Drilling for Real-time Data
OPC UA in the Oil Business

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Agenda

- Introduction
  - Who am I and what am I doing here?
  - Drilling Automation and OPC UA – the Odd Couple
- The Problem
  - Drilling Automation – what is it and why do I care
  - Introduction to roughneck ways
  - Current state of Drilling Automation
  - How do we improve
- The Innovative Revolution
  - OPC UA to the rescue
  - Consequences of an OPC UA solution
- Summary

Introduction - Personal

- Educational
  - B.S.   Physics   Manhattan College
  - Ph.D. Geophysics Texas A&M

- Professional
  - Oil companies: Shell, Marathon
  - Software development: GX Technology (ION Geophysical)
  - Computer companies: Sun Microsystems
  - Drilling: MezurX, Shell
  - SPE DSA-TS (Society of Petroleum Engineers Drilling Systems Automation – Technical Section
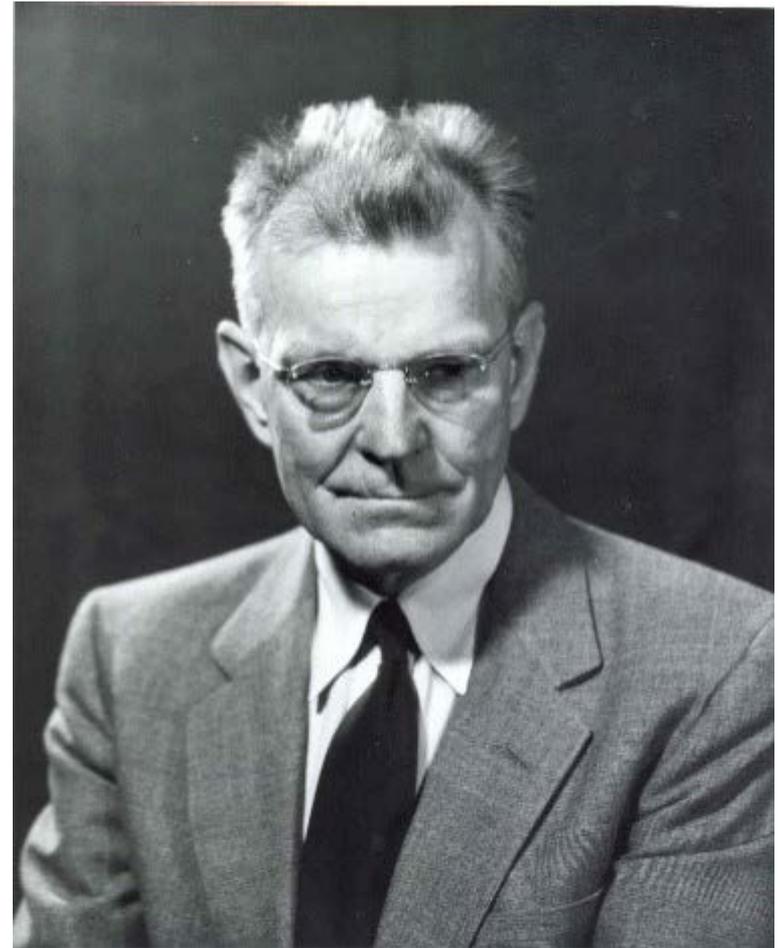
Drilling Automation and OPC UA

- Drilling and OPC UA are odd bedfellows

- Drilling is a brute force process, performed by roughnecks who throw around 500 - 2000 pound joints of steel pipe
  - Highly dangerous work location

- Can computer software change such the drilling business?

