Using Schneider Electric EcoStruxure Geo SCADA Expert (ClearSCADA) to Manage District Flow Meter Telemetry with DNP3-WITS Protocol

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About the Speaker

Graham Nasby, P.Eng., PMP, CAP
Water SCADA & Security Specialist
City of Guelph Water Services

- 10 years in the consulting sector
- Joined Guelph Water Services in 2015

- Vice-president of Industries & Sciences in ISA
- Co-chair of ISA112 SCADA Systems standards committee
- Voting member of ISA101 HMI Design and ISA18 Alarm Management standards committees
- Named Canadian Expert on IEC/SCC-TC65 with Standards Council of Canada
- Active member of American Water Works Association and Water Environment Federation

- Has published over 40 papers and articles on automation topics
- Received University of Guelph "Mid Career Achievement Award" in 2014
- Named ISA's technical division leader of the year award in 2013.

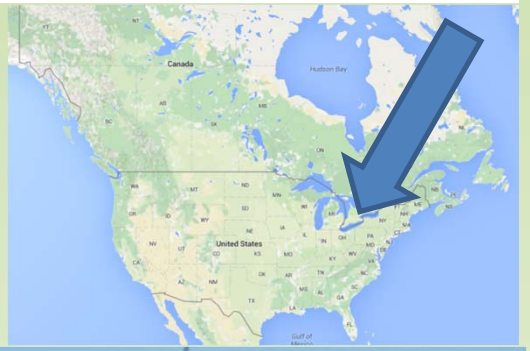
- Contact: graham.nasby@guelph.ca

Presentation Outline

- About Guelph
- DMA Flowmeter System
- Flowmeter Selection
- Flowmeter Communications
- Why use DNP3-WITS ?
- Introduction to DNP3-WITS
- Implementation Challenges
- What DNP3-WITS allows us to do
- How We Use DMA Flowmeter Data

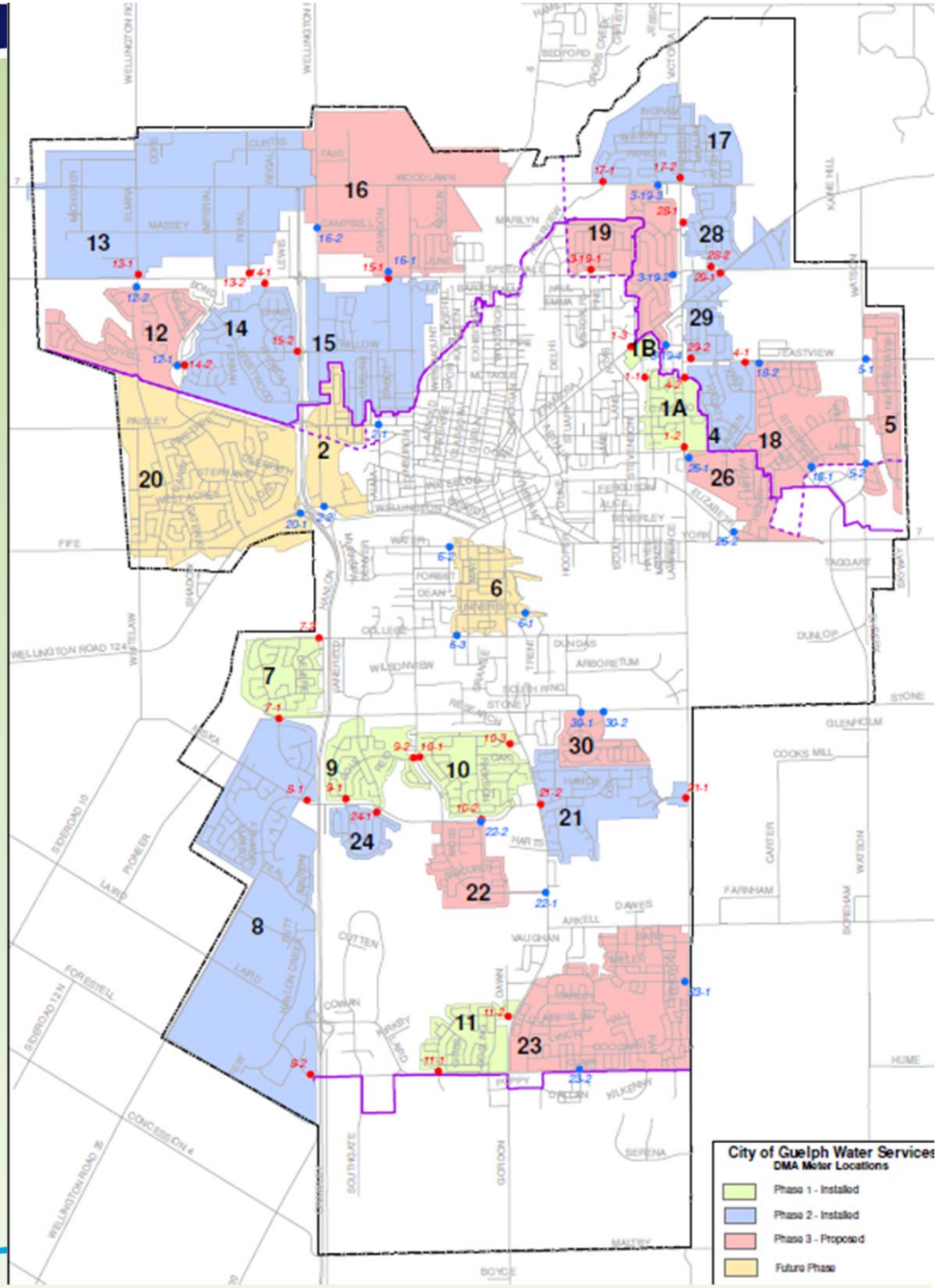
City of Guelph Water Services

- Guelph, Ontario, Canada
- 140,000 residents
- 21 groundwater wells
- 3 water towers
- 549 km of water mains
- 49,000 service connections
- 2,750 fire hydrants
- 46,000 m^3/day [12 MGD]



District Metered Areas

- Segments Water Distribution into DMA Areas with 1-3 connections on borders
- Put flowmeters on the DMA's border connections
- What this give us:
  - Water in/out of DMAs
  - Compare to Customer Meters
  - Compare to Wells & Pumping Station meters
  - Calibrate Water Models

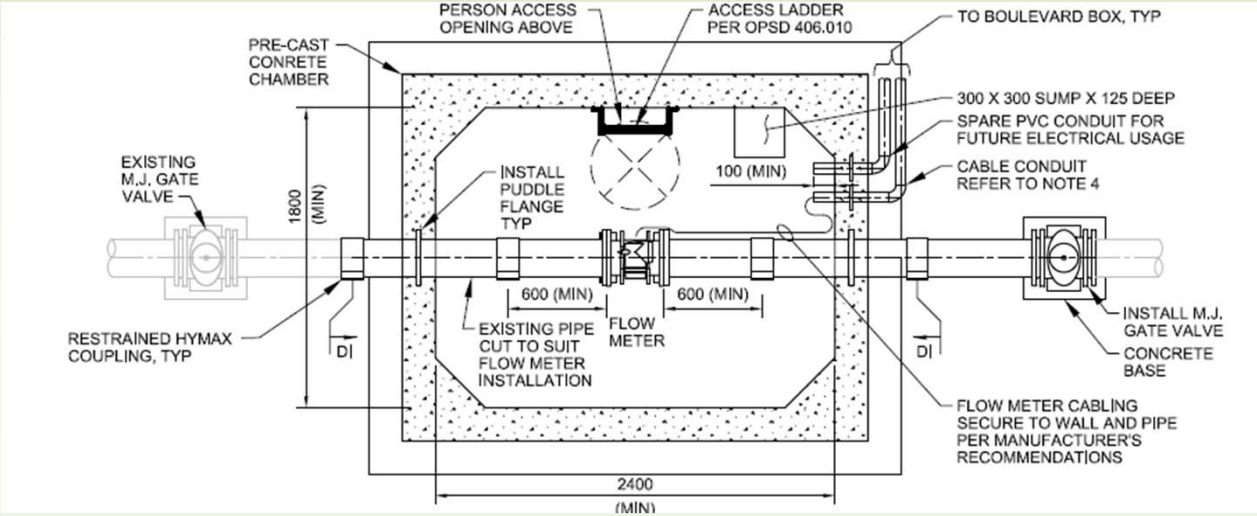


District Flow Meters

- Magnetic Flowmeter
- Integrated Remote Transmitter
  - Transmitter
  - Data Logger
  - Cellular Modem & Antenna
  - Built-in DNP3-WITS Protocol
  - IP 68 Submersion Rated
  - Long Life Battery
- Flow Tube
  - IP68 Submersion Rated

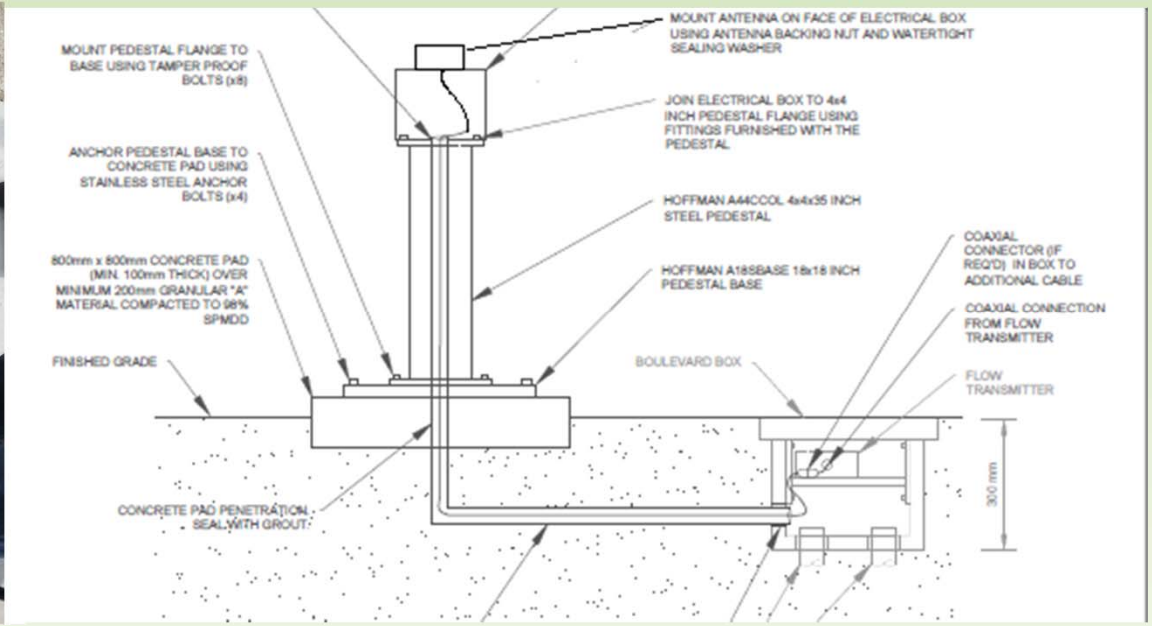
Flowmeter Chambers

- Each DMA is enabled by closing valves, so only 2-3 entry points
- Put Flowmeter chamber on each of DMA's entry points
  - Chamber contains the Flowmeter "flow tube"
  - Pressure sensor (also monitored by flowmeter electronics)
  - Upstream and downstream isolation valves

