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Report:
A Comparison of Synchrophasor Protocols

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Abstract

- Paper compares three protocols used for continuous transfer of real-time synchrophasor data: IEEE C37.118.2-2011, IEC TR 61850-90-5, and a new protocol being developed under the DOE Project OE-859 called the Streaming Telemetry Transport Protocol (STTP).
- Each of the protocols is described in detail along with the basis for their operating characteristics using Internet Protocol (IP) transport.
- The dominant protocol for the exchange of synchrophasor data is IEEE C37.118 which is broken into two parts: Part 1 for metrology requirements and Part 2 for data transmission format.
- Both the IEC TR 61850-90-5 and the emergent STTP specifications only address synchrophasor data transmission; therefore, paper focuses on comparing the data transmission protocol elements of these standards.
- The protocols are compared for: structure, efficiency, susceptibility to data loss, scalability, security, and other operability functionality.

Table of Contents

Background on IP and Impacts of Large Frames

- COMMUNICATIONS BACKGROUND
  - Internet Protocol (IP)
    - Fragmentation / MTU
    - High Level Protocols: TCP / UDP / UDP Multicast
  - Serial
- PROTOCOL DATA CHARACTERISTICS
  - Data Types / Groupings / Serialization
- DATA FRAMING
  - Checksums / Synchronization Bytes / Concentration
- LARGE FRAME IMPACT ON IP
  - Specific impacts on TCP and UDP

Protocol Overviews

Each protocol overviews provides structural details so payload contents can be compared

- IEEE C37.118.2-2011
  - Summary / Structure / Timestamp Format / Security / Bandwidth Utilization
- IEC TR 61850-90-5
  - Summary / Structure / Timestamp Format / Security / Bandwidth Utilization
- STTP
  - Summary / Structure / Timestamp Format / Security / Bandwidth Utilization
  - Compression
    - TCP Compression / UDP Compression

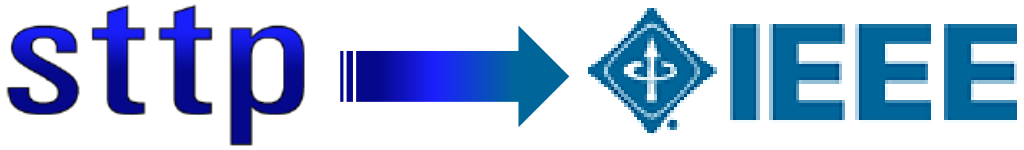
Comparison Conclusions

- **Structure**: *Frame vs Measurement-Centric*
  - Best option depends on use case / scale
- **Efficiency**: *Bandwidth / CPU Utilization*
  - Best option for TCP is STTP, for UDP is IEEE C37.118
- **Data Loss**
  - Best (i.e., minimal loss) is STTP ***at scale***
  - ***All options good*** when total network fragments are less than 20
- **Scalability**
  - Best option is STTP because of non-fragmented transfer – scales to hardware limits
- **Security**
  - Best options are STTP and IEC 61850-90-5 – ideal choice will depend on use case
- **Non-Synchrophasor Data Transport**
  - Best option is STTP as it allows for individual measurement publication frequencies
- **Other Operating Functionality**: *Metadata Extensibility*
  - Best option is STTP because metadata can be extended to any needed datasets
  - IEC 61850-90-5 is good option for substations and CIM integrations

Comparison Summary

FEATURE	IEEE C37.118	IEC 61850 90-5	STTP
Structure	Frame	Frame	Dynamic
Efficiency	Good	Fair	Excellent - TCP Fair - UDP
Data Loss (low volume)	None - TCP	None - TCP	None
Data Loss (high volume)	Low - TCP Some - UDP	Low - TCP Some - UDP	None - TCP Minimal - UDP
Scalability	Fair	Fair	Excellent
Encryption	No	Yes	Yes
Extensible Metadata	No	No (but CIM)	Yes
Multicast Supported	Yes	Yes	Limited

Detailed STTP Appendices to Help Standardization Effort



STTP on track to become:

IEEE 2664

This year the IEEE P10 STTP working group was established to develop a project authorization request (PAR).

The PAR was approved by the IEEE-SA New Standards Committee on September 27, 2018 and given a proposed IEEE standard number of ***P2664***.

Paper Publication Schedule

- Paper undergoing final edits
- Will be published on NASPI.ORG