Turning **insight** into **action**.

OSIsoft. USERS CONFERENCE 2011

Synchronized Data in Smart Grid Applications

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Outline:

- Impending issues
- How can synchronized data be used to address these
- Time synchronized data
- The C37.118 and other evolving protocols
- How can I meet NERC CIP requirements
- How can I use my PI System to handle these data
- Examples from Entergy, CFE, Tenaga, China

Looming issues:

- Transmission and distribution losses
- Transmission asset utilization
- Congestion losses
- PV intermittency in distribution networks
- Wind intermittency within interconnections
- Effect of electric vehicles on network and network components
- Aging infrastructure

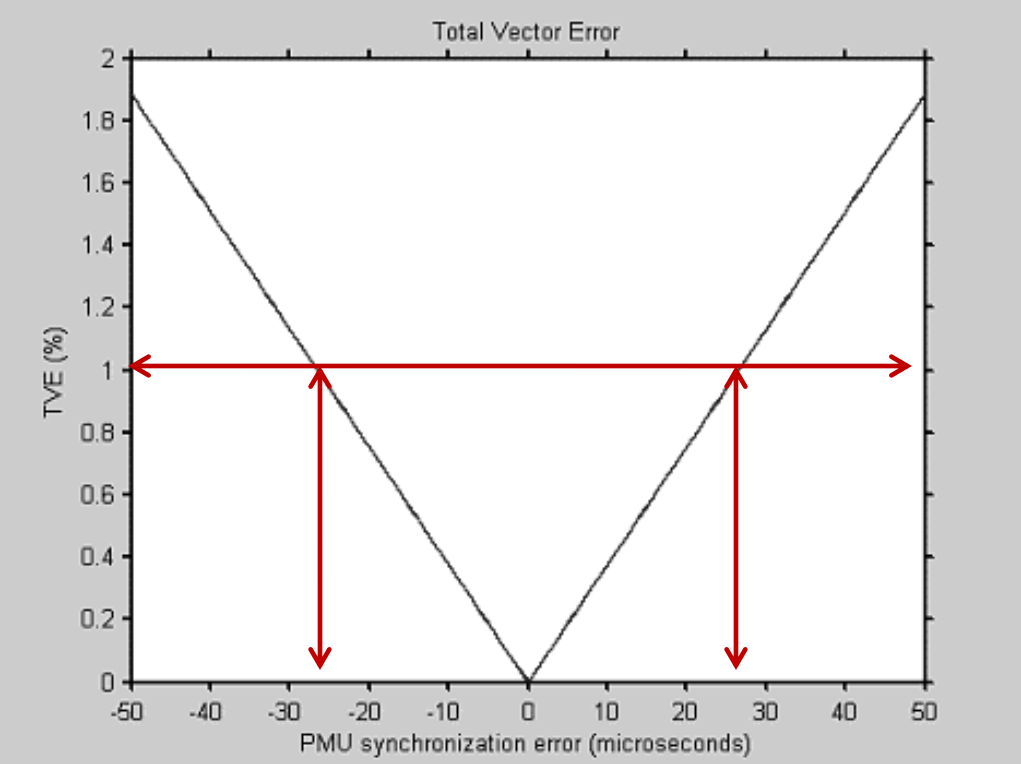
Specific use cases

- Grid coherency (island formation detection)
- Voltage stability
- Small signal stability
- Line ampacity
- State measurement
- Wide area protection
- Wide area control
- Distribution system regulation

Time synchronization

- Measurements made beginning at top of second (TOS).
- Uniform intervals between TOS
  - 10,12,15,20,30 per second for 60 Hz system
  - Optional smaller intervals, 60 and 120 per second
- Accuracy = one percent Total Vector Error
  - This translates to ± 26 microseconds of time error with perfect measurement of voltage and current

