The Canadian Experience:

Using DNP3-WITS Water Industry Telemetry Standard for Gathering Flow and Pressure Data from District Flow Metered Areas

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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 30 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.

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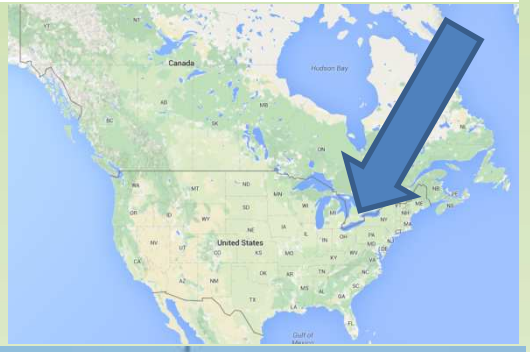
Presentation Outline

- 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

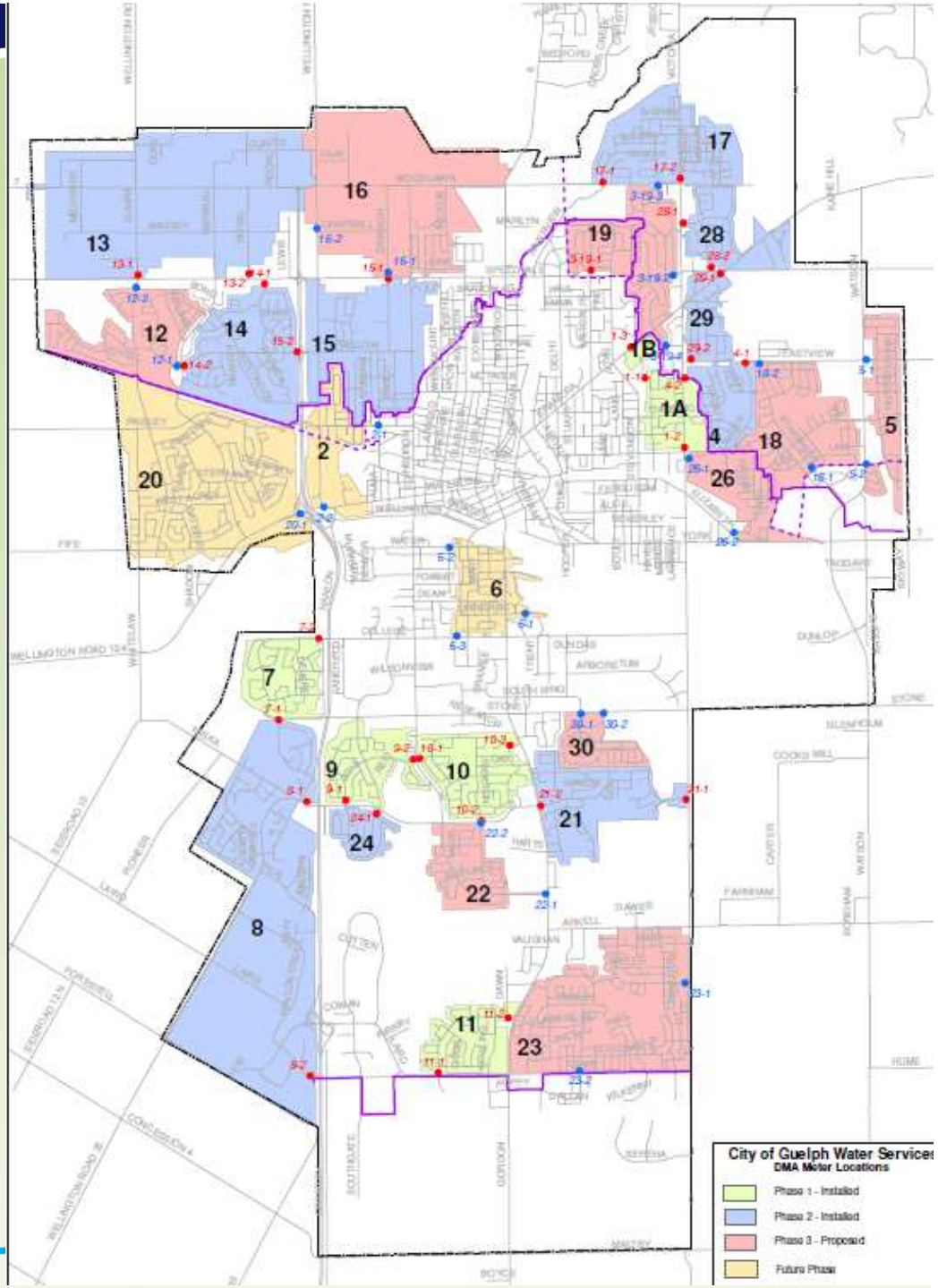
- Guelph, Ontario, Canada
- 140,000 residents
- 21 groundwater wells
- 3 water towers
- 549 km of water mains
- 49,000 service connections
- 2,750 fire hydrants
- 46,000 m^3/day [12 MGD]



