

openPDC @ ISO-NE

Qiang (Frankie) Zhang

GPA User Forum

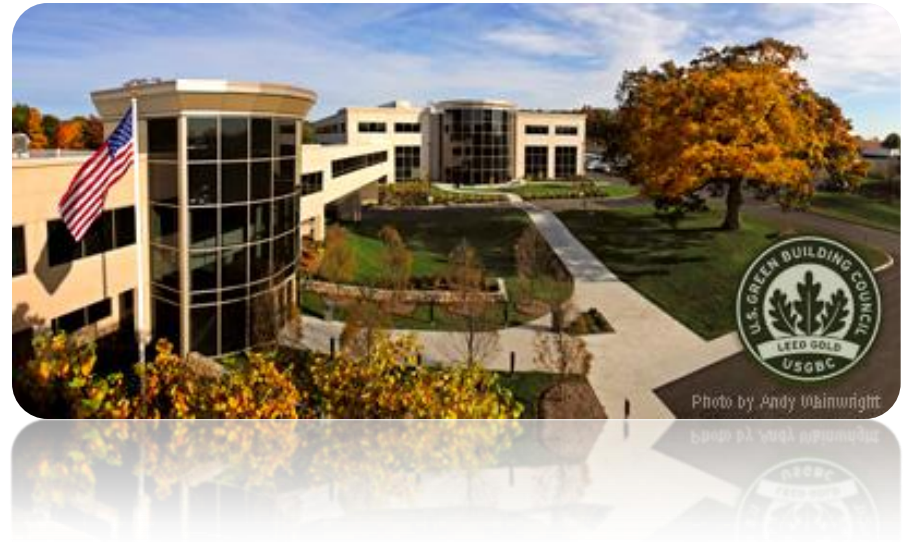
Atlanta, GA, Sep. 7, 2011

Outline

- Synchrophasor Data Project Overview
- User Experience
- Lessons Learned
- Data Quality Monitoring System
- Suggestions

About ISO New England

- **Not-for-profit corporation created in 1997 to oversee New England's restructured electric power system**
 - Regulated by the Federal Energy Regulatory Commission (FERC)
- **Regional Transmission Organization**
 - Independent of companies doing business in the market
 - No financial interest in companies participating in the market
- **Major responsibilities:**
 - Reliable **operation** of the electric grid
 - Administer wholesale electricity **markets**
 - **Plan** for future system needs



About ISO New England

- 6.5 million electricity customers, population 14 million
- 350+ generators
- 8,000+ miles of high-voltage transmission lines
- 13 interconnections with systems in New York and Canada
- 32,000+ megawatts of total supply (summer)
- 2,500+ MW of demand response (10/10)
- Peak demand:
 - Summer: 28,130 megawatts (8/06)
 - Winter: 22,818 megawatts (1/04)
- 400+ participants in the marketplace
- \$12 billion electric energy market (2010)