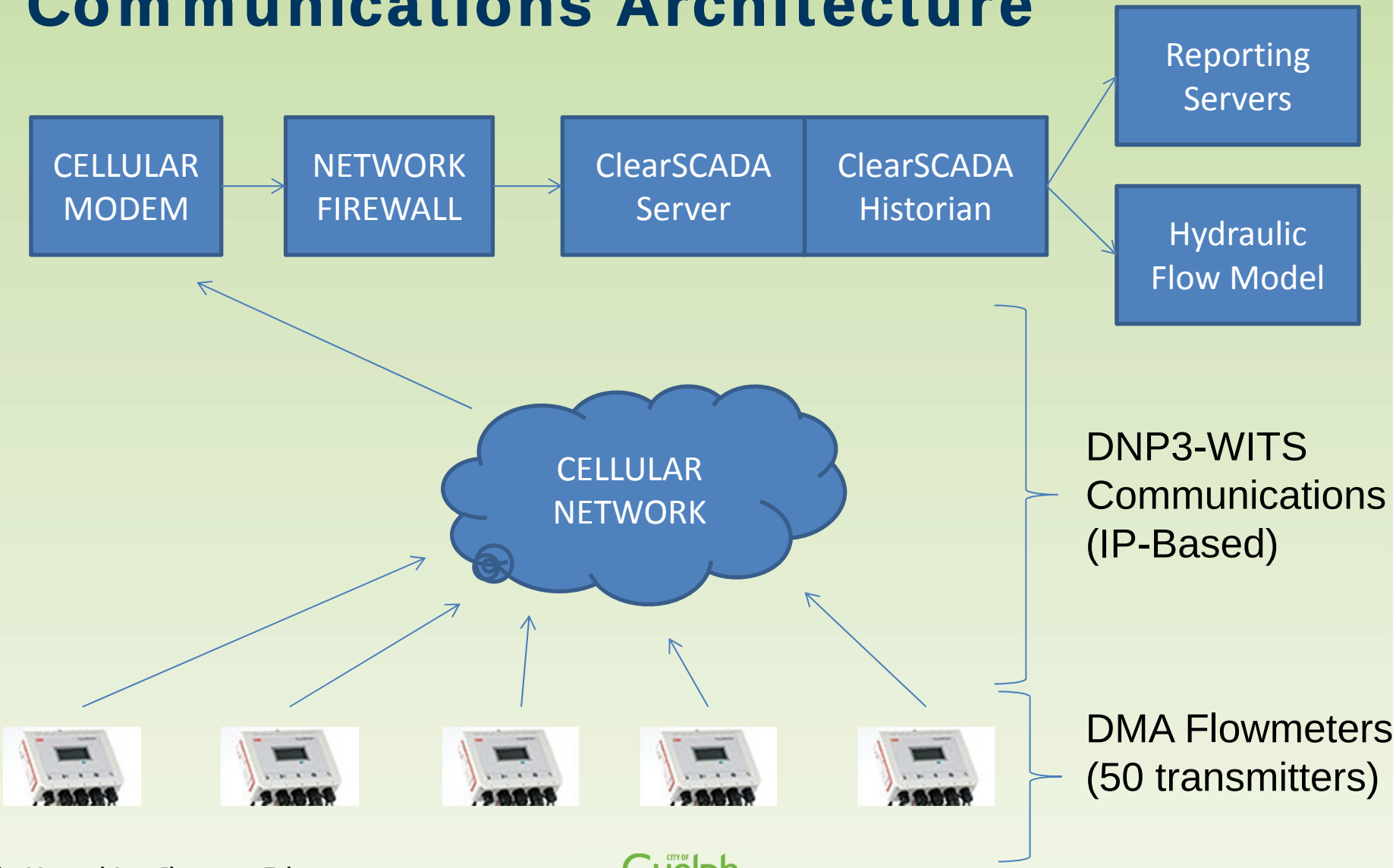


Flowmeter Transmitters

- Flowmeters installed into boulevard boxes
- Antenna pedestals to mount cellular antennas on



Communications Architecture



Why DNP3-WITS Protocol?

- **Publicly available and non-proprietary! (www.witsprotocol.org)**
- **Supports both cumulative totalizers and instantaneous flow**
- **Automatic store and forward data logging built into protocol**

- Automatic time-stamping of data at the flowmeter
- Automatic time synchronization of all flowmeters
- Remote configuration of flowmeters using XML device profiles
- Remotely configure data logging interval on meters
- Remotely configure data upload interval from meters
- Extensive troubleshooting tools are standard with DNP3-WITS

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WITS
WATER INDUSTRY TELEMETRY STANDARDS

dnp Distributed Network Protocol

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Introduction to **WITS** and the **Protocol Standards Association**

Designed **By** The Water Industry **For** The Water Industry

Most water companies use telemetry to monitor and control their remote assets. Traditionally, telemetry systems consist of "Field Devices" which are linked to a "Master Station" using one or more telemetry protocols and communication methods. Many protocols are proprietary and suffer from vendor lock-in. Other open standards can be difficult to match with the water industries' particular set of needs. The WITS Protocol is different...**[Read more]**

Developing The **WITS-DNP3** Protocol

The Water Industry Telemetry Standards (WITS) group was formed in 2003 by members drawn from a wide cross

Latest News

04-May-2017 Cyber Security Briefing on 18th May

03-May-2017 DNP3 TB2016-005 information for WITS members

03-May-2017 DNP3 TB2016-004 information for WITS members

27-Apr-2017 Forthcoming Plugfest

27-Apr-2017 WITS Master Station Licencing

WITS-DNP3 Status

Current Version:
3.0 Released: April 2016
Details here

WITS-IOT Status

Current Version: 0.4 (In Development)
WITS-IOT Blog

Join Us

Water Industry Telemetry Standards Group
A brief history

WITS
WATER INDUSTRY TELEMETRY STANDARDS

Supporters included

- Anglian Water
- Environment Agency
- Northumbrian Water
- Scottish Water
- Severn Trent Water
- Thames Water
- United Utilities
- Wessex Water
- Yorkshire Water

UK Water Utilities

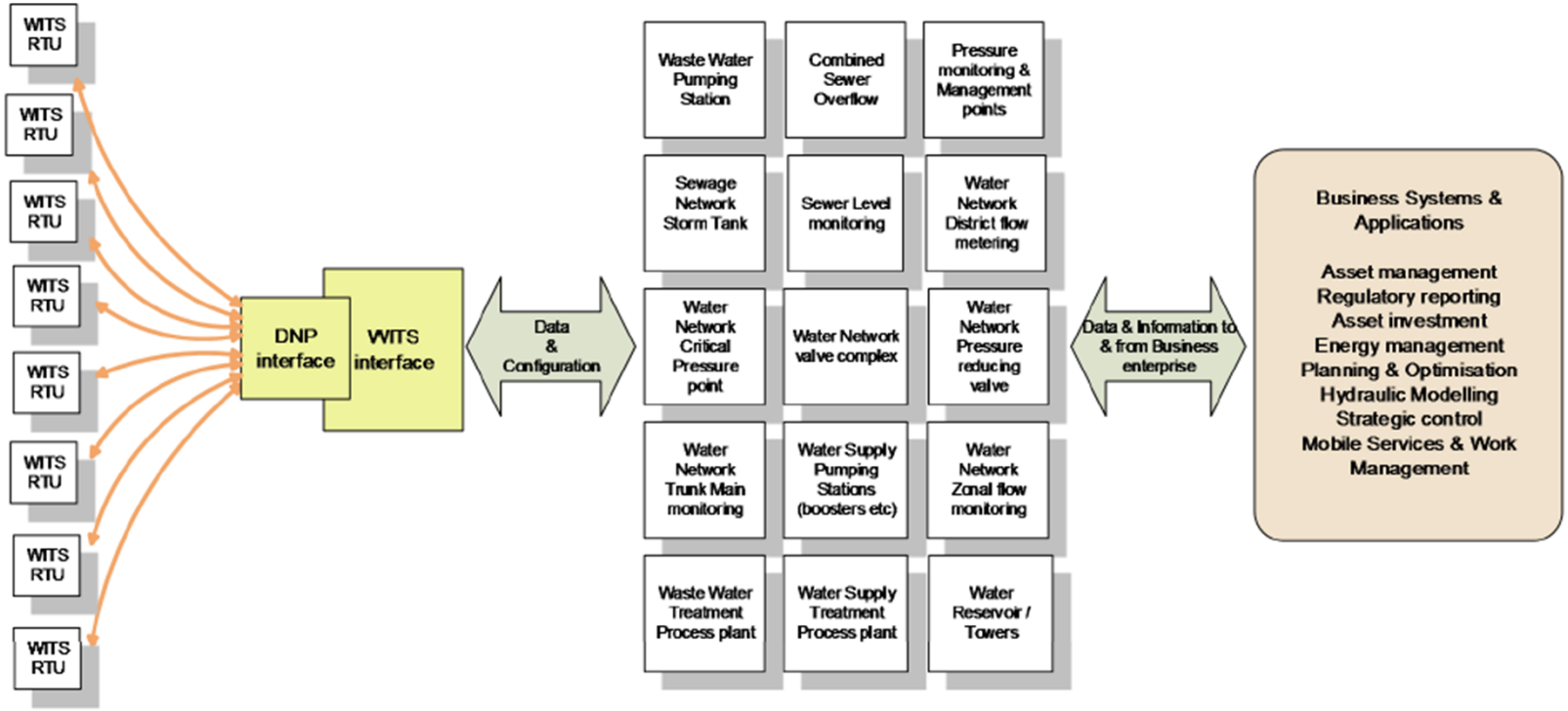
* And now Guelph Water Services

- In the water industry, telemetry system vendors developed proprietary protocols for communications between their field devices and master stations.
- Consequently end users of the telemetry system became locked in to the particular supplier.
- The Water Industry Telemetry Standards (WITS) group was created in 2003 to introduce change
- The first project undertaken was to produce an open standard for transferring data between field devices and a telemetry master station
- Designed By The Water Industry For The Water Industry

Protocol Selection
Development and Testing

- To provide the required interoperability and the water industry functionality, there was the need for a precise specification
- This was achieved through the development of the Application Notes and associated test specifications
- Six water industry telemetry suppliers developed both master stations and field devices to prove and enhance the specification.
- The WITS DNP 3 Protocol Standard was then released as an 'open standard'

WITS provides a common SCADA interface and standard data sets



SCADA templates share common protocol and WITS features

Common WITS alarm/event reporting supports robust asset alarm management process

WITS data reporting features constructed to create asset centric data sets for SCADA control & monitoring

WITS configuration management (incremental) provides the capability to obtain consistent data and alarm reporting

WITS configuration management (incremental) provides the mechanism to change the configuration as business requirements change

WITS configuration management (Bulk & Inc) provides consistent deployment and efficient RTU recovery

The WITs standard will increase the RTU choice across asset types from multiple vendors. WITS simplifies the migration from one vendor to another if required.