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

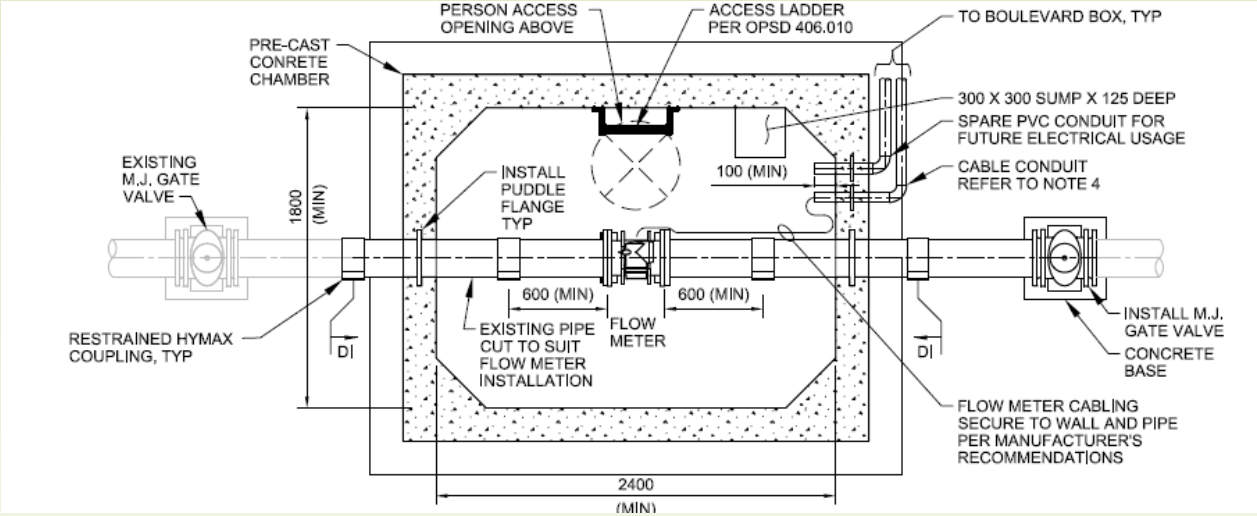


Flowmeter Selection

- 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

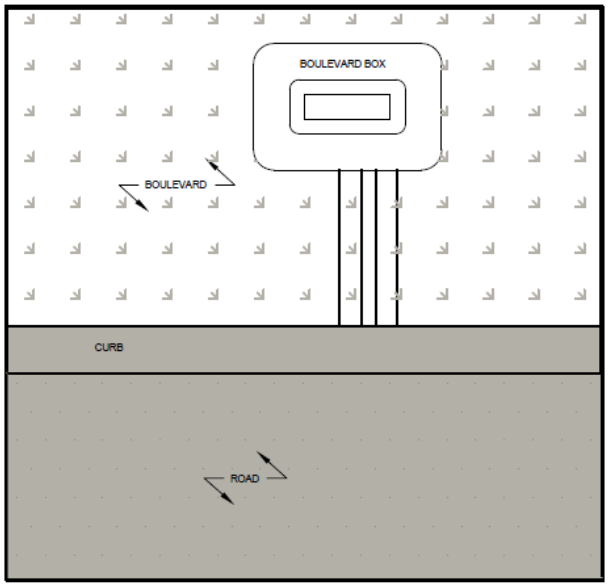
Flowmeter Install: Chambers

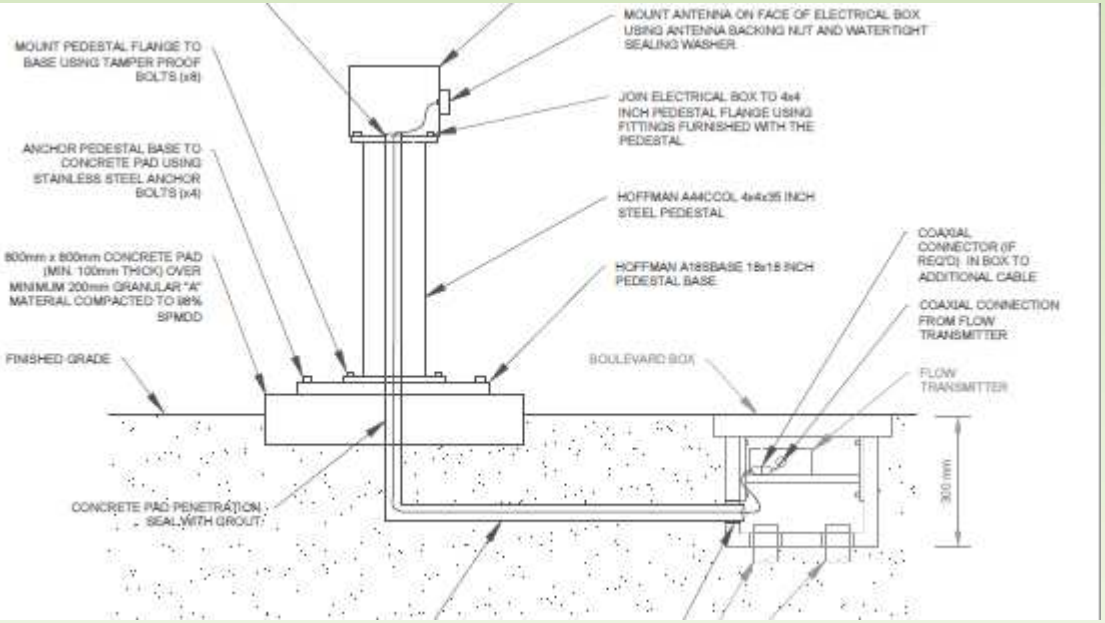
- Each DMA is enabled by closing valves, so only 2-3 entry points
- Put Flowmeter chamber on each of DMA's entry points
  - Chamber contains the Flowmeter "flow tube"
  - Pressure sensor (also monitored by flowmeter electronics)
  - Upstream and downstream isolation valves