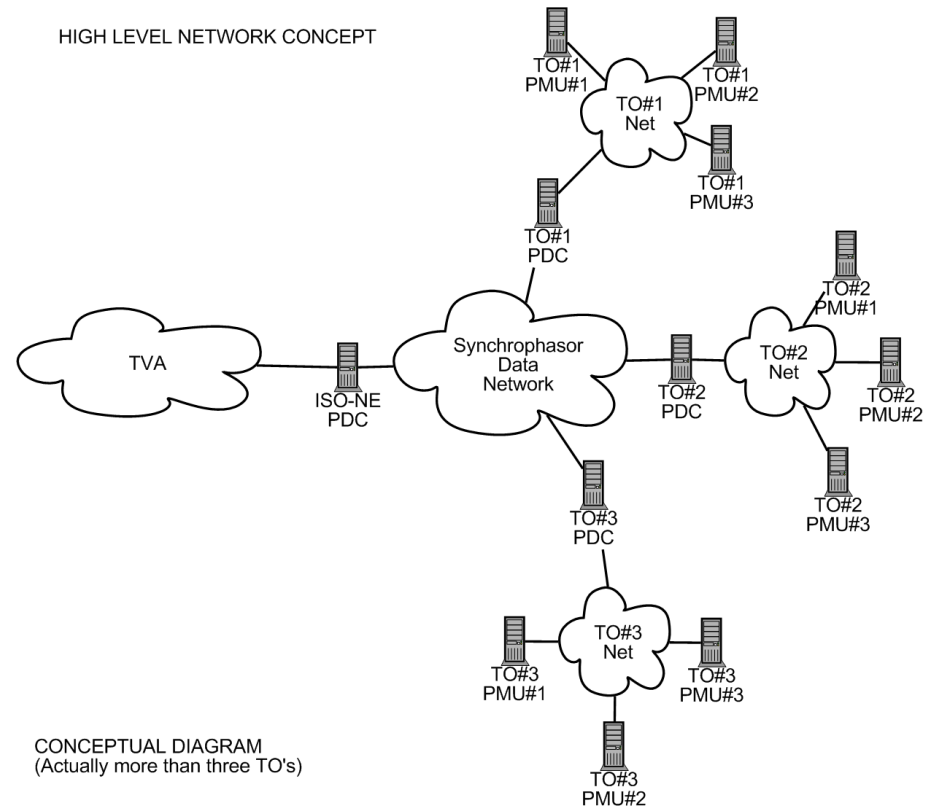
ISO-NE Synchronphasor Project Overview

- Total budget: \$18M
- 3 years, 2010 - 2013.
- 7 TOs, 40 Substations.
 - 345kV Observability.
- 7+2 openPDC.
- 3 Applications:
 - ROSE (V&R)
 - TEA/DEMA/VIS (ALSTOM Phasorpoint)
 - Historian (ALSTOM)

