Introduction and Advancements in Flow Measurement and SCADA Technology

By Michael Rozic

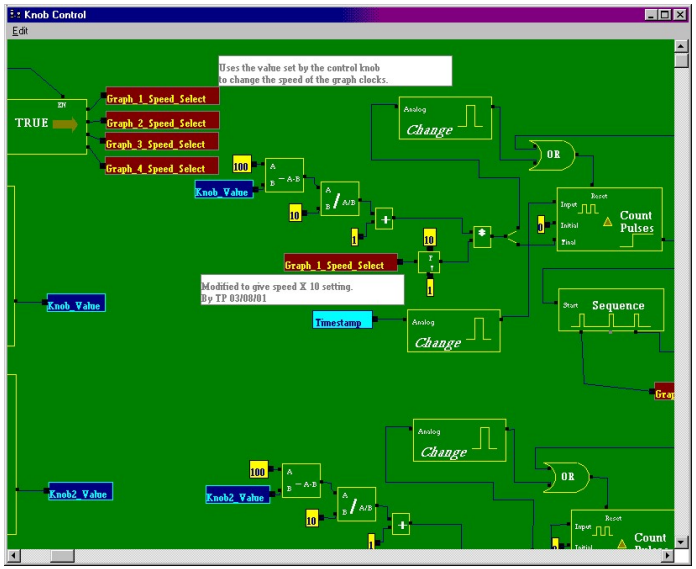
Remote Automation Solutions

EMERSON™
Process Management

Outline – Presentation Subject

- Instrumentation
- Control/Monitor devices
- Communication
- Collection/Database
- Conclusion
- Open Discussion

Objectives of Gas SCADA Systems



Remember When???

Gas Measurement…… why and how

- Why????
  - Land owners royalties
  - Understanding system and what is going through it
  - To make money!
- How??
  - Measured in volume in cubic feet, but sold on heating content BTUs (amount of heat to raise one lbs of water one degree)
  - Sold at one cubic foot at standard temperatures and pressure (60 degrees F and 14.73 PSI)
    - If all methane 1000 cf = 1 Million Btu or MMBTu….Not real
    - Not real why? Methane, ethane, propane……

How do we measure gas at MMBTU??

Especially when gas is flowing under varying degrees of BTU content, pressures and temperatures. How you ask….

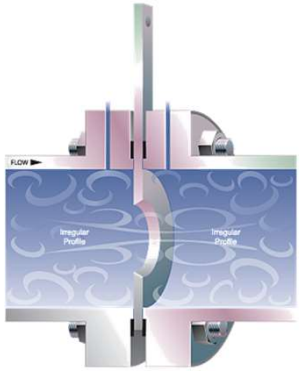
Flow Computer

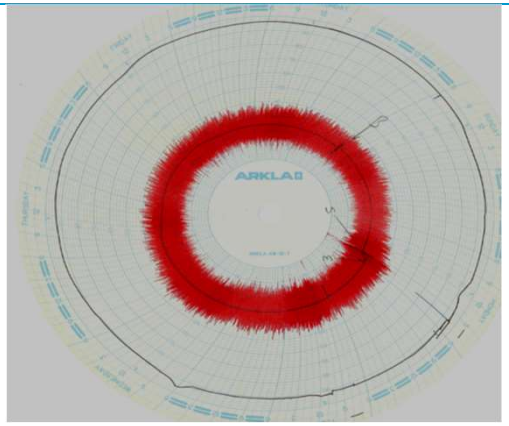
- What is a flow computer?
  - Measures volume, pressure and temperature of the natural gas at flowing conditions and calculates the SCF and MMBTU per API/AGI standards
    - API has lead to development of equipment and maintains standards along with operating practices
    - AGA develops standards to help ensure the safe delivery of natural gas to customers, more trade related
  - Capable of allowing gas content to be read or entered so BTU content and mass flow can be calculated and stored in the device

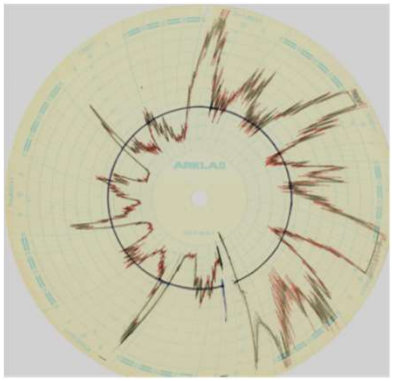
Traditional Field Gas Measurement Equipment

Ahhh the old days…….