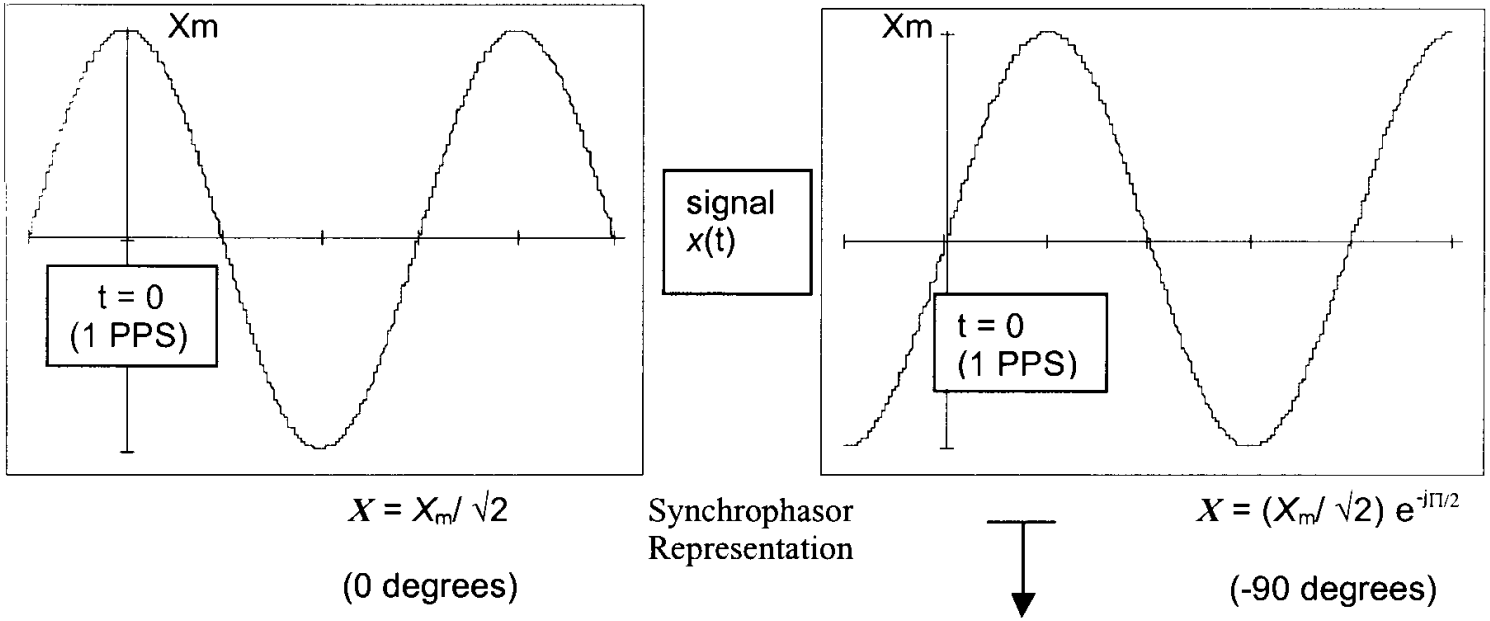
Effect of time error on TVE



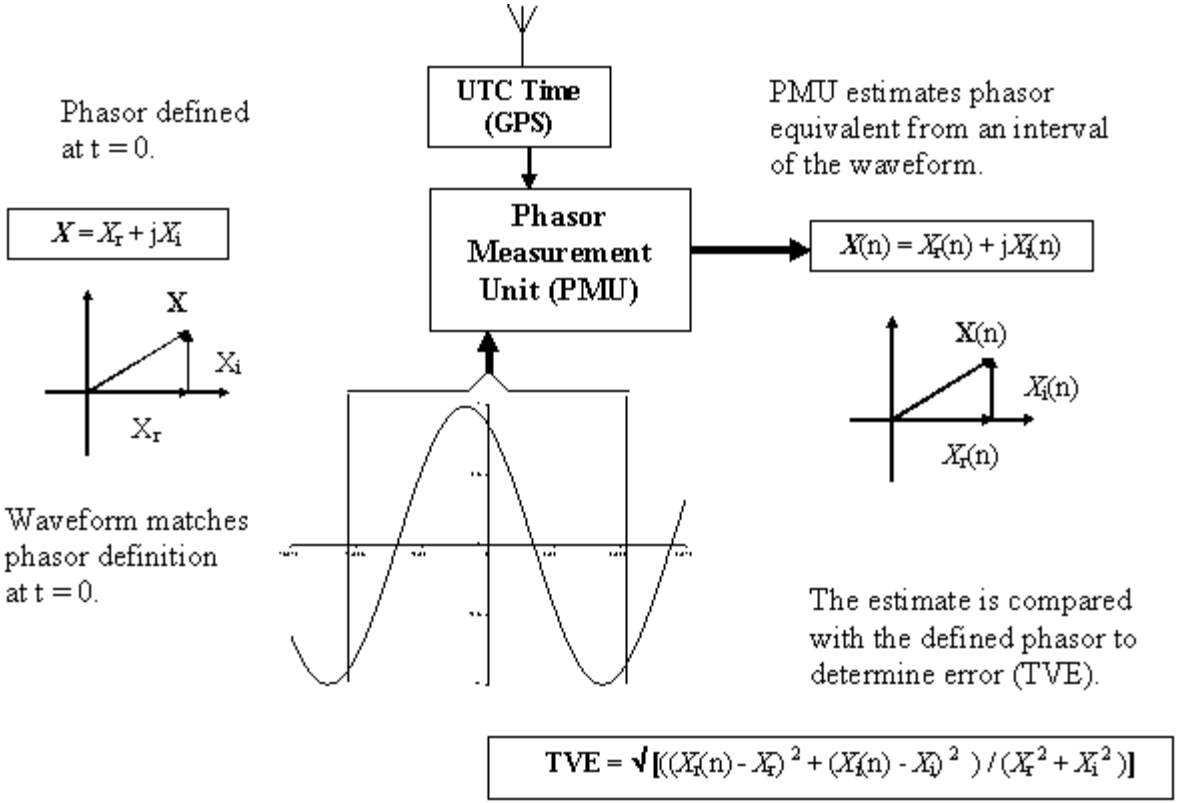
Other errors:

(1) CT or PT calibration
(2) ADC errors
(3) Internal CT and PT errors
(4) Anti-alias filter delay