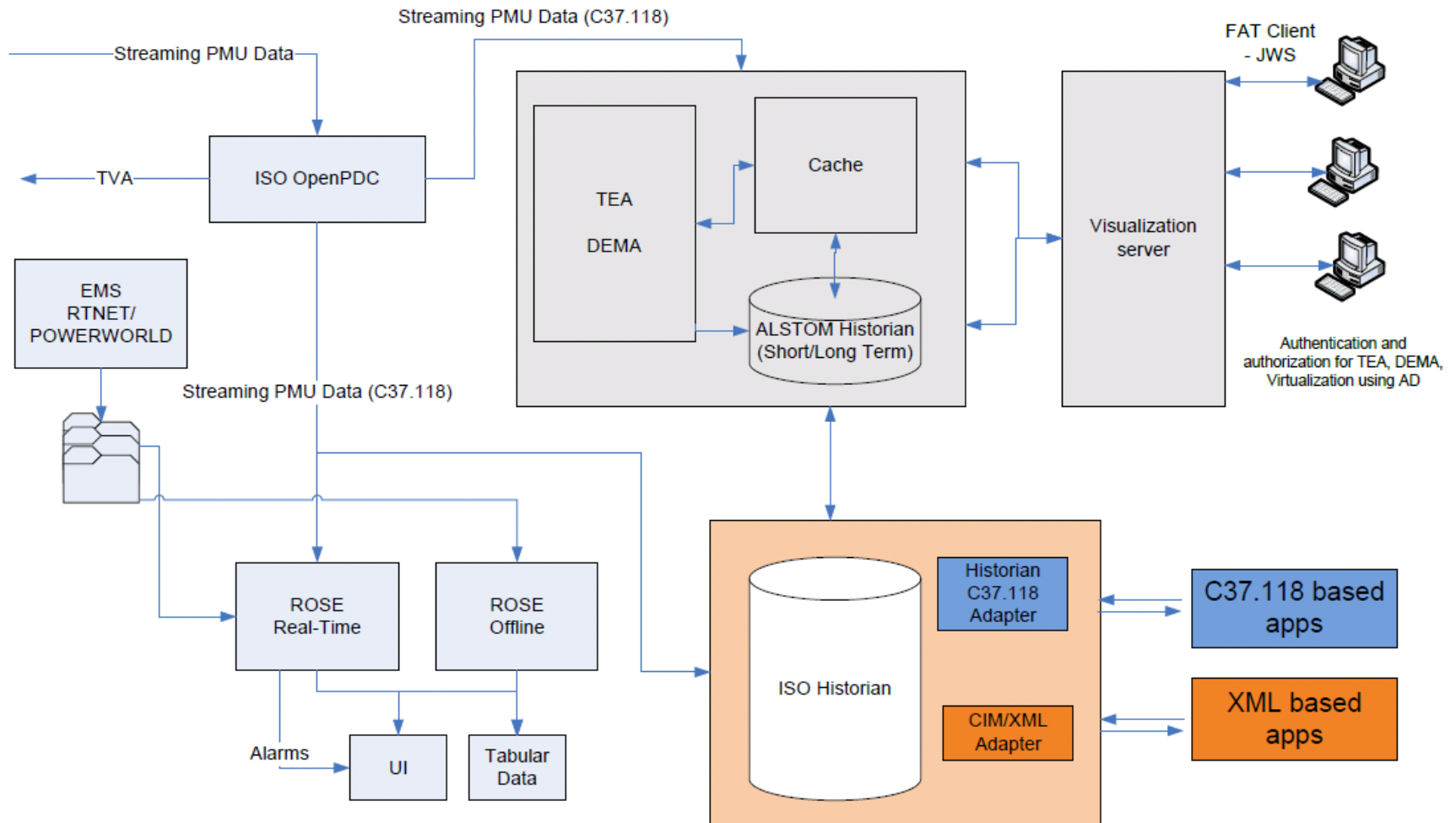


Network Infrastructure

- PMU, DFR, Relay, etc.
- C37.118 - 2005.
- TCP/IP.
- 7 TOs -> ISO communication.
- GPS time signal to each PMU and PDC.



Internal Architecture



Our PDC Requirements

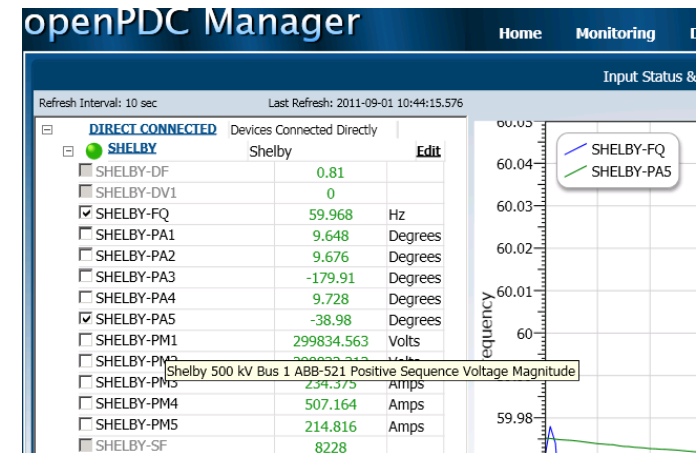
- Stream data to other standalone applications.
- A separate Historian.
- Stream status report/log.
 - PMU data stream changes.
 - Component failure.
- Performance.
 - Latency, availability, capacity.
- Compatibility with other vendors.
 - Conformity with standards.
- Data sanity check.

Why openPDC

- Software PDC
 - Flexibility
- Open source
 - User debugging.
 - Supports outsourcing.
 - Customization.
- Emphasis on advanced adapters
 - Expandability.
 - Code reduction.

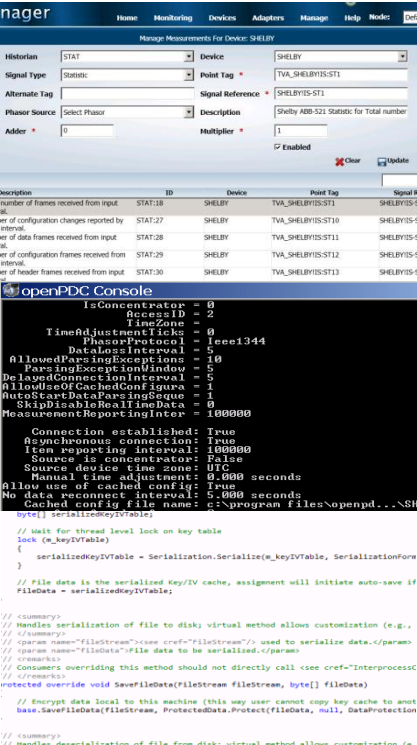
ALSTOM Grid Support

- Documentation and Training.
- Release testing.
- Onsite installation.
- Troubleshooting.
- Customization.
 - Channel name display (in progress).



