Edge Analytics at the Rig

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Poll Question

Which Geographical Area are you from?

Source: Wikipedia: https://en.wikipedia.org/wiki/Edge_computing

Poll Question

What is your affiliation ?

Source: Wikipedia: https://en.wikipedia.org/wiki/Edge_computing

Poll Question

What is your main job interest ?

Source: Wikipedia: https://en.wikipedia.org/wiki/Edge_computing

Poll Question

How did you learn about the DUPTS ?

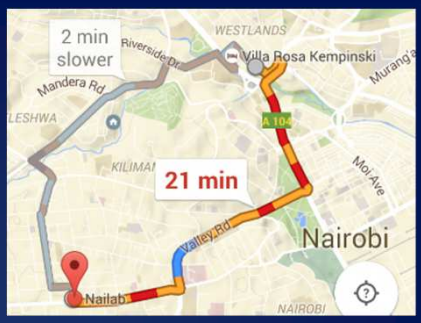
Source: Wikipedia: https://en.wikipedia.org/wiki/Edge_computing

A Real-Time Operations Centre….. Traffic Control

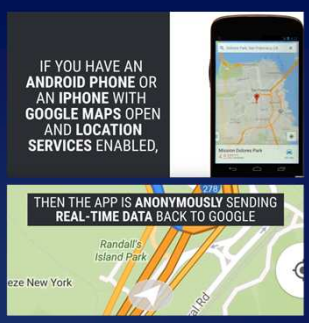
Radio Station Updates…….. Contact Emergency Services……..

GPS and Online Maps have replaced Traffic Centers

Suggestions for an alternative route based on Traffic



How does Google Maps know when there is traffic ?



The Smart Phone is the Edge Sensor

Source: Wikipedia: https://www.youtube.com/watch?v=nLasxr0GsoQ

Google Car : 'Edge Analytics'

Definition of Edge Analytics

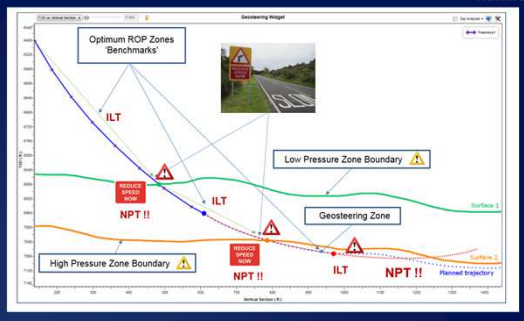
- Edge computing is a method of optimizing cloud computing systems by performing data processing at the edge of the network, near the source of the data
- This reduces the communications bandwidth needed between sensors and the central data center by performing analytics and knowledge generation at or near the source of the data
- This approach requires leveraging resources that may not be continuously connected to a network such as laptops, smartphones, tablets and sensors

Source: Wikipedia: https://en.wikipedia.org/wiki/Edge_computing

Reaction and Prediction

Reaction	Prediction
"We are Stuck…."	"We have a 50% chance of getting Stuck…."
"We have taken a Kick…."	"We are approaching the High Pressure Zone…."
"We have Lost Circulation…."	"The Drilling Analytics is advising us to change Mud Weight…."
"We are Drilling too slowly…."	"For this known Rock Type we need to change the Mechanical Drilling Parameters…"
"The RTOC are busy with another Critical Well at the moment…."	"We have Smart Alarms on the Rig…."

Big Data Analytics will reduce NPT and ILT

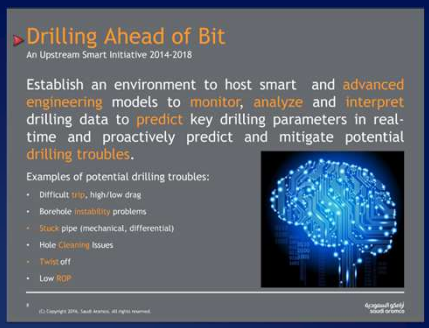


Link between Drilling Data and the Subsurface Earth Model

Poll Question

- What type of analytics do you or your team deal with predominantly ?
  - Descriptive Analytics (to know what is happening – reports, dashboards)
  - Diagnostic Analytics (to know why certain events are happening, and provide root cause)
  - Predictive Analytics (to know the likelihood of an event/value in the future
  - Prescriptive Analytics (to provide recommendations before an event happens)
  - No Analytics

