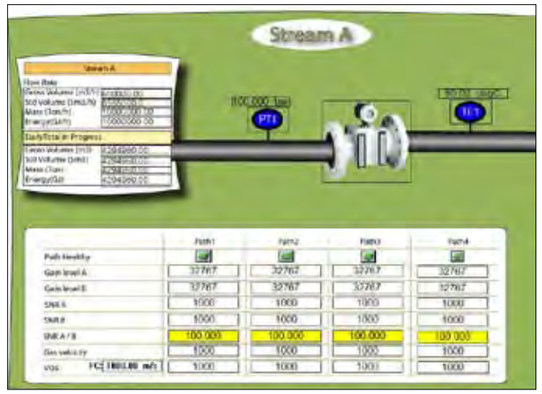
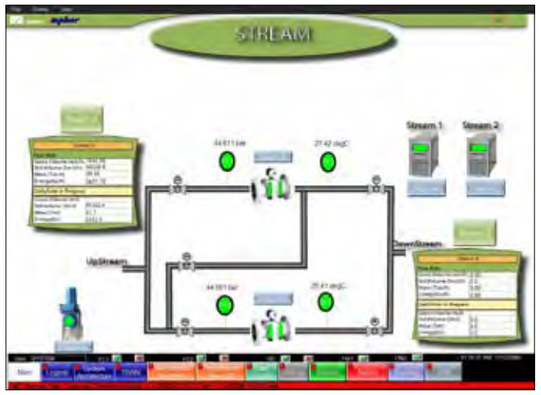
Custody Metering for Electricity Generation

The Dubai Electricity and Water Authority has commissioned a new gas powered electricity generation plant in Aweer where the turbines are powered by natural gas that is extracted offshore. A key part of the control of the plant is Custody Metering – where the mass of the gas and its calorific value is measured as it is supplied from the gas field. A consortium of Siemens, Mott McDonald, and Process Group sub-contracted the metering skid to the integrator in instrumentation & metering skids Emphor Fzo. Emphor Fzo has been looking for several years for the ideal DPM (Diagnostic Performance and Monitoring) software for metering skid projects that could satisfy DEWA (Dubai Electricity Water Authority) specifications. In 2007, after meeting Mr. Daniel Geha, area manager of COPA-DATA Middle-East, they were convinced that zenon® technology from COPA-DATA would be the perfect solution. KD engineering has been responsible of implementing the integration project with the support of COPA-DATA Middle-East that has assured total success in the project.



Status of flow metering



Single train architecture with Z configuration

KD Engineering is an automation integration company that provides specialised highly integrated solutions for custody transfer measurement applications for the oil & gas industry. Custody Metering is an essential tool for the profitable operation of offshore platforms. Metering systems are in constant evolution to meet the exacting standards for accuracy, reliability and safety required for the operation of these increasingly sophisticated and automated platforms and, given their extreme space constraints, the need is for compact, light equipment.

WHY METERING MATTERS...

Simply, it is an important cost saving. If a typical offshore oil production facility produces 150,000 bpd (barrels per day) and incurs a random $5 barrel extraction cost, an under-reading error of 0.5 % in flow can lose you $1.3m in a year assuming an oil price of $35 a barrel. As a custody metering station only costs around $1m, it will have paid for itself in a little over nine months. At $50 a barrel—the cost at the time of writing—that loss, or potential saving, amounts to $2.25m per year.

However, the primary reason for offshore metering is security, as you can only be sure of the output of a facility if you meter it at source. It is possible to offload crude by shuttle tanker to a shore terminal for custody metering. However, in practice this opens the way to disagreements with production partners and the tax authorities over issues such as 'bill of lading'.

FISCAL, CUSTODY AND ALLOCATION

In the metering business the terms 'fiscal' and 'custody' are essentially interchangeable, although fiscal means 'concerned with government finance and policy' and custody means 'safekeeping or guardianship'. Neither term defines a level of metering accuracy in itself, although both are taken to mean the 'best accuracy' in normal oil field practice.

THE PROBLEM

Metering of gas flow alone does not reveal the actual value of the gas being supplied. Flow and density will vary according to temperature, whereas Custody Metering is centred upon mass as opposed to volume. Additionally, the calorific value of the gas will vary according to the chemical variation of the gas as it extracted. This requires a solution that is called 'Diagnostic & Performance of gas quality and Metering' (DPM) - used in the application for the Dubai Electricity & Water Authority.