DNP3 Layer Technical Details

- Timestamping data at the device/instrument
- Automatic Time synchronization
- Automatic store/forward data logging in protocol
- Both “Change on Value” and “Polling Interval” data gathering
- Data Quality Flags

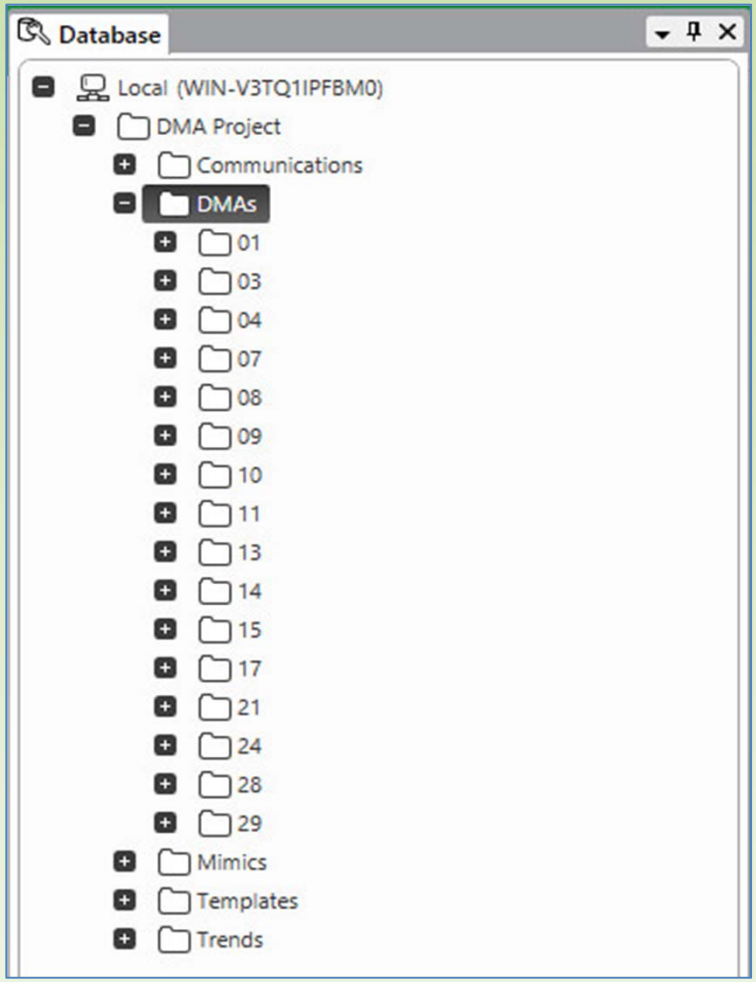
- Supports both Encryption and Authentication
- Automatic Error checking of data packets
- Prioritized Communications (Tags can be grouped in classes 0-4)
- Variety of networks supported: Ethernet, serial, ATM, cellular, etc.
- Supports wide range of analog, digital and structured datatypes

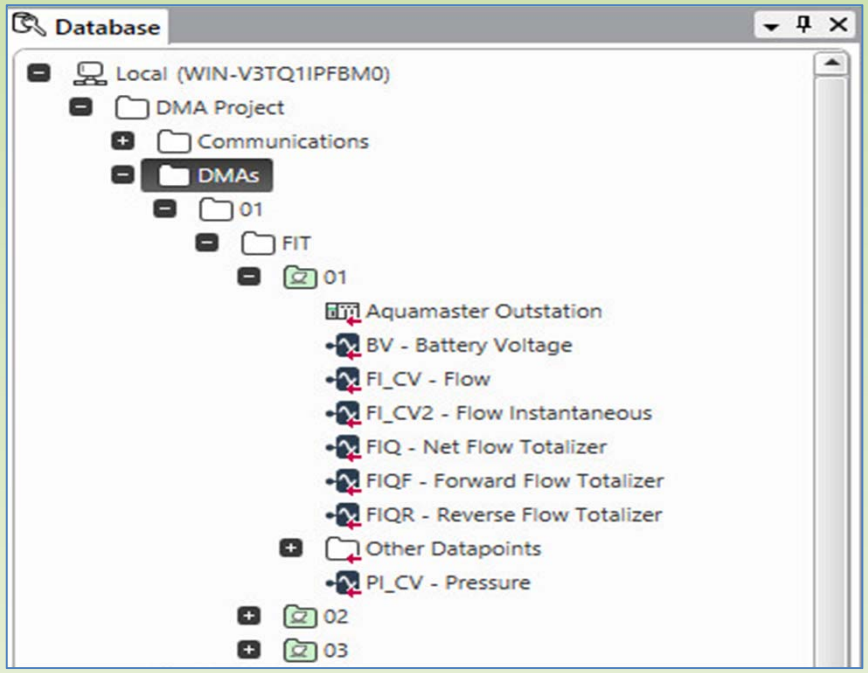
WITS Layer Technical Details

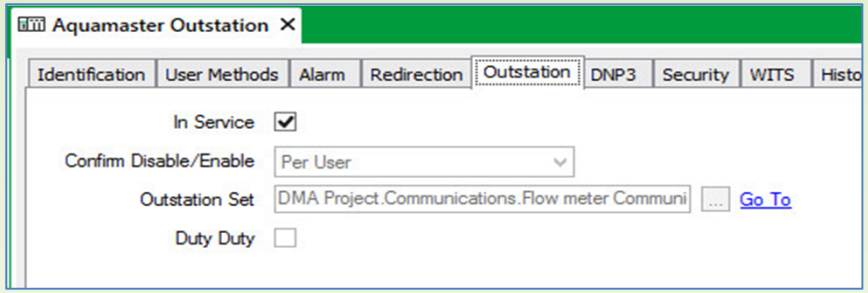
- Devices can be remotely configured/queried from SCADA
- Statistics generation at the device (min, max, average, totalization)
- Dynamically configurable periodic/event-based logging
- Device can generate its own alarms which are timestamped

- Remote configuration/setup of devices
- XML-based device profile templates, make for very fast setup
- When a device added, data tags come automatically from its profile
- Advanced troubleshooting/diagnostics via SCADA software
- **No custom programming needed for telemetry**

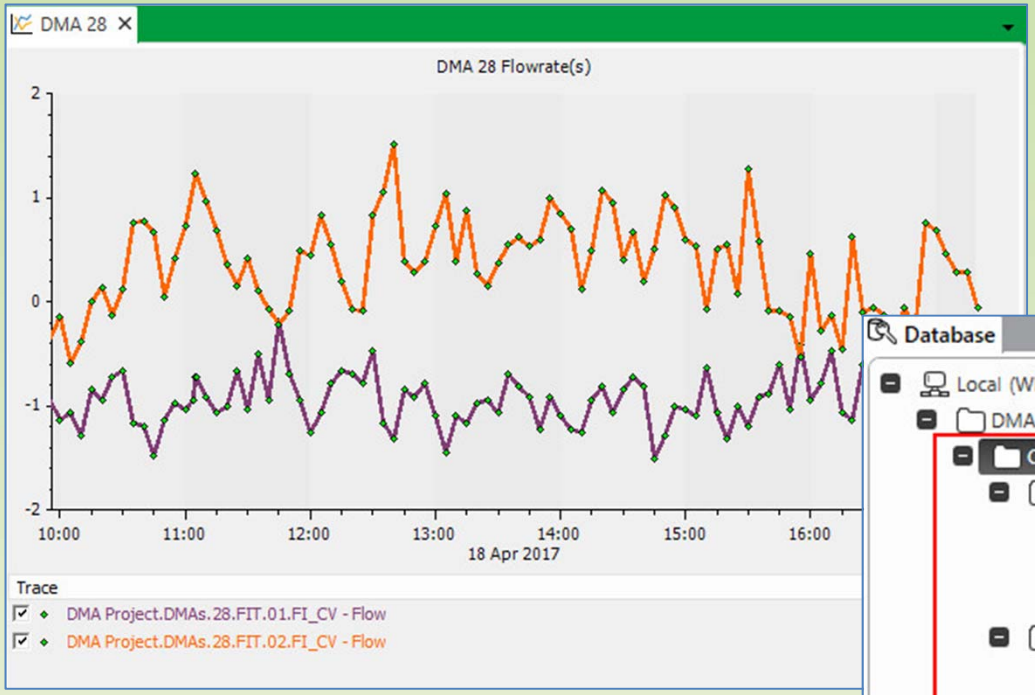
WITS: Configuration on ClearSCADA

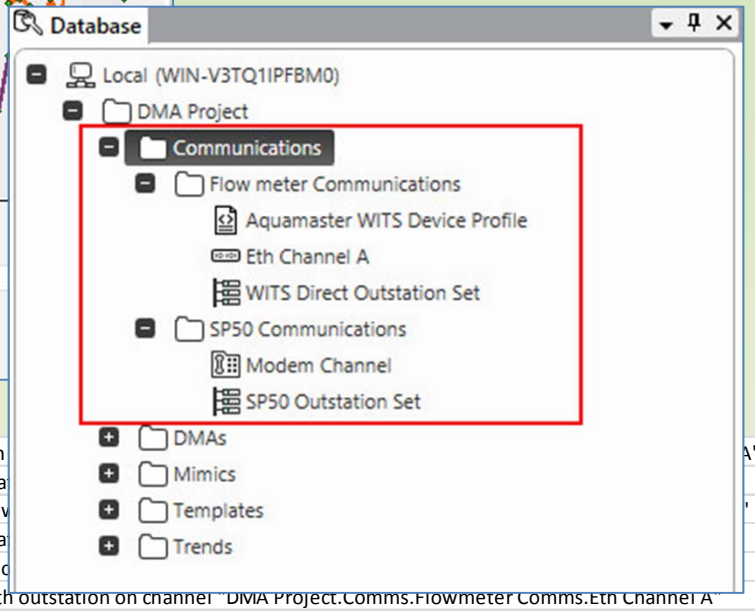






WITS: ClearSCADA Tools





DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Inbound connection	A"	Outstation Comms
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DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Established comms v	'	Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Communications sta		Multidrop
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Scheduled connectio		Scheduled Dial In
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:43	Stopped comms with outstation on channel "DMA Project.Comms.Flowmeter Comms.Eth Channel A"		Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:43	Communications state - Disconnected		Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 12:40	Inbound connection from outstation on channel "DMA Project.Comms.Flowmeter Comms.Eth Channel A"		Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 12:40	Communications state - Connecting		Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 12:40	Established comms with outstation on channel "DMA Project.Comms.Flowmeter Comms.Eth Channel A"		Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 12:40	Communications state - Healthy		Multidrop

