GRID PROTECTION ALLIANCE

GEP vs. IEEE C37.118

Results from Testing at Peak RC

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Gateway Exchange Protocol

SIEGate

Why a test?

PEAK SEEKS TO IMPROVE PHASOR DATA AVAILABILITY

The Project

- SOPO Task 7.0 Data Delivery Efficiency Improvements, Subtask 7.1 – New Technology Value Peak Reliability
  Synchrophasor Program Pre-Commercial Synchrophasor R&D Contract No. DOE-OE0000701
  Phasor Gateway
- Peak deployed IEEE C37.118 over UDP, spontaneous mode, as it built out the WISP WAN
- There were concerns that:
  - Data delivery losses with IEEE C37.118 will increase with increasing data volume
  - Communications costs as bandwidth requirements increase may limit data sharing

Test Objective

- To investigate alternatives to IEEE C37.118 for use in the wide-area distribution of phasor data.

What is GEP?

A QUICK INTRODUCTION

Background: GEP was Created for SIEGate

- Open and non-proprietary
- True pub/sub, measurement-based protocol
- Automated exchange of authorized metadata
- Tightly-compressed, binary serialization of time-series values
- Adapters provided in .NET, C/C++ and Java for convenient native integration in other systems
- Efficient -- includes lossless compression
- Available transports include TLS, TCP, TCP with UDP, TLS with AES key-rotated UDP, and ZeroMQ
- GEP is embedded in all GPA products

GEP is Small Without Being Frame-based

Serialized Measurement Structure – 9 Bytes:

Unique ID	2 Bytes	128-bit Guid ID mapped to 16-bit runtime ID
Timestamp	2 Bytes	64-bit full resolution timestamp mapped to 16-bit offset
Value	4 Bytes	32-bit floating point value
Quality	1 Byte	8-bit quality flags

Several serialized measurements are grouped together to create a message payload. Total size is adjusted to reduce fragmentation.

Note that lossless compression techniques are applied to serialized measurement groups to further reduce packet size.