Manual and pneumatic measurement and control







Advanced Measurement and SCADA

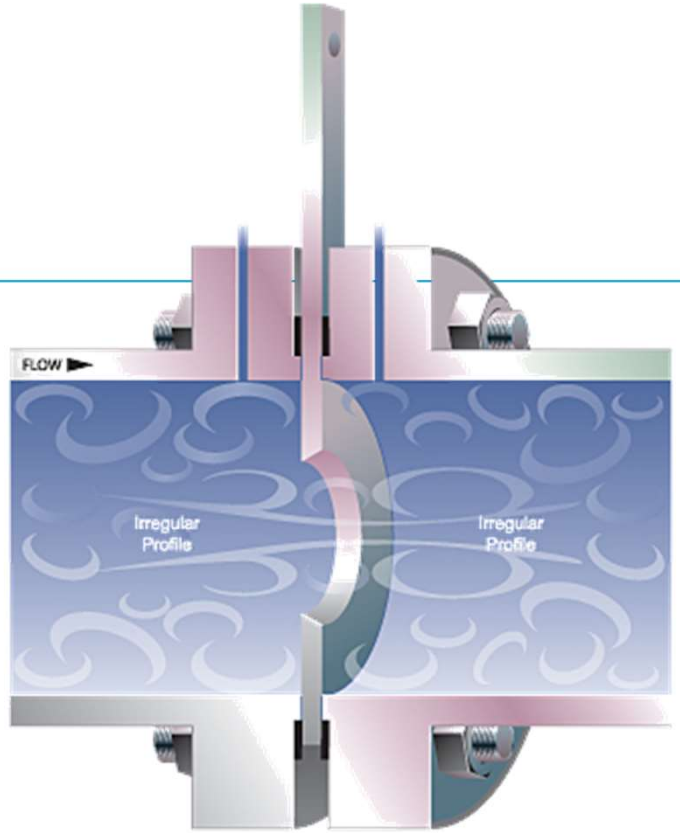
What does this mean for Measurement and SCADA???

Better, Stronger and Faster!!!!

Wait what about non microprocessor devices????

- Have there been improvements in the field devices??
- Is there only orifice plates, PD, turbine meters, wooden tank gauge sticks and manual entry of measurement information?

Orifice Measurement



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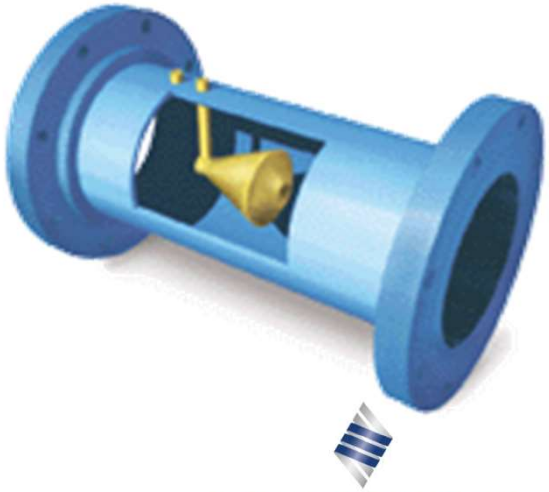
Field Equipment

- P/D and Turbine Meters (AGA7)
  - Idea for low flow
  - Very little upstream piping
  - Meters above 10” tend to be large and expensive
  - Max pressure typically under 400 psi
  - Accuracy 1 to 3% (10%)
- *Auto-Adjust* 0.2% over range
  - Turndown 67:1 to 115:1
  - Adjusts to changes in wear, calibration and flow conditions
  - Maintenance (Moving parts)
  - Not ideal for dirty gas
  - 4-12” Line Size

Improvements in Measurement

- **DP Element Improvements**
  - Conditioning Orifice Plate – Not approved by API
    - Reduce upstream and downstream to 2
    - Minimize liquid build-up on wet gas
    - Accuracy of 0.5%
  - V-Cone – Good in Canada not US
    - Act as its own flow conditioner
    - No straight run, ideal for limited space
    - ½” to 120” diameter
    - 10:1 turndown and 0.5% reading
    - Works on wet gas
    - Different DP curve than orifice plate

