Metadata Requirements for Drilling Data

Pradeep Ashok, Research Scientist, Drilling Automation

What is Metadata ?

met·a·da·ta

/ˈmedəˌdādə,ˈmedəˌdadə/

noun

a set of data that describes and gives information about other data.

	A	B	C	D	E	F	G	H	I
1	Date Time	Hole Depth	Diff Press	Top Drive RPM	Top Drive Torque	Toolface Grav	Toolface Mag	TOTAL_GAS3	Svy Azimuth
2	6/19/2016 19:00	8938.56	213.98	40	13829	360	95.6	0	240.7
3	6/19/2016 19:00	8938.67	204.9	40.1	13208	360	160.9	0	240.7
4	6/19/2016 19:00	8938.78	199.15	39.9	12938	360	175.5	0	240.7
5	6/19/2016 19:00	8938.88	201.85	40	13628	360	295.9	0	240.7
6	6/19/2016 19:00	8938.99	205.41	40.1	13244	360	295.9	0	240.7
7	6/19/2016 19:00	8939.1	200.01	40	12918	360	318.7	0	240.7
8	6/19/2016 19:01	8939.21	205.82	39.9	13565	360	334	0	240.7
9	6/19/2016 19:01	8939.32	204.46	40	12989	360	284.2	0	240.7
10	6/19/2016 19:01	8939.43	192.93	40	12423	360	194.6	0	240.7

Metadata for Drilling Data ?

- CSV files
  - Compiled information
  - 6+ GB
  - 590 columns
- No Metadata
  - Header names only information
  - After compiling 5 docs, still ½ without info

Vendor A

TIME(datetime)
ACCZ(g)
BOBMAG(N.m)
BOBPHI(rad)
MAG
RPMACC(rev/mn)
SIDEACCMAG(g)
SIDEACCPHI(rad)
TOB(N.m)
WOB(kN)

Vendor B

TIME(datetime)
ACCZ(g)
BOBMAG(N.m)
BOBPHI(rad)
MAG
RPMACC(rev/mn)
SIDEACCMAG(g)
SIDEACCPHI(rad)
TOB(N.m)
WOB(kN)

