Qualitrol's PMU Technologies
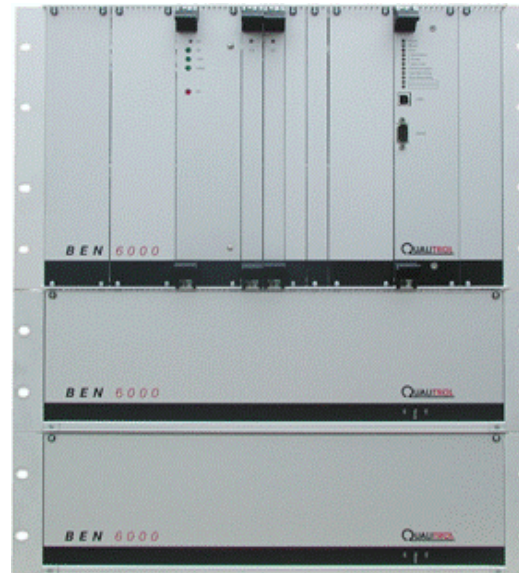
NASPI Conference

June 2008

IDM

Hathaway

BEN

BEN 6000

QUALITROL.®
Defining Reliability

Agenda

1. Qualitrol's experience

2. Recording functions that compliment Phasor Measurement

3. A Multi function PMU

4. PMU Case Study → Queen's University of Belfast (Windfarm)

5. Live Demo → All – Ireland Interconnect data streaming

Qualitrol's Recording Products

- Qualitrol has two families of substation digital fault recording systems

- Hathaway

  - Has been supplying Digital Fault Recording systems since 1980

  - Installed base includes DFR range, DFR1200 and IDM

  - Upgrade options include

    - Upgrade paths to the latest product – the IDM

      - This upgrade includes optional Phasor Measurement

- BEN

  - Has been supplying Fault Recording systems for almost 30 years

  - Installed base includes BEN 2000, 4000, 5000, 500 and 6000

  - BEN 6000 PMU card developed 2008

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Qualitrol's experience in synchronized WAM

- Experience of synchronized measuring devices for over **9** years

- Experience of wide area measuring devices for over **22** years

- PMU in IDM digital fault recorder in **2004**

- IEEE1344, PC37.118 accreditation in **2005**

- BEN 6000 PMU successful Beta testing (Statnett Norway) – launch **July 2008**

- Potential of over **10,000** systems worldwide capable of being upgraded to synchronized WAM/PMU devices

- Potential to upgrade over **2,000** DFR systems in NA region with synchronized WAM / PMU functionality

Hathaway   *BEN*

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Power System Event Data Capture

- Requirements range from analysis of fast fault clearance events to study of long term system events that can last tens of minutes, even hours

- Data required includes

  - Point on wave voltage and current data

  - Event data for protection and breaker operation

  - Real and reactive power over longer time intervals

  - Accurate frequency measurement

  - Synchronized measurement to facilitate wide area analysis

  - Real-time phasors for WAMS and future WAPS
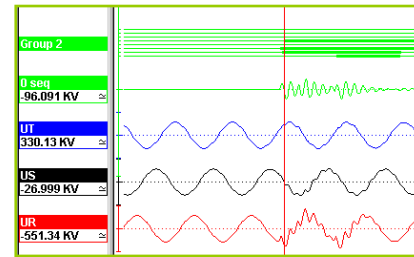
Practical Aspects of Event Analysis

- Off-line
  - Local storage of recorded data
  - Access to High Speed Triggered Data for Fault Analysis
    - Assessment of Protection Performance Breaker clearance times
  - Sow Scan data for Assessment of long duration system disturbances
  - All data about a local event available quickly in a single record
  - Need ability to easily perform time coordination across different sites and data types
    - Synchronised sampling resolves this
- On-Line
  - Reliable 24/7 communications
  - Open protocol – C37.118
- Providing all this data from a single system
  - Reduces capital cost, installation costs and total cost of ownership
  - eliminates manual data integration and time coordination
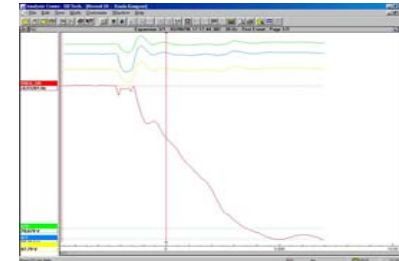 - simplifies data analysis