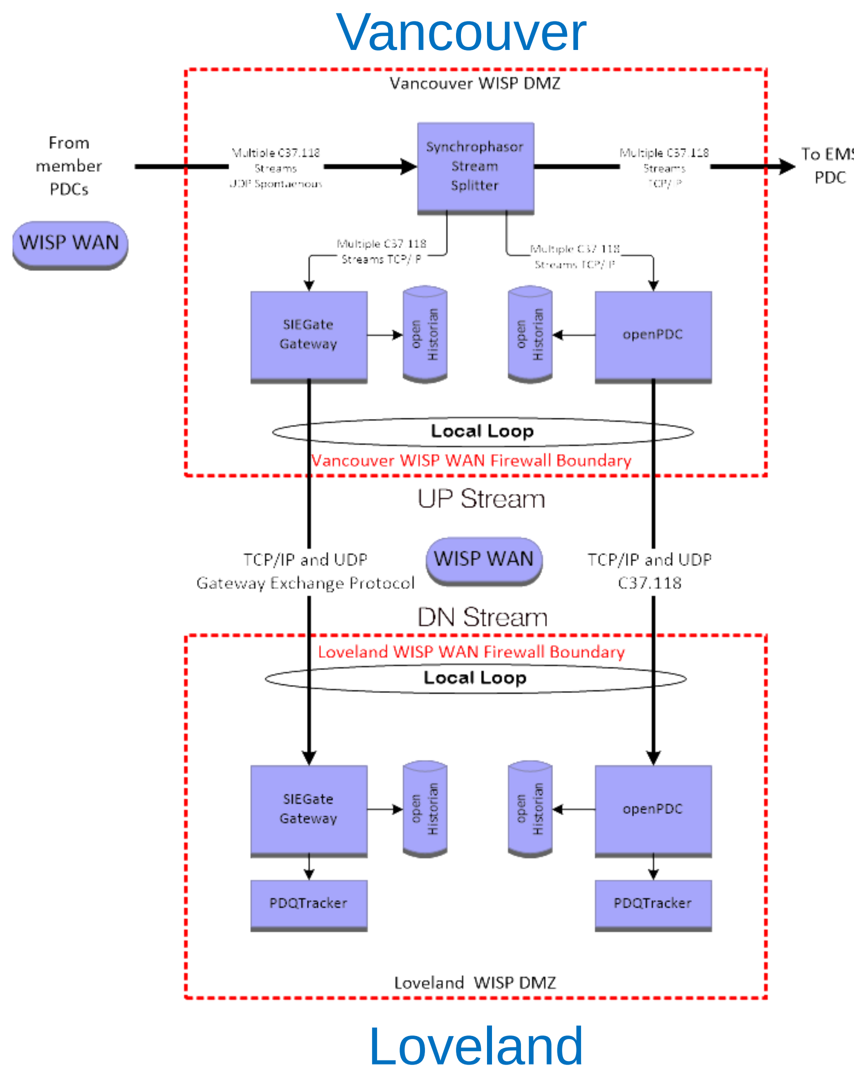
GEP is in Production Use Today

- Entergy
  - Exchanging data securely with neighbors including SPP, OG&E, Southern Company and MISO using SIEGate
  - Sending data from substation, to control center, to analytics, visualizations and development environment
- MISO
  - Exchanging data with MISO
  - Sending data from production to visualizations and development environment
- TVA
  - Production data distribution to analytics, historians and visualizations
- Every openPDC Deployment
  - Service ➔ Manager

What was the test plan?

THE WISP WAN WAS USED AS THE TEST PLATFORM

Tests Conducted Between Vancouver and Loveland



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To Assure Valid Results

- Testing was conducted in parallel (side-by-side):
  - The same network (WISP WAN) under identical network conditions
  - The same hardware under very similar hardware loading conditions
- Multiple tests were run in real-time from a large block of historical phasor data, i.e., 242 PMUs / 3,145 measurements producing ~94,350 measurements per second
- All tests were run over a two-hour window and executed 3-times each then compared and averaged to validate results. Additionally, one final test was run over a 7-day period to assure the short-term tests were representative of long-term performance.

What was learned?

