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High Speed Analog Telemetry Recording at the NYISO

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ABSTRACT

The New York Independent System Operator (NYISO) receives approximately 180 analog quantities from key locations across the New York State power system. These quantities represent critical line flows, voltages and system frequency, and are separate from the traditional 25,000+ EMS values that are transmitted over the ICCP links.

The NYISO had used a custom hardware and software solution since 1997 to record and store this analog data. The data was stored at 10 samples per second, and used primarily for power system event reconstruction and analysis. The custom hardware and software solution was reaching the end of its useful life in 2007, and had become expensive to maintain. Additionally, the data could be accessed by only one user at a single workstation.

The NYISO investigated various options for the custom solution, including upgrade or replacement, and decided to replace it with off-the-shelf products. These products included a readily-available analog-to-digital conversion interface, a standard protocol converter, and a widely used data historian, which was already in use by the NYISO for other applications.

The replacement solution cost roughly half of the cost to simply maintain the custom solution, and as an added benefit the data is now available enterprise-wide. This paper will detail the hardware and software used for the project, and will also include representative power system event data.

[1] Dean Ellis worked at the NYISO prior to Dynegy and submitted the abstract for this paper as a NYISO employee.

INTRODUCTION

This paper describes the High Speed Analog Telemetry Recording System which was deployed by New York Independent System Operator (NYISO) in December, 2007. Within NYISO, this system is referred to as, "Phase 1 Analog Telemetry Data Acquisition System". Also within the NYISO, the term "Phase 1" refers to the first phase of the State-wide telemetry system, which was based on analog technology. The NYISO retains these original nearly 200 analog telemetry points as an important part of its system operations, and continues to refer to this group of analog points as "Phase 1." Generally speaking, included in "Phase 1" are the most critical quantities, such as flow (MW) across area interconnections, flow (MW) across the highest capacity transmission lines, output (MW) of the largest generators, and Voltages (kV) at key substation busses. These analog quantities are measured in the field, at the respective substations, and transmitted to the NYISO Site A over specially conditioned analog phone circuits that provide a bi-directional path for a continuous data stream. The data is received by tone telemetry receiving modules, and the signals are converted to analog mA quantities and sent to various devices, such as strip chart recorders, an RTU for communication with the EMS, and the Phase 1 Analog Telemetry Data Acquisition System for data archival.

This document is intended to provide the reader with a general description of the purpose, functionality and general use of "Phase 1 Analog Telemetry Data Acquisition System". A high level overview of the software and hardware aspects will also be provided. Detailed hardware specifications and software configurations are not included, and can be accessed in one of many supporting documents provided by the manufacturers.

The Phase 1 Analog Telemetry Data Acquisition System was designed and deployed to replace the legacy hardware and software solution for processing and storage of the analog telemetry system. The NYISO referred to this legacy system as the Specialized Data Acquisition. The Specialized Data Acquisition was originally placed into service in 1994, and the bulk of Specialized Data Acquisition processing functions were replaced in February of 2005 with an RTU. While the RTU could perform many of the Specialized Data Acquisition functions, it could not store data at 10 times per second; NYISO staff considered the storage rate to be a requirement. Additionally, the RTU could not readily interface with the corporate data historian. Hence, a replacement was chosen that would fulfill the need of an "off-the-shelf" solution that could store the analog telemetry data at a 100 ms data rate. The authors of this document feel that the 100 ms data storage is important in event analysis and reconstruction. In fact, following the Northeast blackout of 2003, the 100 ms data were extremely valuable, due to its high resolution of dynamic events. Furthermore, the legacy hardware system facilitated retrieval of the data in a continuous, common format. In comparison, data from various disturbance monitoring equipment (DME) in the substations was also important, due to the high sampling frequency and lack of significant delay; however, the continuous 100 ms analog telemetry data used throughout the investigation proved to be a framework for understanding the many events.

Two locations of the NYISO are mentioned in the following text, and they are SITE A and SITE B. NYISO uses a widely used data historian for much of our data management and display functions.

SYSTEM OVERVIEW

The Phase 1 Analog Telemetry Data Acquisition System is comprised of hardware and software as well as, servers and special management software for the acquisition equipment.