Multifunction Device with Phasor Measurement

- Qualitrol's Digital Fault Recorders are true intelligent multi functional devices providing benefits in a number of areas of WAM disturbance recording:-
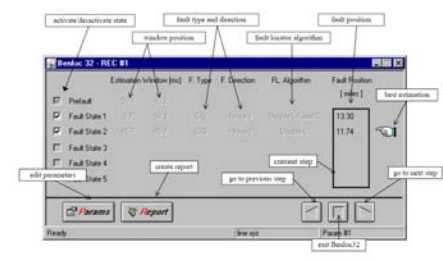
  1. Fast transient fault recording

  2. Disturbance Monitoring Equipment (DME)/ Dynamic System Monitoring (DSM)

  3. Phasor Measurement Unit (PMU)

  4. Power Quality (PQ)

  5. Impedance Fault Location (FL)
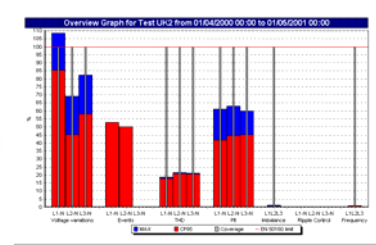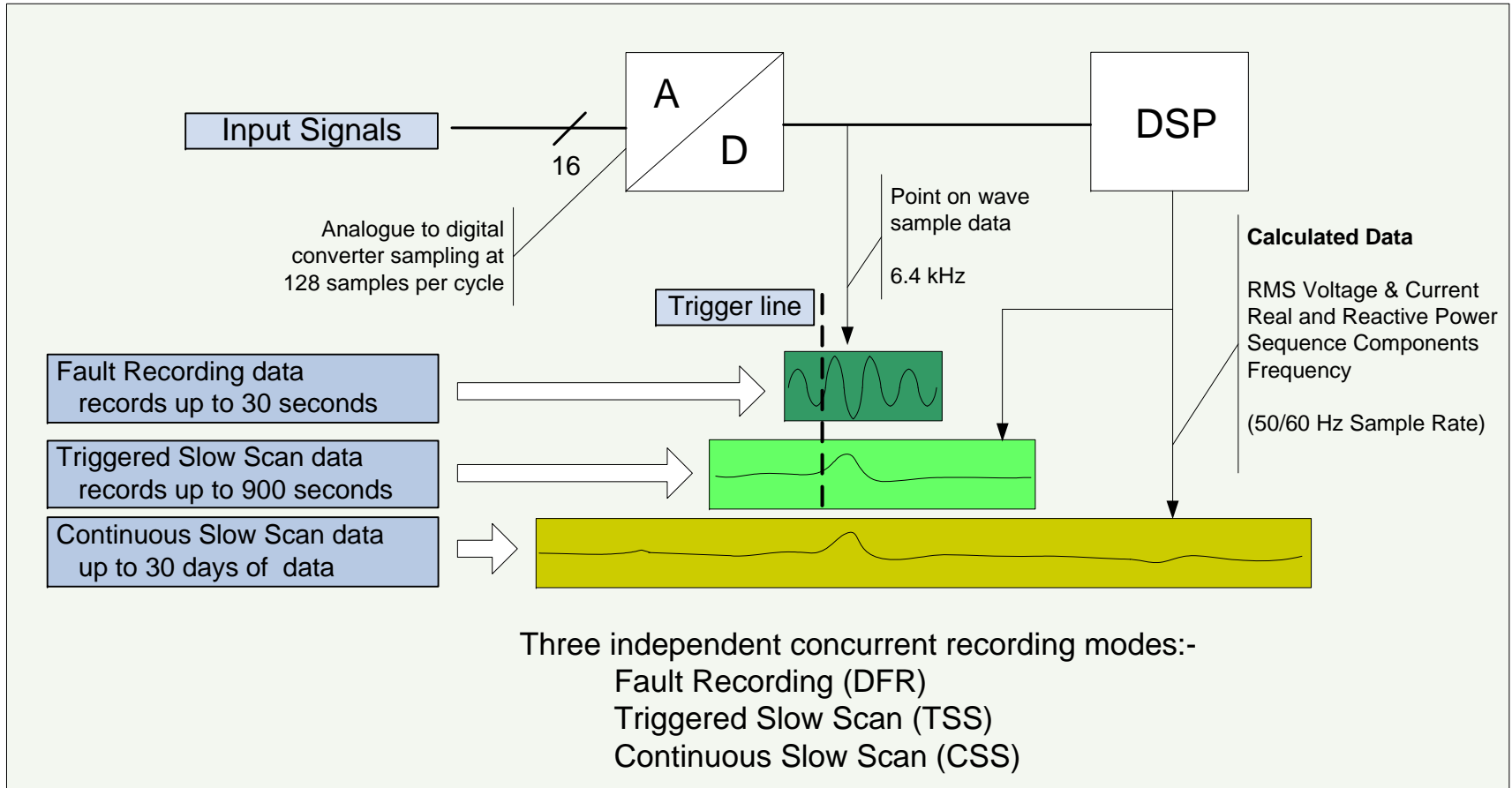
  6. Sequence of Events display (SOE)
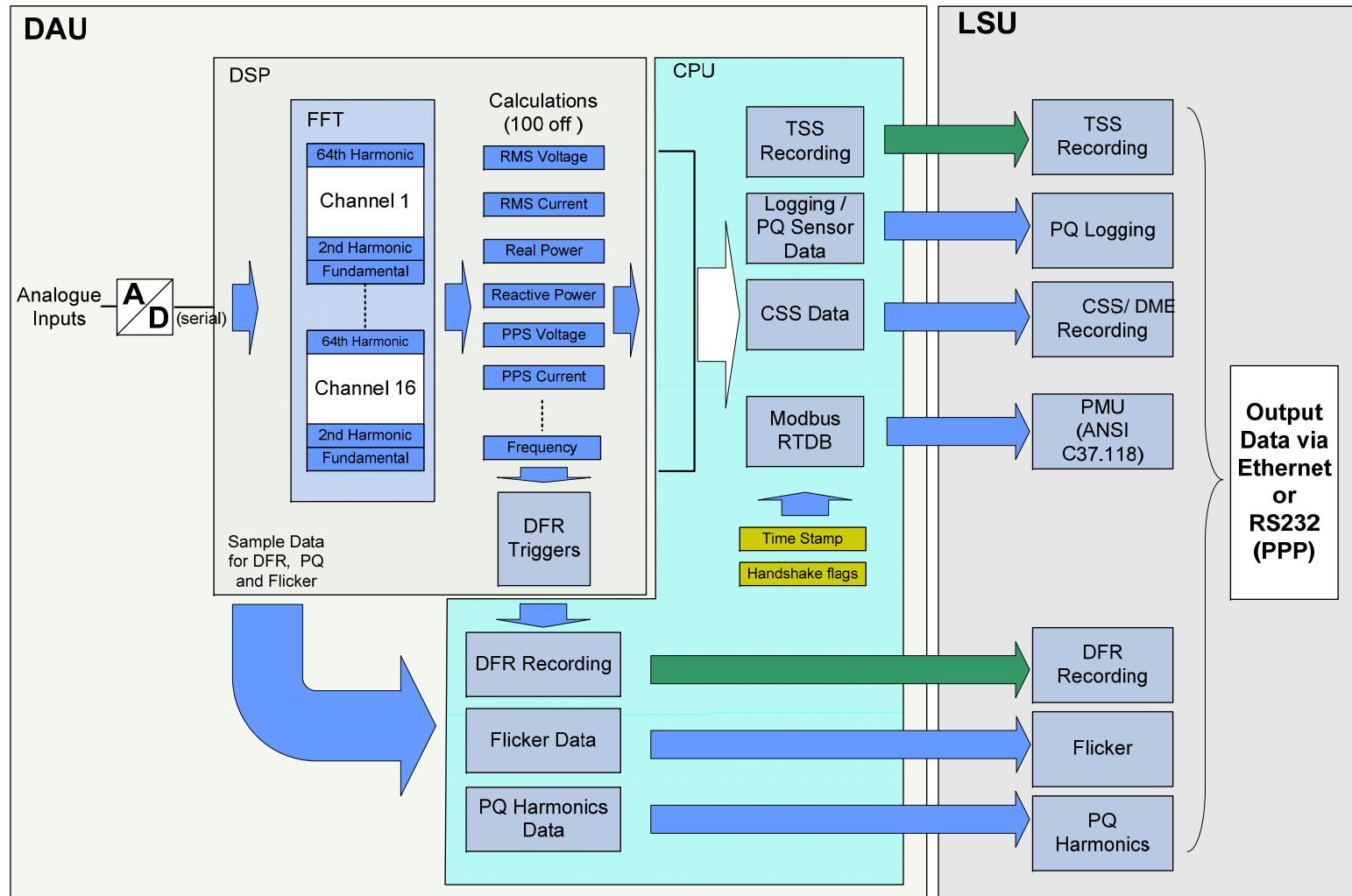