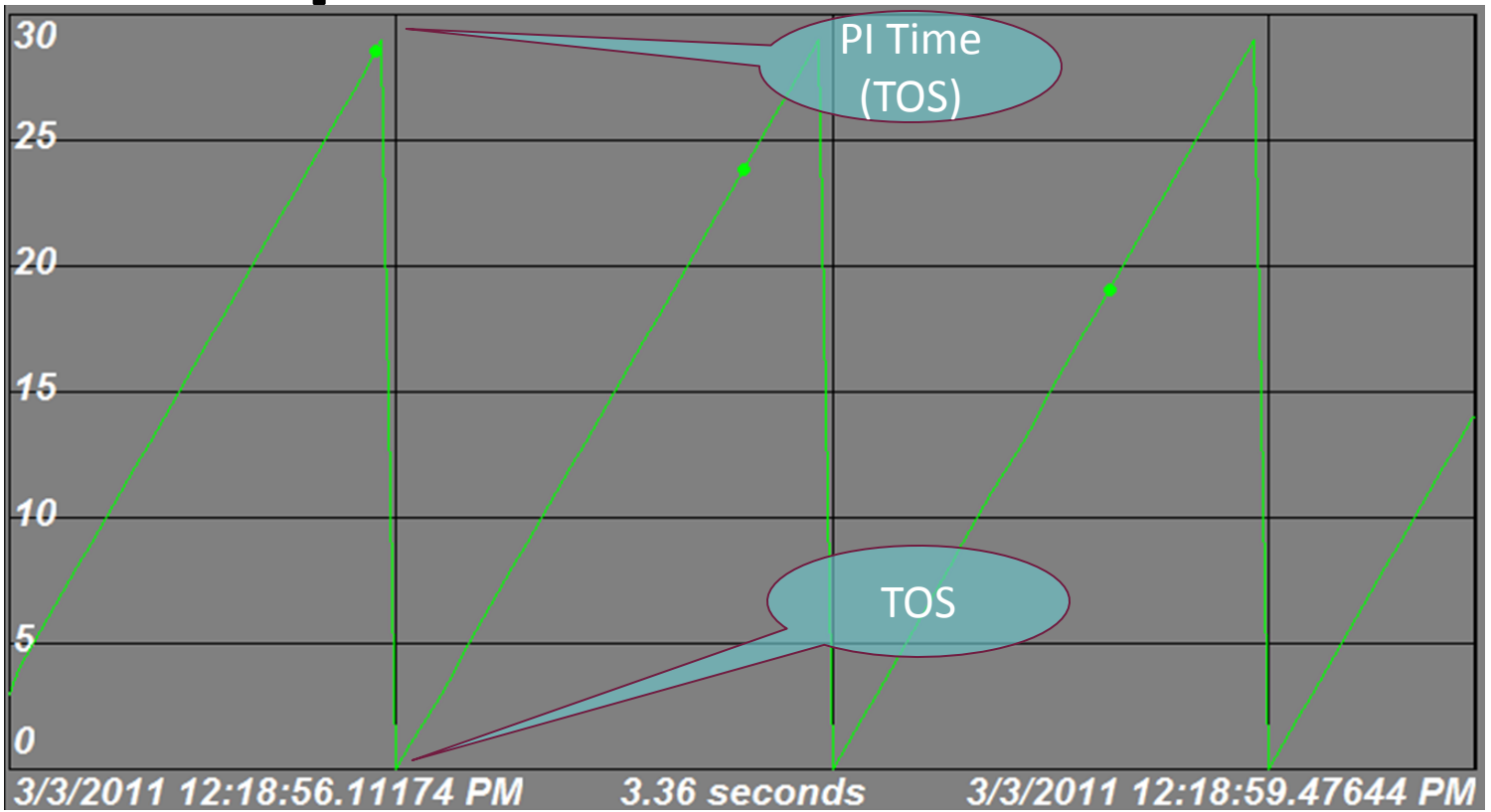
Phasor definition



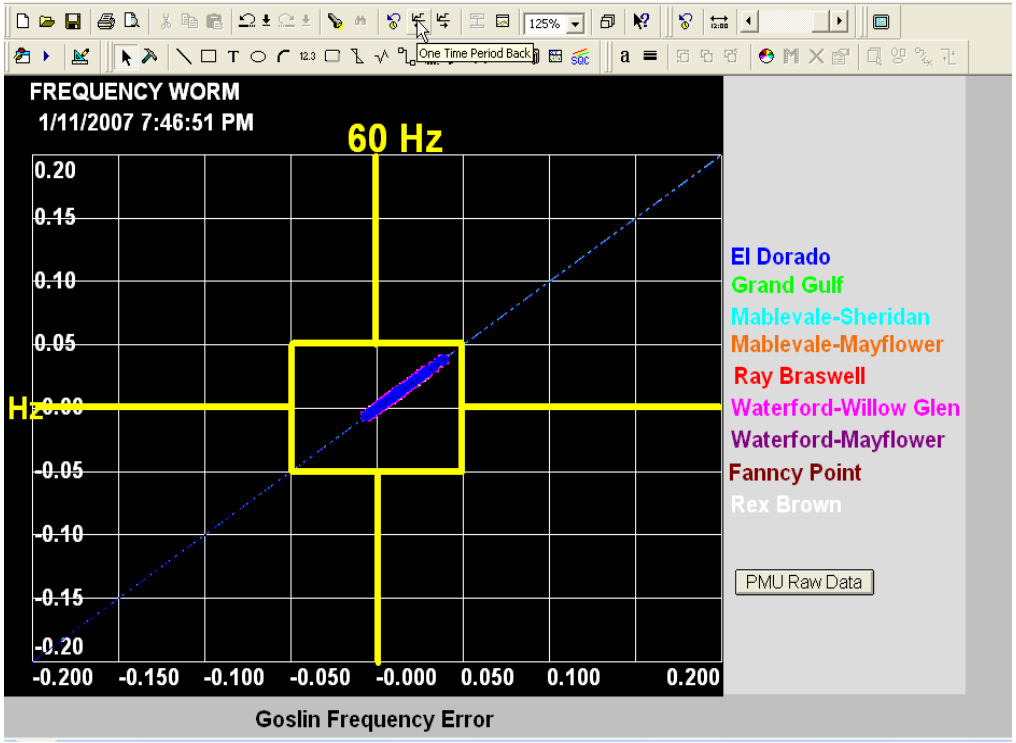
Measurement of TVE

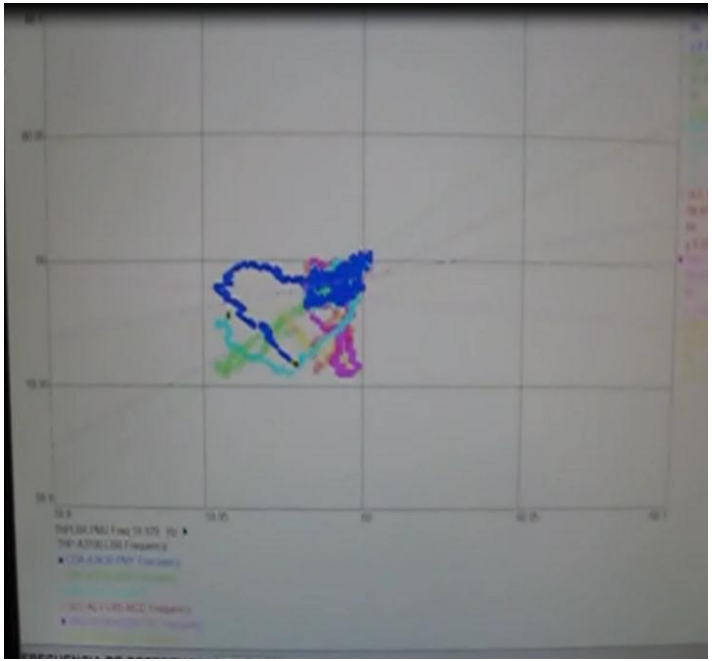


Event sequence

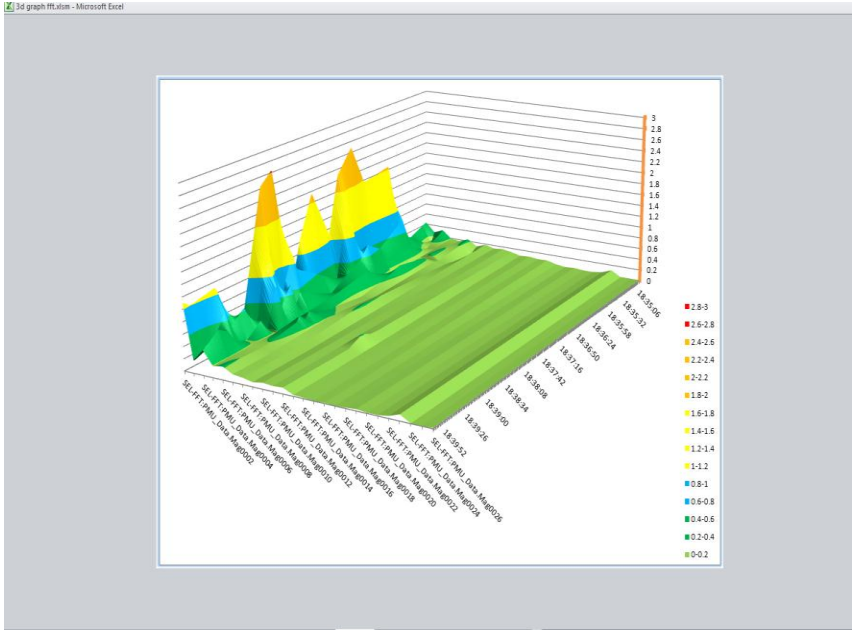


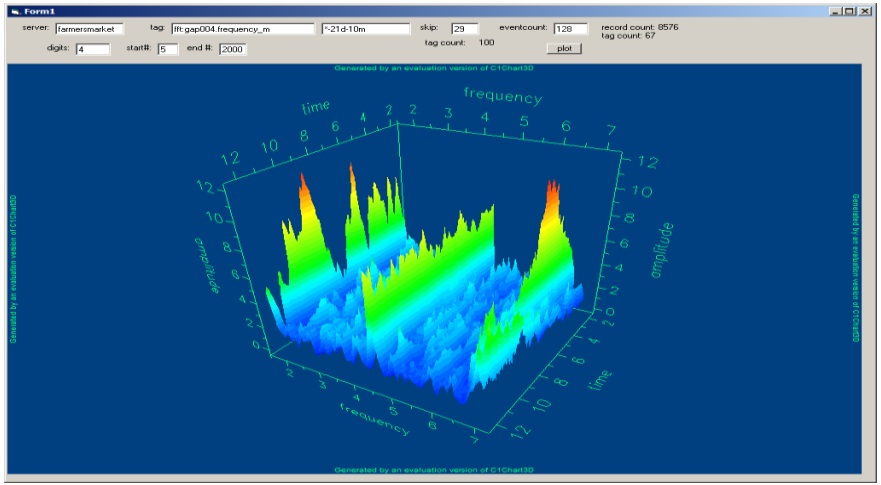
Worm chart



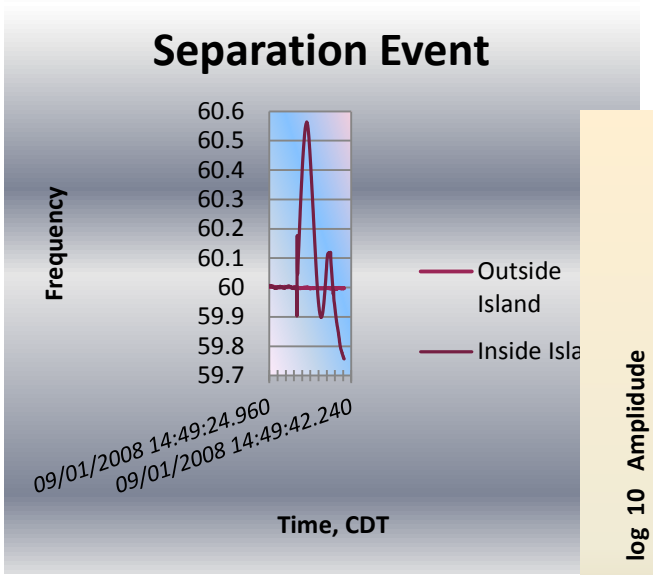


