Why IEEE C37 Does Not Work Well for Distribution-level Synchrophasors

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All errors attributed to Alex, all good ideas attributed to Harold, due to Alex’s scheduling problems making it impossible for Harold to review.
Hidden assumptions in C37 (1)

• Synchrophasors are a compression algorithm
  – Compress synchronized time-domain waveform samples to far less frequent magnitude/angle pairs
  – Compression ratio is >3:1, typically 100:1
  – It’s a lossy compression, i.e. it isn’t reversible
Hidden assumptions in C37 (1)

• Key point: in lossy compression algorithms, we make assumptions about the underlying data.
  – What information losses are we willing to tolerate? Answer is based on our expectations of data...
Distribution microsynchrophasors and C37 filters

- Require better resolution on magnitude and phase (2 orders of magnitude) than transmission
- Digital filters are tradeoffs between sharpness, damping, and resolution...
- C37 filters are optimized for typical transmission applications
  - Problems with rapid changes during distribution events
  - Problems with resolving distribution-level differences
Distribution microsynchrophasors and C37 definition of frequency

• There is no single definition of frequency!
  – *Harold*: only defensible definition is the LSE estimate of the value of the parameter in the equation, for the window-time defined.
  – *Alex*: The optimal definition depends on your purpose or application.

• The C37 definition is useful for transmission grids (large numbers of generators with rotating mass)

• The C37 definition doesn’t work so well for microgrids, inverters, distribution generally
  – Depends on the application...
  – Microgrid control, coordination with distribution protection devices, inverter loop control, etc.
Distribution microsynchrophasors and C37 data communication

• C37 protocol is optimized for quasi-real-time control, with low latency, highly reliable data channels, and relatively low data rates.

• Distribution microsynchrophasors
  – Failure-prone data channels, especially during interesting events
  – Higher data rates: per individual sensor location, and multiple sensor locations (500MB per day per sensor)
  – Research, mostly, rather than control...
Conclusions

• There’s not much wrong with IEEE C37 when used for its intended application: transmission-level synchrophasors
• Distribution microsynchrophasors have a different set of requirements.
• Micro PMU’s have IEEE C37 built in, but it’s not optimal for most microsynchrophasor applications.
• Other filters, and other comm channels, work better for microsynchrophasors.
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