1

2

5

4

DFR and DME/DSM Recording Mode

Input Signals

16

A / D

Analogue to digital converter sampling at 128 samples per cycle

Point on wave sample data

6.4 kHz

Trigger line

DSP

Calculated Data

RMS Voltage & Current
Real and Reactive Power
Sequence Components
Frequency

(50/60 Hz Sample Rate)

Fault Recording data
records up to 30 seconds

Triggered Slow Scan data
records up to 900 seconds

Continuous Slow Scan data
up to 30 days of data

Three independent concurrent recording modes:-
Fault Recording (DFR)
Triggered Slow Scan (TSS)
Continuous Slow Scan (CSS)

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Multifunction PMU Block Diagram

Unique Benefits of DFR Devices as PMU

- Primary purpose is to monitor large amounts of data on different speeds therefore PMU is natural add on to DFR

- DFR is independent of primary protection systems, so this independent nature provides ability to communicate to/from constantly (config, polling etc) without compromising system protection

- Wide area monitoring for DFR, DSM, PQ on top of PMU therefore maximizes benefits in one device

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PMU System Architecture
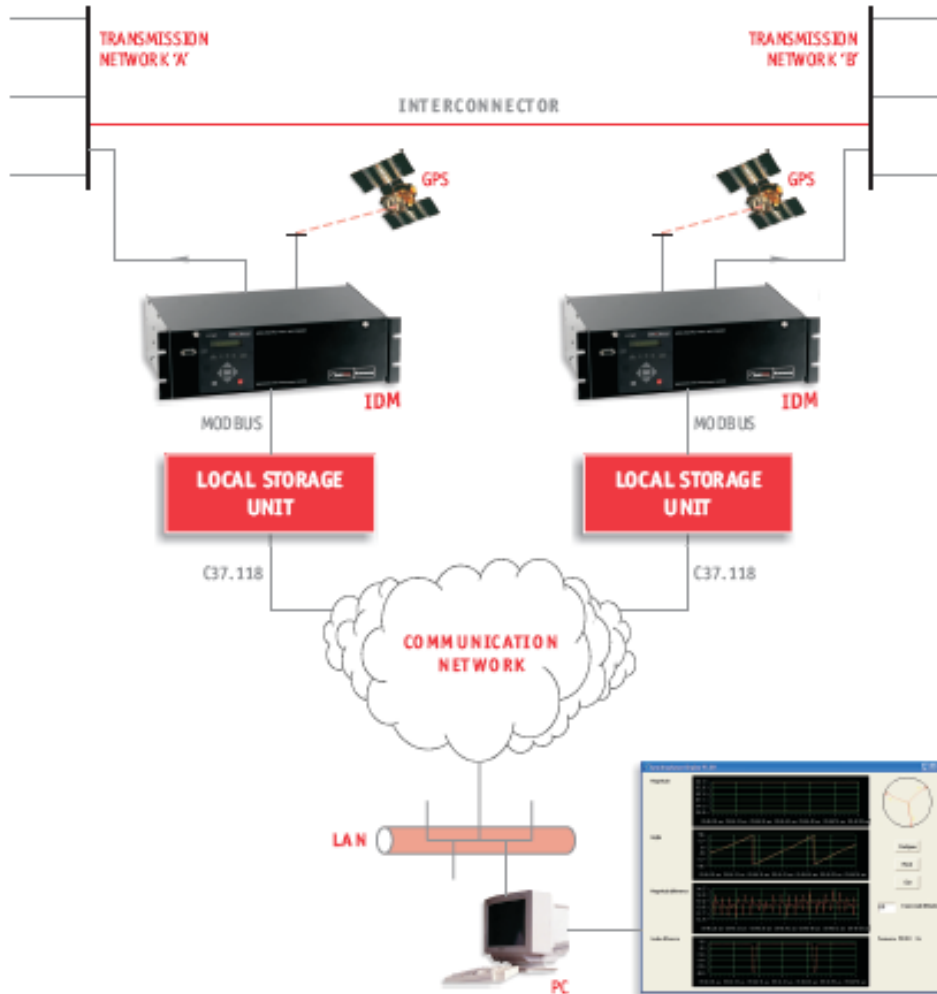
- An IDM T3 has 16 analog inputs