- Drilling Automation – the man and dog rig
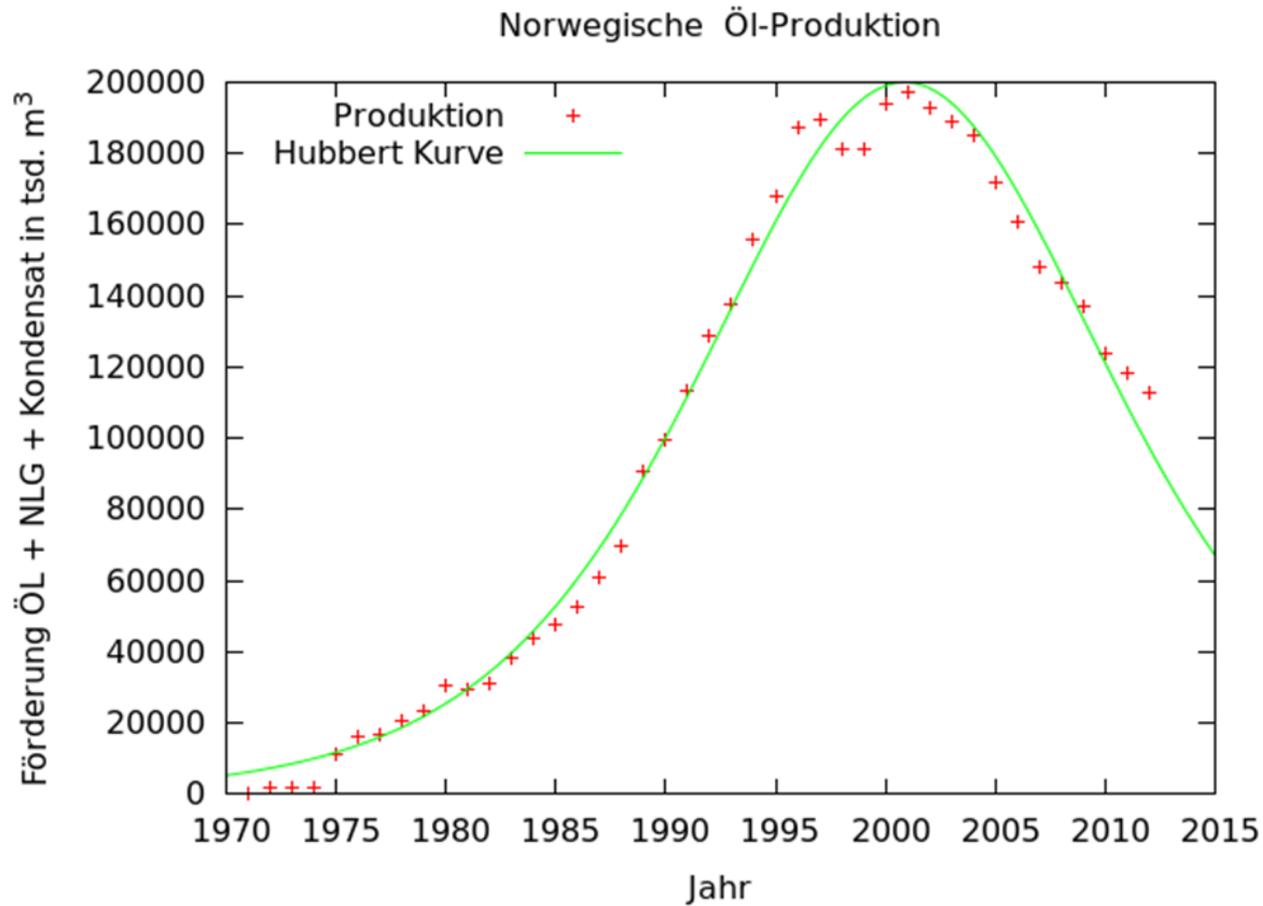
What is driving Drilling Automation

