TCIPG

Trustworthy Cyber Infrastructure for the Power Grid

Lossless Compression of Synchrophasor Measurement Unit Archives

Overview and Problem Statement

Data from syncrophasor measurement units, or PMUs, promise to increase wide-area situational awareness of grid conditions like no previous technology. However, as PMUs become more widely deployed, and as their reporting rate grows from 30 measurements per second to higher levels, the amount of data that must be archived and retrieved for later analysis and reporting requirements will grow to cumbersome levels. The purpose of this work is to develop a compression technique for PMU data that preserves the data's meaningful signal content.

Research Objectives

- Develop a compression technique tailored to the unique characteristics of PMU data.
- Characterize the bits of PMU data in terms of signal content and possible noise.
- Extract meaning from PMU data even when metadata identifying the nature of individual data streams are lacking.
- **Smart Grid Application Area:** Wide area visualization and coordination.

Technical Description and Solution Approach

- Power system data exhibit temporal and spatial coherencies. This tendency toward continuity across time and space is similar to the continuities that exist in images, characteristics used by image compression techniques.
- Similar to PNG compression, our compression algorithm estimates the next value of a measurement based on its previous value and the change seen in a neighboring measurement. The algorithm stores the difference between the expected value and the actual value. If these differences tend to be small, they will lie within a narrow range, and the resulting stream will therefore be more compressible.
- An analysis of the bits in each PMU value reveals some interesting characteristics related to randomness and noise. The least-significant bits of the data in our test streams passed NIST randomness tests, suggesting that they are not part of the meaningful signal content. Our compression approach filters these bits.
- A block diagram of the approach is shown below.
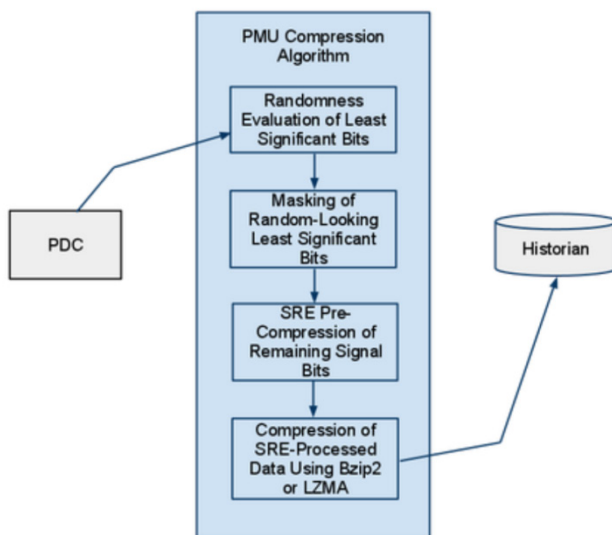
Results and Benefits

- Compression ratios of up to 20 to 1 have been seen with actual PMU data.
- **Partnerships and External Interactions:** Data and tool support from GPA.
- **Technology Readiness Level:** After further testing, the algorithm will be ready for integration with existing PMU archiving software ,like openPDC.

Researchers

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Industry Collaboration

- Paul Trachian and Ritchie Carooll from TVA. Have also been supported with data and PMU streaming tools by the Grid Protection Alliance (GPA).