- Therefore each T3 will be able to record 5 voltage or current phasors.

- Positive sequence phasor is calculated using a Fourier algorithm

- An integral GPS receiver provides a time specified 1 PPS pulse for use in synchronizing the sampling clock of the ADC

- Common communication interface allows real time monitoring.

Case Study

IDM as PMU

QUB Project (2006)

"Variations in the phase angle difference between a remote 11kV connected wind farm and the centre of Belfast during a typical working day"
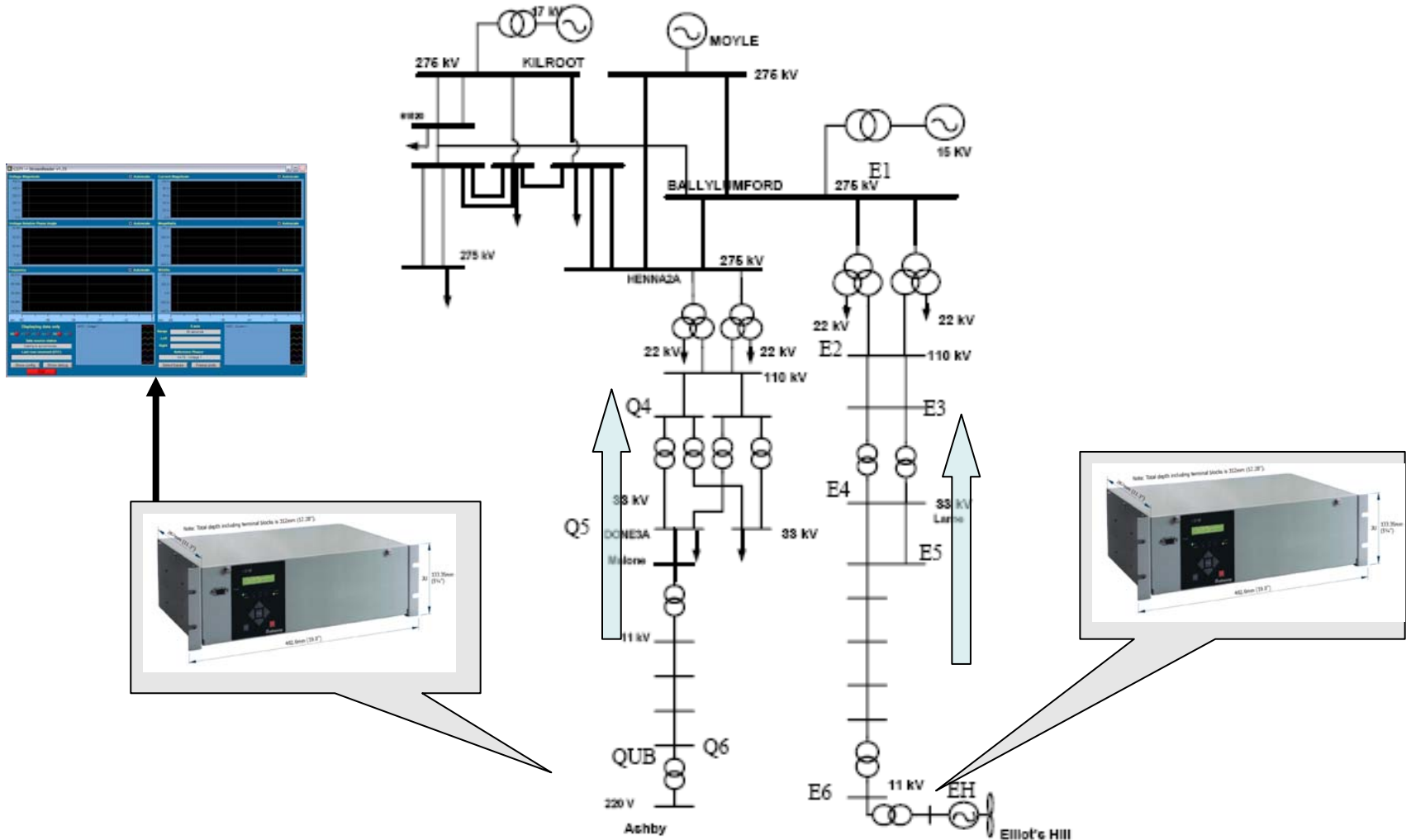
Elliot's Hill Windfarm

