C37 Status and Quality Flags

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Data & Network Management Task Team

C37.118 Data Quality Flags TF Report

The Data Quality Flags Task Force : Participants

Kyle Thomas, Dominion
Kevin Jones, Dominion
Ken Martin, EPG
Tony Johnson, SCE
Sarma Nuthalapati, ERCOT
Jim Hiebert, CAISO
David Bertagnolli, ISO-NE
Jim McNierney, NYISO
Tony Faris, BPA
Jeff Otto, SEL
Dan Brancaccio, Bridge Energy Group
Mark Adamiak, GE
Ryan Nice, PJM

The Data Quality Flags Task Force : The Task

Primary concern: the best practical use of C37.118 in regards to accurate transmission of data quality and data accuracy between parties, particularly given the challenges of equipment planned outages and several PDC to PDC hops in some data paths.

Operational Issues

Challenges unique to large-scale operational synchrophasor data networks:

1. **Planned Outages:** PMUs and PDCs are subject to planned outages, both for it's own maintenance and in the case of some PMUs the maintenance of the host relay or data recorder as well. Downstream users want to be able to differentiate planned outages versus unplanned failures.
2. **Dropped or Missing data versus Default Filler Data:** Downstream users want to be able to differentiate between data that truly was not received from the source versus data that was received from the source but incidentally has default values and stats.
3. **Synthetic Data**: Downstream users want to be able to differentiate between actual measured values versus values that have been calculated, filtered, or modified.

Order of Synchrophasor Standards

- IEEE Std 1344-1995
- IEEE Std C37.118-2005
  - The message formats were updated from the original standard to improve information exchange with other systems such as a master station. Specifically, the sync, frame size, and station identification fields were added to the data frame, configuration frame, header frame, and command frame. Analog data was added to the data frame, the fraction-of-second (FRACSEC) field replaced the sample count field, and the status field was significantly modified to include time quality.
- IEEE Std C37.118.2.2011
  - The “data transfer requirements” split off from “measurement requirements”. STAT Bit 15 and 14 reinterpreted from Data Valid and PMU Error to 4 state Data error. Bits 09-06 from reserved to PMU Time Quality.

Costs of a Change to the Protocol

Protocol changes are extremely expensive:

- Any additional bits costs bandwidth in route and storage at end.
- The standards must be updated through intensive committee processes.
- Vendors must work changes into product lines.
- Updates/upgrades/patches/reconfiguring in the field.
- If changes are not backwards-compatible, must create and execute a migration plan for each product line and hierarchy.
- IEC 61850 integration of C37.118 could solve some/most/all of shortcomings, but some phasor data consumers are not ready for 61850 integration.

Some Answers Already in C37.118.2-2011 over 2005

Better definition of STAT bit 15 and 14

- In 2005 version, bits are used independently for Data Valid and PMU Error flags
- In 2011 version, bits are a four state map, with the possible states:
  - Good
  - PMU Error
  - Test Mode – don't use the data
  - Error – don't use the data

Some Answers Already in C37.118.2-2011 over 2005

A suggested and reserved value data value for filler data frames for dropped data frames.

- Section 6.3.1 describes standard “filler” data, where STAT is set to “Test Mode” (10), and a special default data value is used (NaN for floating point, -32768 for fixed-point rectangular, -32768 angle for fixed-point polar)

Some Answers Already in C37.118.2-2011 over 2005

A new STAT flag to indicate data modified by post processing.

- 2011 provides a “Data Modified” STAT flag (bit 9), and Section 6.3.1 provides a clear definition of exactly what “modified” means:
  - “This shall include data points inserted by interpolation or lost point reconstruction, and data modified by down-sampling methods, offset adjustment, or error correction. In all other cases this bit shall be set to 0. It shall not be used to indicate conversions such as polar-rectangular and integer-floating point.”
- In a CONFIG frame, the PHSCALE maps “the type of data modification when data is being modified by a continuous process” including a “type not defined here” options, meaning all modifications should be specified on the map.

Recommendations for C37.118.2-2011 Implementation

To explicitly indicate a planned outage event use recommended STAT bits for “Test Mode” (10)

- Downstream data takers can use that STAT value alone to detect outage state, or correlate that STAT value with other out-of-band outage tracking exchanges (email, web forms, etc).
- Outage state might also often precede and proceed an dropped/missing data event.
- State could be set at PMU itself or the responsible party’s PDC.
- No protocol changes needed – just a wide philosophical acceptance that Test Mode is practically equivalent to a Planned Outage state.

Recommendation to Vendors:

- Practical tools at the PMU or PDC interface for Planned Outage handling.

Recommendations for C37.118.2-2011 Implementation

To explicitly identify “filler data” (a synthesized C37.118 sample created at a PDC to fill in for a missing or dropped sample) all PDCs should use the standard for filler samples.

- PDC Output should send proper filler samples per C37.118.2-2011.
- PDC Input and connected Applications should correctly interpret and handle the filler samples.
- Properly used, complete differentiation between test/outage samples, filler/dropped samples, and miscellaneous default value samples is possible.

Recommendation to Vendors:

- In-spec creation and identification of filler data.

Recommendations for C37.118.2-2011 Implementation

To avoid risk of downstream data-takers undesirably or unknowingly receiving modified data instead of strict source data:

- Disciplined and universal use of the data modified flag.
- Standard business practice is to send *unmodified* data to downstream parties unless explicitly requested/notified otherwise.
- Local databases may want to store modified or unmodified data depending on the particular use and purpose of the archive.

Recommendation to Vendors:

- In-spec use of the modified data flags. Architecture to preserve source data where appropriate.

Other Comments from the Team

- Consider joint work with the IEEE PSRC working on C37.118.
- Merging with IEC 61850 may manifest in several changes to C37.118, including data point (not just PMU) level quality indication.
- Working with the NASPI DNMTT to see if there are any other opportunities to improve these recommendations and champion for acceptance.

Questions or Comments

Ryan Nice, PE
PJM Interconnection
Ryan.Nice@pjm.com