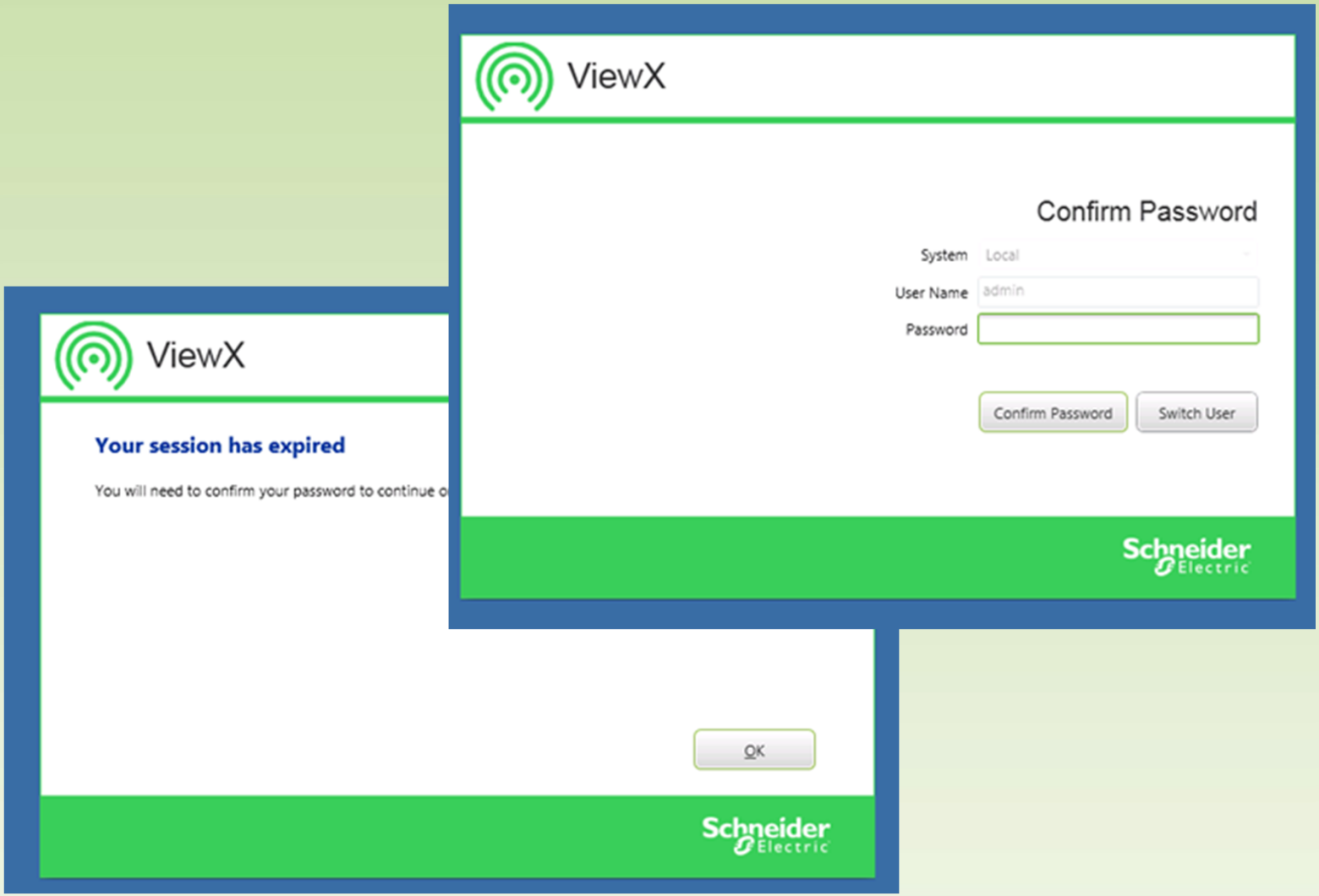
WITS SCADA Objectives

- Obtain consistent data sets and alarm/event reporting.
- Standardise data/alarm/logging configuration for all asset types.
- Minimise the number of SCADA interfaces for RTU types.
- Remove the bespoke development required for each of the vendor RTUs on the estate.
- Reduce the support requirement to maintain the RTU standard configurations.
- Improve SCADA security. (RTU / SCADA communications secure authentication).

Challenges


Guelph

Tools Within ClearSCADA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ViewX
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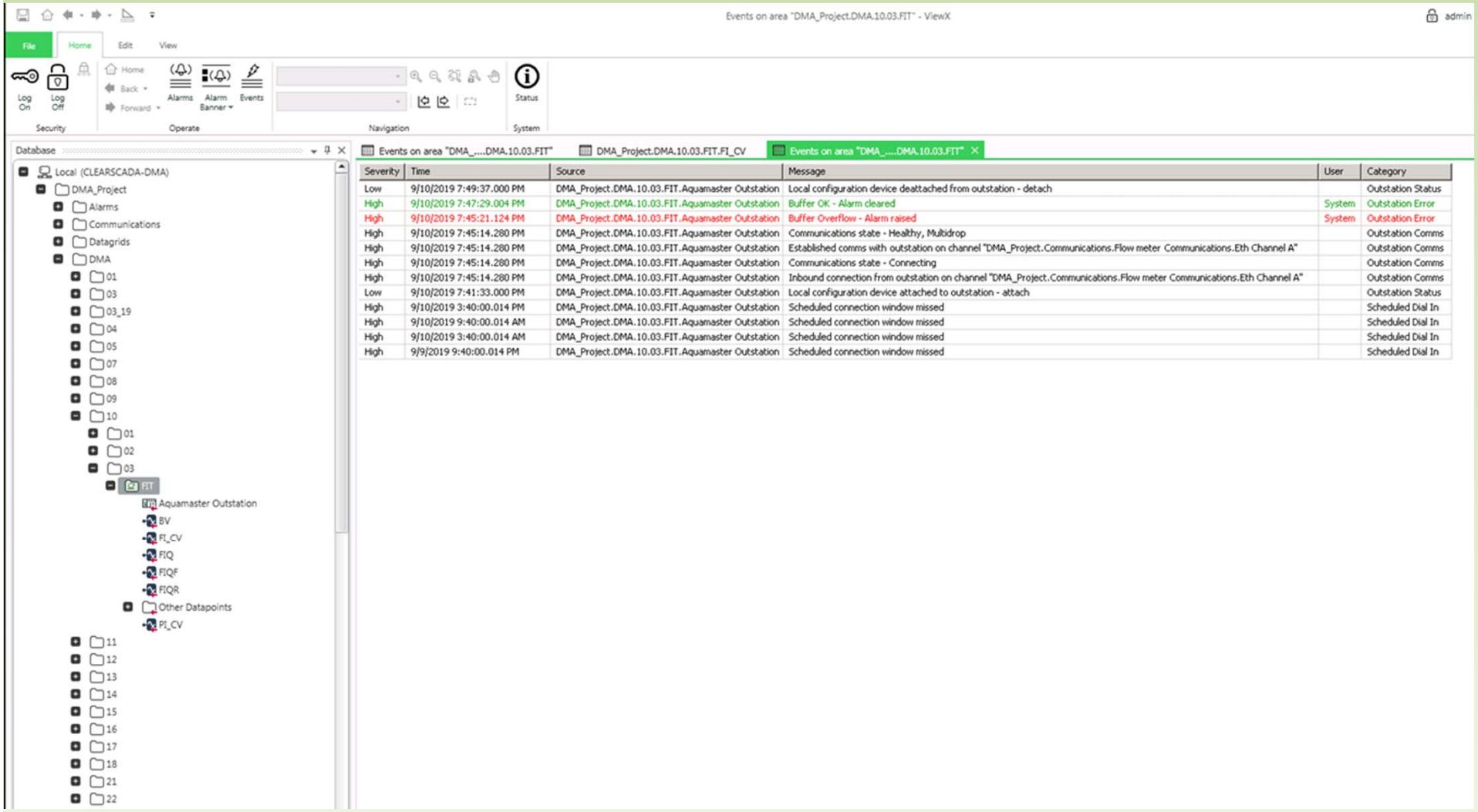
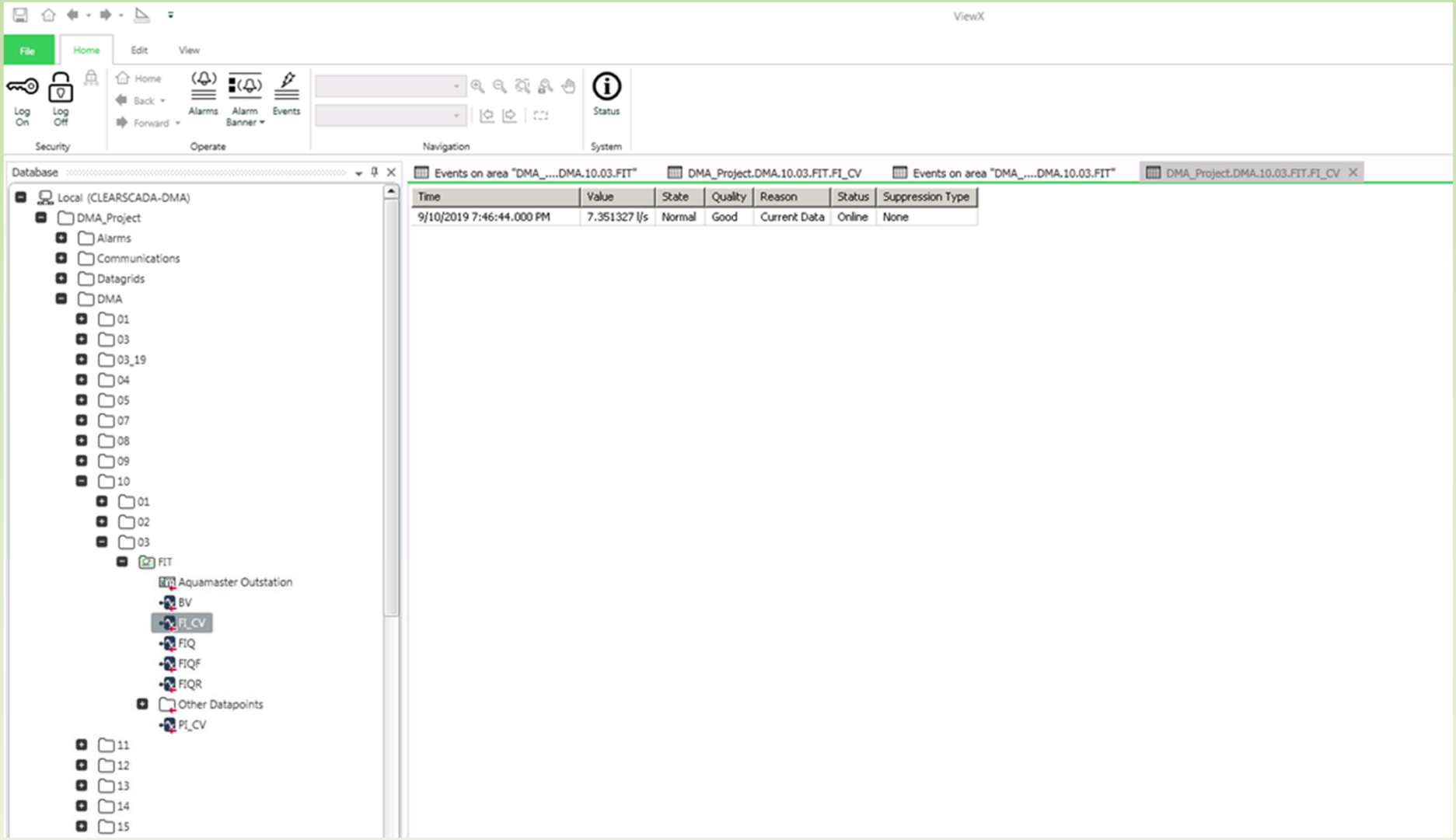
You will need to confirm your password to continue o
OK
Schneider Electric