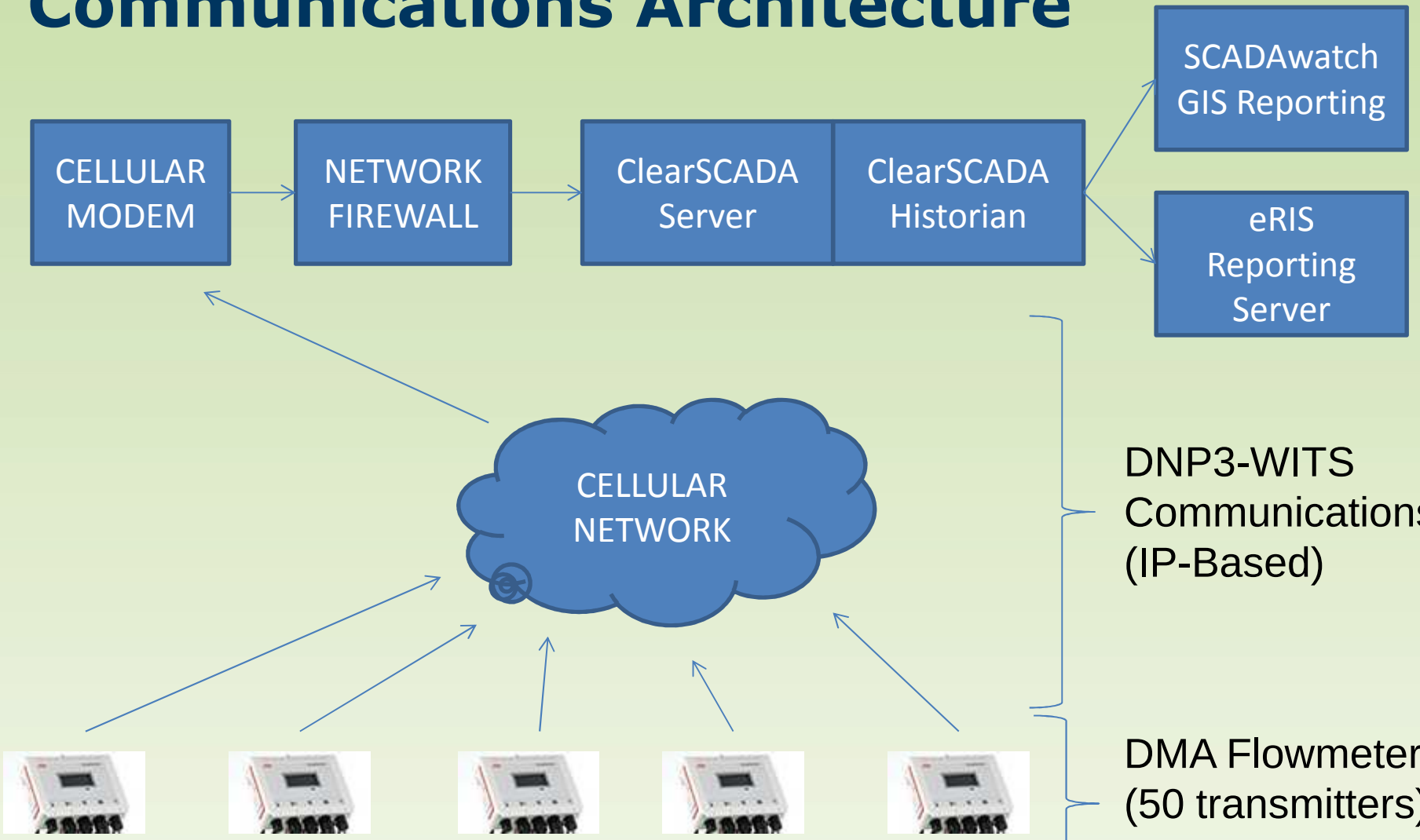
Flowmeter Install: Transmitters

- Flowmeters installed into boulevard boxes
- Antenna pedestals installed for areas with weak cellular signal





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

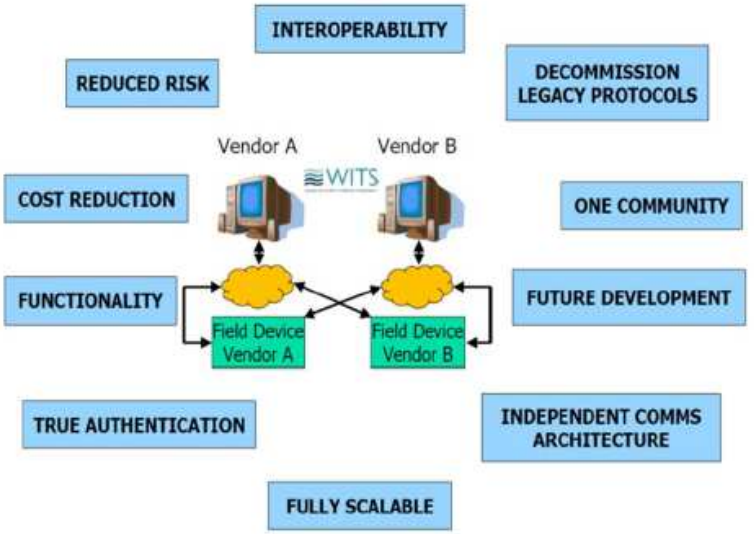
UK Water Utilities

* 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
Distributed Network Protocol (DNP) 3

- DNP3 (Distributed Network Protocol) was selected
- Originally developed for use in power utility applications
- An internationally recognised standard
- DNP3 enables communication between different types of data acquisition and control equipment
- Includes secure authentication and encryption protection against hacking
- Supports a wide range of communication types



Protocol Selection
Development and Testing

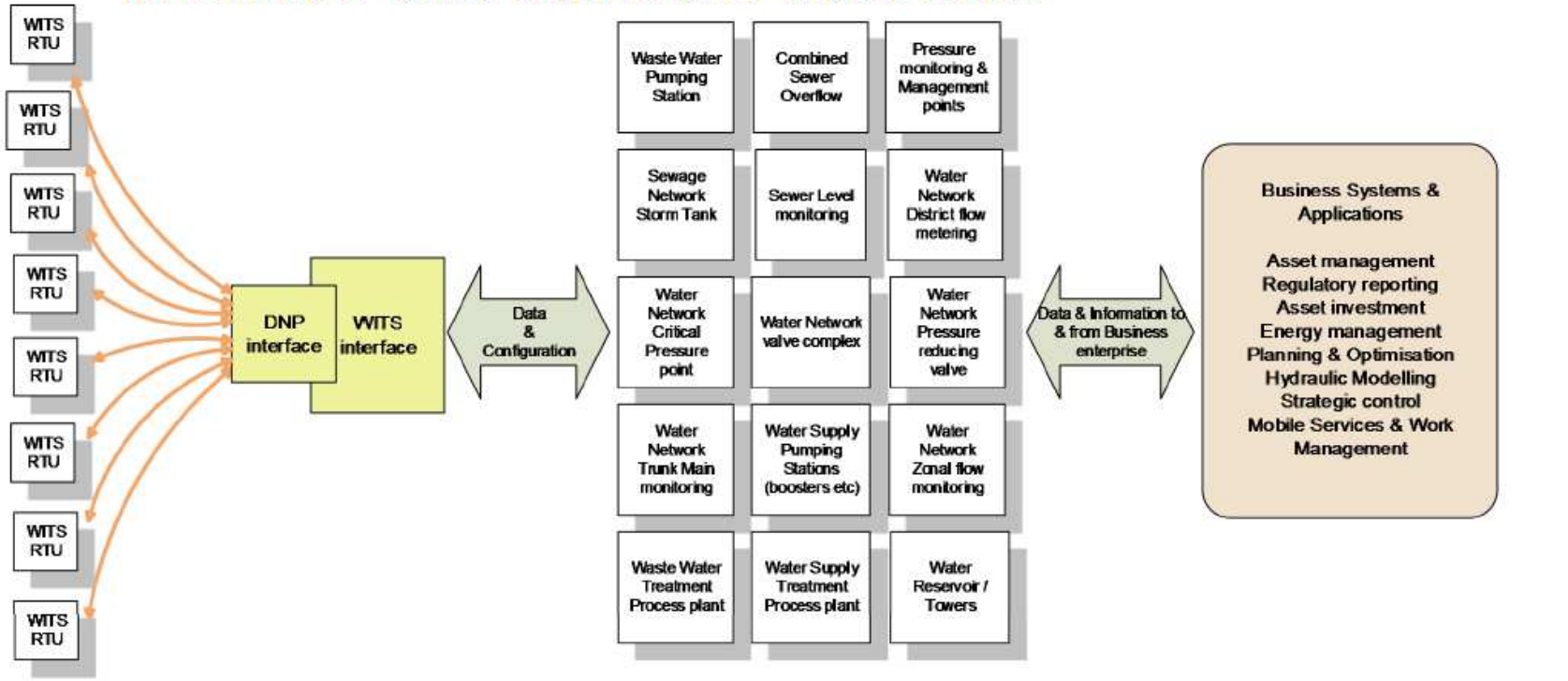
- To provide the required interoperability and the water industry functionality, there was the need for a precise specification
- This was achieved through the development of the Application Notes and associated test specifications
- Six water industry telemetry suppliers developed both master stations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