- The Phase 1 Analog Telemetry Data Acquisition System provides data acquisition for up to 192 points
- (6 chassis x 16 modules x 2 inputs per module) in its current configuration.
- The system is easily scalable by adding additional chassis and input modules with very little software reconfiguration.
- Data is available from analog telemetry receivers and included the following:
  - MW from a select group of bulk power lines inside New York
  - MW from external Control Area ties
  - Voltage 230kV and 345kV
  - Frequency at selected points

System Features and Benefits are as follows:

- The system is completely separate from NYISO's Enterprise EMS system.
- If the production EMS system or its network is down, Phase 1 Analog Telemetry Data Acquisition System will not be affected.
- Phase 1 Analog Telemetry Data Acquisition System uses a dedicated data historian server used exclusively for analog 100 ms data.
- The scan rate for the original Phase 1 analog system is that data is sent to the EMS system every two seconds and the data historian server retrieves the data every six seconds. Phase 1 Analog Telemetry Data Acquisition System is sent 10 times/second to data historian server.

HARDWARE OVERVIEW

Chassis - Each chassis (of which there are six total) consists of:

- Single 120VAC power supply
- 16 module mounting rack (chassis)
- Up to 16 Analog input modules
  - Current 2 inputs (isolated) per module
  - Voltage 2 inputs (isolated) per module
- One PAC Brain for I/O processing and Ethernet communication.
  - Contains redundant Ethernet connections

The hardware device scans analog inputs at the rate of 10 times per second.

Management PC

- Purpose: to manage and maintain the configuration of the hardware chassis.
- Hosts software for Phase 1 Analog Telemetry Data Acquisition System.
  - Professional software suite.
  - Data historian data collection software
  - Software that converts proprietary code and time stamps the data.

- Used to view real time data in engineering units from the device.
- To send configurations and firmware updates to the individual chassis.
- Used primarily by Test technicians for maintenance and troubleshooting.

DATA HISTORIAN SERVERS

- Redundant, dedicated data historian servers are used; one in each data center which span two buildings across a WAN. The same analog data is available to each server.
- The data historian servers are backed up to off line media.

Input Wiring to Chassis:

- Wiring to the hardware chassis originates from analog telemetry receiver modules located in Site A.
  - These modules receive continuous analog readings from field located transmitting devices via dedicated analog phone circuits. The receiver modules convert the modulated phone carrier tone to either a corresponding current loop (+/- 10mA DC) or (0-10 mA DC) or a voltage (+/- 10 VDC) or (0-10 VDC).
- Connectorized wiring- (DC current) from the telemetry modules is joined to a "bridge" panel where it is directed to the analog input modules and an RTU (for SCADA/EMS) in a current loop.
  - Some voltage wiring (where current loop is not available) is sent directly from the telemetry module racks (on terminal panels) to the analog input modules and the RTU in parallel.

NETWORK OVERVIEW

Data Flow

Please see Network Overview Diagram which follows. Analog data from telemetry receivers is digitized in the Phase 1 Analog Telemetry Data Acquisition System device. Digital data is sent from the device over the LAN to the data historian server. Users access the data directly from the data historian server over the LAN by using the client software installed on their pc.

USE OF PHASE 1 ANALOG TELEMETRY DATA ACQUISITION SYSTEM

The primary use of Phase 1 Analog Telemetry Data Acquisition System will be to view and analyze analog data through the data historian applications in Excel and the data historian software interface. This analysis could be for any one of a number of applications, some of which are listed below:

Disturbance Analysis
Operational Analysis
Furnish Data for NPCC or NERC analysis per NERC Standard PRC-002-1
Check against other data sources to insure consistency.

Several examples will follow this paper. These were chosen to help illustrate the usefulness of the 100 ms. data from Phase 1 Analog Telemetry Data Acquisition System in the applications above.

MAINTENANCE

Phase 1 Analog Telemetry Data Acquisition System requires very little maintenance; the hardware is maintained by Test Technicians at Site A. Any other maintenance would be to add a point or check for accuracy of points (magnitude and polarity) or name changes.

