Distribution Data for FIDVR & Load Modeling

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Initial Motivation

2011 Timeframe

- NERC TPL-001
  - Addition of dynamic load model requirement in planning studies expected/planned

- Initial Simulation Observations
  - Simulations using composite load model with best guess load composition parameters show widespread FIDVR on Transmission system
  - Actual Transmission level monitoring shows little to no widespread FIDVR

- Goal:
  - Improve distribution level monitoring capability
  - Use captured data to understand phenomena & model parameters
  - Use improved model parameters to perform better informed studies
Distribution Data Gap – Capture Duration

- **Transmission**
  - Distribution Substations
    - Distribution Circuits
      - Customer
        - **Revenue & AMI Meters**
          - Snapshot
          - ms
          - sec
          - Continuous
  - **DFRs, Digital Relays**
    - Digital Relays, PQ Meters
    - PMUs
      - Large deployment

**SCADA**
Distribution Data Gap – Monitoring Resolution

Transmission

Distribution Substations

Distribution Circuits

Customer

DFRs, Digital Relays, PMUs

Digital Relays, PQ Meters

Digital Reclosers

SCADA

Revenue & AMI Meters

μs  ms  sec  min  hr  day  months
Initial Field Installations
2012-2014

- Portable Digital Fault Recorders (DFRs)
  - 3 Portable DFRs purchased
  - Placed in distribution substations throughout our system
  - Can monitor 3-phase voltages and 3-phase currents at two distribution feeders
  - High resolution oscillography
  - Continuous RMS
  - Synchrophasors
  - Local storage and communications
Initial Field Installations

2012-2014
Initial Field Installations
2012-2014

- High quality data captured over 3 summers
  - Moved the Portable DFRs around every summer
- Devices never failed
- Communications had high uptime, local storage a perfect backup
- Excellent service to customers
  - No significant events captured!
    - Very few events occurred at all
    - The couple of events occurred at very end of the circuits
Distribution PQ Meter Data

2013 and on

- Power Quality meters installed on low-side of Distribution Transformers
  - Primary purpose for helping with customer service issues

- PQ data automatically collected via network and dial-up

- Historical data going back to 2005
Example 1 - July 2006 4pm

- Rated Voltage: 12.5kV<sub>ll</sub>
- Fault Voltage: ~0.5 pu
- Over-voltage: ~1.2 pu

Graph showing voltage over time with markings for rated voltage, fault voltage, and over-voltage.
Example 1 - July 2006 4pm

Line Current [kA]

Time [s]

Phase A RMS Current
Phase B RMS Current
Phase C RMS Current
Neutral RMS Current

10 s
Example 2 – August 2006 6pm

Voltage

Rated Voltage: $34.5kV_{LL}$

Fault Voltage: ~ 0.5 pu

Over-voltage: ~ 1.1 pu

Time [s]: 10 s
Example 2 – August 2006 6pm

Line Current [kA] vs. Time [s] graph showing RMS currents for Phase A, Phase B, Phase C, and Neutral channels. The graph includes a time label of 10 s on the x-axis.
PQ Meter Settings

– Did not find any FIDVR events in the PQ meter network since the 2006-2008 timeframe
  • Problem solved?

– Past: Magnitude trigger with duration setting
  • Can capture longer term dynamics following faults

– Current: Trigger on V < 0.9 pu, stop capture upon recovery back to 0.9 pu
  • Very useful for fault analysis, but not for longer dynamics such as A/C motor stalling
Latest Field Installations

Summer 2015

- 10 PQube devices from Joe Eto & Richard Bravo
- Installed on pad mount transformers around our territory
- Selected circuits with portable DFRs and/or digital relays on distribution feeder
- Data being collected at this time
Going Forward

Standardization = Proliferation

- Transmission PMUs as % of Total Capital Expenditure <= 0.1%
  - $1M/yr expected on PDC infrastructure & architecture

- Distribution Substation Hurdles
  - Use 300-series SEL relays (387/351) w/o PMU capability
  - Use Power Quality meters (SEL 734/735) w/o PMU capability
  - Adding PMU functionality to these devices will proliferate PMU technology into Distribution

- Fix/standardize meter and relay settings
- Automate data/file collection
- Distributed Generation increasing need/push for high resolution data on distribution (ex: PMUs)