TOWARDS A SOLUTION

Most authorities insist upon 'stand alone' flow computers for each metering stream. This allows individual units to continue operating even if a neighbour is damaged. A supervisory computer can 'manage' the disparate stream, as well as prover flow computers, alongside additional tasks such as flow scheduling and automatic flow sampler control. These are now most often 'dual redundant' arrangements rather than the earlier and arguably much more complex 'hot standby' systems.

Many now prefer a single station supervisory function since the primary metering data is retained in the separate flow computers.

A flow computer is an electronic computational device which implements the required algorithms to convert the raw data

received from flow meters, to which it is connected, into volumes at base conditions. A flow computer also audits changes that have been made to any of the parameters required to turn the raw flow meter data into volumetric information. It records events and alarms related to the flow meter (for example, loss of flow, loss of required electrical signals from measurement transducers, or transition of these electrical signals near their upper or lower range). It will keep a running tally of the volume for each flow meter it monitors and perform a 'gauge off' of this volume on an hourly, daily or monthly basis. The flow data is made available externally through an electronic interface so that other computers can download the information for the purposes of supervision, accounting or auditing.

A gas chromatograph is a laboratory device that is used to analyse gas or light liquid streams to determine their composition by component. Gas stream compositions are typically reported in 'mole'4 or volume percent. Liquid stream compositions are typically reported in liquid volume percent.

THE SOLUTION

zenon offers both functionality and value for such applications, key issues being one-click redundancy, open networking and a vast library of drivers to connect to various instruments and devices that comprise a metering system. zenon is a high performance SCADA system, therefore all aspects of visualisation were to be found within the basic package and could be easily configured to provide displays of plant status and detailed reports and alarms.

ZENON IN APPLICATION...

The DPM SCADA software supervises a two stream line metering system (duty and standby/master meter system) configured in 'Z pattern' arrangement. The 'two streams' arrangement is called a 'Train configuration'. This comprises; a multi-path UltraSonic Flow Meter (USFM) to measure the flow in each of the two streams. A 'prover' flow-computer that reads flow from the USFM flow-meter and performs the following calculations in each of the two streams; correction to give the flow rate under standard condition (Volume of gas differ according to temperature and pressure), calculation of total flow in term of energy, mass and volume, and it also performs the AGA10* calculation to check performance of the USFM, it also performs the ISO 6976** calculation to check performance of the Gas. Advanced and very complex thermodynamics calculation has been made possible by zenon's automatic multithreading, 'mathematical driver' and the straton softPLC that provided real-time capabilities and C++ encapsulating container for the thermodynamic real-time calculation.

ZENON IN METERING SYSTEMS; KEY FEATURES...

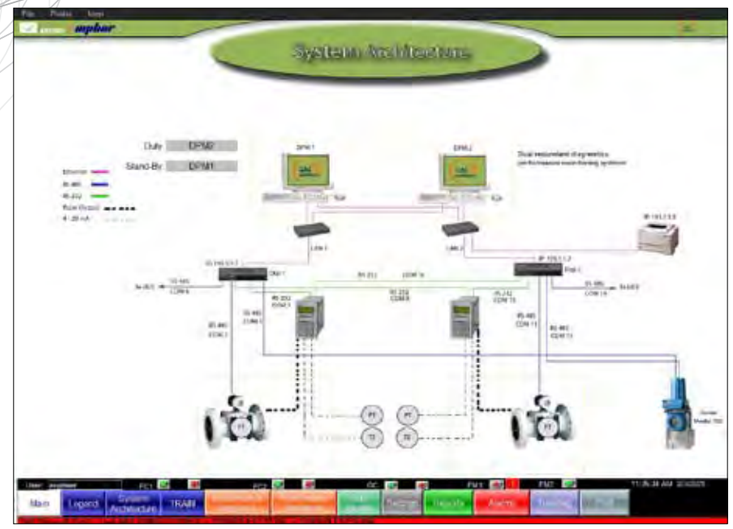
To take an example; each of the two metering streams has two Flow Meters, two Flow Computers and a Gas Chromatograph requires only a zenon license of 512 tags. For four stream systems it requires 1024 tags; and for a four stream system where GC composition has to be transferred to another DPM, 2048 Tags. Sometimes only one station has real access to the Gas Chromatograph, and this station then acts as a Modbus slave gateway to several other stations several kilometres away; thanks to straton this allows a zenon station to act as a Modbus slave to the other stations even with the Modbus serial protocol. It is also note-worthy that the duty/standby server redundancy is easily configured in zenon with one mouse click.