Severity	Time	Source	Message	User	Category
Low	9/10/2019 7:49:37.000 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Local configuration device deattached from outstation - detach		Outstation Status
High	9/10/2019 7:47:29.004 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Buffer OK - Alarm cleared	System	Outstation Error
High	9/10/2019 7:45:21.124 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Buffer Overflow - Alarm raised	System	Outstation Error
High	9/10/2019 7:45:14.280 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Communications state - Healthy, Multidrop		Outstation Comms
High	9/10/2019 7:45:14.280 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Established comms with outstation on channel "DMA_Project.Communications.Flow meter Communications.Eth Channel A"		Outstation Comms
High	9/10/2019 7:45:14.280 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Communications state - Connecting		Outstation Comms
High	9/10/2019 7:45:14.280 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Inbound connection from outstation on channel "DMA_Project.Communications.Flow meter Communications.Eth Channel A"		Outstation Comms
Low	9/10/2019 7:41:33.000 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Local configuration device attached to outstation - attach		Outstation Status
High	9/10/2019 3:40:00.014 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Scheduled connection window missed		Scheduled Dial In
High	9/10/2019 9:40:00.014 AM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Scheduled connection window missed		Scheduled Dial In
High	9/10/2019 3:40:00.014 AM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Scheduled connection window missed		Scheduled Dial In
High	9/9/2019 9:40:00.014 PM	DMA_Project.DMA.10.03.FIT.Aquamaster Outstation	Scheduled connection window missed		Scheduled Dial In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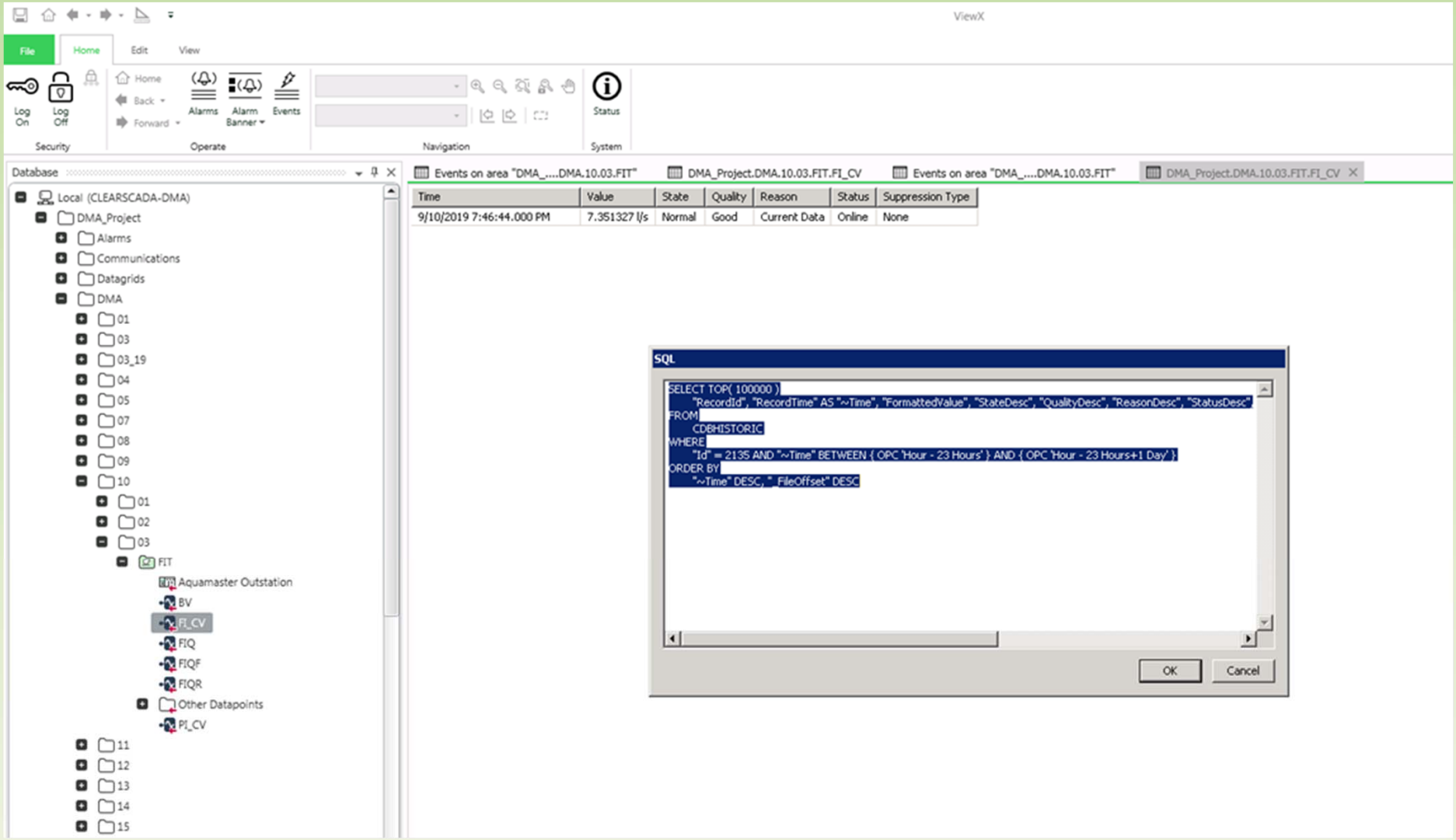
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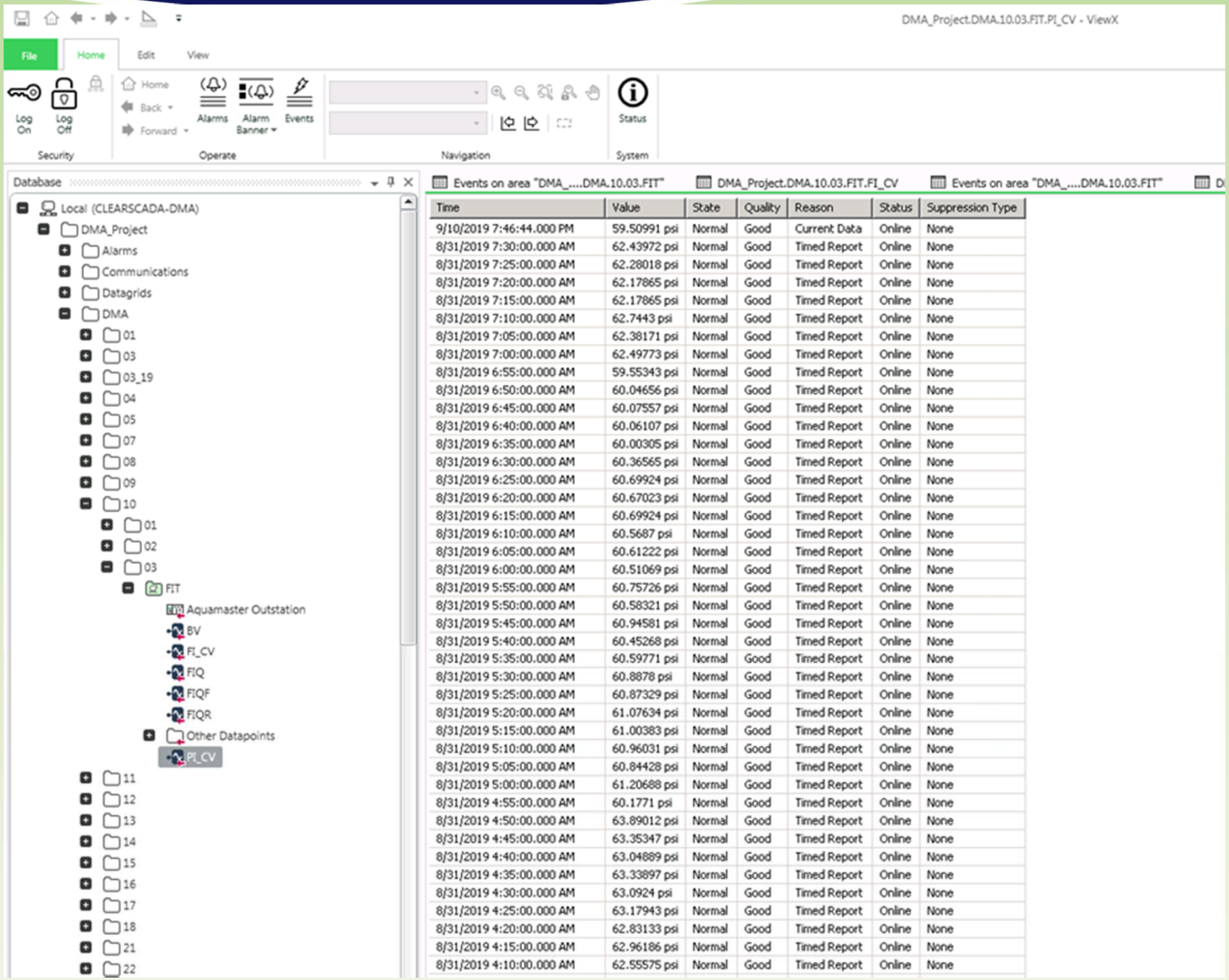
SQL
SELECT TOP(100000)
"RecordId", "RecordTime" AS "~Time", "FormattedValue", "StateDesc", "QualityDesc", "ReasonDesc", "StatusDesc"
FROM
CDBHISTORIC
WHERE
"Id" = 2135 AND "~Time" BETWEEN { OPC 'Hour - 23 Hours' } AND { OPC 'Hour - 23 Hours+1 Day' }
ORDER BY
"~Time" DESC, "_FileOffset" DESC
OK
Cancel