- Dr M. King Hubbert

- Statistical study the life cycles of reservoirs
- Production curves are nearly Gaussian
- Distribution relation holds regardless of scale
- In 1956, predicts Peak Oil
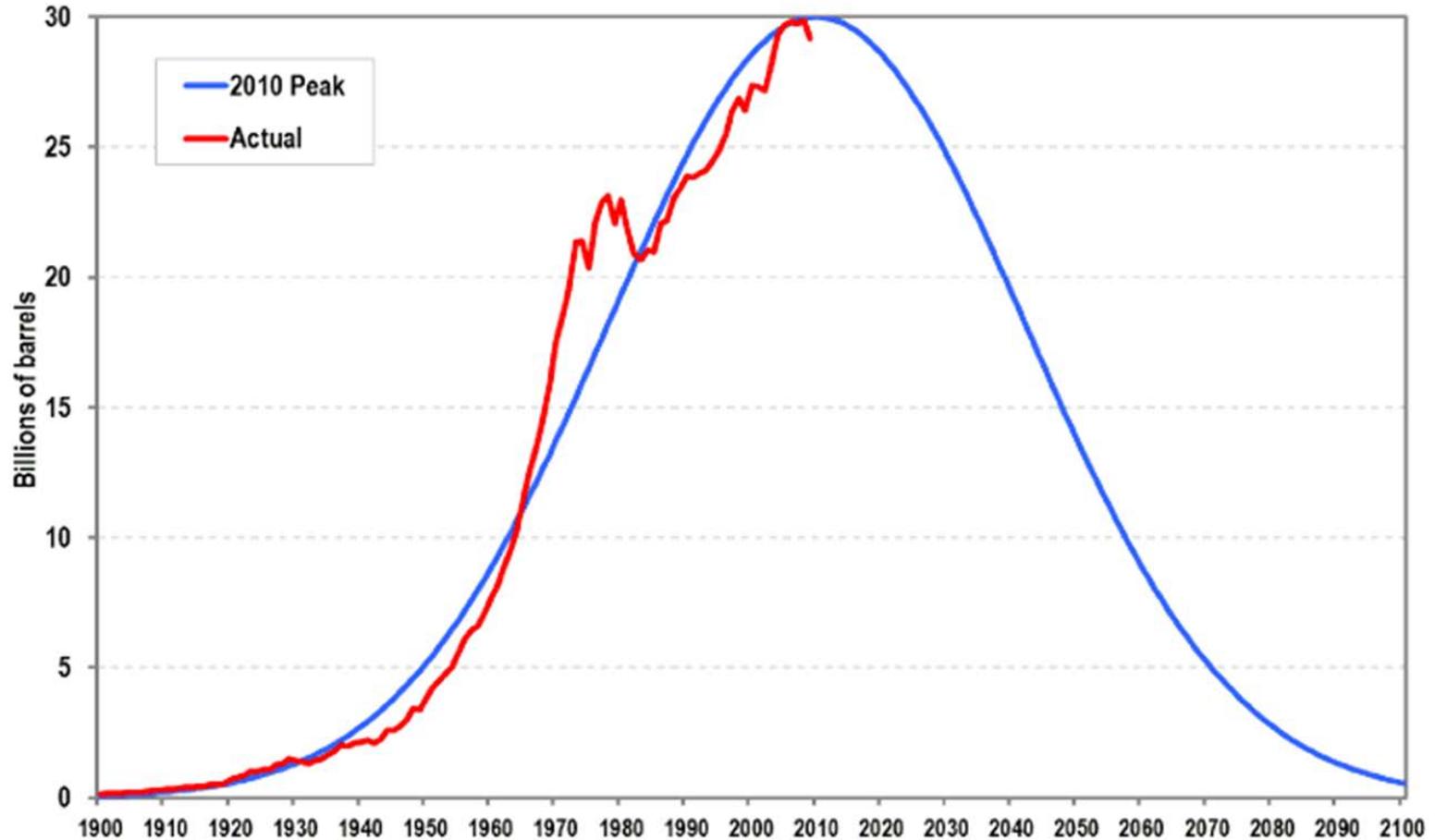- US to peak in 1970
  - (~3.0 GB/year)
- World peak in 1995