A most important feature of DPM software is its capability to interface as a gateway to several DCS interfaces; information such as totalizing flow and alarms must be sent safely to the DCS system; using the zenon process gateway and straton, multi link to several DCS channels is made easy.

zenon fully handles system diagnostics, metering overview, totals, reports, trending, alarm history & summary, gas quality and also a continuous monitoring of meter diagnostics (swirl, asymmetry), ultrasonic foot print and ratio, velocity of sound verification and performance monitoring. zenon also handles Gas Calculations in accordance with international standards such as API/AGA 10/ ISO as well as customer-specific logic. zenon's embedded communication drivers with integrated protocol analyzers are fully utilised.

ZENON DISPLAYS INFORMATION IN A STANDARD OIL & GAS INDUSTRY LAYOUT FOR....

- Graphical display with System diagnostics containing device information for each connected device.
- A Graphical display page with an overview of the metering data. It contains relevant information as retrieved from the flow computers.



System Architecture, showing zenon in dual-redundant mode.

- Display pages with totals for Mass, Volume and Energy, obtained from the flow computers.
  Record and display Real time and historical trending pages, Alarm History & summary.
- Gas Quality page with actual gas composition from the gas chromatograph.
- Appropriate pages with continuously monitored ultrasonic meter diagnostics, ultrasonic footprint & ratio, velocity of sound verification and performance monitoring.
- Totalization of individual stream data into overall station flow and flow rate totals.

FUNCTIONALITY AND FEATURES THAT HAS ALSO BEEN DEVELOPED BY KD ENGINEERING...

- Checking the validity of the stream flow computers.
- Determination of the 'foot print' based on the ratio of the VOS (Velocity of Sound) for each path for each ultrasonic meter and the display this footprint graphically.
- Obtaining diagnostic information, including status information and waveform data from the ultrasonic meters, and presentation this diagnostic data on a display page for the operators.
- Provision of an HMI and presenting all retrieved and calculated data from the flow computer, ultrasonic meters and internally calculated data. A number of graphic mimic pages of the process contained in menu-structure are presented to the operator.
- Trending in real-time and historical for all major signals in the system, including the VOS for the ultrasonic meters, and other parameters.
- Alarm management of real-time alarms. Alarms are derived from primary input signals as well as calculated figures. Alarms are printed on the station alarm printer and stored on the hard disk. Alarms messages and 'return to normal' messages, as well as acknowledgements that are to be reported. Alarms are suppressed when a metering line is closed.
- Validation of the meter cross section (Z) of the master meters and check meters.
- The appropriate gas composition is sent to the appropriate flow computers, after verification of the analysis in accordance with ISO69762 energy calculation on the diagnostics computer.

- The operator is able manually select either the in-use gas composition or a keypad value in case of GC failure.
- Communication with the OMNI flow computer using the Modbus/Serial protocol to obtain transmitter values. Flow totals, alarms, hourly data, daily data, accumulative totals per stream, and station totals. The DPM acts as Modbus master (RTU) device, whilst the flow computer acts as a Modbus (RTU) slave.
- Communication with each ultrasonic meter to obtain diagnostic and performance data, and to display all related data.
- Communication with the Gas Chromatograph to obtain gas composition data, including H2S. The gas composition data is downloaded, after validation, to the appropriate connected flow computer set. The GC data is derived from the controller is also available for transmission to the central DCS over the serial Link.
- Calculation of the velocity of sound based on the gas composition and the pressure and temperature of each meter run in accordance with the AGA-10 and monitor differences between the calculated value and the VOS per path of each connected ultrasonic meter.