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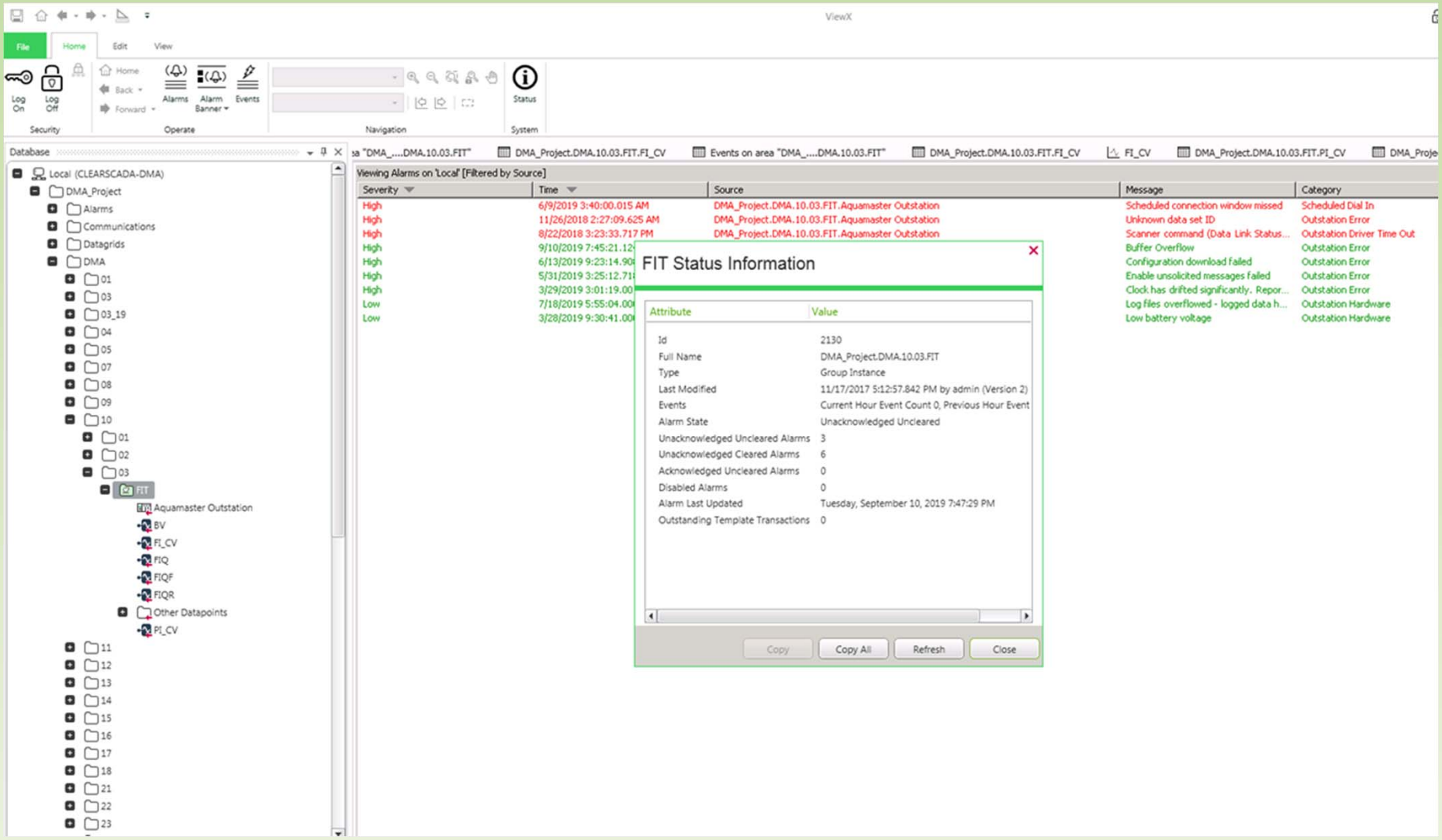
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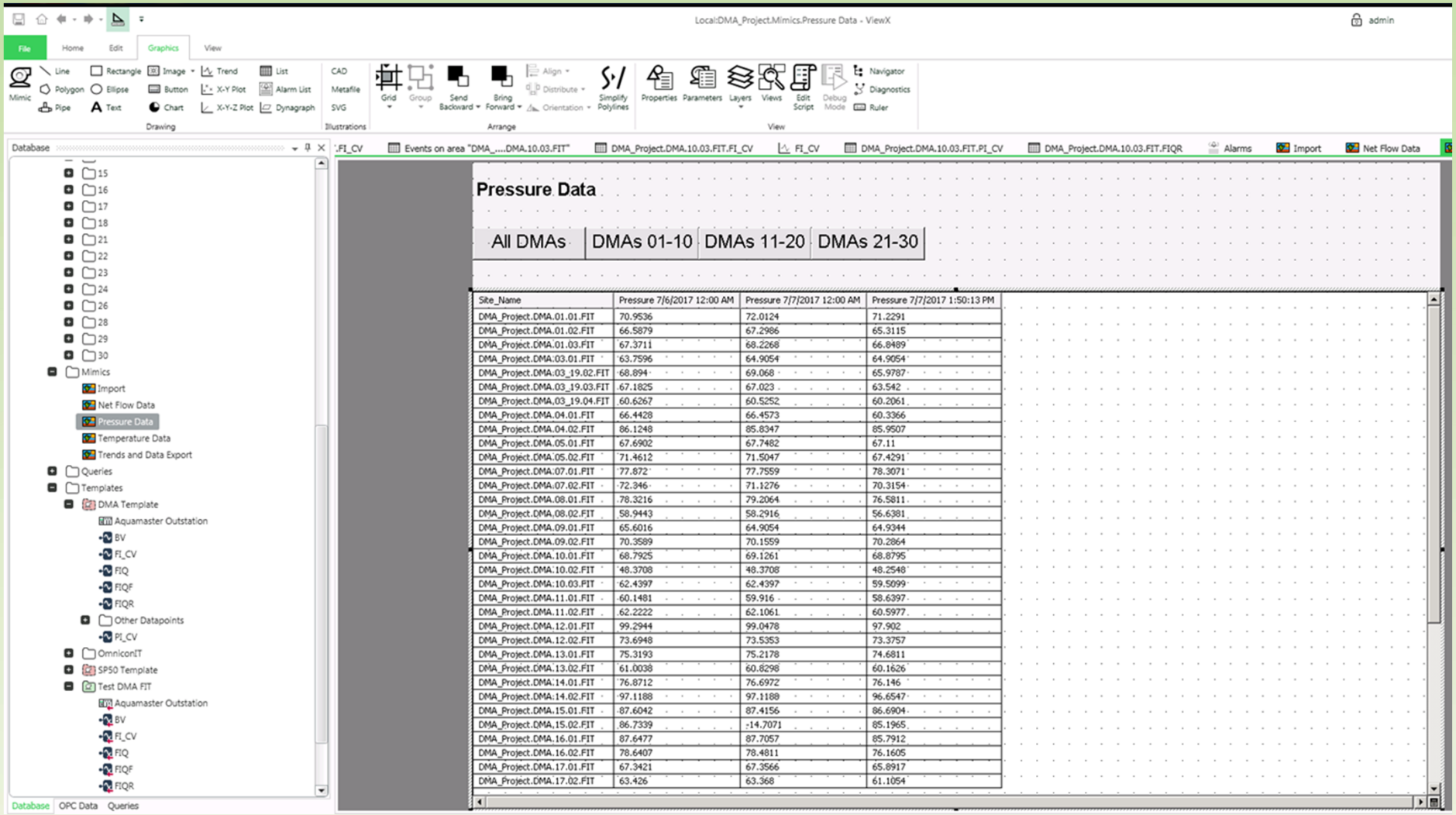
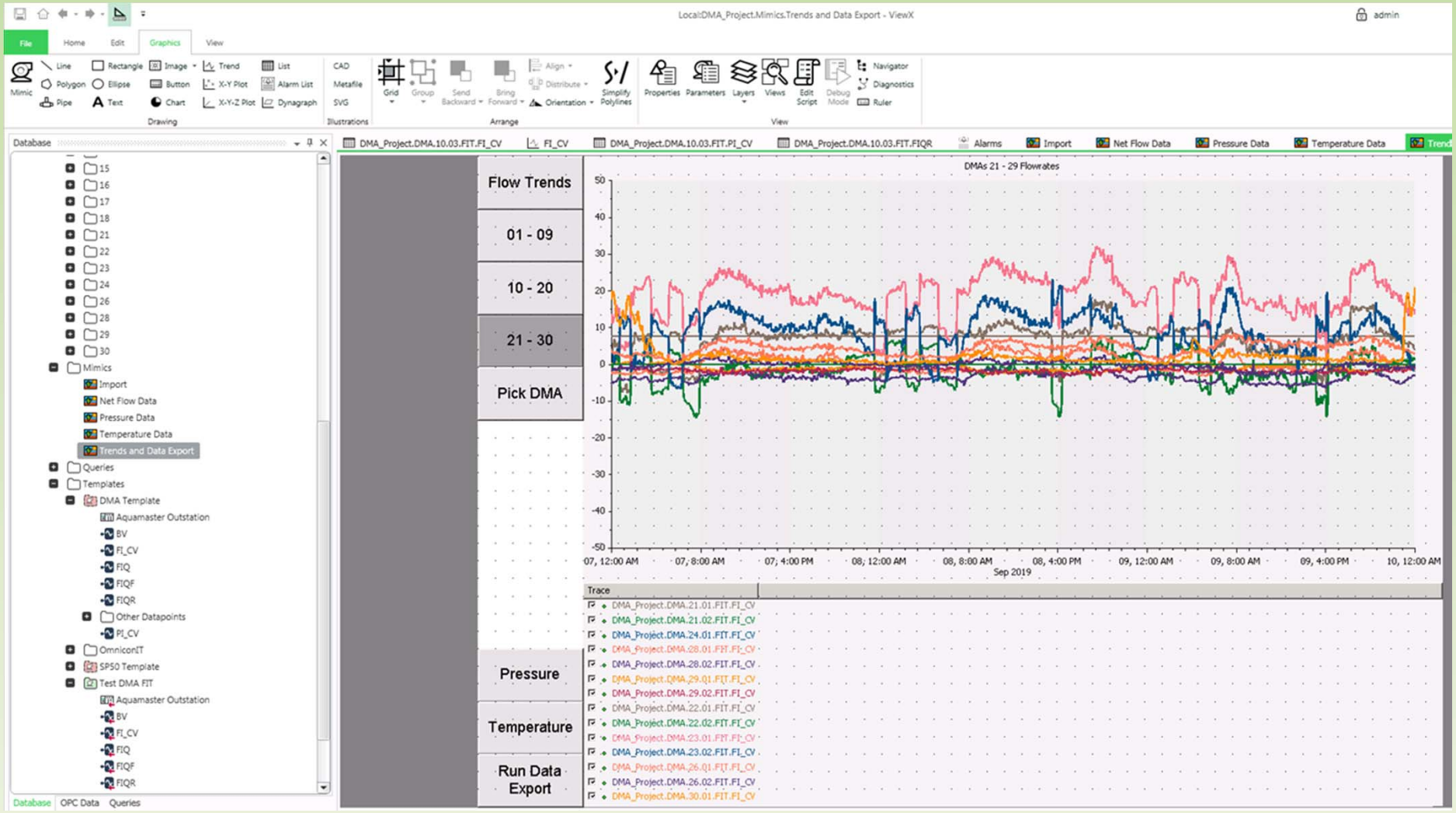
Scheduled Dial In
High
11/26/2018 2:27:09.625 AM
DMA_Project.DMA.10.03.FIT.Aquamaster Outstation
Unknown data set ID
Outstation Error
High
8/22/2018 3:23:33.717 PM
DMA_Project.DMA.10.03.FIT.Aquamaster Outstation
Scanner command (Data Link Status...
Outstation Driver Time Out
High
Buffer Overflow
Outstation Error
High
Configuration download failed
Outstation Error
High
Enable unsolicited messages failed
Outstation Error
High
Clock has drifted significantly. Repor...
Outstation Error
Low
Log files overflowed - logged data h...
Outstation Hardware
Low
Low battery voltage
Outstation Hardware
FIT Status Information
Attribute
Value
Id
2130
Full Name
DMA_Project.DMA.10.03.FIT
Type
Group Instance
Last Modified
11/17/2017 5:12:57.842 PM by admin (Version 2)
Events
Current Hour Event Count 0, Previous Hour Event
Alarm State
Unacknowledged Uncleared
Unacknowledged Uncleared Alarms
3
Unacknowledged Cleared Alarms
6
Acknowledged Uncleared Alarms
0
Disabled Alarms
0
Alarm Last Updated
Tuesday, September 10, 2019 7:47:29 PM
Outstanding Template Transactions
0
Copy
Copy All
Refresh
Close