HARDWARE MAINTENANCE

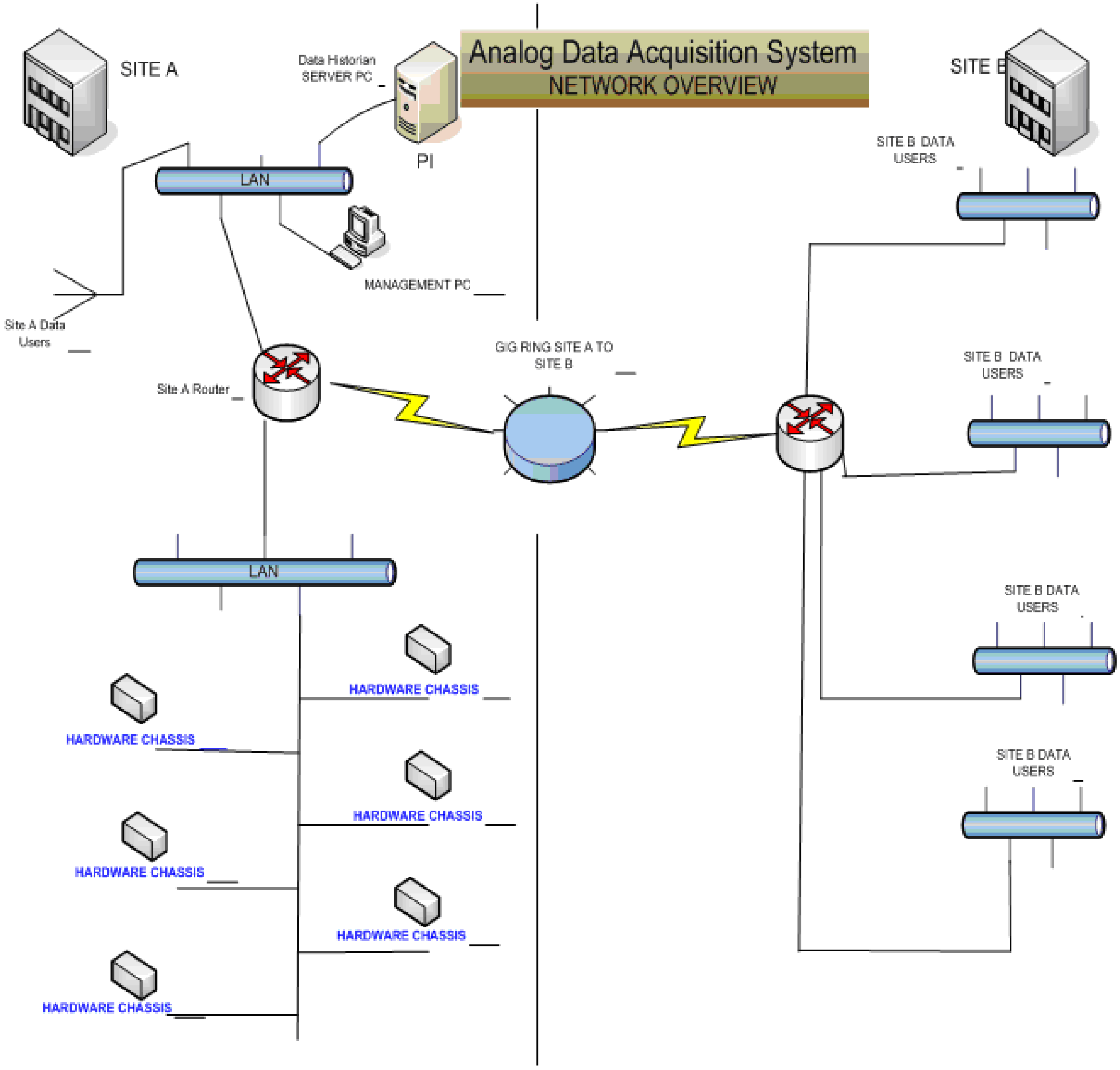
Hardware maintenance is performed by Test Technicians at Site A.
Examples include:

- Wiring in a new point
- Adding I/O modules
- Re-scaling a point;
- Changing polarity
- General hardware troubleshooting.