User Experience – openPDC

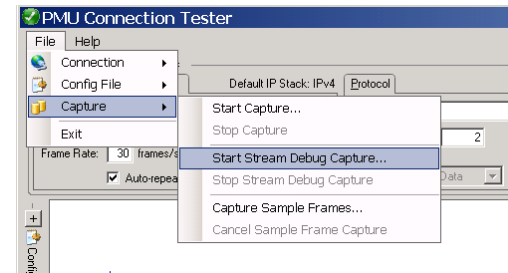
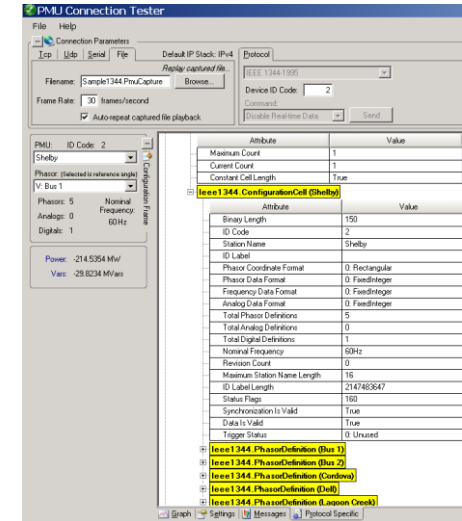
- What we like:
 - Does not tamper with data, yet capable of doing it if desired.
 - Highly Configurable.
 - 3D user experience.
- Horizontal, **vertical**, development life cycle.
- Improvements:
 - Much more stable now.



The image shows two screenshots. The top one is a web browser window displaying the 'nager' interface for managing measurements for a device named 'SHELBY'. It includes fields for Signal Type (Statistic), Point Tag (TVA_SHELBYIS-ST1), Signal Reference (SHELBYIS-ST1), Phasor Source (Select Phasor), and Multiplier (1). Below these fields is a table with columns for ID, Device, Point Tag, and Signal. The bottom screenshot is a terminal window titled 'openPDC Console' showing configuration parameters such as IsConcentrator, AccessID, TimeZone, and various intervals. It also displays a large block of C# code for serializing and deserializing Key/IV tables.

User Experience – PMU Connection Tester

- Pre-installation network verification.
- Synchrophasor data validation.
 - C37.118 configuration frame decoding.
 - Voltage, power value display.
 - CSV files for further analysis.
- Troubleshooting.
- Potential usage.
 - A “multi-meter” for PMU vendor and everyone.



Lessons Learned

- User exhaustive tests and feedbacks are important.
 - GPA/ALSTOM have limited test environments/manpower.
 - TCP/IP: “Send config” ->“Stop” will stop everything.
 - Multiple user log in.
- Reliable and accurate time source is very important to the whole synchrophasor project.
- Parameter settings needs investigation.
 - Lead time, lag time.



Data Quality Monitoring System

- A new openPDC Adapter.
- 24x7 online monitoring and alarming.
- Ensure applications get “quality data”.
 - Availability, Timeliness, Validity.
- Extends current openPDC data quality monitoring adapters.

Data Quality Monitoring System

- Add other features to make it comprehensive:
 - Reasonability check:
 - Engineering judgment (require experience with PMU data).
 - Endless scenarios: anything can go wrong (R&D).
 - Crosscheck:
 - Compare data with SCADA/SE and other PMUs.
 - Other features:
 - UI reporting for IT daily maintenance monitoring (alarm).
 - Diagnose problem element (source).
- Is “State Confirmation” project still around?

Suggestions

- PMU Connection Tester (very useful tool):
 - Make it a single package that already includes necessary .Net contents (No need to install .Net framework separately).
 - CSV file first line displacement.
 - Output power (P&Q) in CSV files (useful in data validation).
 - Output config file in a more human readable format.