THE TEST RESULTS

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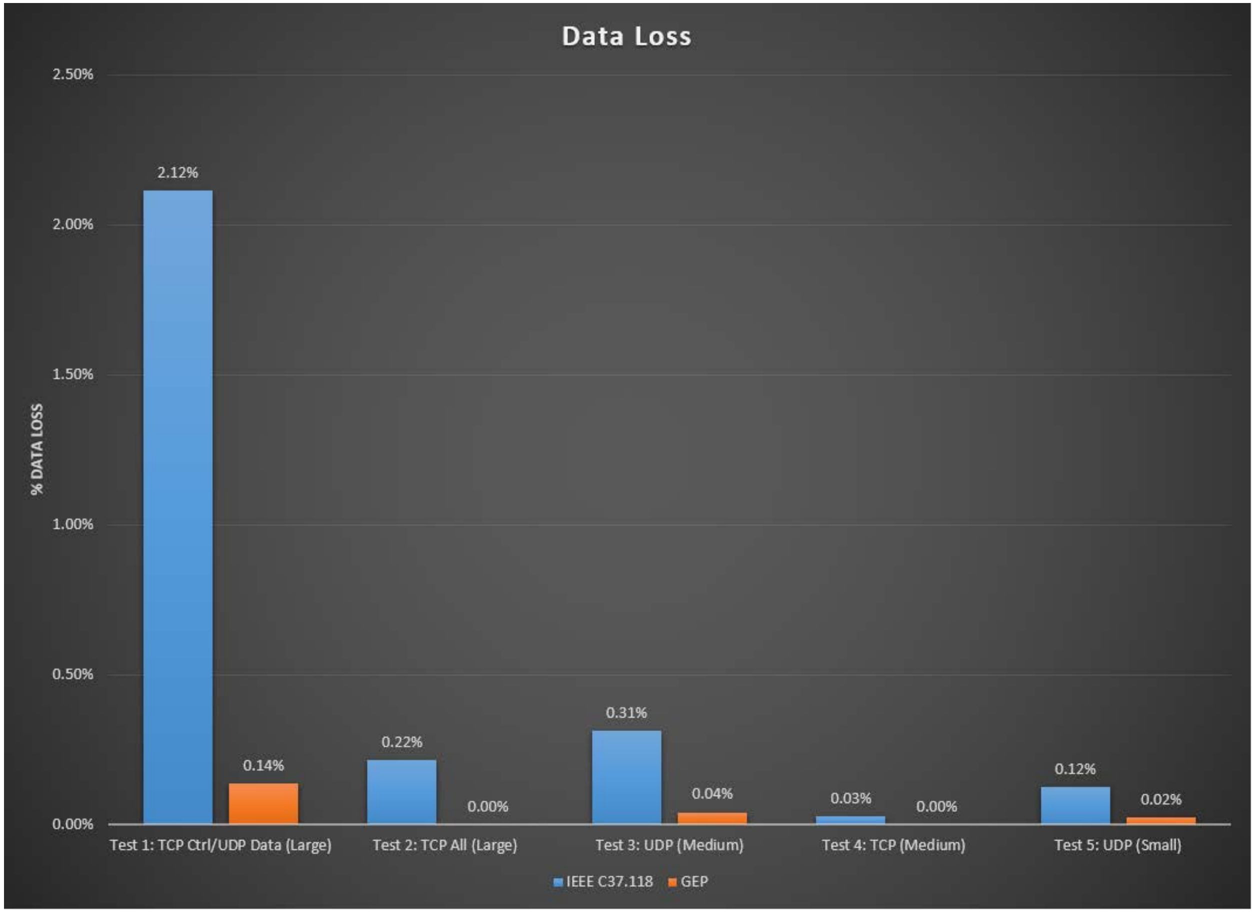
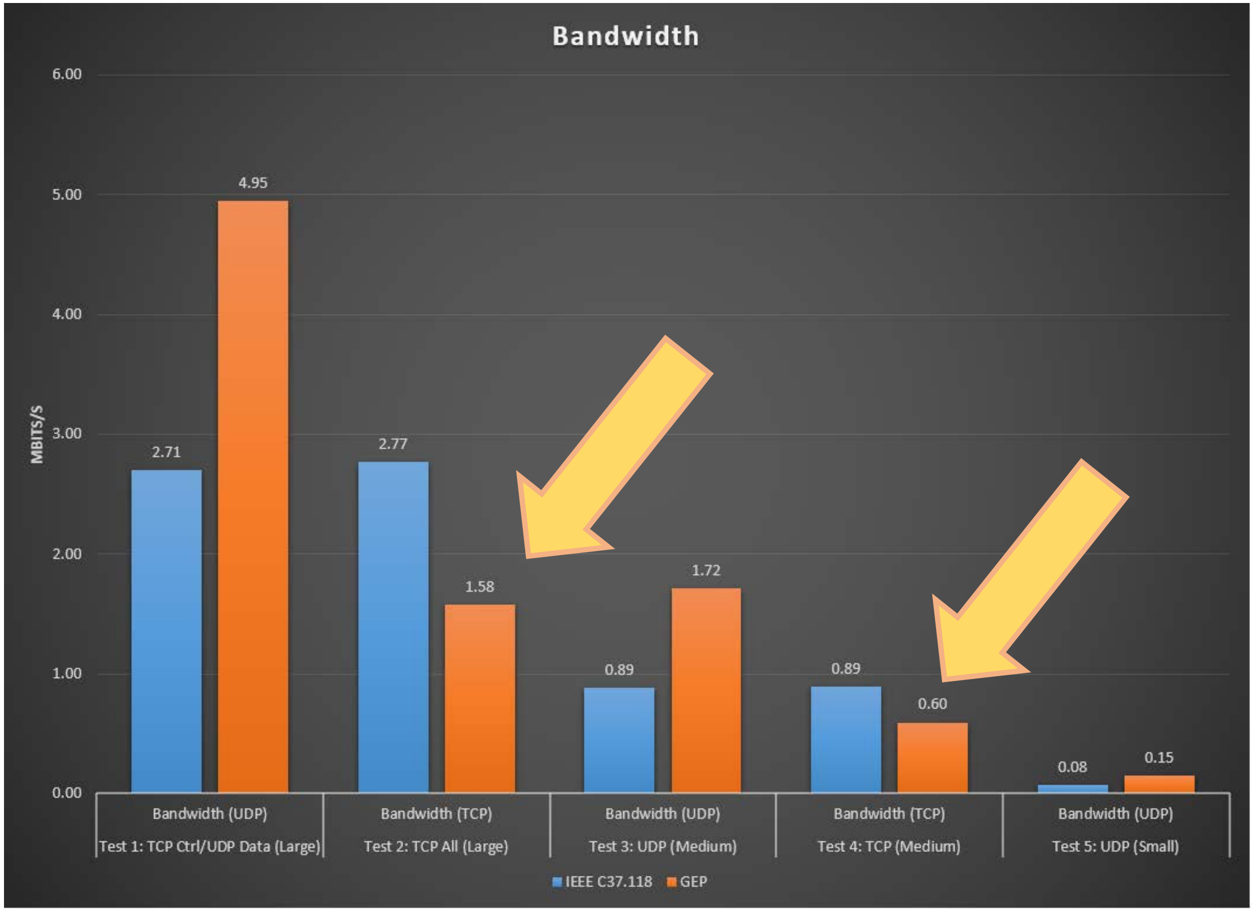
As Expected, Much Less Data Loss with GEP