Historical US Oil Production

US Production (Crude Oil + Condensate)
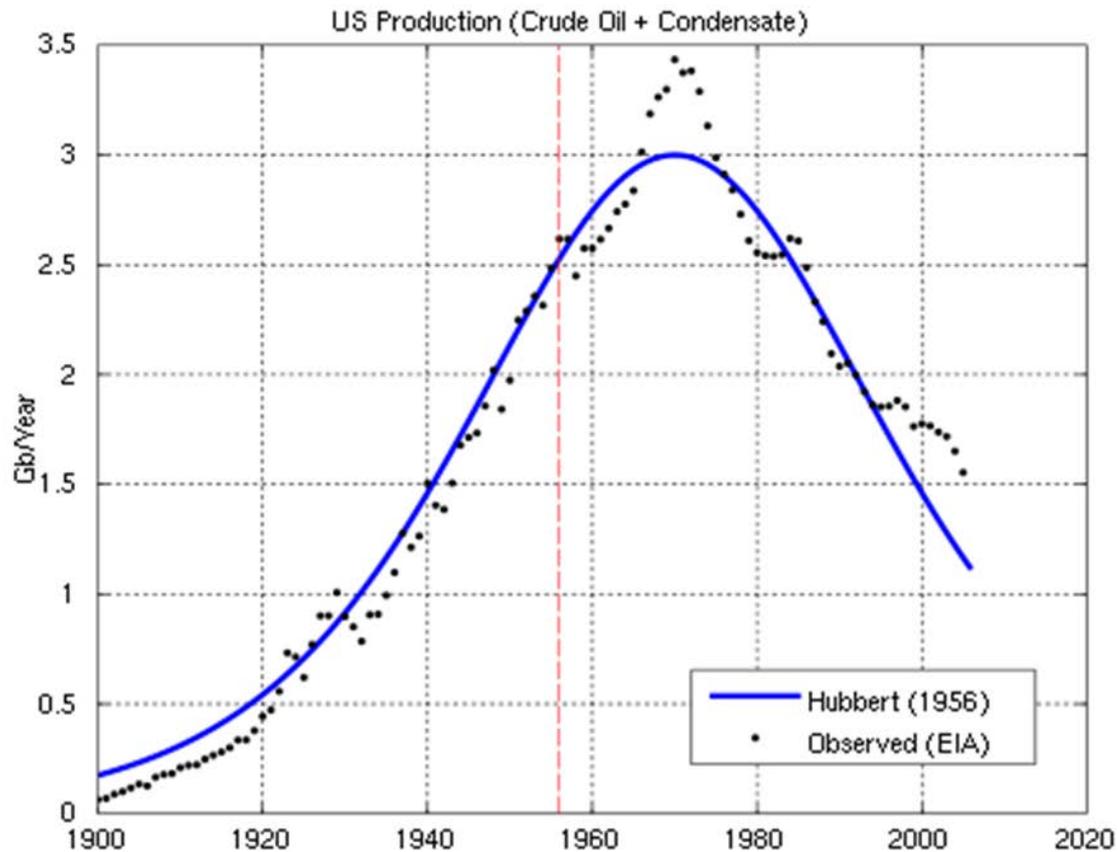
Historical Norwegian Oil Production

Norwegische Öl-Produktion

World Oil Production (to 2007)

What is driving Drilling Automation (cont.)

▸ Change in the nature of hydrocarbon reservoirs
  ◦ In mining industry terms, we're facing lower grade ores

▸ In drilling traditional reservoirs, many hydrocarbon saturated formations were noted, but where not economical to produce
  ◦ These are referred to as unconventional plays by the operating companies
  ◦ Shale oil, hydrocarbon rich, but do not have the permeability to flow
  ◦ Recent developments in drilling technology – horizontal drilling and fracking
  ◦ US Production rises from 1.8 (2007) to 2.7 GB/year (2013)

▸ Since these formations are "tight", the you only get production from localized area around the wellbore (fast decline curves)
  ◦ Many more wells are needed to drain a region
  ◦ To drain a reservoir, the drilling pattern must be repeated.
  ◦ Instead of a few wells, we will need hundreds to maintain production

Road to automated Drilling

- Change in the reservoir type to Shale Oils requires a least an order of magnitude more wells with continuous drilling to prevent decline

- The characteristics of the well plan will be identical for wells in same field.

- Highly repetitive tasks are great candidates for automation.

- How do we automate drilling?
  - Look at the hardware that needs to be automated
    - Establish standardized communications between rig devices
  - Look at the data/information that the Driller bases their decisions on
    - Organize and establish a standard interface for access to that information
 - Capture and emulate the Driller's logic as algorithms

Introduction to Drilling

- The driller has 3 main controls to operate a rig
  - It goes up and down
    - Drawworks/Hoisting system
    - Block Position and Hookload sensors
  - It goes round and round
    - Top Drive system
    - RPM, Torque, Standpipe Pressure sensors
  - It circulates fluids
    - Mud Pump system
    - Flow Rate (Stroke Counts)
    - Mud density and viscosity

- The main credo of drilling - the driller must balance the earths' in-situ pressure with the weight of "mud" in the borehole