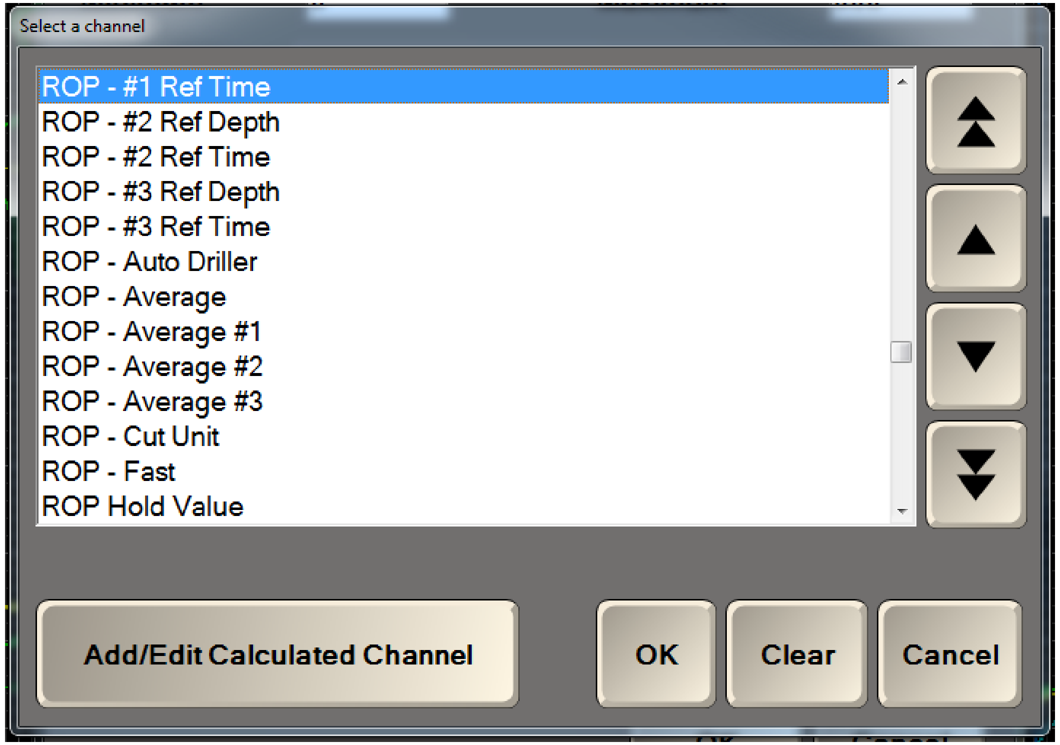
Vendor C

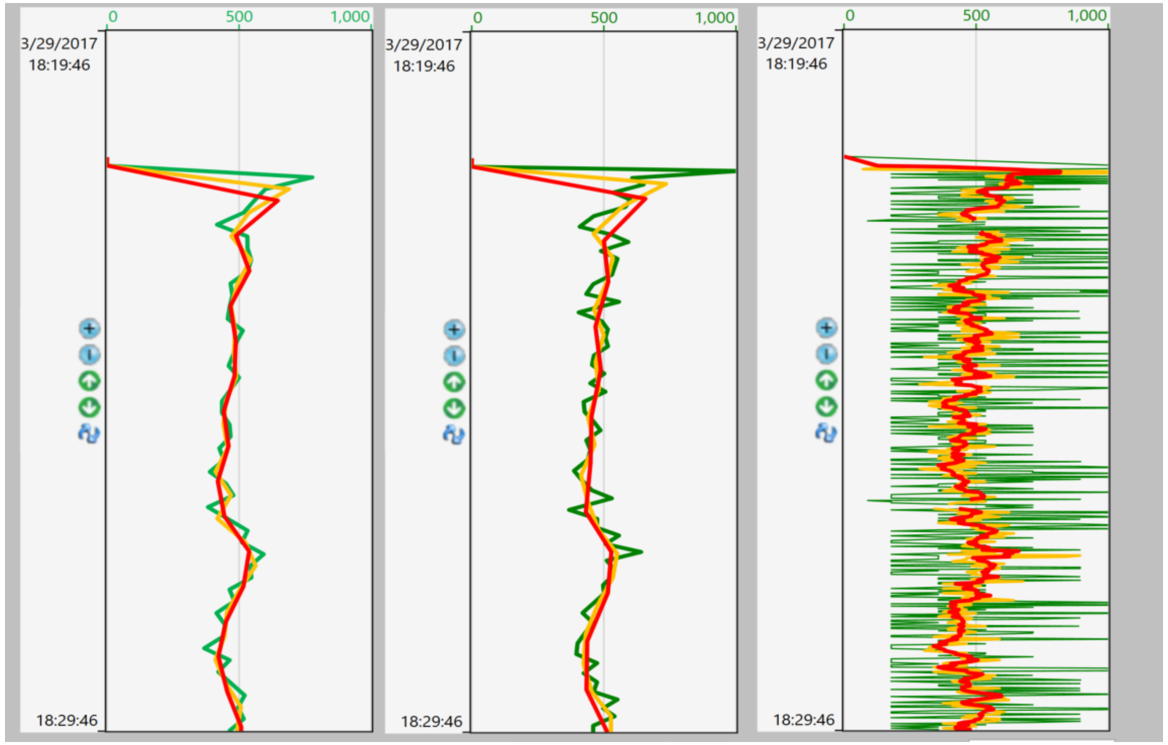
TIME(datetime)
AP(KPSI)
AXIAL_VIBRATION(G)
ELAPSED_TIME(SEC)
GX(G)
GY(G)
LATERAL_VIBRATION(G)
RPM_GYRO(RPM)
RPM_MAG(RPM)
TOR(RAD/S^2)
TORQUE_CORRECTED(KLB-FT)
TORQUE_UNCORRECTED(KLB-FT)
TORSIONAL_VIBRATION(RAD/S^2)
WEIGHT_CORRECTED(KLB)
WEIGHT_UNCORRECTED(KLB)
X_ACCEL(G)
Y_ACCEL(G)

Vendor E

TIME(datetime)
COPINXYR(DEG)
DANPAR(PSI)
DATEMPR(DEGF)
DBMAR(FT-LB)
DBMTFR(DEG)
DEPTH(FT)
DIFPAR(PSI)
HFRMSR(KLBF)
MTRAVGR(RPM)
RPMAR(RPM)
RPMMNR(RPM)
RPMMXR(RPM)
SEVTDR
SEVXYDR
SEVZDR
SSLIPDR
T1RMSR(GRAVITY)
TORCR(KFT.LB)
WHIRLDR
WOBCR(KLBF)
WOBDR
XY1RMSR(GRAVITY)
Z1RMSR(GRAVITY)

Is Metadata Important?





Do we really need to know how the ROPs were calculated ?