Saudi Aramco early initiatives lead to the DUPTS



Source: DUPTS Webinar by Salem Gharbi of Saudi Aramco
https://webevents.spe.org/products/drilling-real-time-prediction-environment-in-saudi-aramco#tab-product_tab_handouts

Society of Exploration Geophysicists Machine Learning Contest

https://github.com/seg/2016-ml-contest

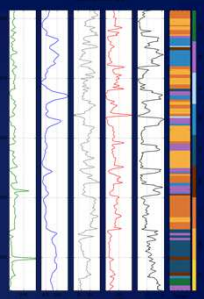
Objective: Predict the Rock Type for 2 Wells

Inputs:

- Wireline logs of 10 Wells and the Geological Interpretations

Predictor Variables:

- Five Wireline Log Curves



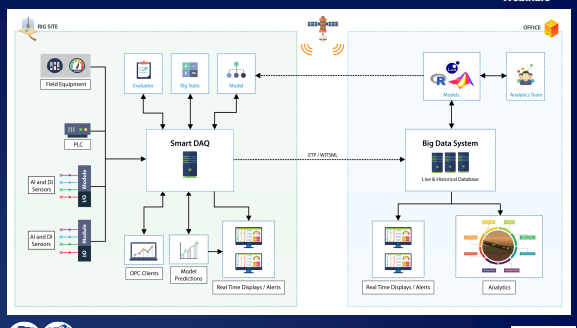
Source: DUPTS Webinar by Sridharan Chandresekan of PetroAnalytix
https://webevents.spe.org/products/rock-type-classification-using-machine-learning

Challenges for the use of Big Data mechanisms

- Data Quality – Lack of Calibration Standards / Frequency
- Data flow is typically Uni-Directional:
  - Sensor to DAQ; DAQ to Output Format; Transfer to Office Servers
  - Monitoring and Data Analysis made by Real-Time Operations Centres
- Data Formats (WITS / WITSML) and Data Frequency (1Hz or worse)
- Aggregation / Satellite delay / Multiple Firewall / Server Hops
- Lag Time to transfer data, run Big Data analytics and make results available
- Lag Time for the Support Process – then calls back to the Rig

Conclusion: Move the Analytical Process 'To the Edge' on the Rig

Machine Learning Model Workflow



Analytics at the Rig

Webinars

- Rig State
- Rig specific KPIs
- Dynamic Alerts and Events
- Flow back
- Torque and Drag analysis
- Stick and Slip
- Hydraulics for hole-cleaning analysis
- Kick detection
- Dynamic Alerts
- ROP Optimization
- Hole Cleaning
- Stand Pipe Pressure Roadmap
- Mechanical Specific Energy
- String Vibration & Bit Bounce
- Depth of Cut – Inch of Formation cut for unit RPM
- Dog Leg Severity
- Equivalent Circulation Density
- Flowback Fingerprinting
- Drill String Washout
- Stuck Pipe
- Motor Yield
- Survey Deviation and Tortuosity
- Casing Torque Fingerprinting

SPE International

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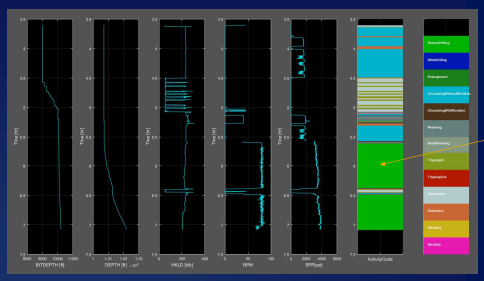
Automated Rig State on the Rig from Engineering Logic