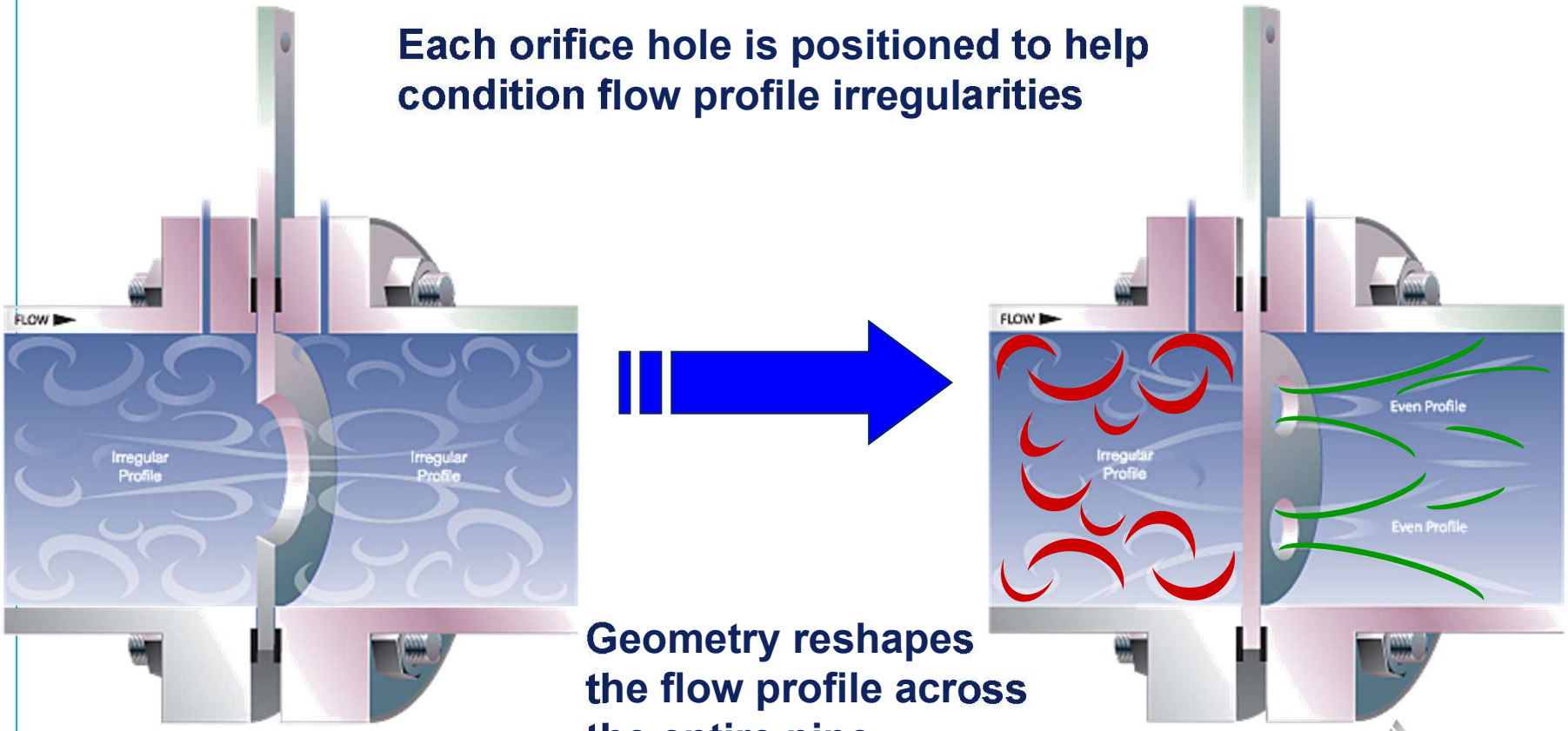


Better Accuracy Than A Standard Orifice Plate

Unique Design Measures Accurately in Short Straight-Run

"Better accuracy than a standard orifice plate"

Each orifice hole is positioned to help condition flow profile irregularities



Geometry reshapes the flow profile across the entire pipe

Improvements in Measurement

(DP Improvements Continued)

Chamber Type Orifice Fittings

- Prevents non-concentric orifice installation
- Quickly service and inspect plate condition
- Reduces maintenance down time
- Meets latest AGA3/AP 14.3
  - Guarantees that plate is properly centered and adds no additional error

Advancements in Transmitters

- Communication and Accuracy
  - HART, Modbus, % of Reading

Rosemount 4088 MVT

Rosemount 2088

Rosemount 3051 MVT

Level Measurement

- GWR
  - No stick!
  - No floats/moving parts
  - No need to open vent
  - Unaffected by P or T
  - Interface measurement
  - Communication
    - 4-20
    - Hart
    - Modbus
    - Fieldbus

Advancements in Transmitters

Rosemount 248

WirelessHART!!!!!

