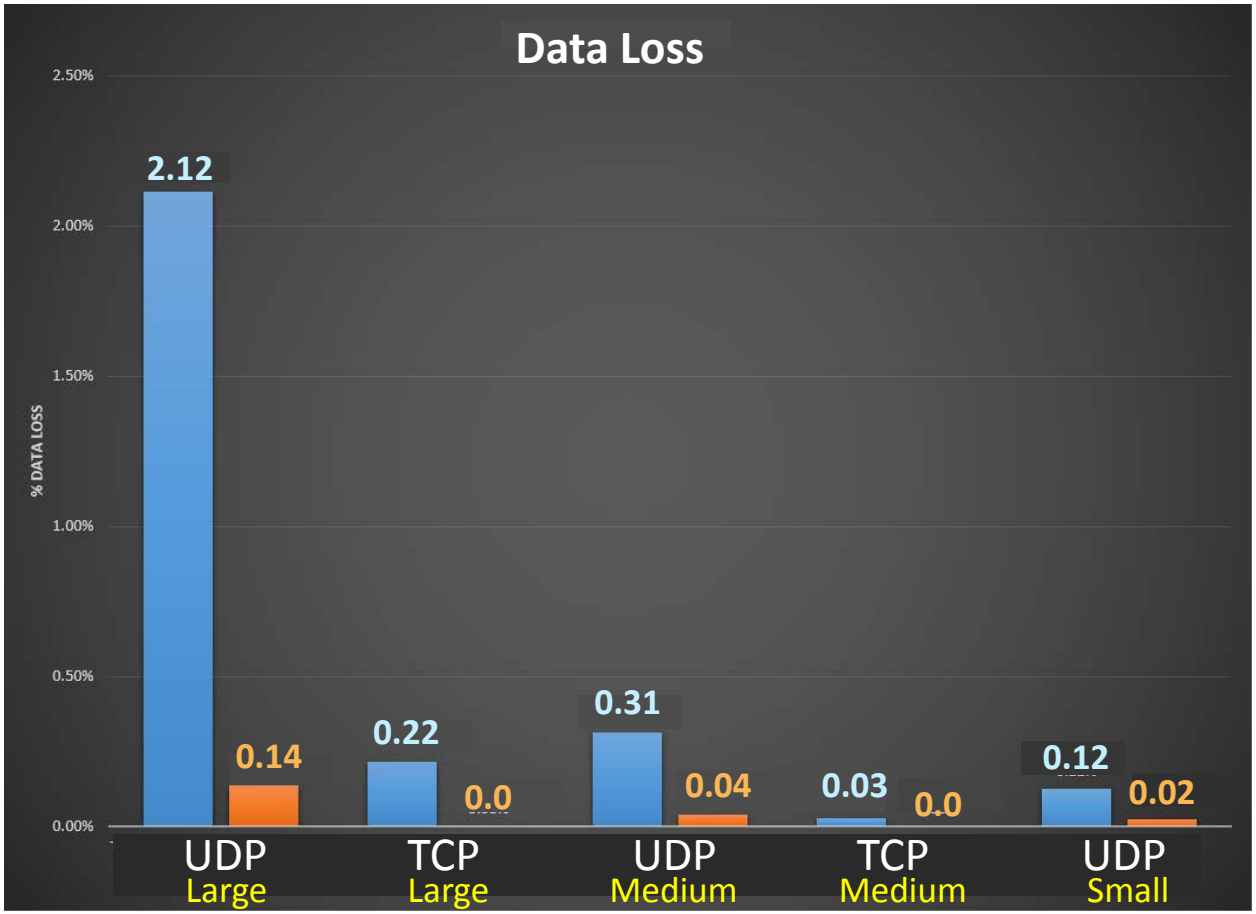


Losses compression techniques are applied to serialized measurement groups to further reduce packet size.