Webinars



Rig Device running LUA Code

SPE International

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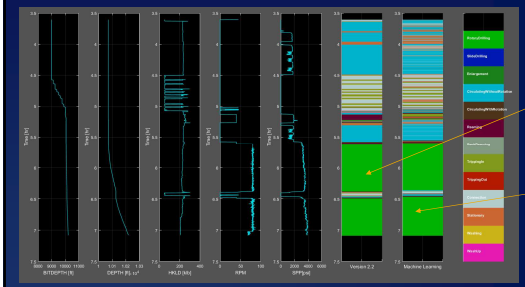
Comparison Rig State from Engineering & ML Logic

Webinars



Engineering Calculation

Machine Learning Prediction

SPE International

Trained with Data from 2 Wells Only

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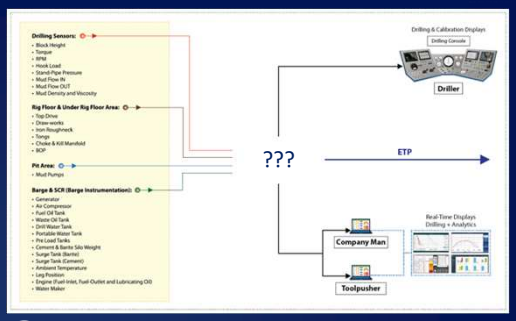
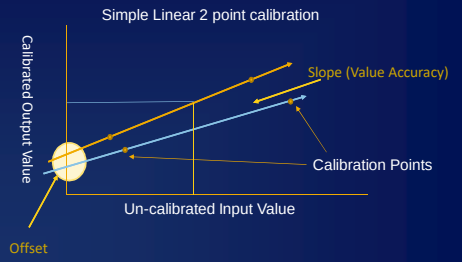
Challenges: Comparison to other Industries

- Aircraft use common dialog to inter-connect multiple devices (e.g. ARINC 629 - https://en.wikipedia.org/wiki/ARINC_629
- Yachts use common dialog to inter-connect multiple devices (e.g. NMEA 0183 - https://en.wikipedia.org/wiki/NMEA_0183
- Oil Rigs use OPC extensively in Drilling DAQs - https://opcfoundation.org/ …… but there is little inter-connectivity taking place :
  - Cyber-Security Fears
  - Standard not being driven by the Operator / Rig Owner

Challenges: Inter-Connectivity on the Rig



Challenges: Sensor Values used in Analytics



Wits Data Formats: 0105 (Date) and 0106 (Time)

Webinars

RECORD # 1 : GENERAL TIME-BASED

WITS Record ID 1	**Logical Record Type** 151	**Auto/Manual** AUTOMATIC
Trigger [TIME] Transmit at a specified time interval (secs)		
Data Source Data acquired in real-time and computed over the trigger interval; record transmitted and computation reset when triggering interval occurs		

Item	Description	Long Mnemonic	Short Mnemonic	Type	Length	Metric Units	FPS Units
1	Well Identifier	WELLID	WID	A	16	----	----
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	----	----
3	Record Identifier	RECID	RID	S	2	----	----
4	Sequence Identifier	SEQID	SQID	L	4	----	----
5	Date	DATE	DATE	L	4	----	----
6	Time	TIME	TIME	L	4	----	----
7	Activity Code	ACTCOD	ACTC	S	2	----	----
8	Depth Bit (meas)	DEPTBITM	DBTM	F	4	M	F
9	Depth Bit (vert)	DEPTBITV	DBTV	F	4	M	F
10	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
11	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
12	Block Position	BLKPOS	BPOS	F	4	M	F
13	Rate of Penetration (avg)	ROPA	ROPA	F	4	M/HR	F/HR

Rig DAQ	0105 (Date)	0106 (Time)
A	Yes	Yes
B	No	No
C	No	No
D	Yes	Yes
E	Yes	Yes
F	No	No
G	Yes	No
H	No	No
I	Yes	Yes
J	Yes	Yes
K	Yes	Yes
L	Yes	Yes

DUPTS

WITS Data Formats: 0105 (Date) and 0106 (Time)