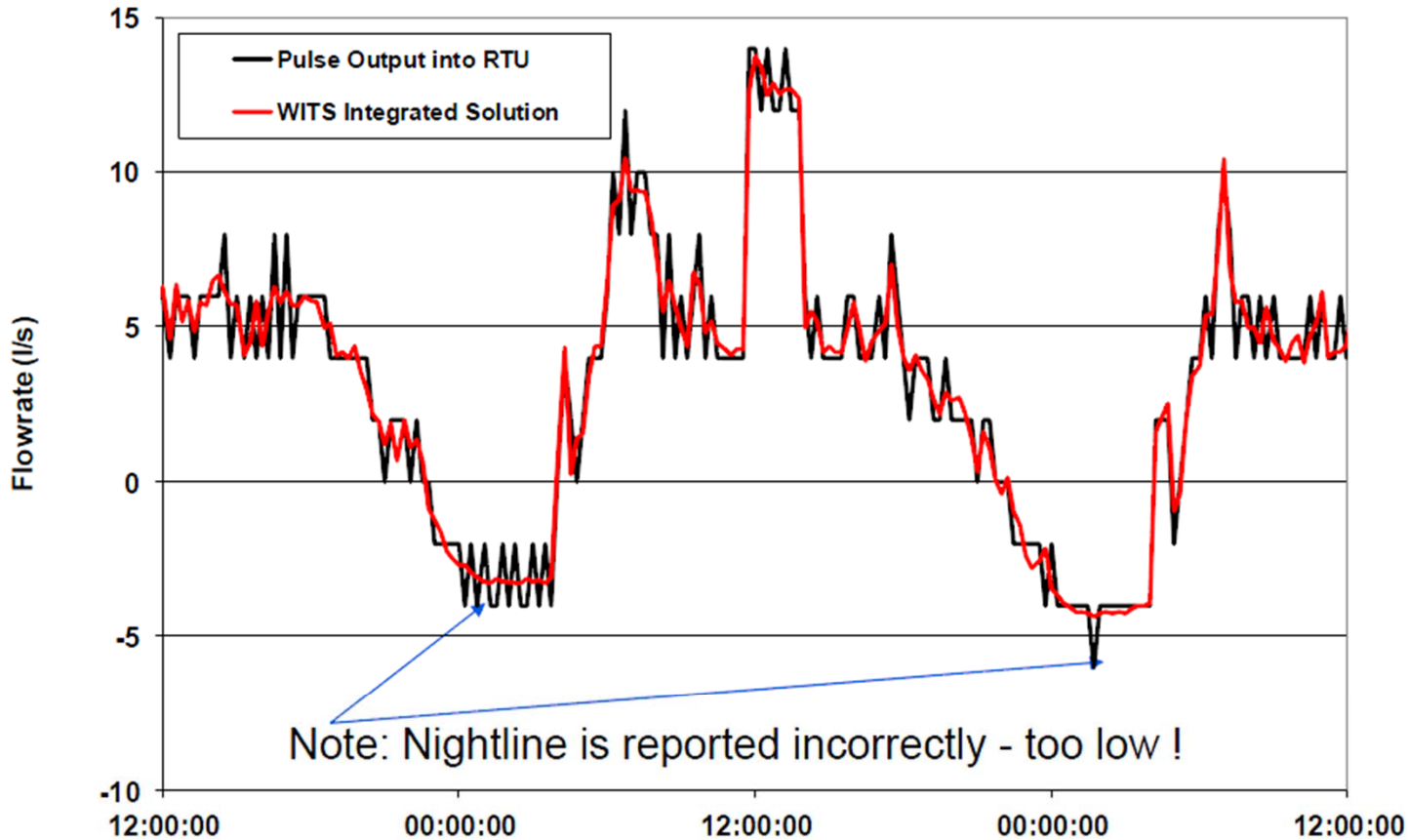


Site_Name	Pressure 7/6/2017 12:00 AM	Pressure 7/7/2017 12:00 AM	Pressure 7/7/2017 1:50:13 PM
DMA_Project.DMA.01.01.FIT	70.9536	72.0124	71.2291
DMA_Project.DMA.01.02.FIT	66.5879	67.2986	65.3115
DMA_Project.DMA.01.03.FIT	67.3711	68.2268	66.8489
DMA_Project.DMA.03.01.FIT	63.7596	64.9054	64.9054
DMA_Project.DMA.03_19.02.FIT	68.894	69.068	65.9787
DMA_Project.DMA.03_19.03.FIT	67.1825	67.023	63.542
DMA_Project.DMA.03_19.04.FIT	60.6267	60.5252	60.2061
DMA_Project.DMA.04.01.FIT	66.4428	66.4573	60.3366
DMA_Project.DMA.04.02.FIT	86.1248	85.8347	85.9507
DMA_Project.DMA.05.01.FIT	67.6902	67.7482	67.11
DMA_Project.DMA.05.02.FIT	71.4612	71.5047	67.4291
DMA_Project.DMA.07.01.FIT	77.872	77.7559	78.3071
DMA_Project.DMA.07.02.FIT	72.346	71.1276	70.3154
DMA_Project.DMA.08.01.FIT	78.3216	79.2064	76.5811
DMA_Project.DMA.08.02.FIT	58.9443	58.2916	56.6381
DMA_Project.DMA.09.01.FIT	65.6016	64.9054	64.9344
DMA_Project.DMA.09.02.FIT	70.3589	70.1559	70.2864
DMA_Project.DMA.10.01.FIT	68.7925	69.1261	68.8795
DMA_Project.DMA.10.02.FIT	48.3708	48.3708	48.2548
DMA_Project.DMA.10.03.FIT	62.4397	62.4397	59.5099
DMA_Project.DMA.11.01.FIT	60.1481	59.916	58.6397
DMA_Project.DMA.11.02.FIT	62.2222	62.1061	60.5977
DMA_Project.DMA.12.01.FIT	99.2944	99.0478	97.902
DMA_Project.DMA.12.02.FIT	73.6948	73.5353	73.3757
DMA_Project.DMA.13.01.FIT	75.3193	75.2178	74.6811
DMA_Project.DMA.13.02.FIT	61.0038	60.8298	60.1626
DMA_Project.DMA.14.01.FIT	76.8712	76.6972	76.146
DMA_Project.DMA.14.02.FIT	97.1188	97.1188	96.6547
DMA_Project.DMA.15.01.FIT	87.6042	87.4156	86.6904
DMA_Project.DMA.15.02.FIT	86.7339	-14.7071	85.1965
DMA_Project.DMA.16.01.FIT	87.6477	87.7057	85.7912
DMA_Project.DMA.16.02.FIT	78.6407	78.4811	76.1605
DMA_Project.DMA.17.01.FIT	67.3421	67.3566	65.8917
DMA_Project.DMA.17.02.FIT	63.426	63.368	61.1054


LocalDMA_Project.Mimics.Trends and Data Export - ViewX
admin
Database
Mimics
Import
Net Flow Data
Pressure Data
Temperature Data
Trends and Data Export
Queries
Templates
DMA Template
Aquamaster Outstation
Other Datapoints
OmniconIT
SP50 Template
Test DMA FIT
Flow Trends
01 - 09
10 - 20
21 - 30
Pick DMA
Pressure
Temperature
Run Data Export
DMAs 21 - 29 Flowrates
Sep 2019
Trace