WITS DNP 3 Protocol Standard
Water Industry Adoption

- The WITS Protocol Standards Association has over 70 members mainly from the UK but also with a growing number from overseas.
- The following UK water companies have adopted WITS as their standard
  - Anglian Water
  - Northern Ireland Water
  - Northumbrian Water
  - Severn Trent
  - South West Water
  - Thames Water
  - United Utilities
  - Welsh Water

- WITS telemetry master stations from:
  - Schneider
  - Servelec
- WITS field device products from:
  - ABB
  - Brodersen
  - Halma Water Management
  - Metasphere
  - Schneider
  - Servelec
  - Technolog
  - Xylem

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

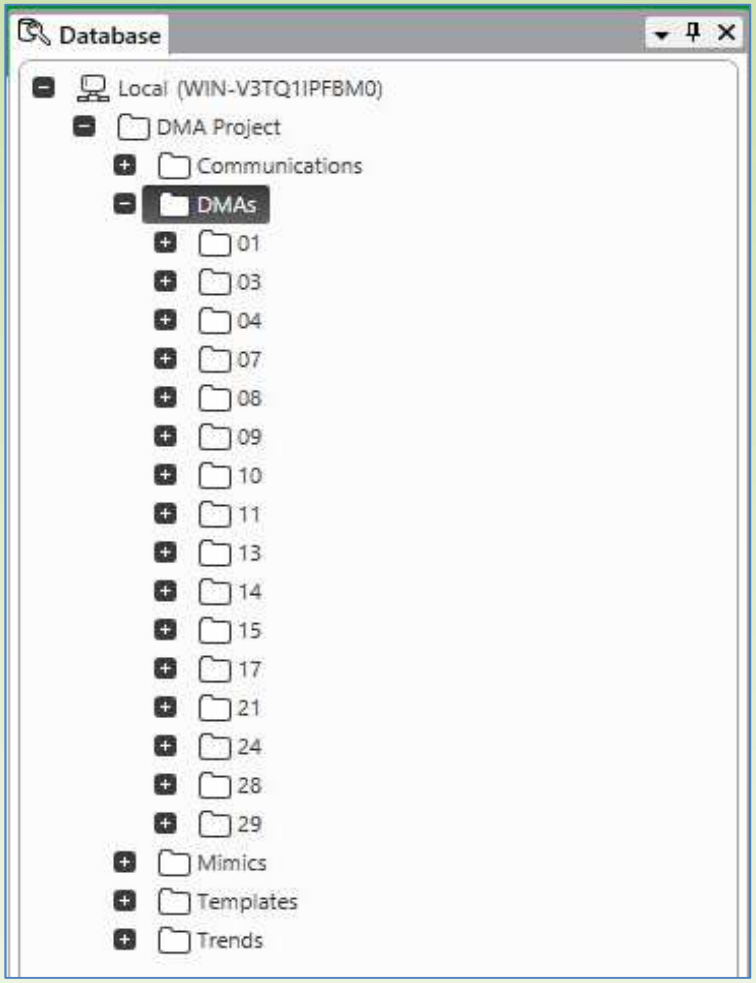
- Supports both Encryption and Authentication
- Automatic Error checking of data packets
- Prioritized Communications (Tags can be grouped in classes 0-4)
- Variety of networks supported: Ethernet, serial, ATM, cellular, etc.
- Supports wide range of analog, digital and structured datatypes