THUM Adapter

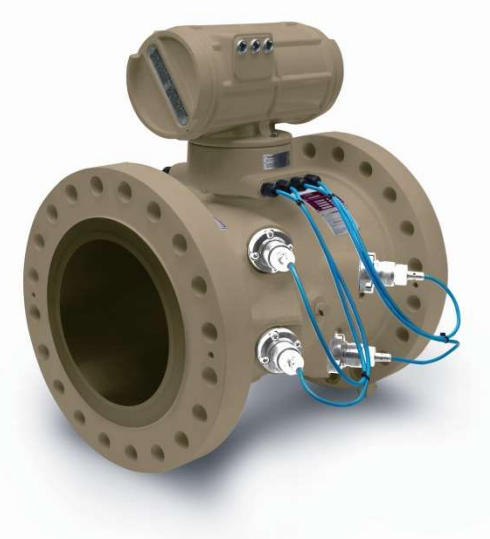
Rosemount 3051S

Rosemount 2160

Rosemount 702

Improvements in Measurement

Ultrasonic Metering (AGA-9) (AGA-10 SOS)



- Accuracy / repeatability 0.1 to 0.2% reading
- Rangeability 50 to 100:1
- Size 2 to 48”
- No moving parts, or pressure drop
- Less prone to build-up, low maintenance
- Less upstream and downstream requirement (3D up and down)
- Onboard diagnostics and audit trail
- Power consumption 1W to 15watts
- Fairly expensive – ideal for custody transfer, transmission lines and pipeline balancing applications.

Improvement in Measurement

- **Coriolis Flowmeter (AGA- Report No 11)**
  - Mass measurement, Temp, Density
  - Impervious to P, T, Vis, or Den
  - No moving parts, min maintenance
  - Good for 1 to 12” lines (Sweet spot 1-4”)
  - Low / medium pressure drop
  - Can operate with liquid contaminants to an extent
  - Power consumption 1-6W
  - No Flow Conditioning Required
  - Accuracy 0.35% of reading for gas
  - Accuracy 0.1% of reading for liquids

Uncertainties of Measuring Systems

- July 2007, Pipeline & Gas Journal – Uncertainties of Measuring Systems by Ilia Bluvshtein, Senior Advisor, Duke Energy, Canada

Measuring System	Description	Uncertainty
Rotary	Temp and Pressure Compensation with Volume Corrector	1.4%
Turbine	T and P Comp., above and below transition flow	1.4 to 1.8%
Multipath Ultrasonic	<12” above and below transition flow	0.8 to 1.5%
	>12” above and below transition flow	1.1 to 1.5%
Orifice	With GC/Density meter	1.3%
	Without GC/Density meter	1.8%

Improvements in Measurment

- Gas Chromatographs
  - •Typically measures C1-C4, N2 and C02
  - •Calculates heating value, specific gravity and other gas quality values H2S
  - •Provides better and more complete and accurate AGA 8 calculations
  - •Has been very expensive, but price and size has been reduced
  - •55W to 100W
  - •50% less consumption of Helium
  - •Bring in moisture to do actual BTU
  - • Can predict hydro carbon dew point