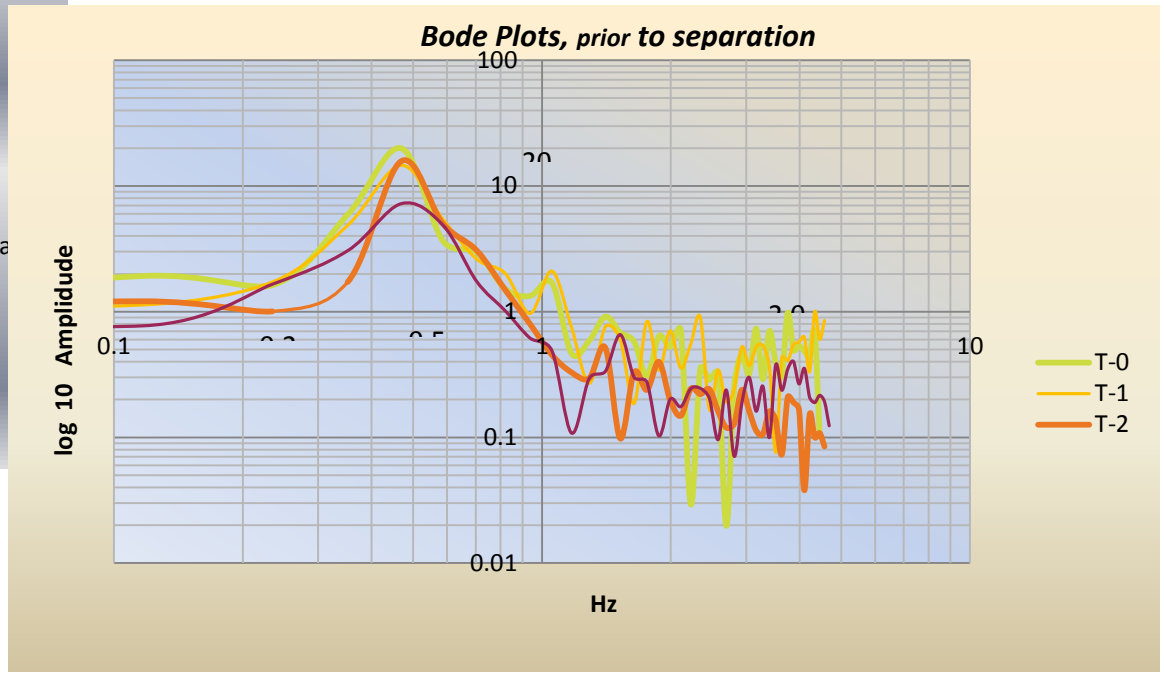
Damping

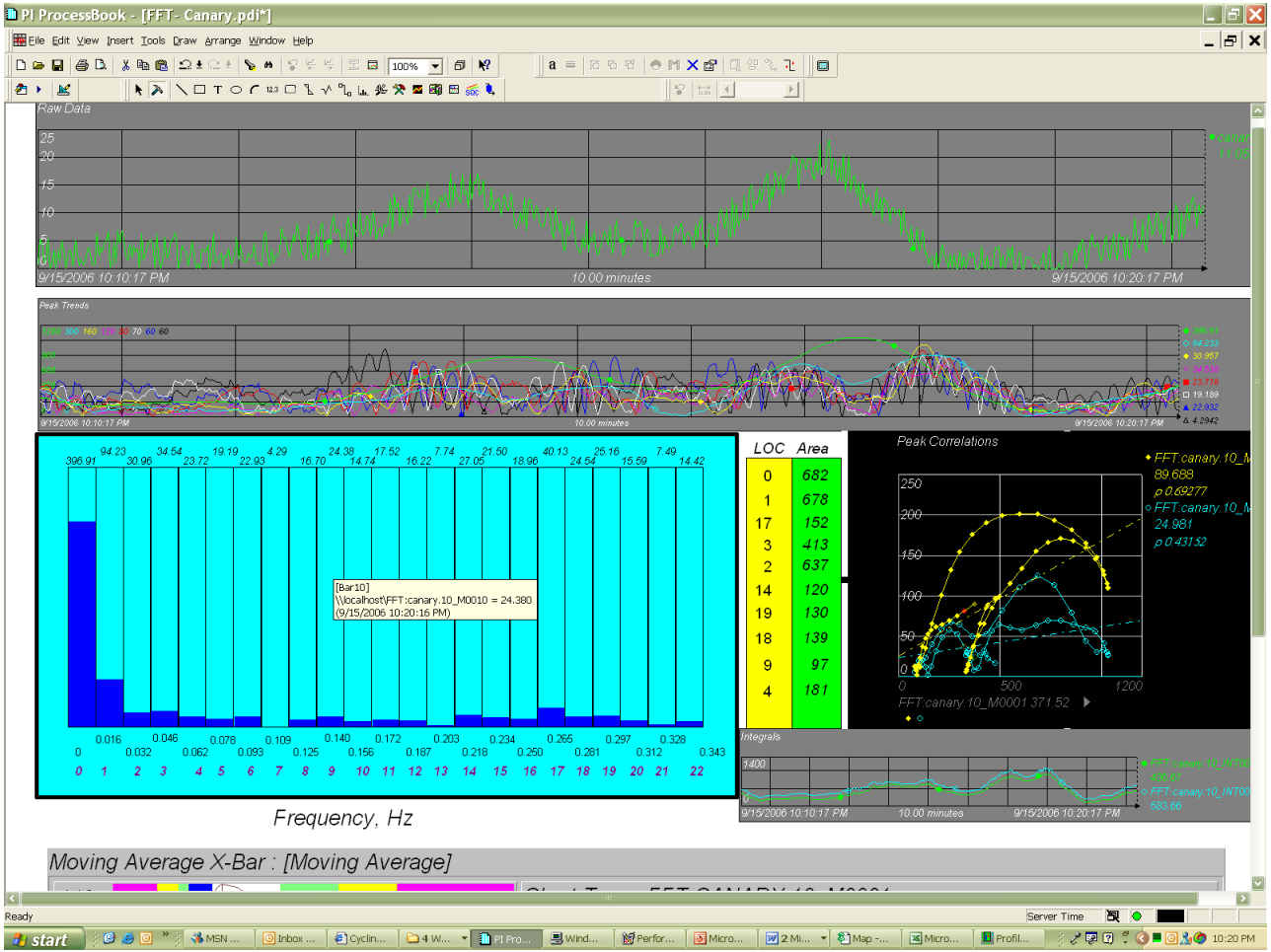




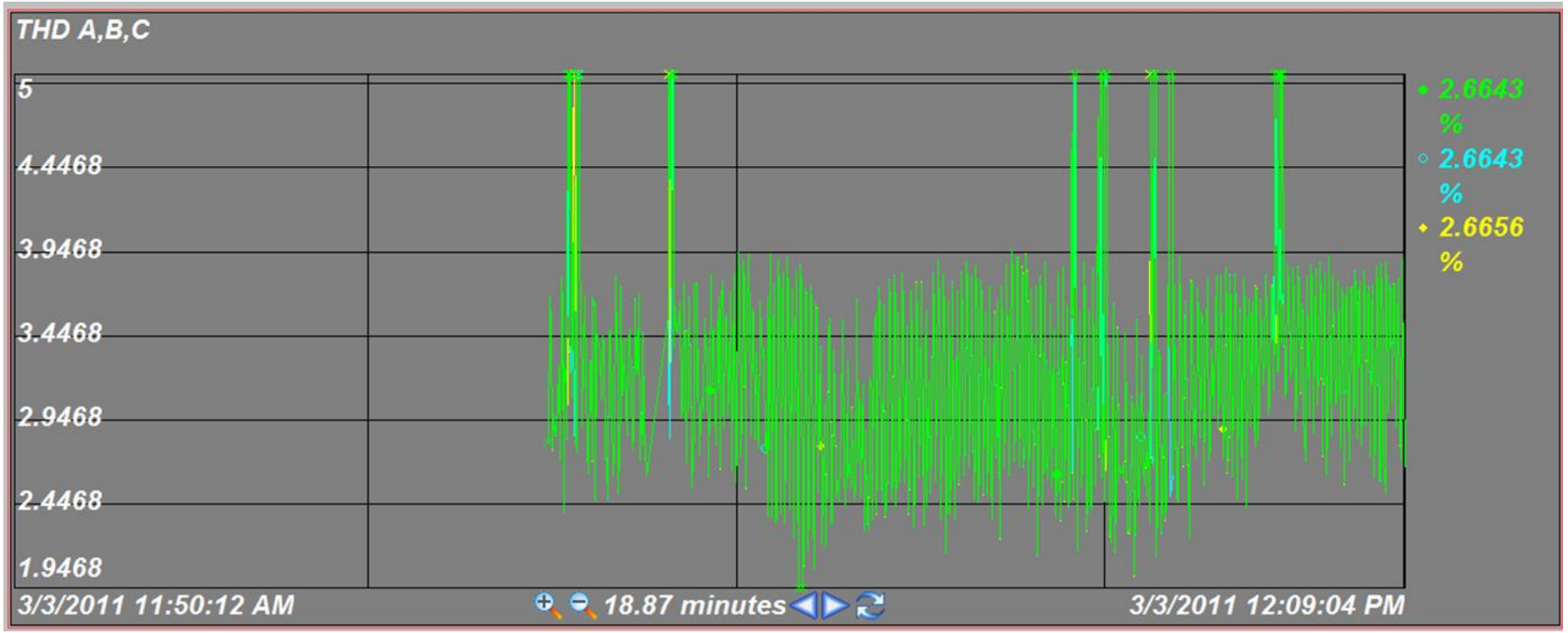
Grid failure detection



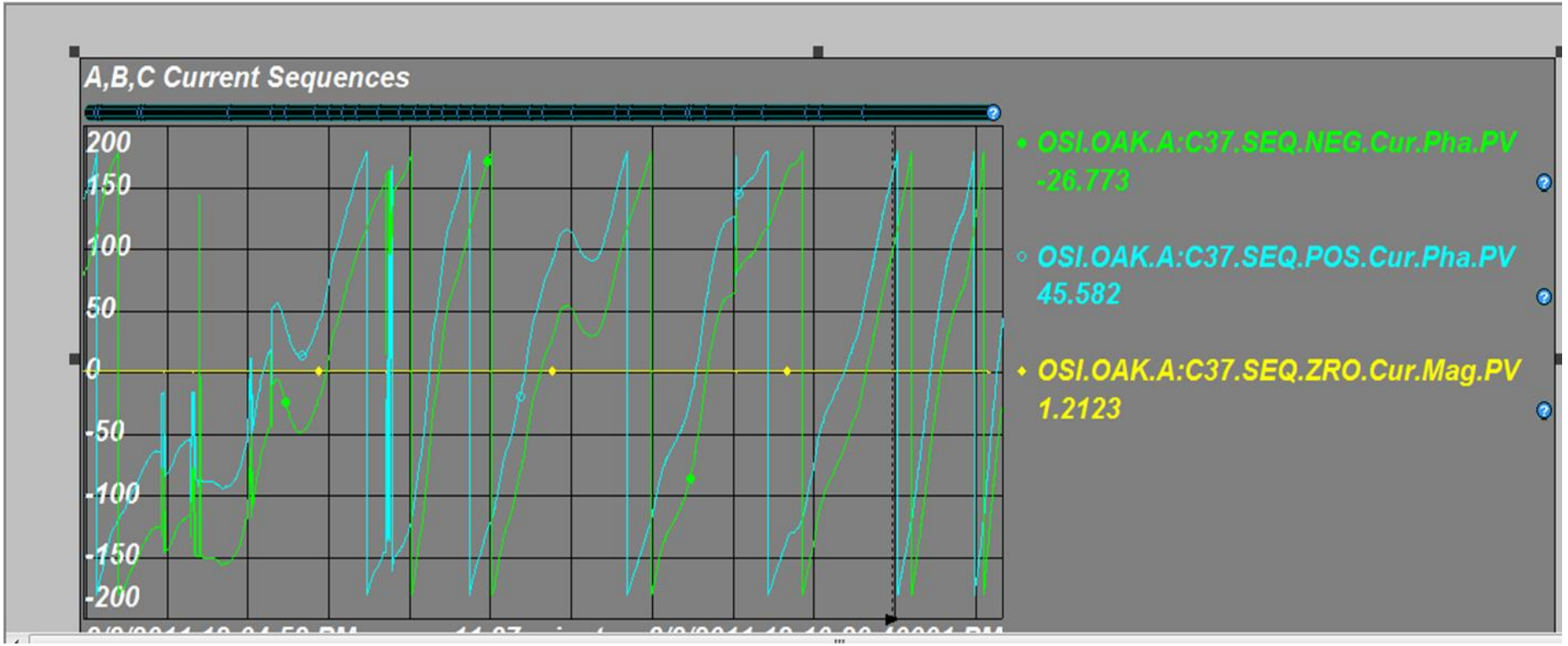




Total Harmonic Distortion



Bad time quality



C37.118 and beyond

- Evolving to C37.118.1 and C37.118.2