Webinars

Rig DAQ	0105 (Date)	0106 (Time)
A	Yes	Yes
B	No	No
C	No	No
D	Yes	Yes
E	Yes	Yes
F	No	No
G	Yes	No
H	No	No
I	Yes	Yes
J	Yes	Yes
K	Yes	Yes
L	Yes	Yes

Date: 12 Mar 2018
Time: 21:09 27 secs

```
&&
0105180312
0106210927
01088195.312
01108195.274
011245.54224
01130.7530122
0114316.0946
0115316.0946
01169.240844
01179.240844
01200
0121945.6276
01220.0
01230
012458
01250
0126311.5602
0127-4.279327
012812
0130303.4908
01400.0
014174.58823
01424937.122
01991520888401
!!
```

Date: No 0105
Time: No 0106

```
&&
1984xxxxx/EDR
01230.00
01200.06
0113144.63
01087163.51
01107823.31
011251.86
01130.00
01170.00
01190.00
01210.00
01220.00
01240.00
01250.00
0126239.30
01272.39
012821.51
01300.00
0137302.00
0141-9999.00
0142287718.76
0143302.00
01440.00
01450.00
01697823.26
0170-9999.00
0171-3624.06
0172-9999.00
0173-9999.00
01405.43
0139-9999.00
01991521493202
!!
```

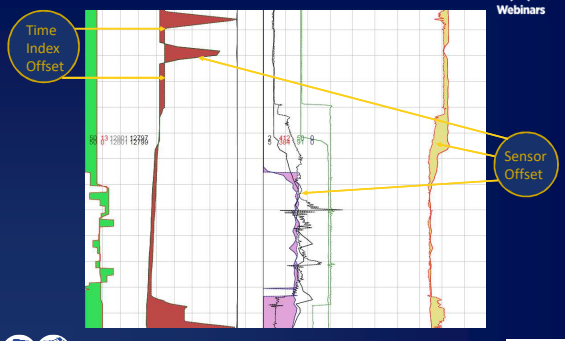
IN USE SINCE 1984

Source : http://home.sprynet.com/~carob/

DUPTS

Challenges: Sensor Offset and Time Index Offset

Webinars



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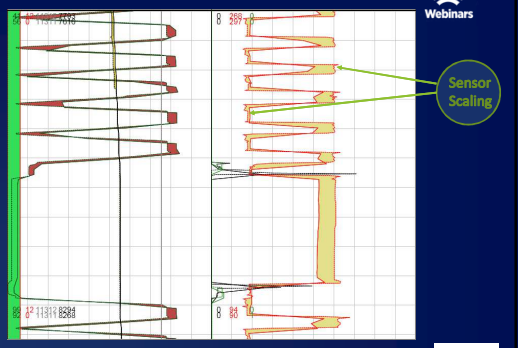
WITSML from the Driller and Mudlogger on the same Well



Opportunities: Sensor Data Analytics – Future Plans

- Automatic Fault Rectification
  - Identify fault in a network of sensors
  - Locate which sensor has failed
  - Reconstruct the signal in the absence of failed sensor

Opportunities: Patterns in High-Resolution Data

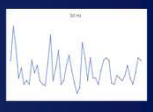
Typical Transmission with WITS or WITSML

1 Hz

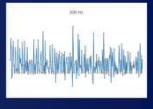
At 1 Hz there is only 1 value per second transmitted as part of a WITS or WITSML Data Stream

10 Hz

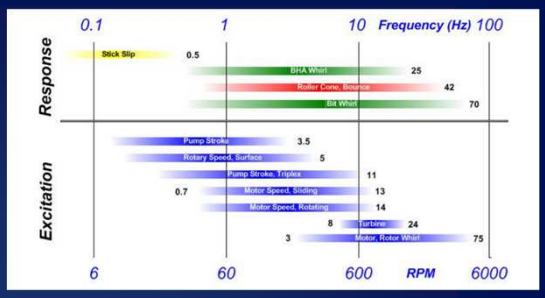
50 Hz



300 Hz



Opportunity: High Frequency Excitation vs. Response



Source : SPE 127413 MWD Failure Rates due to Drilling Dynamics

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Machine Learning Model Workflow