Wide Area Control and Time Synchronization Issues

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AEP PMU circa 1988

Cost of GPS clock: $13,727.50
General Time Sync Requirements

• General Requirement: about 50 μsec accuracy for Sequence of Events
  - 61850 Time Stamp resolves to about 60 nsec
  - Achieved with IRIG-B / 1588
  - Marginal accuracy with SNTP (typical: 1msec)
  - Non-essential for protection

• Synchrophasor Accuracy Requirement
  - Better than 1 μsec
  - Will become essential for Wide Area Protection
  - Hold-over time / Time Inaccuracy becomes important / a requirement
Special Timing Requirements

• Traveling Wave Protection
  o Better than 1 μsec desirable
  o Essential for protection

• PD/Traveling Wave Fault Detection
  o 100 nsec accuracy desirable
  o Non-essential for protection
Timing Challenge: Current Differential

Current Differential – Typically Self-synchronized
Requirement: 10-20usec

GPS Time Sync NOT needed nor desired…. unless Communication Paths are Asymmetric
Problematic with Process Bus Data – given loss of Sync on one side
Time Sync over MPLS

MPLS node
Acting as a Grand Master
Variance in Time on the two Paths:
Time Sync over MPLS

MPLS node
Acting as a Grand Master

Diagram:

- NMS
- MA WAN
- M
- S
- JAN Port
- JPAX B/C
- NMS
- P
- NON PTP SWITCH
- LAPTOP

MPLS node acting as a Grand Master in the context of Time Sync over MPLS.
Variance in Time on the two Paths:
Wide Area Monitoring and Control

State Measurement

EMS applications for self-healing grid

Data Synchronization & Control Coordination

Input Data:
- 1-60 Phasors/sec
- Control Range
- Control Device Status

Wide Area Control
- Operate Point change
- Linear Control
- On/Off

Transmission Paths
- 500kV Lines
- 345kV Lines
- 230kV Lines
- DC Lines

Phasor Measurement Units

Transmission Paths:
- 500kV Lines
- 345kV Lines
- 230kV Lines
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Phasor Measurement Function

Transfer Function of the PMU: \( P(s) \)

Transfer Function of the Comm Latency: \( \frac{1}{(\tau s + 1)} \)

Voltage
Current

Communication Latency is part of the Closed Loop Solution
Time Synchronized Control

Fig. 4