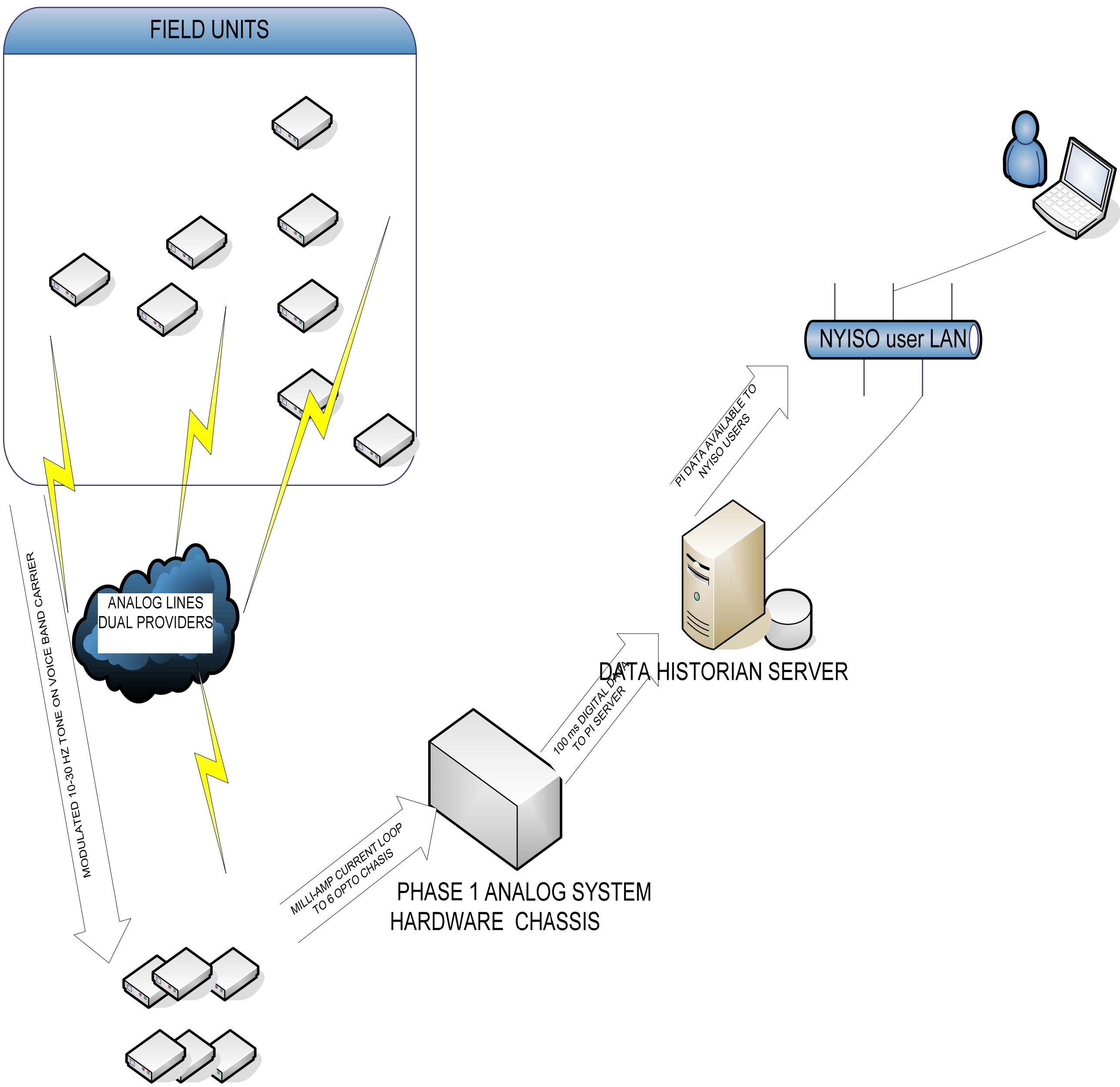
A new configuration is sent to an individual chassis. Note that during this configuration change, none of the other 5 chassis are disrupted; only the chassis with the new configuration experiences a brief, few seconds, interruption as the unit is restarted.