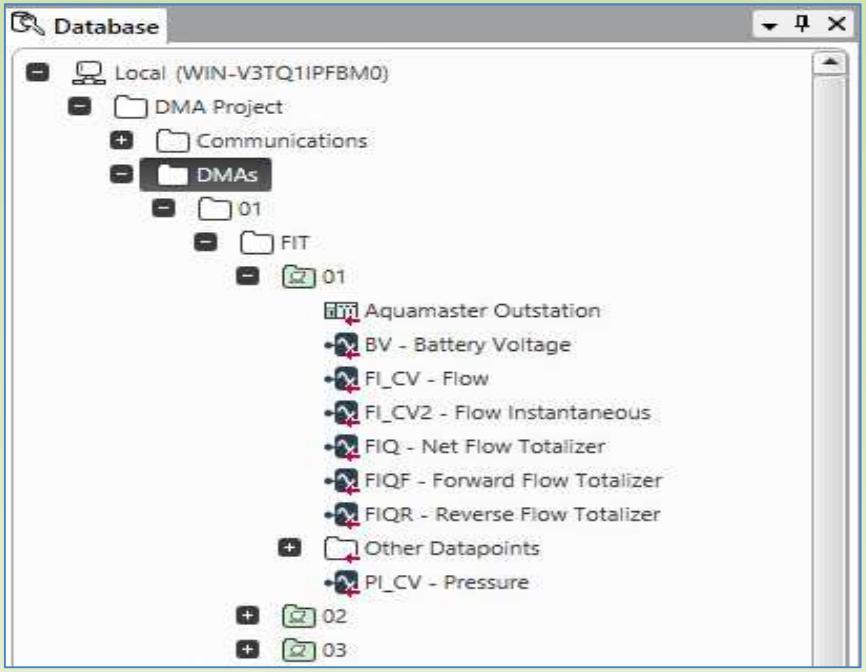
WITS Layer Technical Details

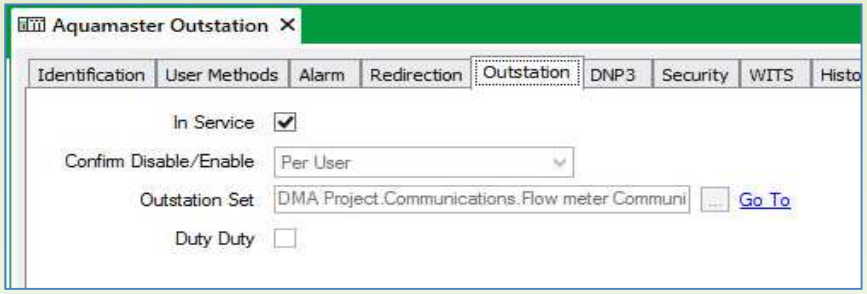
- Devices can be remotely configured/queried from SCADA
- Statistics generation at the device (min, max, average, totalization)
- Dynamically configurable periodic/event-based logging
- Device can generate its own alarms which are timestamped