QUB

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Fig.6 Single diagram of reduced NIE network showing feeders to Elliot's Hill (EH) & QUB (Ashby bldg)
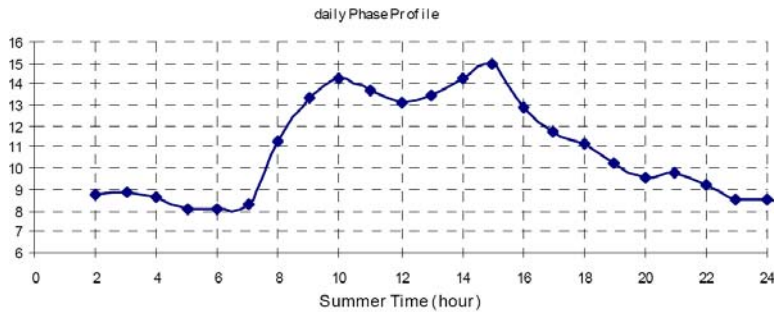
Fig.5 Daily phase profile between EH and QUB.

Fig.8 Angular Difference Profile between EH & QUB measurement results .vs. simulation results

Fig.7 Demand profile in N.Ireland.

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Key Findings

- Angular difference observed was 8-10 degrees when demand was low (ie. before 8am and after 7pm)

- Angular difference observed was 13-15 degrees when demand was high (i.e between 9am and 4pm)

- The phase difference profile was not proportional to the demand profile. The peak of the demand profile was 5pm and the peak of phase angle difference was at 3pm. This highlighted that the phase difference is also affected by the output of the wind farm