Individual point inspection
Individual points can be viewed (inspected) for real time values through the software by choosing the inspect menu and selecting the IP address for the chassis on which the point to be inspected resides.

NETWORK OVERVIEW DIAGRAM



DATA FLOW OVERVIEW DIAGRAM



HARDWARE CHASSIS DIAGRAMS

NYISO maintains a complete set of hardware chassis diagrams in PDF form. There is a diagram for each chassis with the individual point names and their corresponding wiring assignments.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to NYISO management for supporting our participation in the Transient Recorder User's Council, and our attendance at the Fault & Disturbance Analysis Conference, over a period of many years. We appreciate also the assistance of Jim Ingleson in preparing this paper.

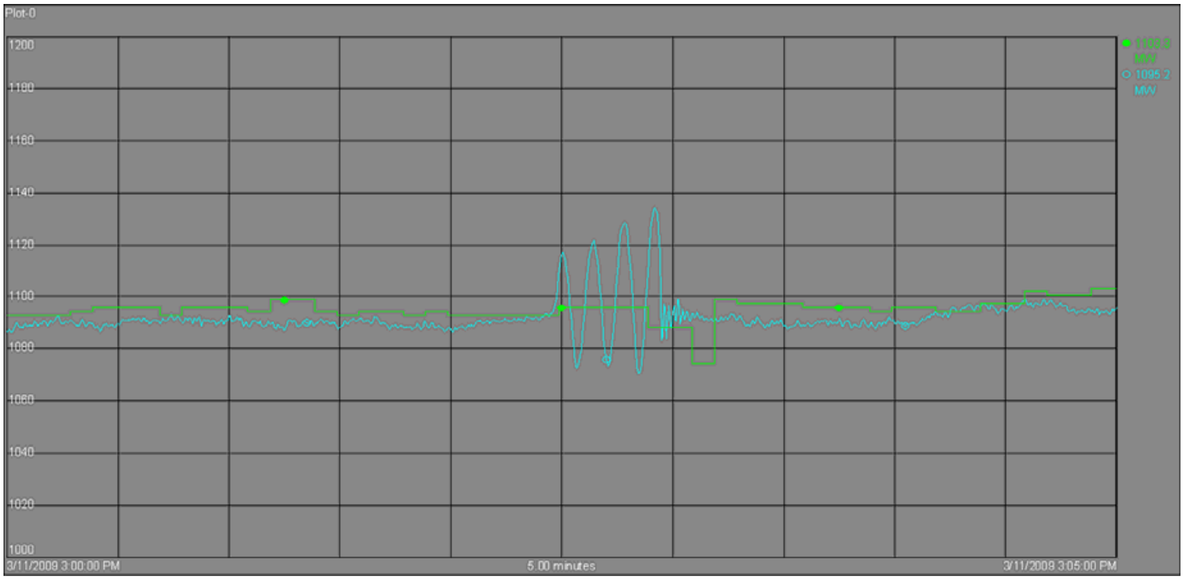
BIOGRAPHIES

Dean Ellis began his electric power career working for Orange and Rockland Utilities and then for Central Hudson Gas and Electric Corporation in New York State. He received his B.S. degree in Electric Power Engineering from Rensselaer Polytechnic Institute in 1991. He has worked in the engineering consulting field, focusing on the design and construction of electric power facilities. Dean served with New York Independent System Operator, Inc. (NYISO) first as Senior Operations Engineer, and later as Manager of Short Term Planning. He is now with Dynegy Corporation. Dean is a registered professional engineer in the State of New York.

Jeremiah Stevens began his career at Ulteig Engineers, a consulting company in Minneapolis, MN, doing substation design. He started working at the NYISO in late 2005 in Operations, moved over to short term planning, now called Transmission Studies. Jeremiah received a B.S. degree from North Dakota State University in 2002 and a Masters degree from The University of Minnesota in 2004.