- 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**

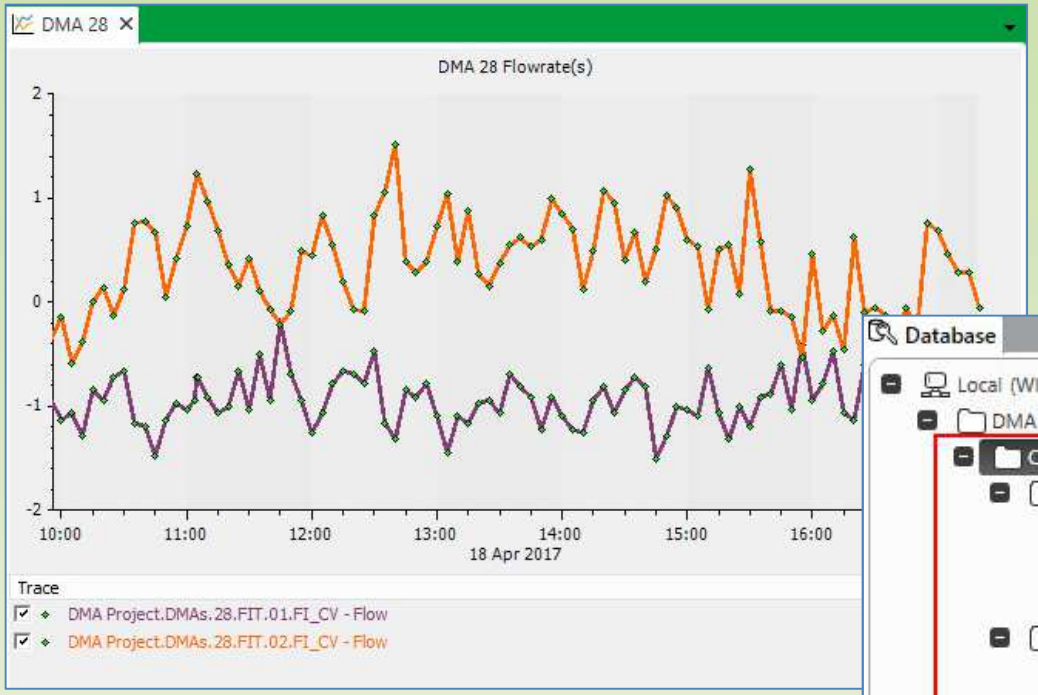
WITS: Configuration on ClearSCADA

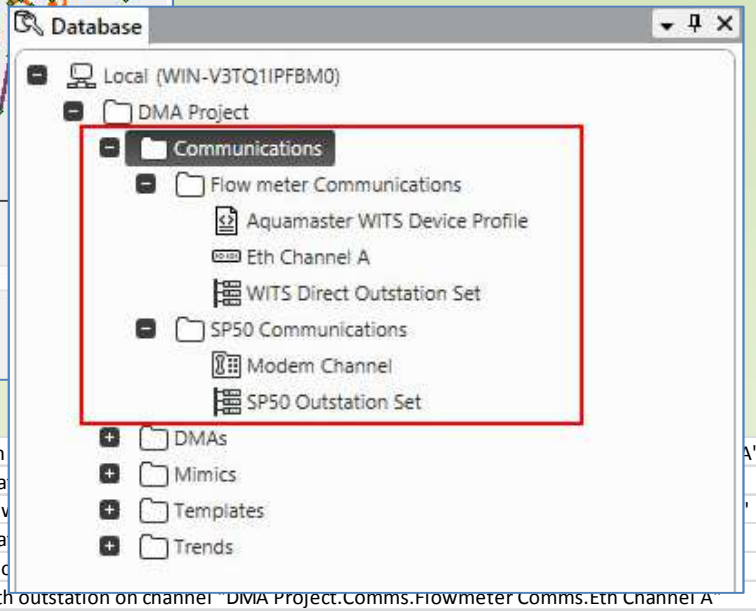






WITS: ClearSCADA Tools





DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Inbound connection	Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Communications sta	Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:41	Established comms v	Outstation Comms
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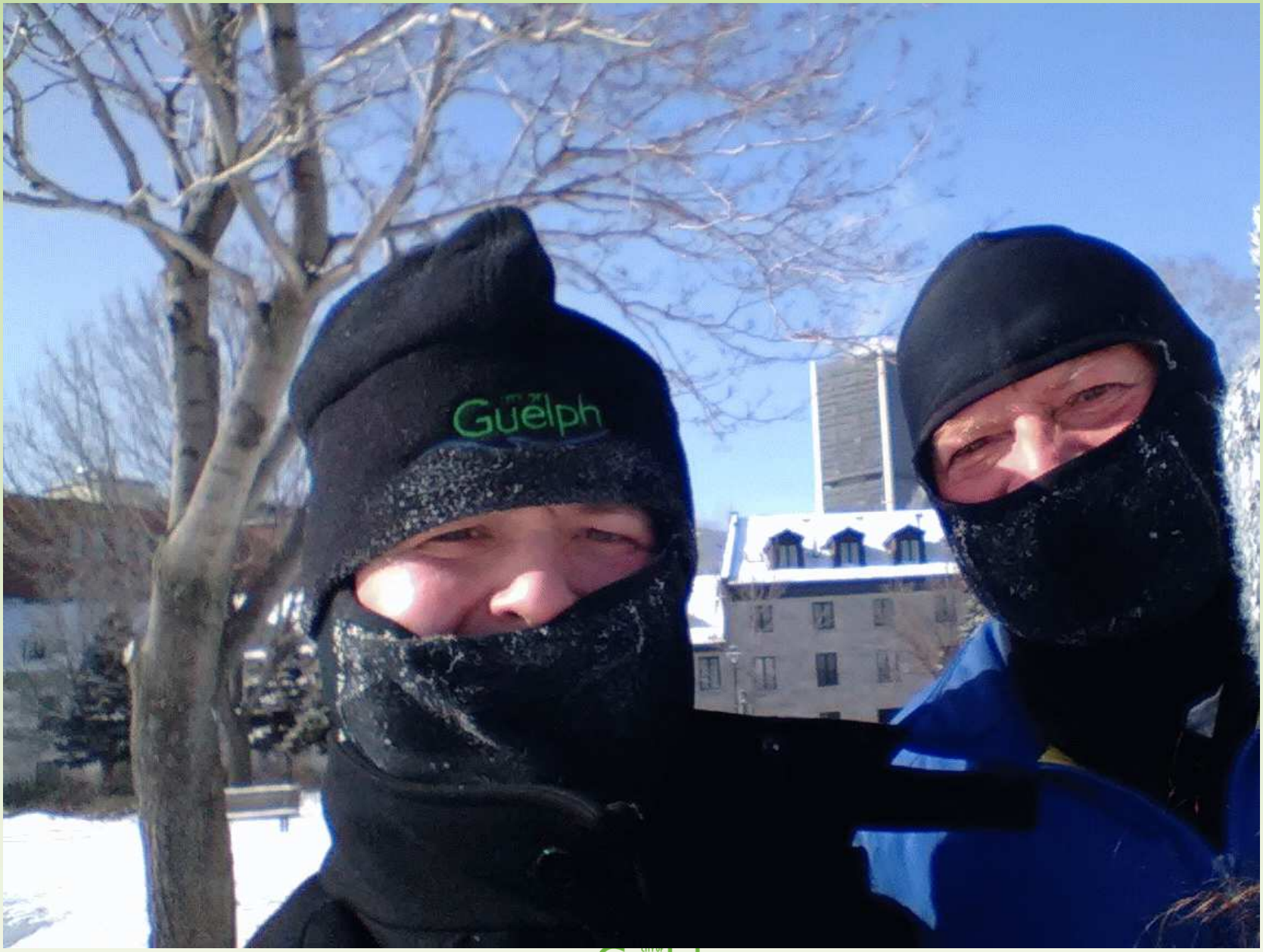
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:43	Stopped comms with outstation on channel "DMA Project.Comms.Flowmeter Comms.Eth Channel A"	Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster Outstation	4/10/2017 6:43	Communications state - Disconnected	Outstation Comms
DMA Project.DMA.08.FIT.01.Aquamaster 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

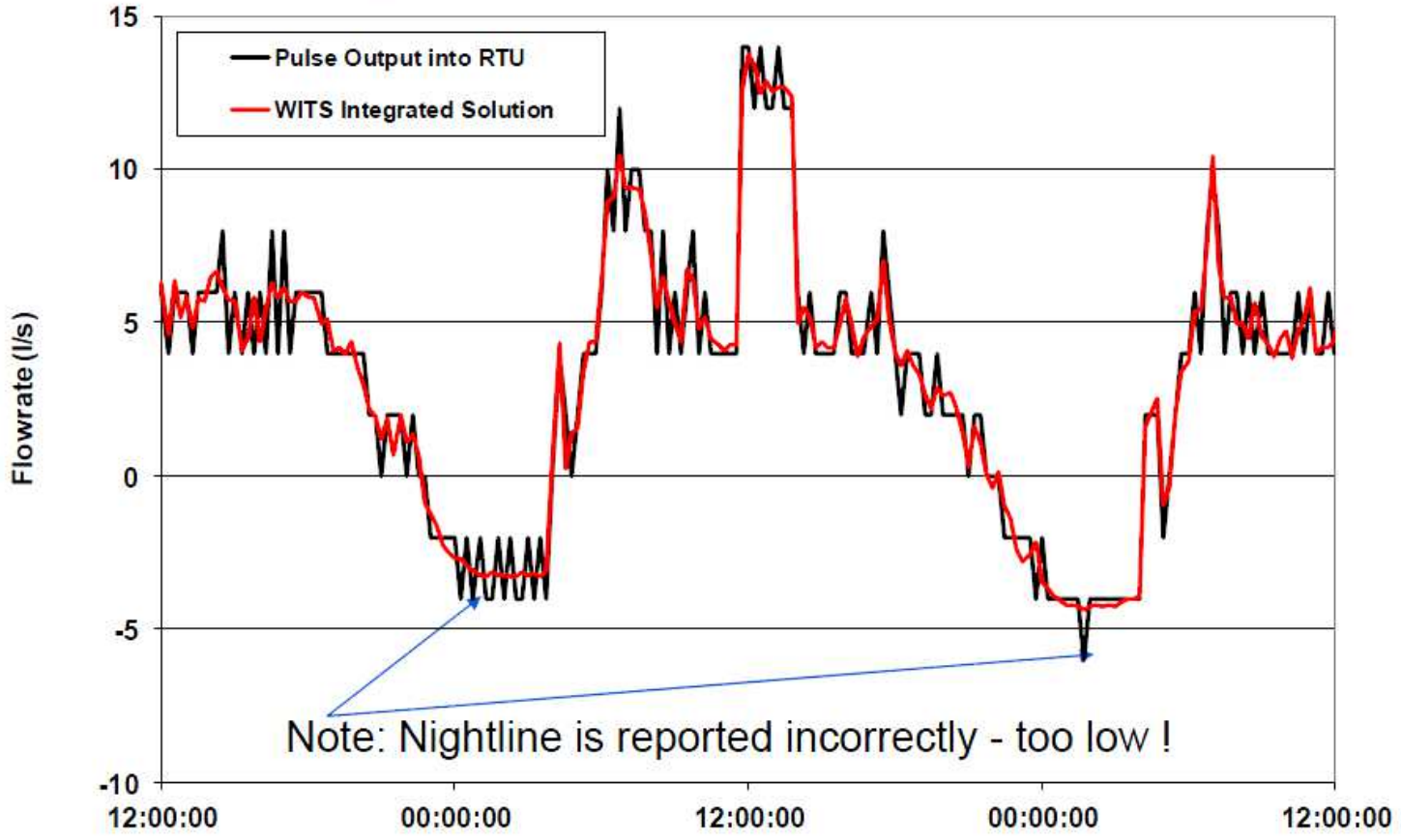
- Obtain consistent data sets and alarm/event reporting.
- Standardise data/alarm/logging configuration for all asset types.
- Minimise the number of SCADA interfaces for RTU types.
- Remove the bespoke development required for each of the vendor RTUs on the estate.
- Reduce the support requirement to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