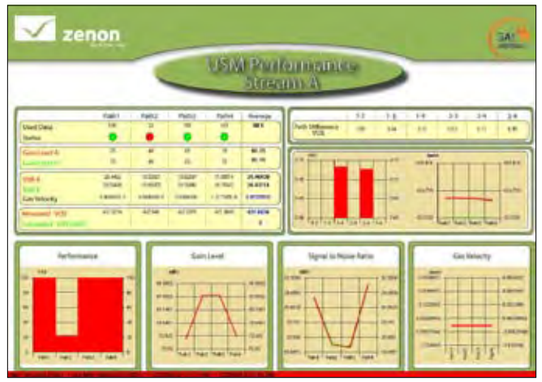
EXPERIENCE IN DEVELOPMENT

Mr Karim Saikali, KD Engineering, "…in zenon we have a very powerful platform to build application solutions that are platform independent with a modern network technology with distributed client-server structure and very sophisticated circular redundancy; and, most of all, more than 250 different driver connections allow connection to all kind of protocol standards in the Oil & Gas industry. Working in close partnership with COPA-DATA a specially developed ASCII Modbus was created for this application, which was also needed to be configured with a backup channel.

Mr Saikali also stated, "We provided the best support to our client and were very flexible to their demands, this is the strongest reason why the client switched to us."

BENEFITS

At the core of the application is an accurate and auditable history. There are daily report and monthly reports these are stored between 6 months and 1 year. The reports are used by customer representatives and operators. The detailed reports are used for daily operation (instead of using DCS reports); moreover if disagreement with suppliers occurs they can check the totalizing



A multi-path Ultra-Sonic Flow Meter (USFM) measures the flow in each of the two streams.

flow from the DPM at any time and over any period. This important information is held in the zenon archive database. An important product of the DPM software is the Totalizing flow that is read from the Flow Computer. A representative of the customer came from time to time to compare flow computer values and DPM values – they were identical.

In developing a solution based upon zenon KD Engineering found that it was easy to use – allowing attention to be focussed upon the application rather than the intricacies of the SCADA system.

FUTURE

This project is large and on-going. KD Engineering has seen that zenon has a key role to play in this application area – in future stages straton, the embedded SCADA-logic of zenon, will be used to provide additional functionality, using the robust tools that straton offers. Mr Saikali, "… in the next three projects we will use straton, as a matter of fact only one of the stations will communicate with the G.C. and act as a Modbus slave to the others stations using the serial Modbus protocol, so straton is need to configure 3 Modbus serial driver slaves." Utilisation of zenon with straton means that risk is further reduced for all stakeholders in the project.

KD Engineering see an efficient way to the future using zenon & straton-based solutions; whilst not everything was required on this project they have additional functionality for Diagnostic and Performance Metering applications that will be required in future projects such as…

- Inbuilt embedded communication drivers with integrated protocol analyzers.
- Gas calculations in accordance with international standards such as API/AGA 10/ ISO as well as customer specific logic.
- Calculation of the velocity of sound based on the gas com position and the pressure and temperature of each meter run in accordance with AGA-10 and monitor differences between the calculated value and the VOS per path of each connected ultrasonic meter
- Validation of the meter cross section (Z) of the master meters and check meters.

SUMMARY

This application for the Dubai Electricity and Water Authority demonstrates the suitability, capability and adaptability of zenon (and straton) in this area of process control and automation. KD Engineering fully utilised zenon's in-built strengths and added key application functionality, based upon their experience, which made their solution both robust and successful. Where special requirements were required the support of COPA-DATA was readily available to provide new, tested and supported functionality. Custody Metering is a critical area in process control for the Oil & Gas sector – one that is safe with zenon.

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[1]AGA 10: method for the calculation of the speed of sound in natural gas and the individual components that make up natural gas.

[2]ISO 6976: method for the calculation of the superior calorific value and the inferior calorific value, density, relative density and Wobbe index3 of dry natural gas

[3]The Wobbe Index (WI) is an indicator of the interchangeability of fuel gases such as natural gas, liquefied petroleum gas (LPG), and Town Gas and is frequently defined in the specifications of gas supply and transport utilities.

[4]mole – SI unit of substance amount - the basic SI unit of amount of a substance equal to the amount containing the same number of elementary units as the number of atoms in 12 grams of carbon-12.