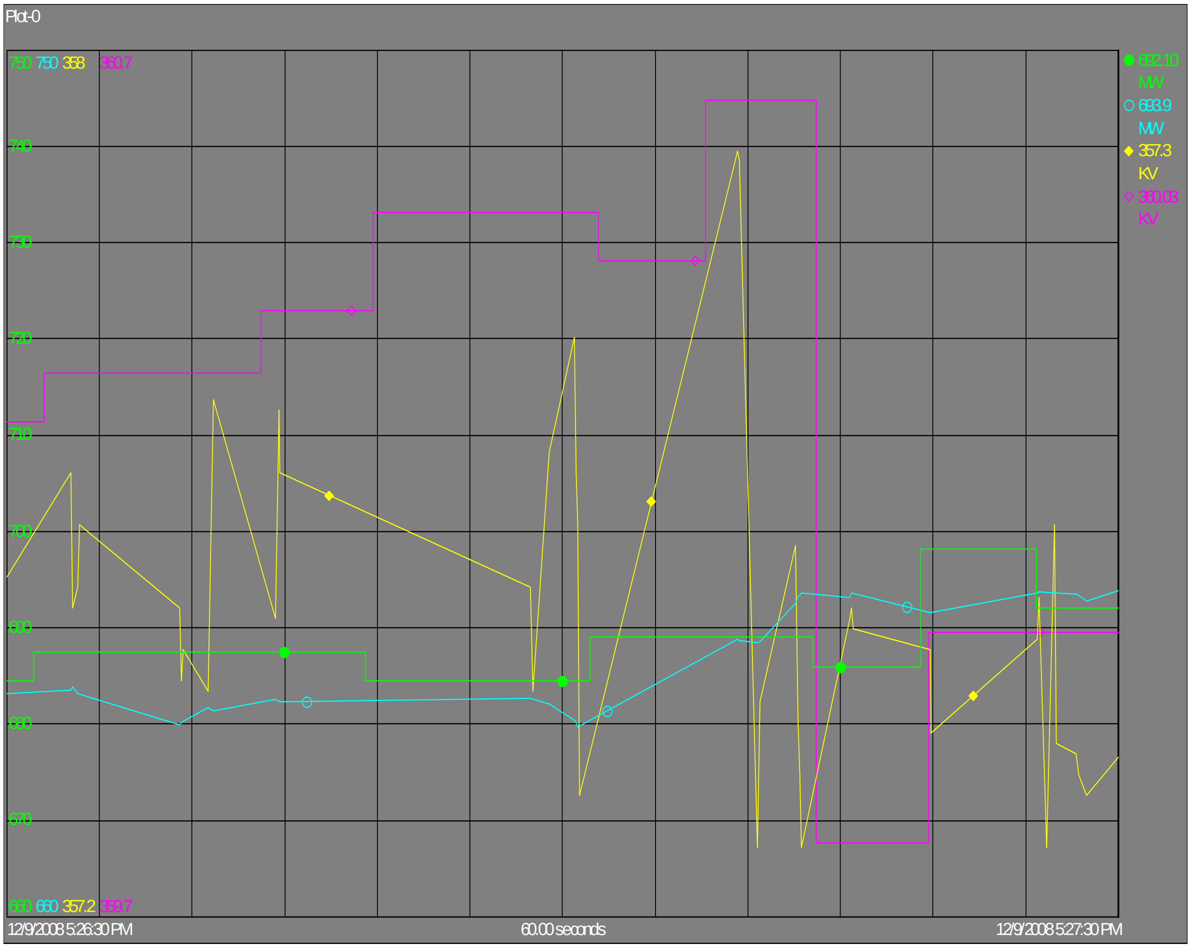
Rick Vara began his electric power career with New York Independent System Operator, Inc. (NYISO) in May 2000 as a Test Specialist. In this position, he supported Operations, metering and networks, and served as technical lead for many projects. In April 2008, Rick transitioned to the System Studies Department at NYISO (a division of System Resource and Planning). He holds a B.A degree from Arizona State University and an A.A.S degree in Electrical Engineering Technology from Hudson Valley Community College.