Challenges


Guelph

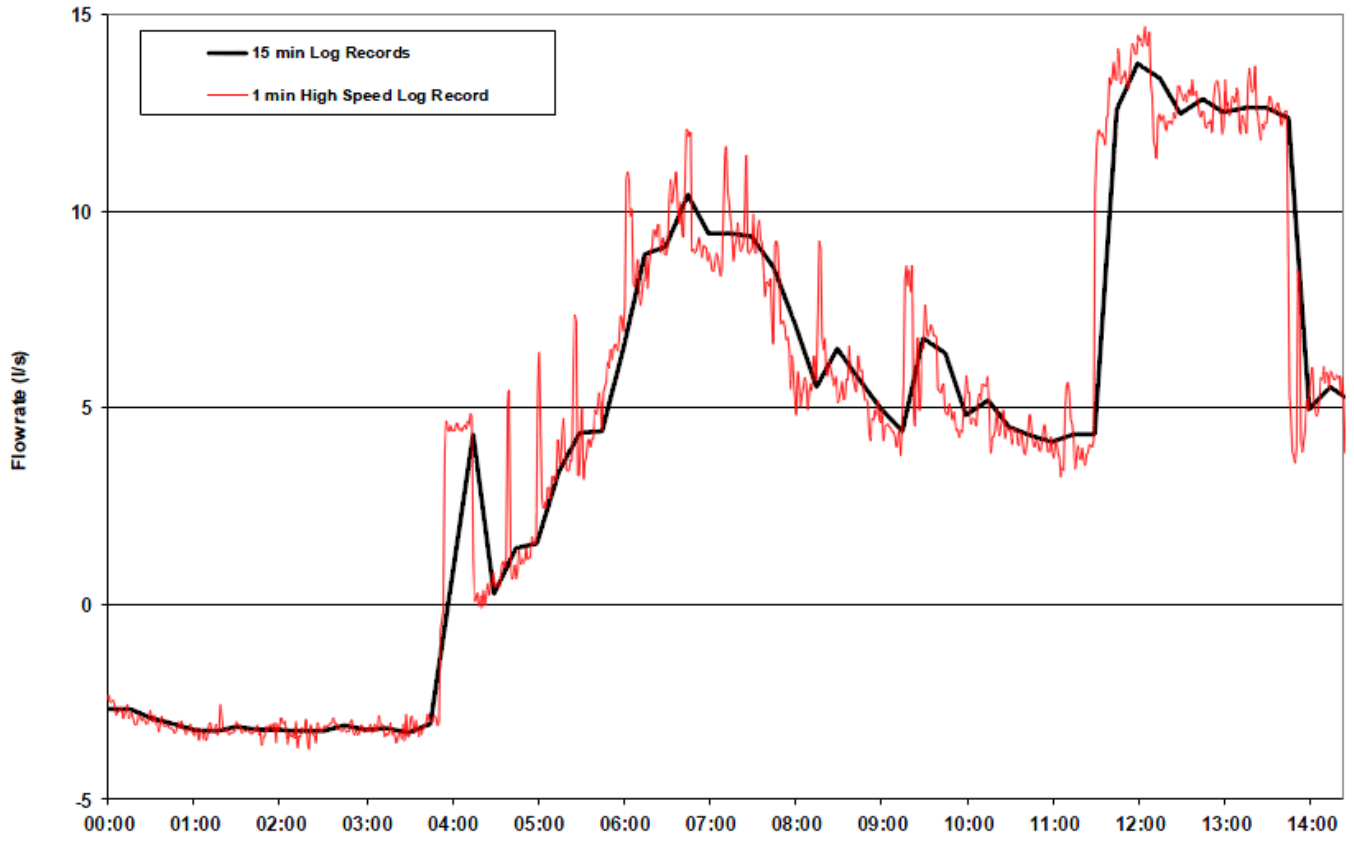
Interesting Things we can do using DNP3-WITS Protocol

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

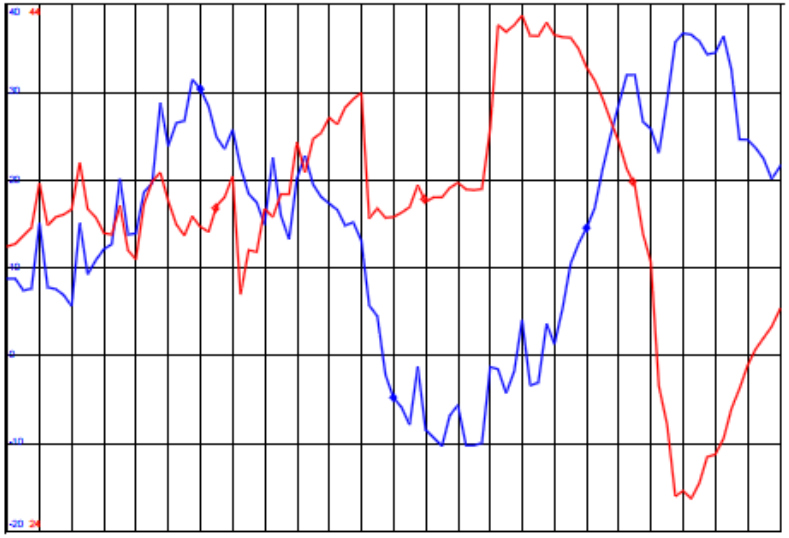
Integrated Flowmeter and WITS Solution
Resolution - Time