Danalyzer 700XA

Danalyzer 500

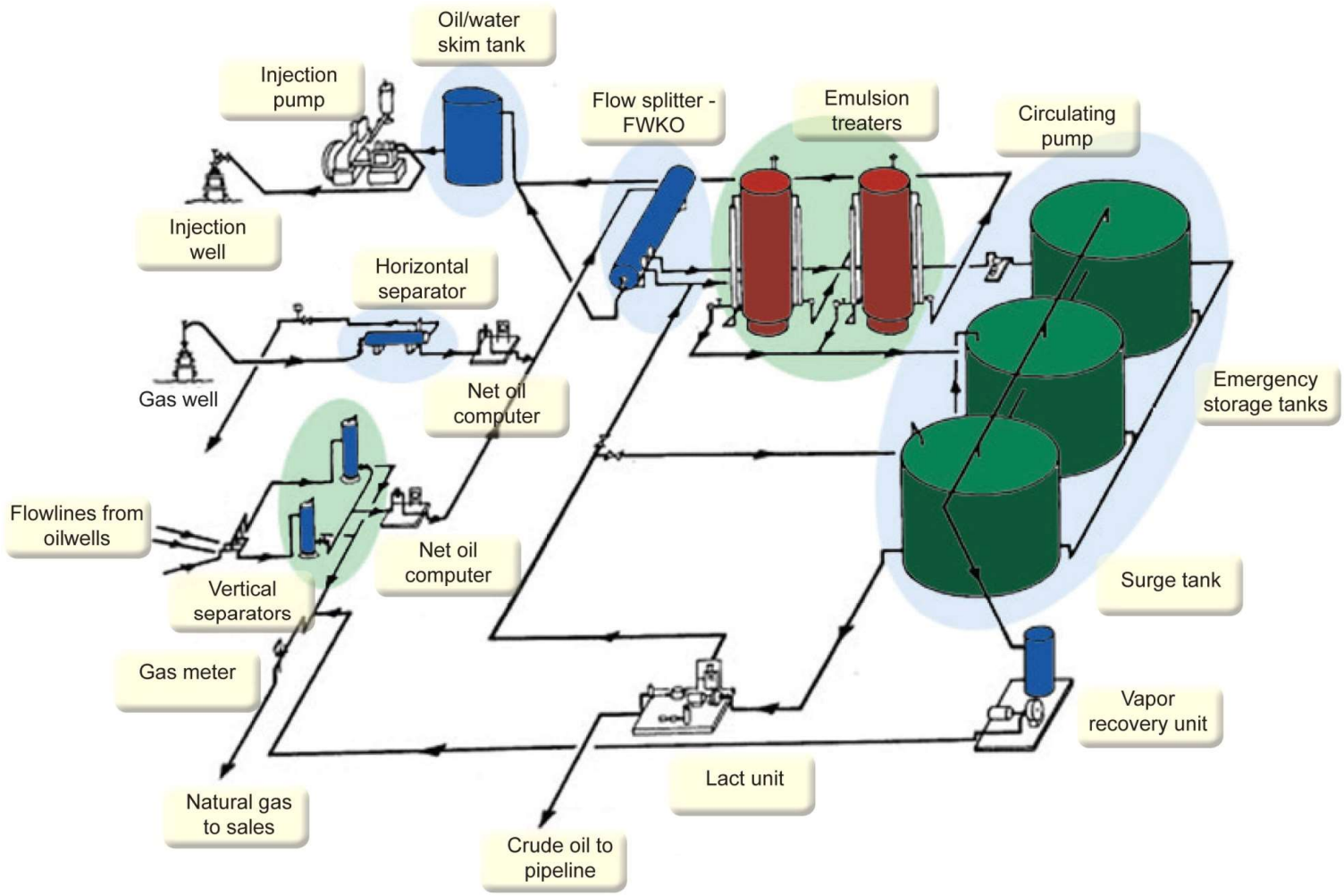
Improvements in Measurement

- Gas Quality Analyzers
  - H2S, CO2, H20, O2
  - Prevent hydrogen sulfide or sour gas entering transmission lines
  - Prevent high level of emissions
  - Prevent high BTU levels
  - Minimize corrosion

Production equipment

- Safety (rag on a stick)
- Temperature control
- Reduces shut-downs due to burner failure
- Prevents harmful gases
- Captures EPA data
- Decreases field visits
- Data gathered by RTU/Flowcomputer

Tying it all together



Measurement, Control and Monitoring System

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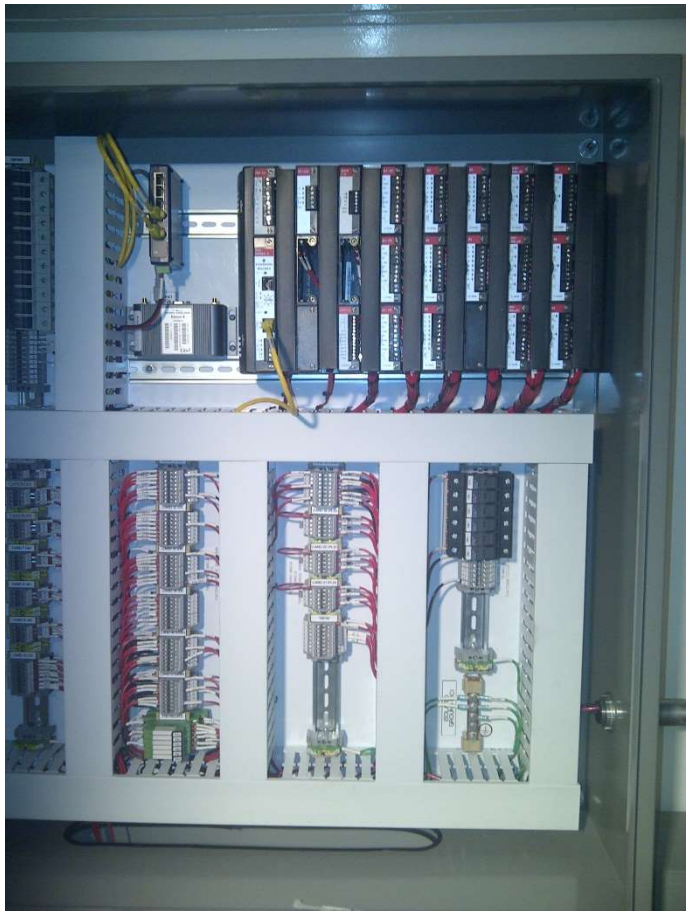
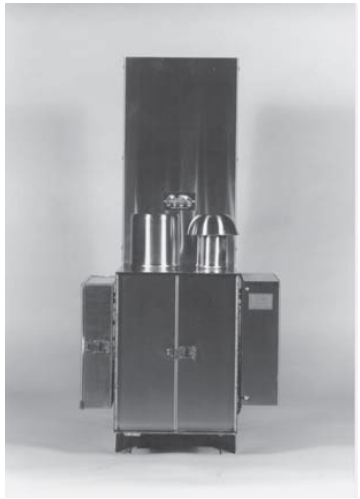
The Control Center