- Then merged into IEC 61850-90-5
  - Expect final version this summer
- Some relays already output IEC 61850 messages

NERC CIP requirements

- CIP – 007 Patch Management
- North American Electric Reliability Corporation (NERC) CIP-007-2a Cyber Security – Systems Security Management (R3, Security Patch Management) states that “the Responsible Entity…shall establish, document and **implement a security patch management program**” [10]. As described by NERC in [11], there is a need to architect and design systems that have a commensurate level of availability. NERC states specifically that implementation should be done securely in **redundant pairs** to avoid systemic data gaps while standard maintenance is performed on the system.

Cyber Secure Synchrophasor Platform

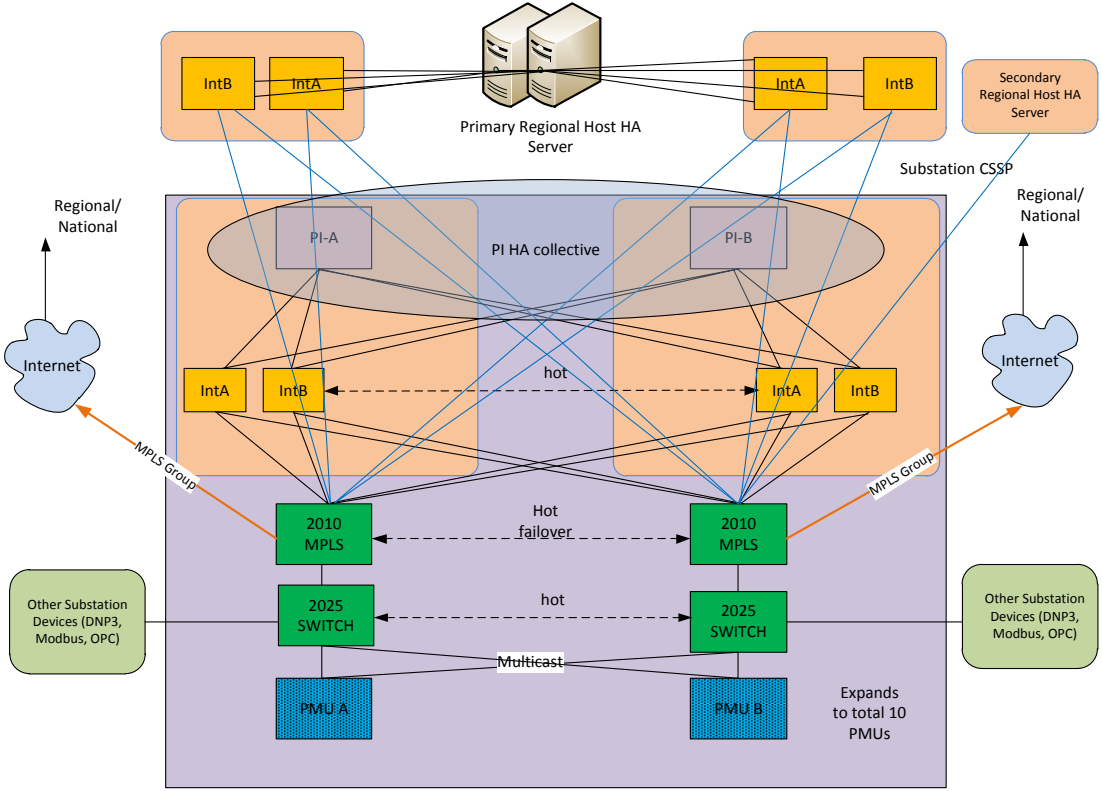
- 2 CT and PTs
- 2 Switches and 2 routers
- 2 PMUs
- 2 Computers
- Standard PI System components