Preliminary Results*, Peak RC Test Data

GEP is Less Demanding on Networks

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



Preliminary Results*, Peak RC Test Data

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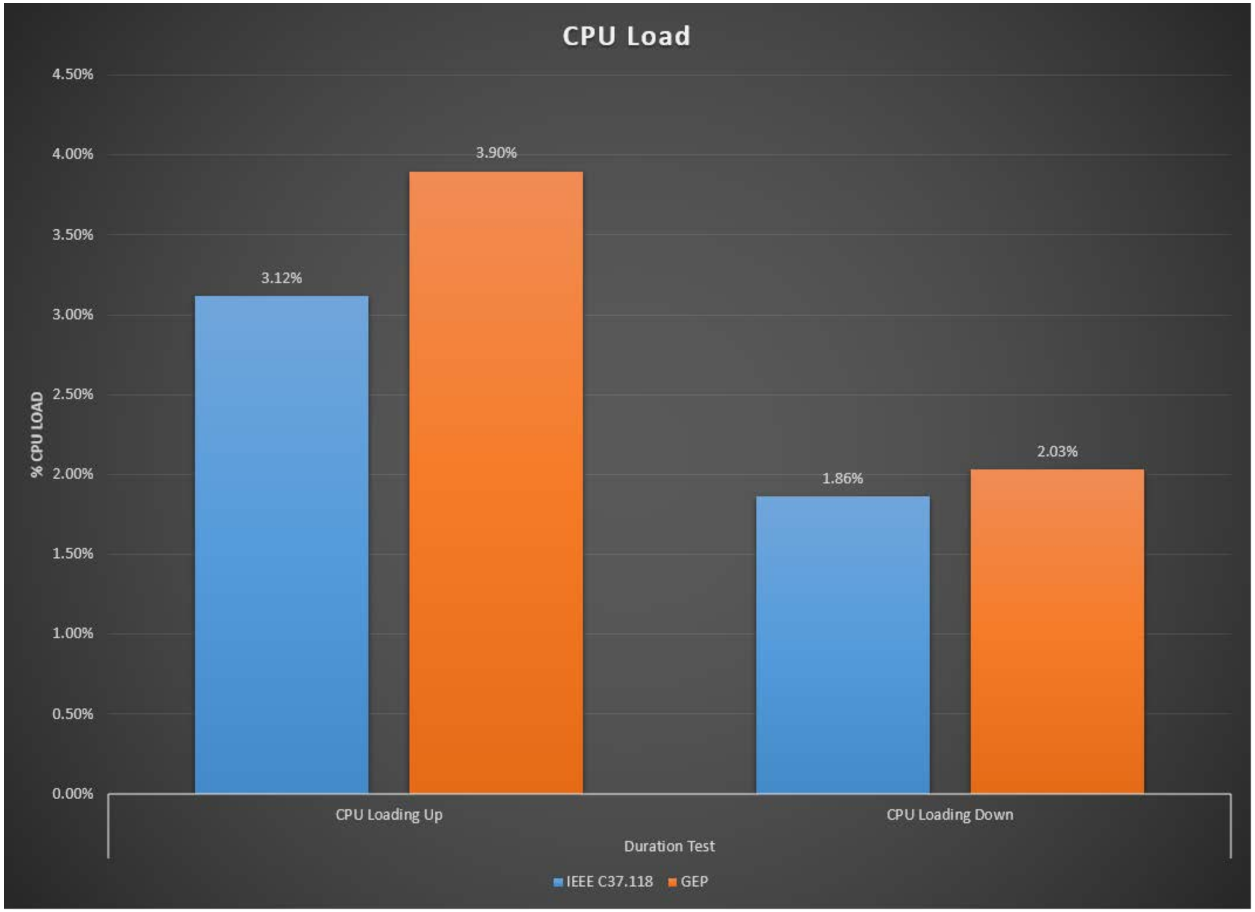
* Report not yet published