- Measurement and more!!!
  - AGA and API calcs.
  - Monitoring and Complex control
    - Pressure control, flow control, FC w/PO
    - Allocation, Tank loading and unloading
    - Burner management
    - Odorization and sampling
    - Automated choke control
    - ESD Logic
    - Plunger/Artificial Lift
  - Methane Detection
  - Large storage - audit trails, history
  - Multiple communication options
    Ethernet, Serial, USB, Local Keypad Interface
  - Wireless Ethernet and HART!



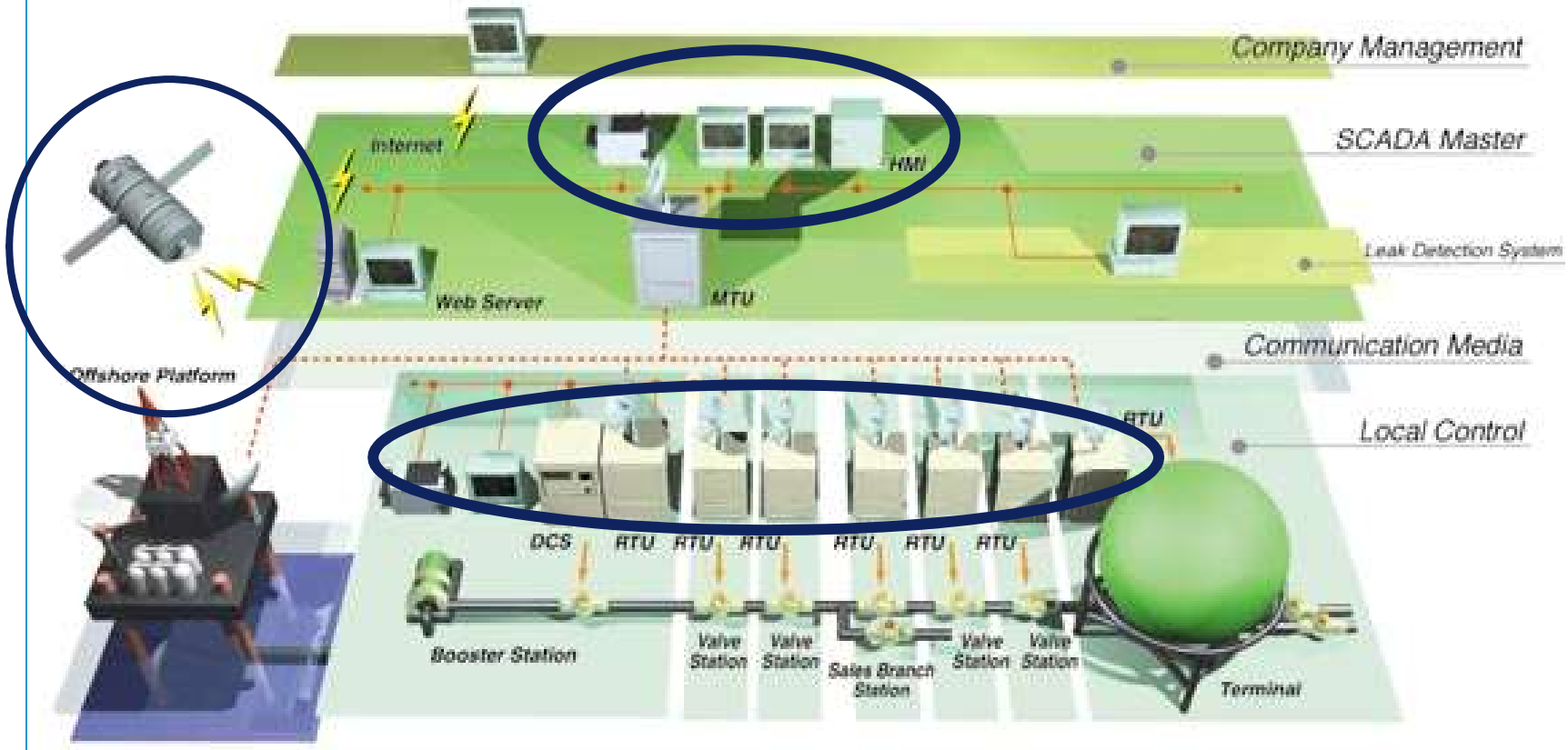
Power Improvements

- Solar Panels
  - Can be fairly large in size
- Thermoelectric Generator
  - 54W to 5000W
  - Consumes gas 155 scfd+
- DP Pressure or Gas Turbine Generator
  - Power based on DP
    - 75 psi – 10 W
    - 105 psi – 20 W
  - No gas consumption
  - Requires pressure drop