Drilling Rig Schematic
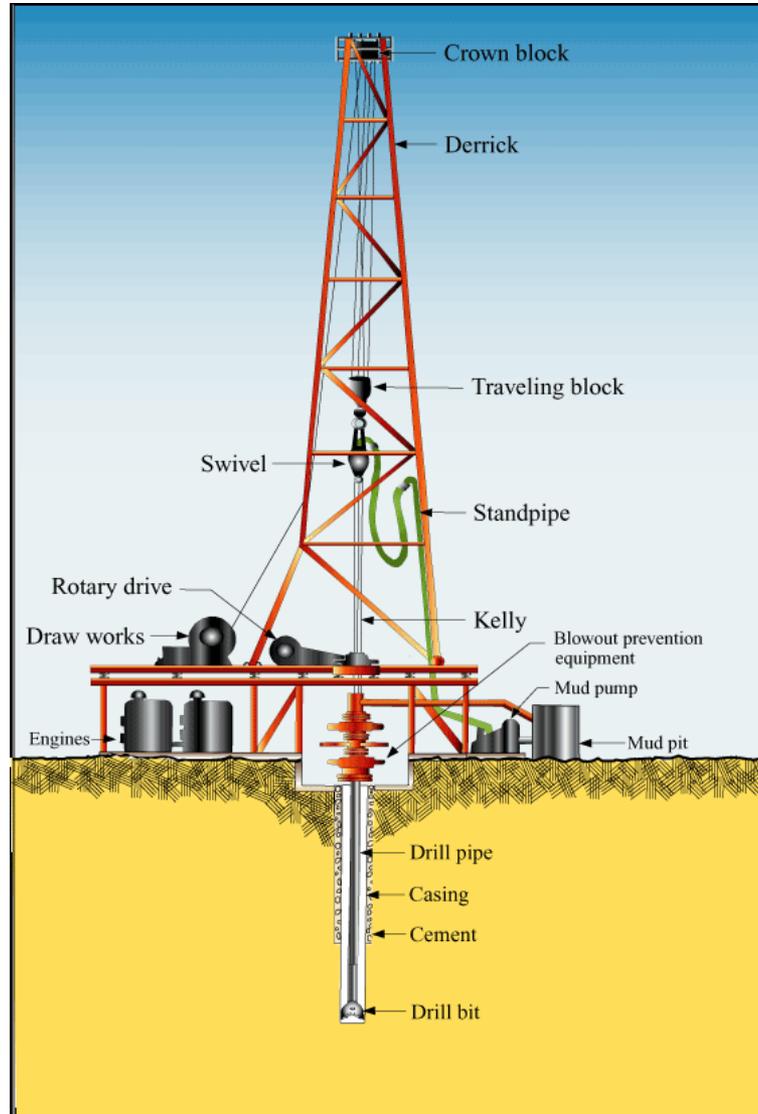
Drilling Operations

- Embedded video of roughnecks making a connection
- Video is too large to include in powerpoint form
- From Discovery Channel series Dirty Jobs

Rig Device Control

- Current rig control systems are a mix of standard and proprietary protocols
- Older rigs tend to use centralized control systems (Modbus)
- Newer rigs use FieldBus for DCS control
- If we are to automate a drilling rig, then we need the ability to control the same rig devices as the driller
- As controls are centralized at the driller's console, automation PLCs interface to the rig at this location
  - This is a highly customized (expensive) and non-portable solution
  - No standardize method for data handling