Gateway Exchange Protocol

GEP has no Significant Impact on Servers



Preliminary Results*, Peak RC Test Data

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Gateway Exchange Protocol

In Conclusion

- GEP has business and technical advantages – especially for high-volume synchrophasor data streams
- GEP represents a target for "NASPInet 2" – flexible, fast, robust, low-maintenance
  - No centralized measurement registry required
  - A true pub/sub protocol
  - Designed to scale-up to address future phasor data volumes
  - No TCP data loss vs. 0.14% for C37.118
    (using UDP, C37.118 has 15 times the data loss of GEP)
  - Requires only 60% of the network resources as compared to C37.118 for large data flows over TCP
  - Production hardened

openECA will Leverage GEP

Today's Approach

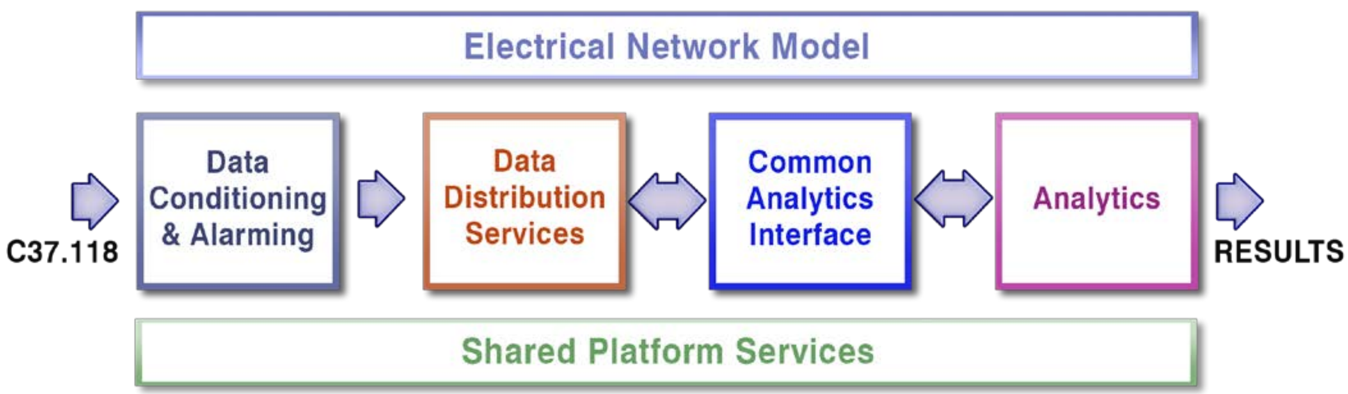
- "Signal" paradigm
- Use C37.118
  - Socket management
  - Protocol parsing
  - Exception handling
- Local data buffering to support analytic cycle times
- Local configuration management

Using openECA

- Both standard and custom data objects
- An API (the CAI) that provides
  - Hi-performance pub/sub data access using standard messaging (e.g., Zero MQ)
  - Access to meta data services
  - Local data buffering options
- Starter templates provided
  - Matlab
  - F#
  - C#

openECA Architectural Elements

- Data Conditioning / Alarming (*Quality Check!*)
- Data Distribution Service
- Common Analytics Interface (CAI)
- Electric System Model
- Shared Platform Services
- Analytics



More information

- White paper delivered to DOE as part od the 2016 Q3 reports will be available on the NASPI website
  - Peak Reliability Synchrophasor Program
    - SOPO Task 7.0 Data Delivery Efficiency Improvements, Subtask 7.1 – New Technology Value Phasor Gateway
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