Communication!

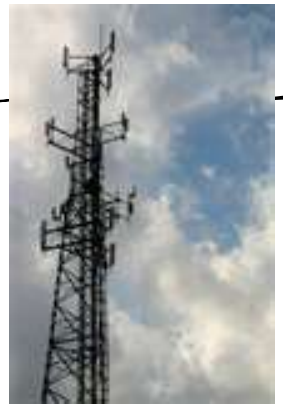
Communication



Private Line and Dial Modems - Continuous Data / Dedicated lines

Current Communication Methods - Radio

Typ 5W



- Radio - ease of installation
- Limited frequencies available
- Requires Maintenance

- One time cost - Unlimited access
- Foliage, terrain and earth curvature constraints
- Power considerations

World War II – Military Technology

HEDY LAMAAR

Latest Communication Methods - Spread Spectrum Radio

Typ 1W

- Spread Spectrum Radio - ease of installation
- Limited signal strength
- LICENSE FREE
- Requires Maintenance
- High Bandwith 115.2K to 12M

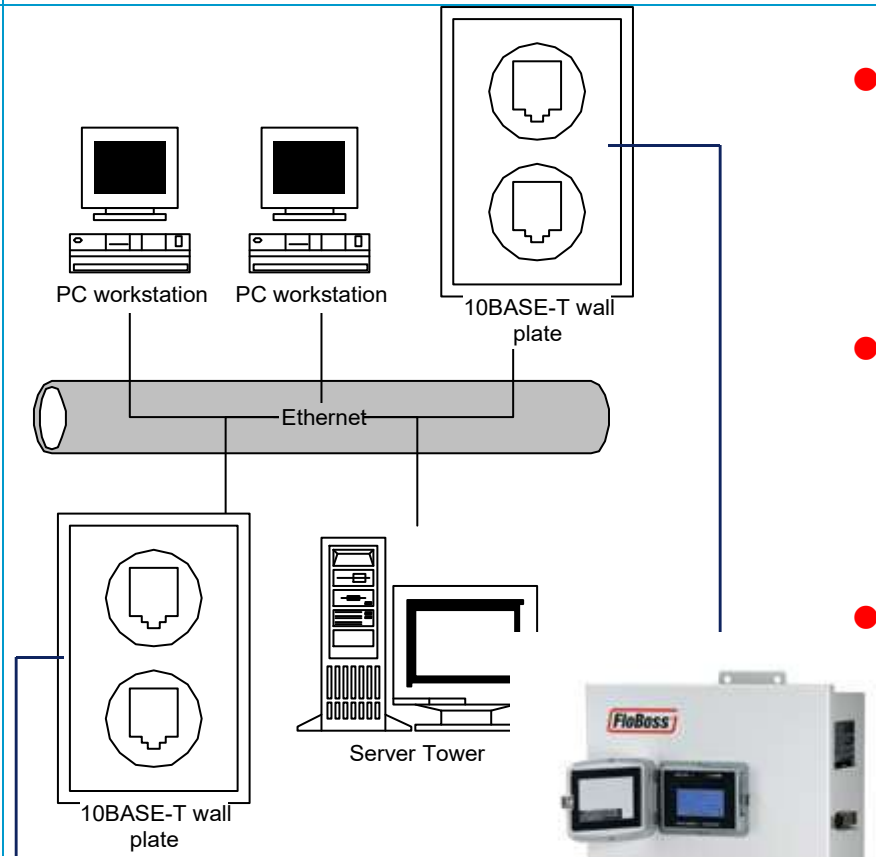
- One time cost - Unlimited access
- Foliage, terrain and earth curvature constraints 14-30Miles
- Power considerations – registration on network