Examples -



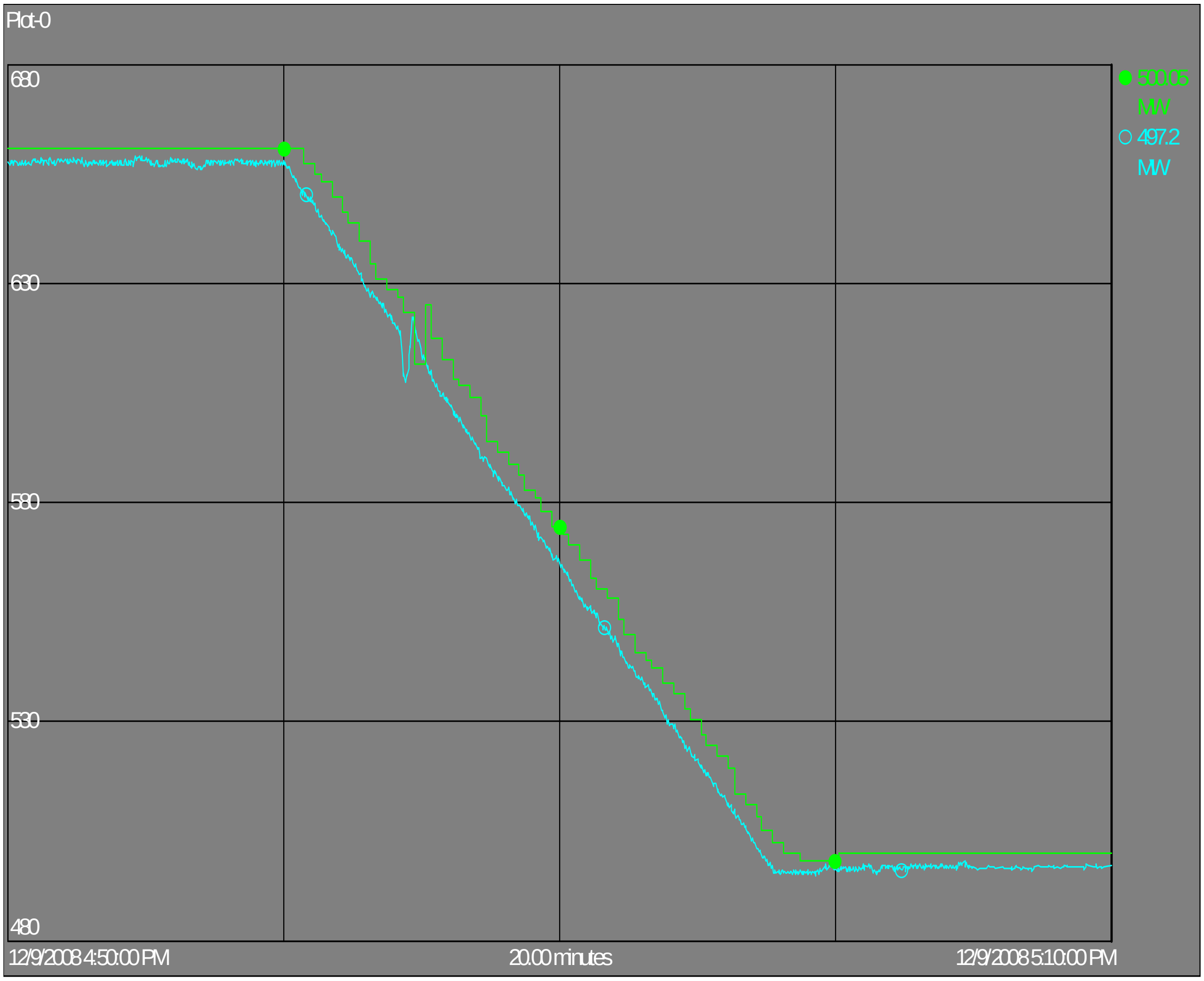
This example shows comparison of traditional EMS data (6 second scan rate) and the Phase 1 Analog Telemetry Data Acquisition System for a line flow over a 5 minute period, during which a system oscillation occurred. The oscillation lasted for a period of 29 seconds. This example shows the inability of the EMS data (6 second scan rate) to follow the oscillation, or even to indicate that there was an oscillation. Phase 1 Analog Telemetry Data Acquisition System sampling frequency was adequate to follow this oscillation.