Rig Control and Instrumentation
Traditional Driller's Console
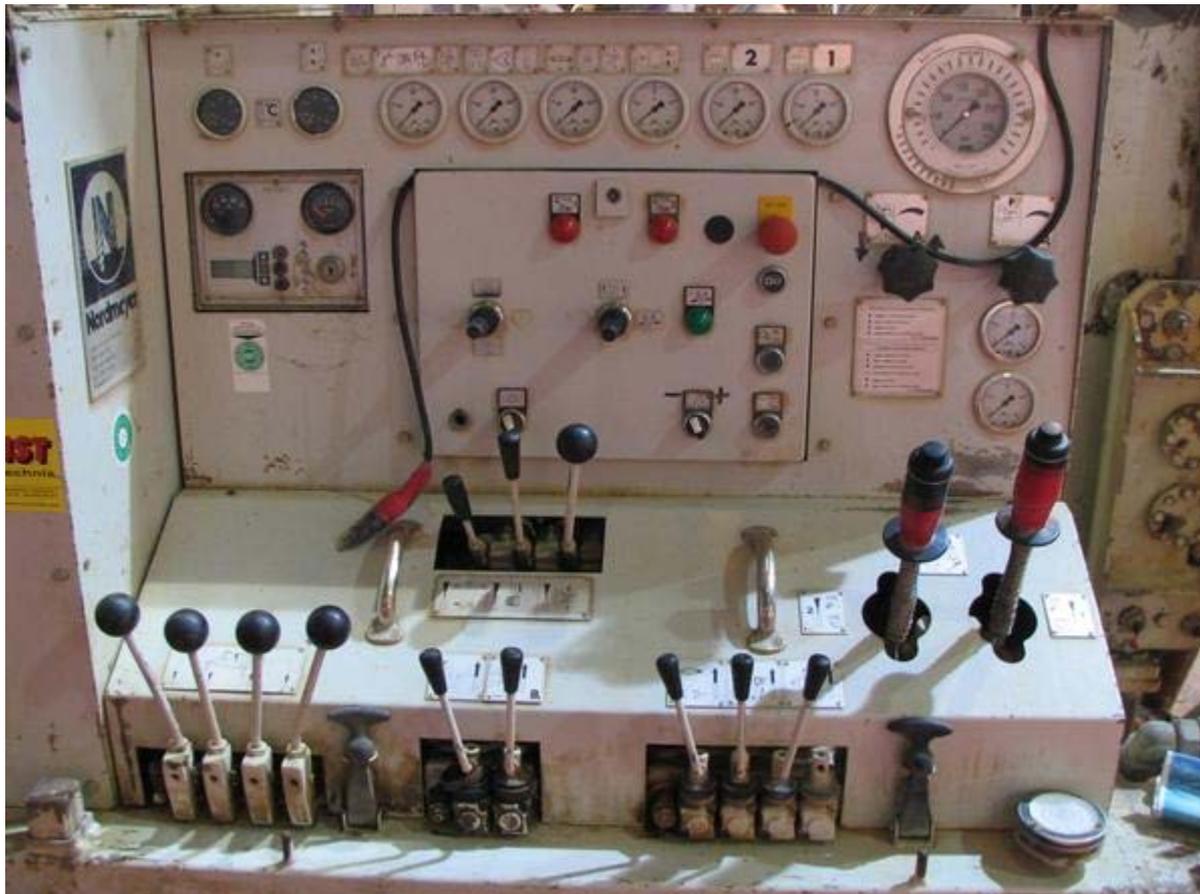
Rig Control and Instrumentation Driller's Console on a Nice Rig

Rig Control and Instrumentation Driller's Chair

Rig Data

- The current standard for rig data transfer is WITS0 (Wellsite Information Transfer Specification, Level 0)
  - One-way, serial data stream from a rig PLC
  - Encoding is a two digit Record Index and a two digit Item index
- WITSML (Energisitics) is web based and built on XML technology
  - The object system works well for reporting and information transfer
  - Not designed as a real-time data acquisition system