- Thus the angular difference steps up once the wind farm output increases

Live Study

IDM as PMU

Measurement of All-Ireland network in real time

and integration with 3rd Party software
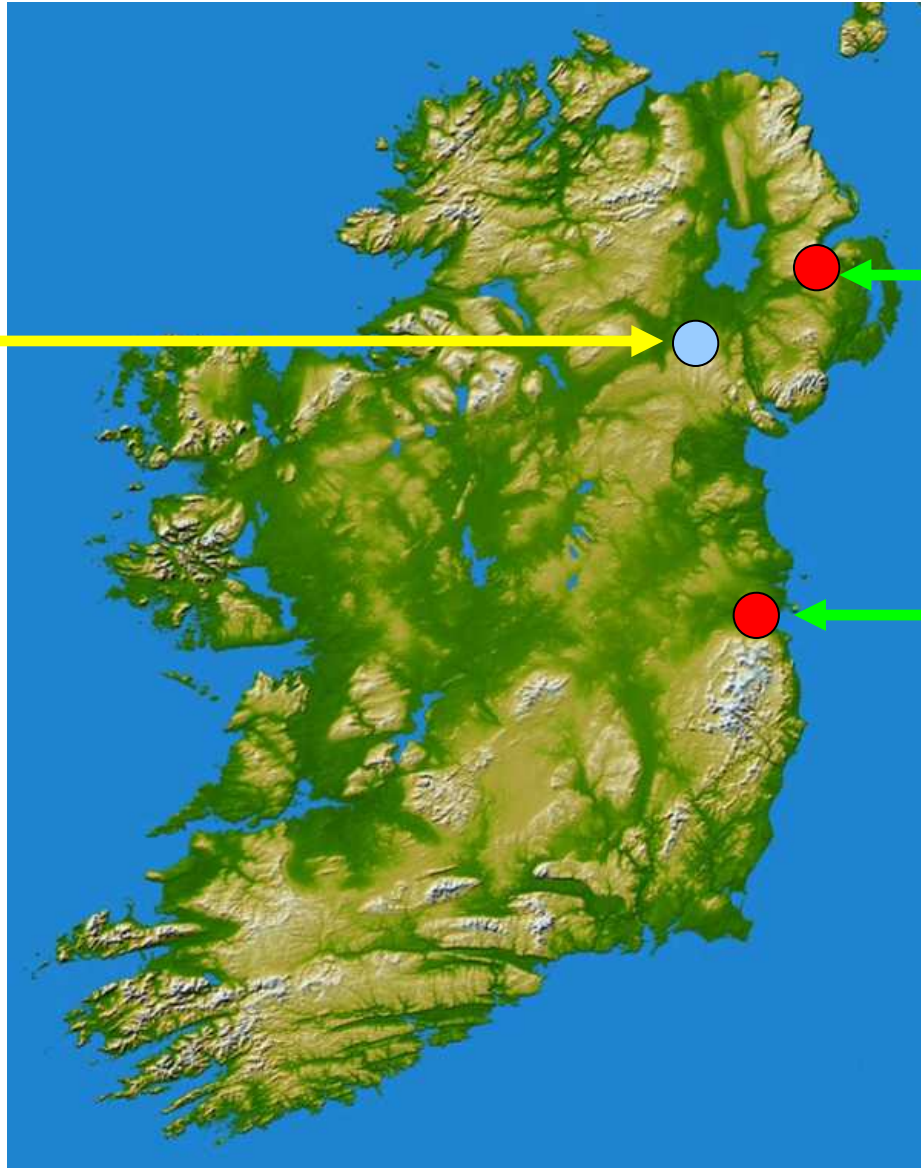
(StreamReader V1.35)

Aim

- Demonstrate interoperability with third party software

- Demonstrate real time WAM ability

- Demonstrate phase angle difference across a North – South interconnect between Northern Ireland and the Republic of Ireland
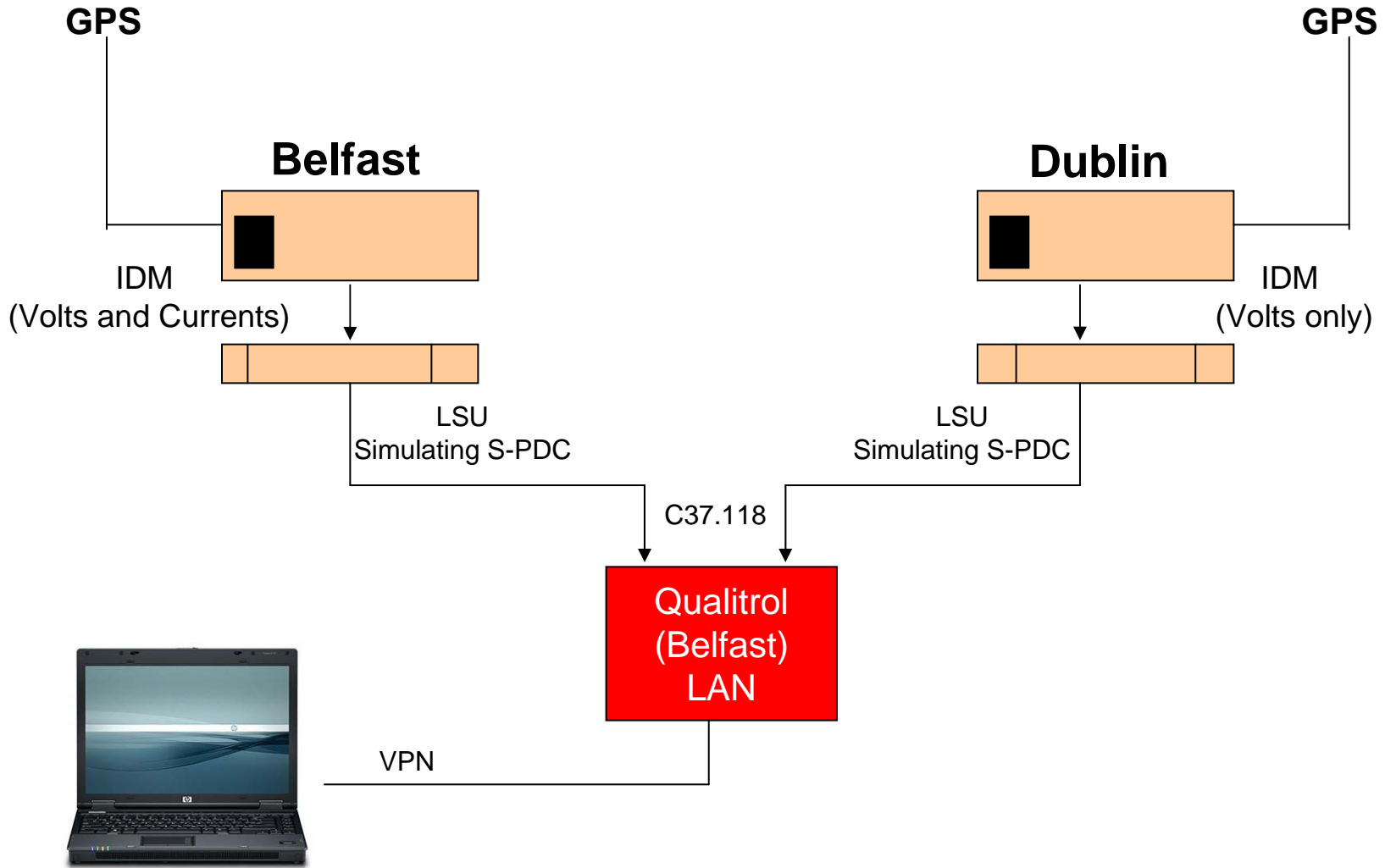
North / South Interconnect