Examples -



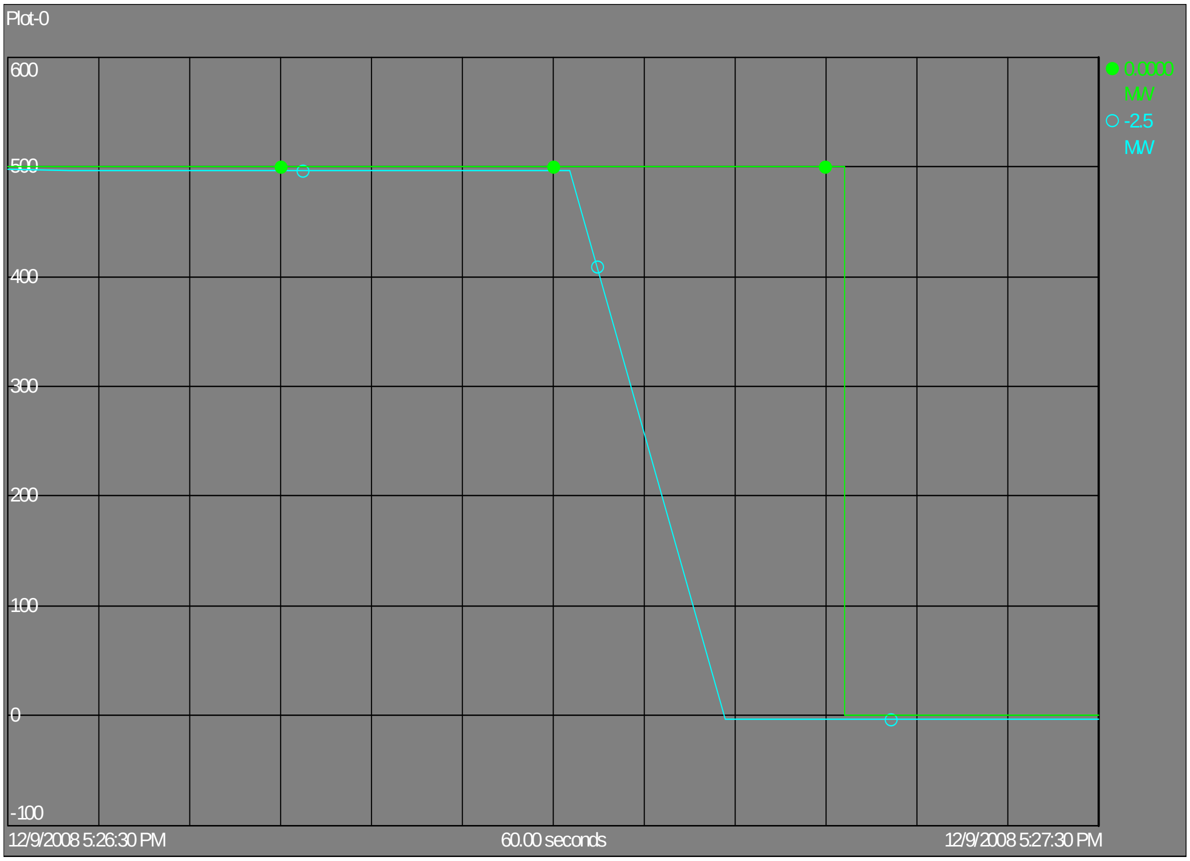
This example shows comparison of EMS data (6 second scan rate) and Phase 1 Analog Telemetry Data Acquisition System for shutdown of a DC transmission link. The Phase 1 Analog Telemetry Data Acquisition System plots are yellow and light blue and in this case are far more useful than the EMS data.

Examples –



This example shows comparison of EMS data (6 second scan rate) and Phase 1 Analog Telemetry Data Acquisition System for shutdown of a DC link. Notice the stair-step effect in the 6 second scan data. Also, the transient is shown nicely in Phase 1 Analog Telemetry Data Acquisition System plot, but obscured in 6 second data. The transient is irrelevant and the cause is unknown.

Examples –



This example shows comparison of the EMS data (6 second scan rate) and Phase 1 Analog Telemetry Data Acquisition System for shutdown of a DC link. Notice that the slower scan rate and filters in the green plot make this appear to be a step change in MW, while Phase 1 Analog Telemetry Data Acquisition System reveals the MW change to be a fast ramp.