GEP vs. C37.118 Tests Conducted by PeakRC

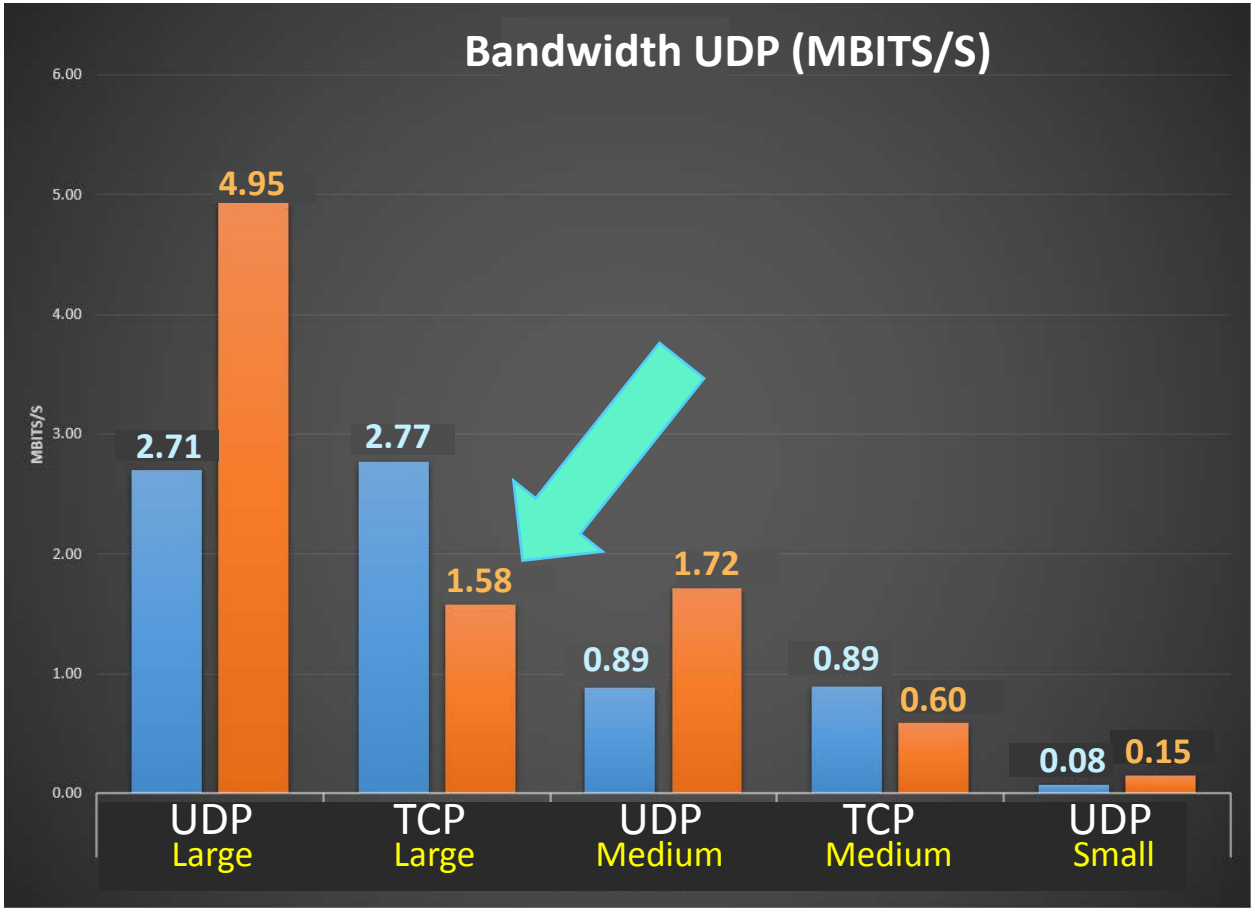


As Expected, Much Less Data Loss with GEP



GEP is Less Demanding on Networks

60% to 70% of the bandwidth for large and medium cases



STTP will improve on GEP

- Documentation to enable understanding and interoperability and to promote use
- Stand-alone API-style code that can be integrated into any development platform/project
- Expanding and extending metadata fields
  - Minimum required set of metadata fields
  - Capability for metadata versioning
- Security – communications established from the higher security zone
- Refinement
  - Simplify throughout
  - Drop any obsolete or relatively unused GEP functionality

STTP will Support Multiple Data Types

- Byte
- Int16
- Int32
- Int64
- UInt16
- UInt32
- UInt64
- Single
- Decimal
- Double
- Complex
- Tuple
- TimeSpan
- Char
- Bool
- GUID
- String
- Byte Array

& more ...

Project Schedule

1.0 Project Governance
- 1.1 Update PMP
- 1.2 Update Data Management Plan
- 1.3 Establish Contracts
- 1.4 Manage Project and Submit Reports

2.0 Protocol Specification
- 2.1 Define Requirements
- 2.2 Create Initial Design
- 2.3 Release ASP Specification

3.0 Alpha Software Development
- 3.1 Develop Alpha APIs
- 3.2 Develop Alpha Tool Kit
- 3.3 Release Alpha Versions

4.0 Incorporate the ASP APIs into Tool Suites
- 4.1 Incorporate Alpha ASP into EPG Tools
- 4.2 Incorporate Alpha ASP in WSU Tools
- 4.3 Bench Test EPG and WSU Tools

5.0 Demonstrations and Final ASP Specification
- 5.1 Develop EPG Tool Demo Plan
- 5.2 Develop WSU Too Demo Plan
- 5.3 Conduct Demo & Publish Results
- 5.4 Publish Ver 1.0 API with Documentation

DOE Acknowledgement & Disclaimer

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