PI System components

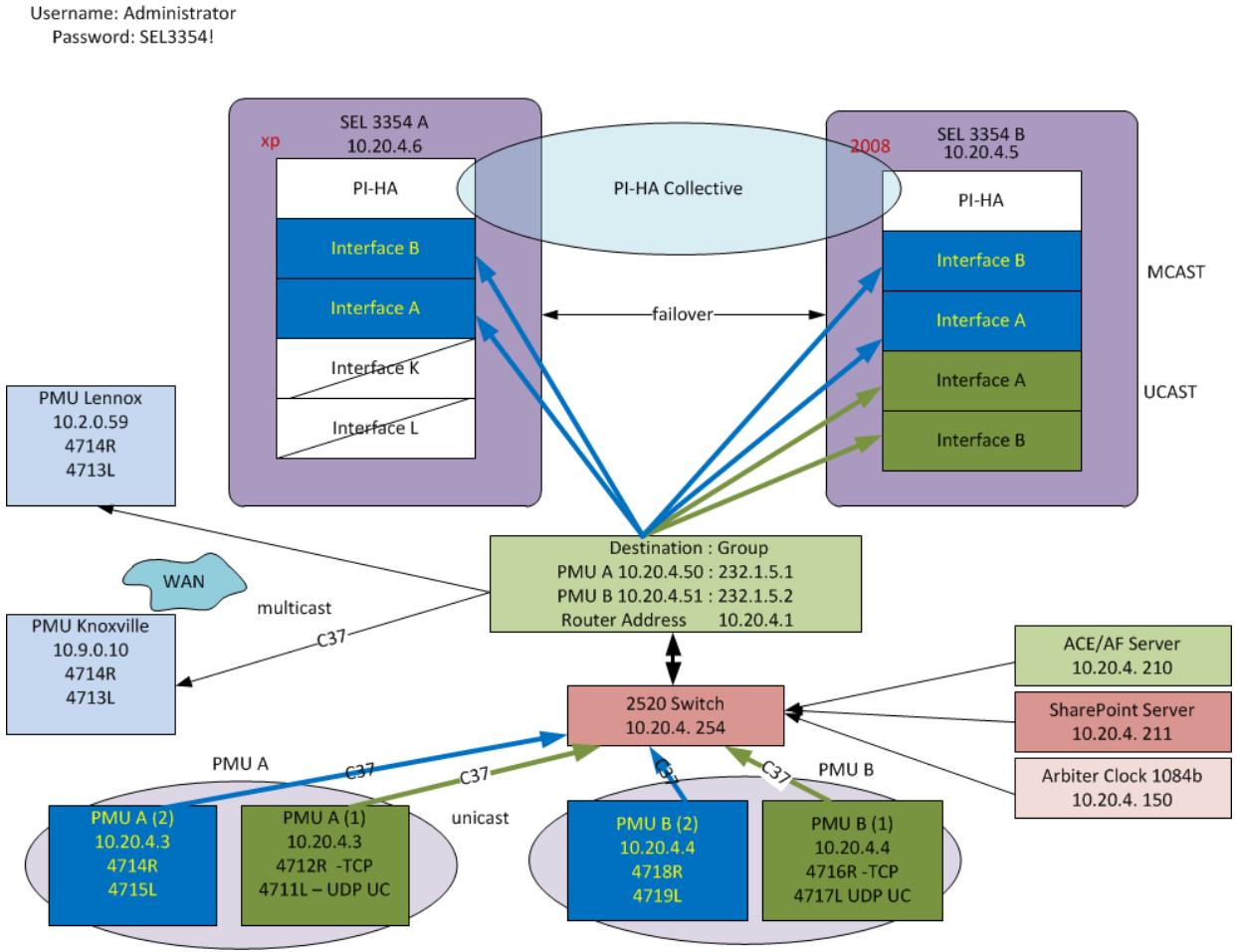
- Four C37.118 interfaces
- Two PI HA server software
- Two PI FFT interfaces
- Two PI ACE running damping calculations
- Two IEEE 1344 interfaces
- PI ProcessBook and PI DataLink

CSSP

Architecture of the CSSP



Details



CSSP Tours

- Entergy, June 2010, San Leandro
- T&D UC , Sept 2010, Chicago
- MISO, Oct 2010, Carmel
- NYISO, Nov 2010, Albany
- Distributech, Feb 2011, San Diego
- NASPI, Feb 2011, Ft. Worth
- IEEE PES, March 2011, Phoenix
- Cisco, March 2011, San Jose
- **OSIsoft Users Conference, March 2011, San Francisco**
- INL, April, Idaho Falls

Take away

- CSSP meets NERC CIP – 007
- Standard PI System components used in CSSP
- MPLS Multicast support
  - No requirement for PDC
- Fully redundant, no data loss
- Compression optional

Thank you

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