PMU: ID Code: 2
Shelby
Phasor: (Selected is reference angle)
V: Bus 1
Phasors: 5
Nominal Frequency: 60 Hz
Analog: 0
Digitals: 1
Power: -220.4251 MW
Vars: -35.8461 MVars

Power/Var Calculations
Voltage Phasor:
0: Bus 1
Current Phasor:
2: Cordova
3: Dell
4: Lagoon Creek
Restore Defaults

```
<a3:AnalogDefinitionCollection id="#ref-9" xmlns:a3="http://schemas.microsoft.com/clr/nsaa"
<maximumCount>0</maximumCount>
<count>0</count>
</a3:AnalogDefinitionCollection>
<a3:DigitalDefinitionCollection id="#ref-10" xmlns:a3="http://schemas.microsoft.com/clr/nsaa"
<maximumCount>1013</maximumCount>
<count>1</count>
<item0 href="#ref-16" />
</a3:DigitalDefinitionCollection>
<a1:PhasorDefinition id="#ref-11" xmlns:a1="http://schemas.microsoft.com/clr/nsassem/T"
<parent href="#ref-5" />
<index>0</index>
<label id="#ref-17">Bus 1</label>
<scale>2466979</scale>
<offset>0</offset>
<type xsi:type="a3:PhasorType" xmlns:a3="http://schemas.microsoft.com/clr/nsassem"
<voltageReference xsi:null="1" />
</a1:PhasorDefinition>
```


Suggestions

- openPDC

- Better UI experience

- Easier and faster navigation and configuration.
- Less unnecessary “confirm”.
- Make displays more informative and easier to get information from.



Comprehensive table
More informative

Input Stream	Shelby	Run-Time Statistics	Time
SHLBY-01	Data Quality Errors	0	2011-09-01 14:05:46.843
SHLBY-02	Time Quality Errors	0	2011-09-01 14:05:46.843
SHLBY-03	Device Errors	0	2011-09-01 14:05:46.843
SHLBY-04	Last Report Time	05:46:53.2	2011-09-01 14:05:46.843
SHLBY-05	Total Frames	296	2011-09-01 14:05:46.843
SHLBY-06	Missing Frames	0	2011-09-01 14:05:46.843
SHLBY-07	Total Data Frames	301	2011-09-01 14:05:46.843
SHLBY-08	Total Configuration Frames	0	2011-09-01 14:05:46.843
SHLBY-09	Out of Order Frames	2	2011-09-01 14:05:46.843
SHLBY-10	Input Stream Connected	True	2011-09-01 14:05:46.843

Put Actual Measurement in front of Statistics.

Description	ID	Device	Point Tag	Signal Reference	Enabled
Shelby Cordova ABB-521 Positive Sequence Current Phase Angle	VIRT-10	SHELBY	TVA_SHELBY-PA3-ABB5H	SHELBY-PA3	<input type="checkbox"/>
Shelby Dell ABB-521 Positive Sequence Current Phase Angle	VIRT-12	SHELBY	TVA_SHELBY-PA4-ABB5H	SHELBY-PA4	<input type="checkbox"/>
Shelby Leagon Creek ABB-521 Positive Sequence Current Phase Angle	VIRT-14	SHELBY	TVA_SHELBY-PA5-ABB5H	SHELBY-PA5	<input type="checkbox"/>
Shelby 500 kV Bus 1 ABB-521 Positive Sequence Voltage Magnitude	VIRT-5	SHELBY	TVA_SHELBY-PM1-ABBV	SHELBY-PM1	<input type="checkbox"/>
Shelby 500 kV Bus 2 ABB-521 Positive Sequence Voltage Magnitude	VIRT-7	SHELBY	TVA_SHELBY-PM2-ABBV	SHELBY-PM2	<input type="checkbox"/>
Shelby Cordova ABB-521 Positive Sequence Current Magnitude	VIRT-9	SHELBY	TVA_SHELBY-PM3-ABB	SHELBY-PM3	<input type="checkbox"/>
Shelby Dell ABB-521 Positive Sequence Current Magnitude	VIRT-11	SHELBY	TVA_SHELBY-PM4-ABB	SHELBY-PM4	<input type="checkbox"/>
Shelby Leagon Creek ABB-521 Positive Sequence Current Magnitude	VIRT-13	SHELBY	TVA_SHELBY-PM5-ABB	SHELBY-PM5	<input type="checkbox"/>



Suggestions

- openPDC cont.
 - Use SQL server more or never – expensive for configuration only.
 - Long term statistics.
 - Put Virtual Historian in initial DB setup.
- Integrate or separate?

Thanks!

Questions?