Latest Communication Methods - Cellular / Code Division Multiple Access (CDMA)

- Cellular - ease of installation
- Cost vs. communication - still high / becoming affordable (1MB for $20/M)
- No Maintenance

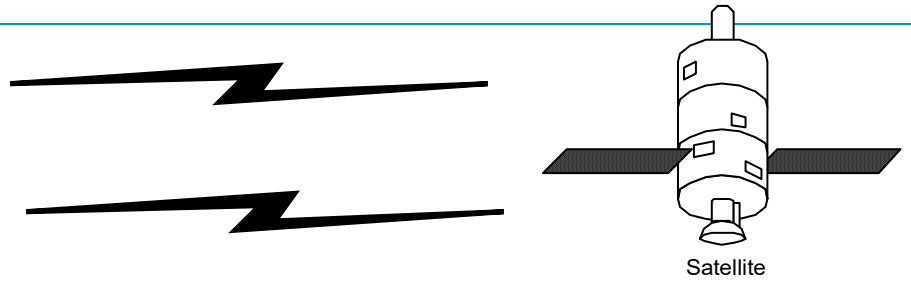
- CDMA (code-division-muti-access)- utilizes IP protocol as node address
- CDMA - Per byte pricing and coverage rapidly expanding
- CDMA's can transport data at high rates 153 kbps to 1.25 MHz (W-CMDA)
- CDMA Replacement for CDPD

Latest Communication Methods - Ethernet technology



- Ethernet utilizes Internet Protocol (IP) node address and message transmission packet
- Local Area Network LAN (applications LNG facility, Storage field, products in a defined area)
- Consumes Power

Latest Communication Methods - Satellite

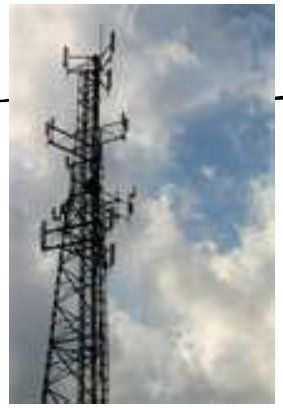


- LEO, BGAN, VSAT
- Initially and currently used to send instantaneous data
- Data rates $20 to $40 month or $7.50/MB
- Cost of equipment $1.2 to 3K

- High bandwidth 153kb to 4 MB
- Sleep mode to conserve power
- Power consumption!
- Solar radiation!!!!
- Hybrid systems??????

Latest Communication Methods – 802.11 or WLAN

Radio Tower



- Wireless Ethernet Radio
- Enjoy the speed of Ethernet in a wireless environment
- Field devices can retain native protocol
- Radios/software can handle IP via “tunneling” methods (encapsulated protocol)
- Security concerns and classification issues

Data collection software and utilities

Collection Schemes - Database

- Collected flow data must be able to be distributed seamlessly between many different departments instantaneously!!!!!!!!!!
- OPEN Platform- easy integration of data, reduction in proprietary software

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- OPEN Platform- easy integration of data, reduction in proprietary software

Collection Schemes - 3rd Party links and other terminology

- Object linking and embedding for process control (OPC)
- Dynamic Data Exchange (DDE) – sends data between applications using Windows messages (send data to Excel)
- Open Database Connectivity (ODBC)
- Structure Query Language (SQL) - software for analysis and forecasting
- Transmission Control Protocol (TCP) – guarantees delivery of data and packets
- Internet Protocol (IP) – deals with packets
- Human Machine Interface (HMI)
- Too Much Information (TMI) – how everyone feels at times

Collection Schemes - Why did I mention the terminology ?

- Data compatibility

Tying it all together

- The “ideal” SCADA network should include all of the following:
  - Use measurement equipment that provides the best accuracy and reliability
  - Incorporation of latest SMT and integration of latest approved and accepted measurement and monitoring devices
  - Optimal communication method (dependent on terrain and network) - wireless preferred!!!!
  - Ability to interconnect 3rd party programs and user workstations
  - Be prepared for internet/intranet connectivity (may or may not be accepted within different companies)
  - Be prepare for the concepts of object orientated design and control
  - User-friendly but secured
  - SCADA Top Host with polling engine able to talk multiple protocols and export data to HMI and reporting software packages

Open Discussion