Unit 1 Qualitrol (Belfast)
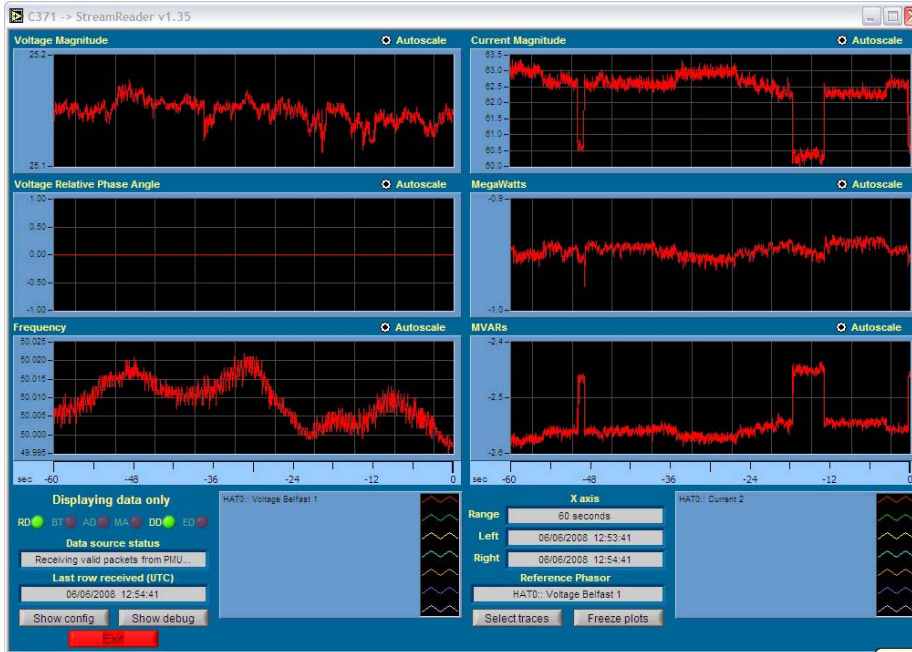
Unit 2 Qualitrol (Dublin)

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System Architecture

GPS

GPS

Belfast

Dublin

IDM
(Volts and Currents)

IDM
(Volts only)

LSU
Simulating S-PDC

LSU
Simulating S-PDC

C37.118

Qualitrol
(Belfast)
LAN

VPN

StreamReader

Unit 1
Qualitrol
(Belfast)

Unit 2
Qualitrol
(Dublin)

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Live Demo

Thank You