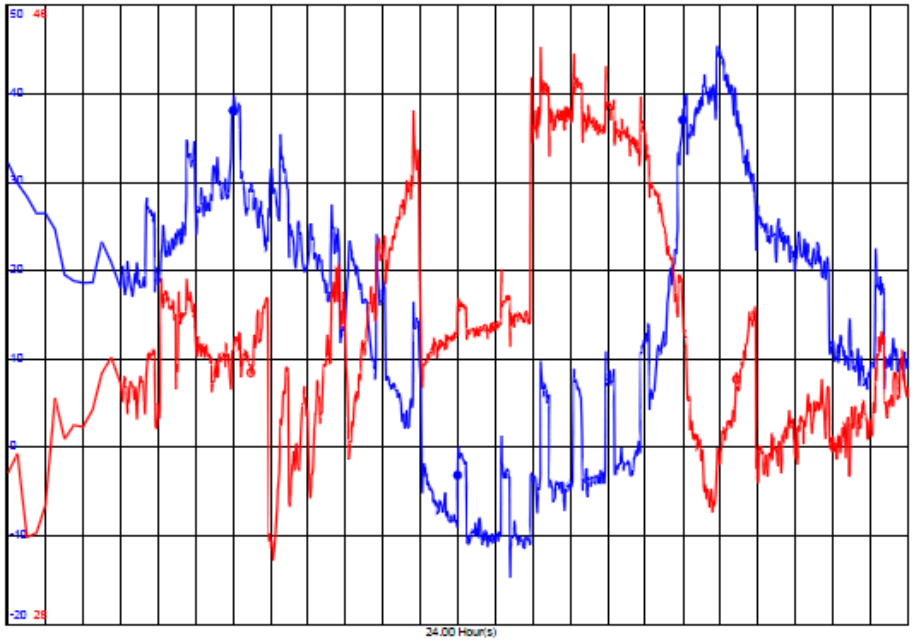
- 15 min log record, compared to 1 min high speed log records, results in significant "Aliasing", loss of detailed flow information and under reading of peak flowrates.

Integrated Flowmeter and WITS Solution
Resolution – Time

15 min records



1 min records



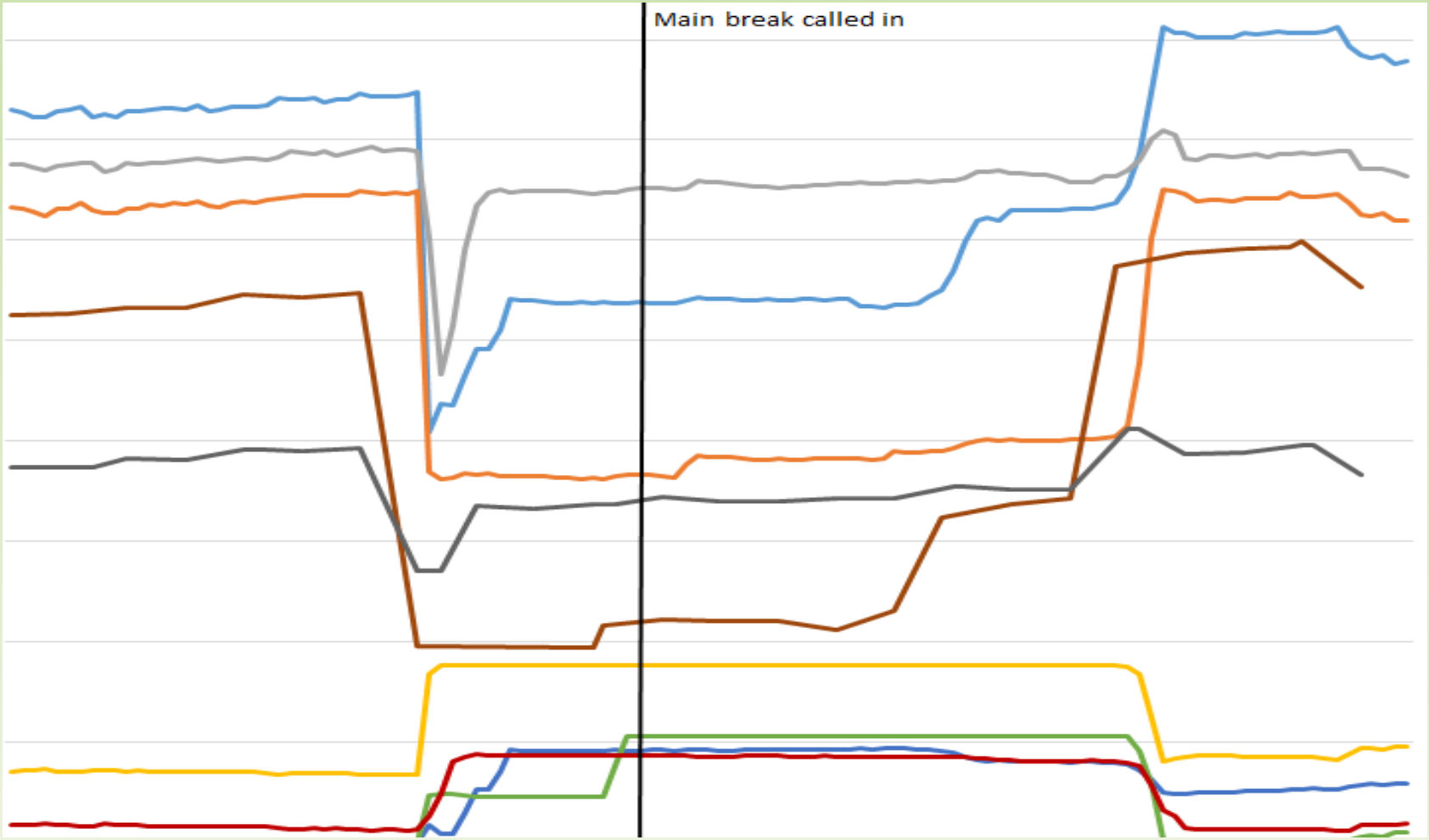
- Note erratic and low resolution information on 15 min data

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

- ABB Canada
- Watermark Solutions Ltd.
- Simark Controls
- Telemetry and Remote SCADA Solutions, Schneider Electric
- ABB UK and Schneider Electric UK
- WITS Protocol Standards Association

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