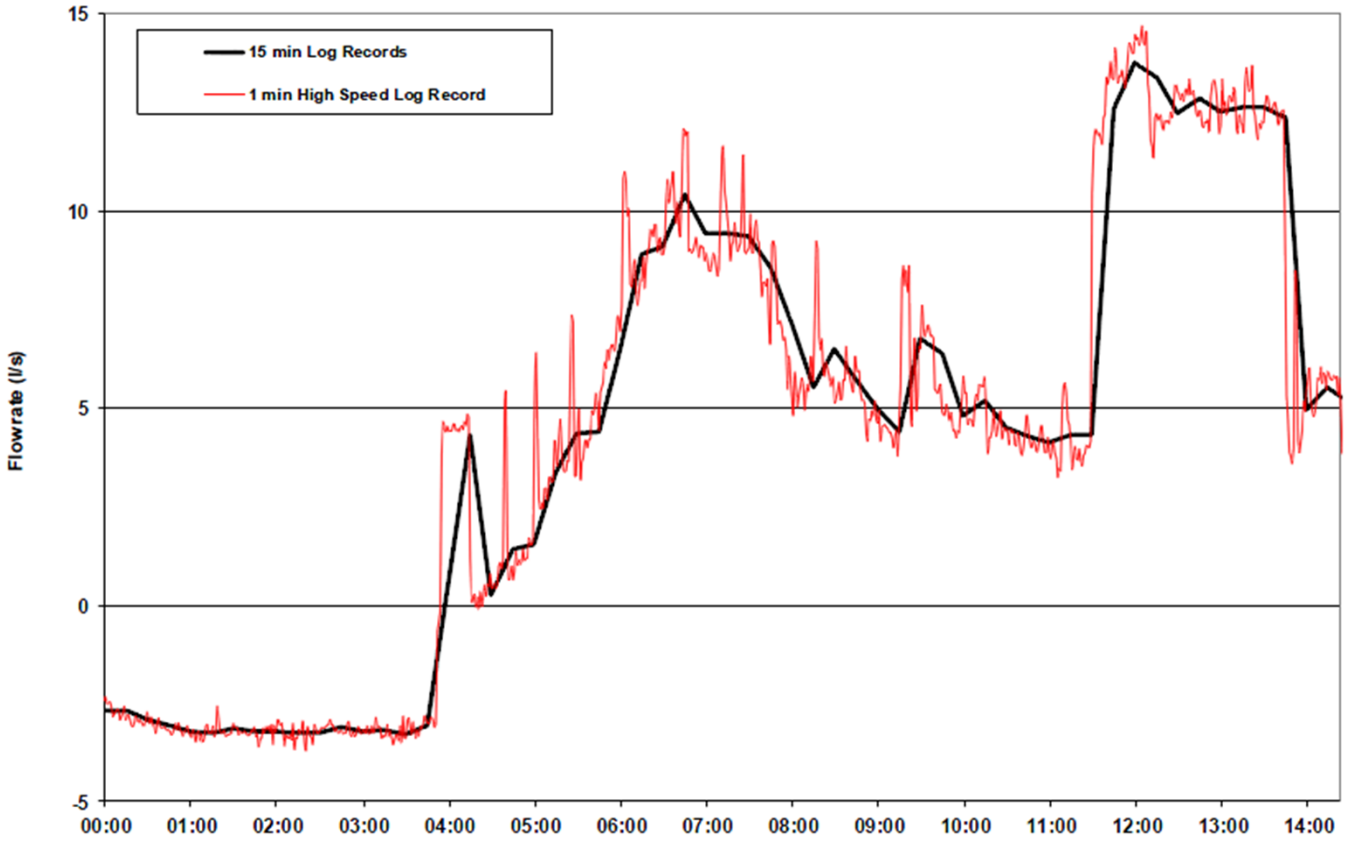
Interesting Things we can do using DNP3-WITS Protocol

Integrated Flowmeter and WITS Solution
Resolution - Amplitude



- Traditional solutions - result is quantised and incorrect values being reported
- This phenomena is worse at low flowrates, e.g nightlines

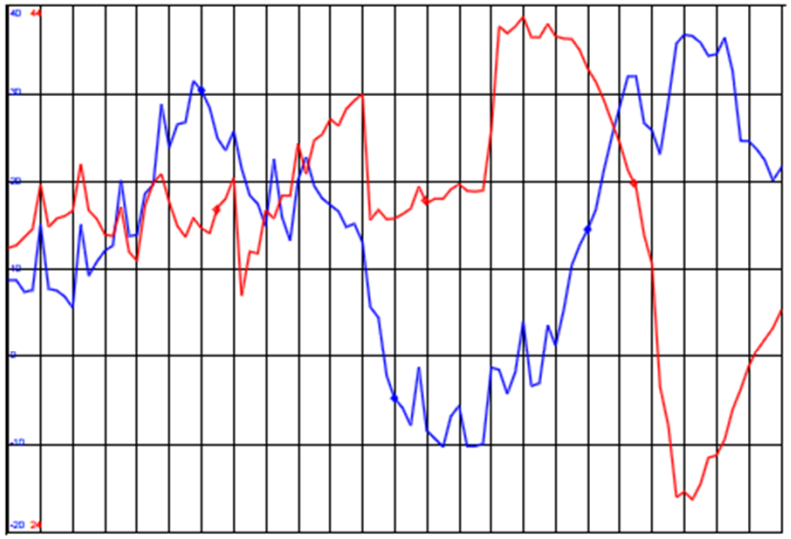
Integrated Flowmeter and WITS Solution
Resolution - Time



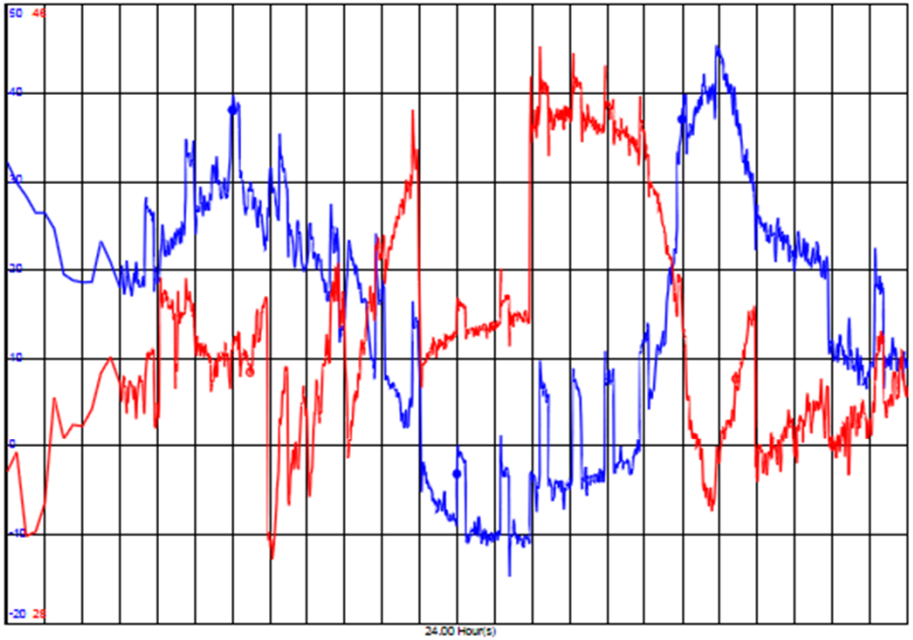
- 15 min log record, compared to 1 min high speed log records, results in significant "Aliasing", loss of detailed flow information and under reading of peak flowrates.

Integrated Flowmeter and WITS Solution
Resolution – Time

15 min records



1 min records



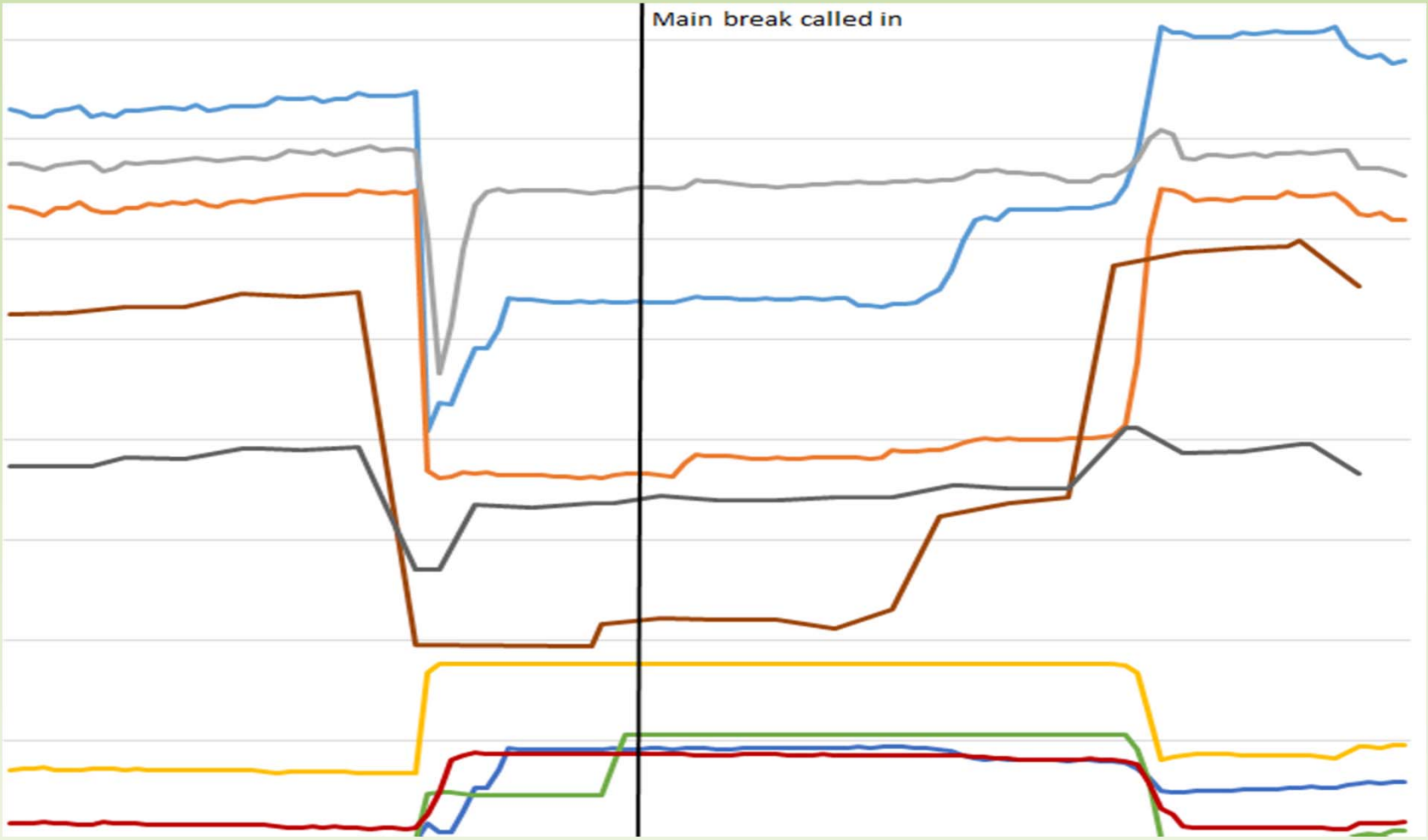
- Note erratic and low resolution information on 15 min data

Flowrate – Blue
Pressure - Red

How we use our DMA Flowmeter Data

- Water Balances: Production vs. Pumping vs. Usage
- Identifying High Leakage Areas for Investigation
- Monitoring Pressure (using pressure probes on meters)
- Auditing Customer Meter Areas
- Calibrating the Hydraulic Model: Flow In/Out of DMAs
- Forecasting Water Demand
- Waterman break investigations
- Identifying low flow areas in the distribution network
- Identifying “low flow” areas at risk of freezing in winter
- Etc.

Example: Using DMA flowmeter data for analysis



Special Thanks To

- Simark Controls
- Telemetry and Remote SCADA Solutions, Schneider Electric
- ABB Canada
- ABB UK and Schneider Electric UK
- NLS Engineering
- WITS Protocol Standards Association

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