The need is to have a standard method of access for finding both rig hardware/metadata and sensor data
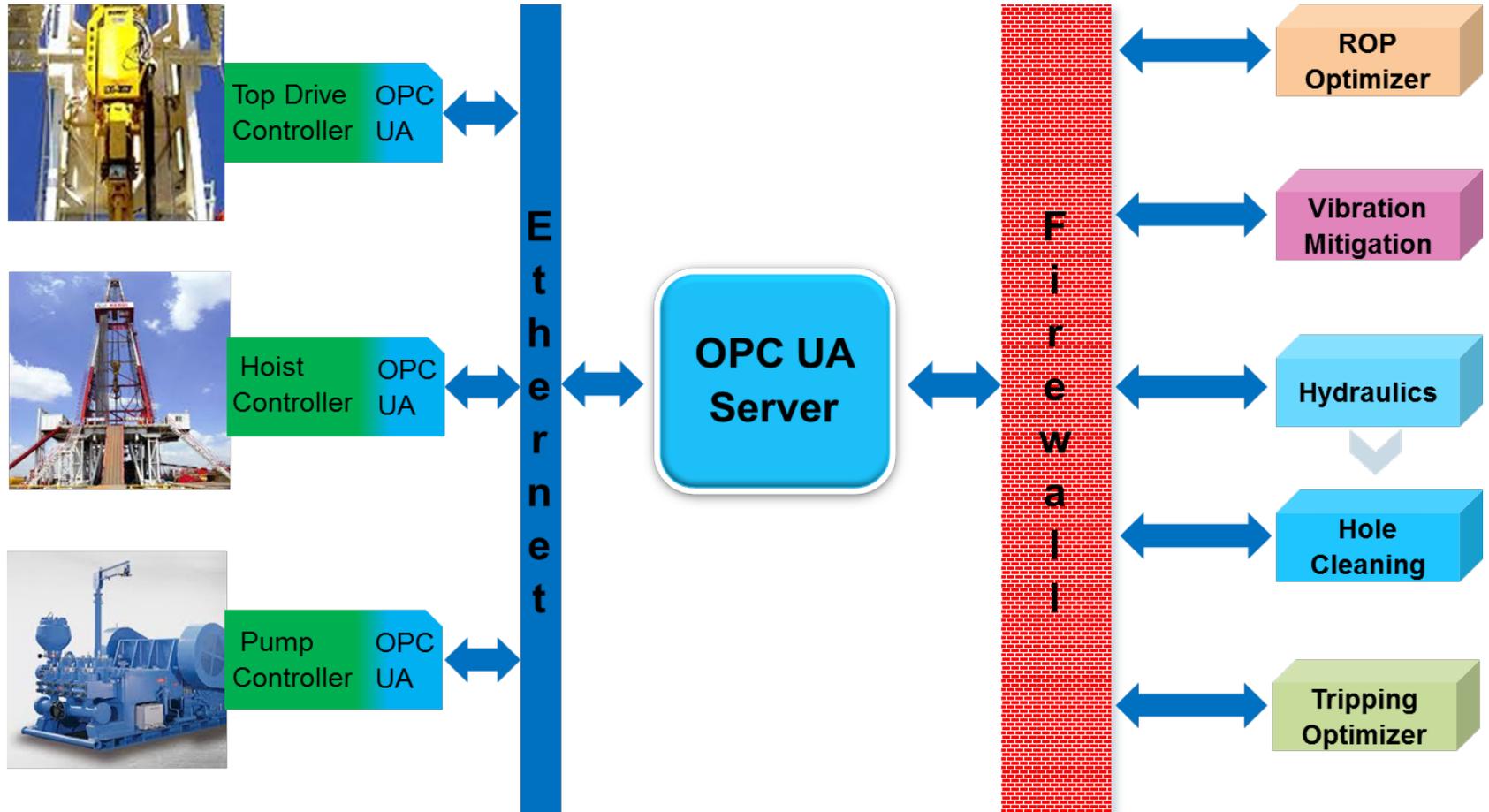
OPC UA

- ▸ Real-Time data acquisition/historizing capabilites
  - ◦ This would allow an "aggregation server" to act as a "black box recorder" and centralized access server for both automation and off-rig data streams

- ▸ Device Communications and Control
  - ◦ OPC UA allows standardize communications between rig devices.
  - ◦ It allows also the set-points and methods to control the device

- ▸ Information Modelling
  - ◦ We can use UA's information modelling capability to accurately model each piece of rig equipment
  - ◦ This model will provide the framework for standardized data query and access

OPC UA Drill Rig Diagram

Concequences

- Rig Construction
  - If each controllable device on the rig had an OPC UA server embedded in it's own controller card, then communications from device to centralized/aggregation server would be via OPC binary
  - OPC technology would allow the rig to discovery its components, even as components change, and expose those components to the outer world
  - Information modelling would allow all data and metadata about that specific device to be maintained on that device, and have a standard location
  - This opens the possibility of plug-and-play rig components
  - Wireless device controllers could simplify rig up/rig down operations by eliminating all data communications wiring.

- Automation
  - The Rig Information Model provides a browsable method for finding rig configurations and sensors.
  - An OPC UA aggregator server allows a standard method for accessing rig data (OPC UA Client)
  - Portable automation algorithms can plug into any rig and can be home developed or purchased best-of-breed

Summary

- Drilling Automation will happen as a higher percentage of hydrocarbons are extracted from unconventional sources
- Cost and safety (human and environmental) will be the drivers
- Drilling Automation can be advanced through the use of OPC UA
  - Open standards and secure web-based communications
  - Information modelling helps the drilling industry organize its' data
- This Information Revolution will result in rigs with commodity components, which should lower the cost of both the individual component and its integration costs.