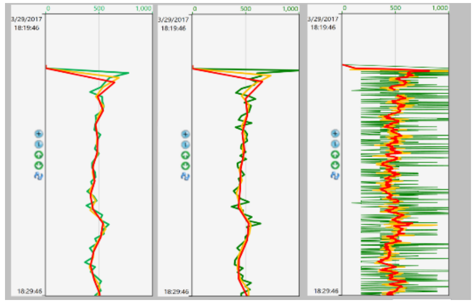
Types and Uses of ROP

Many Types of ROP Calculations

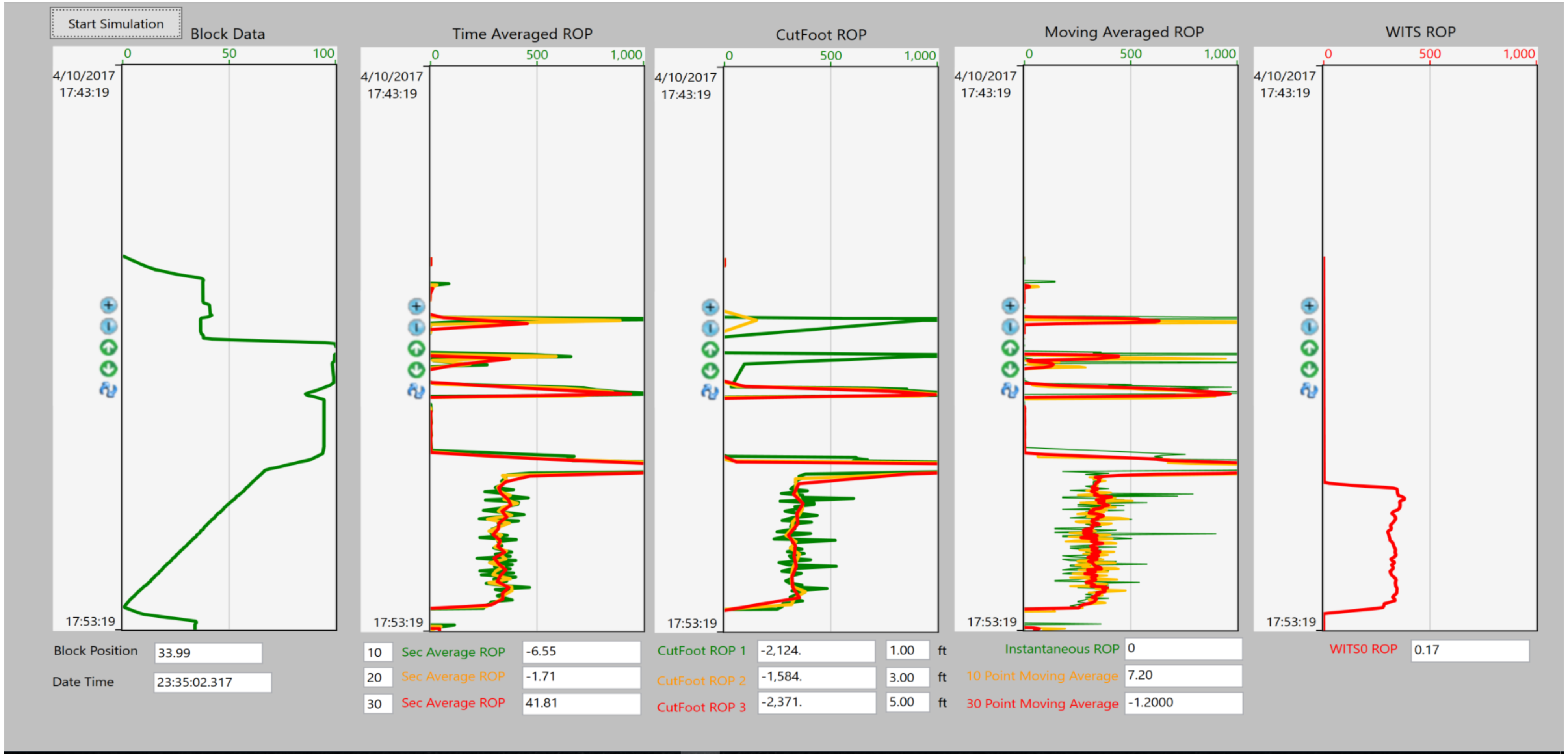
1. Instantaneous
2. Interval Based
3. Time Averaged
4. Cut-Foot
5. Etc.

Many Uses of ROP

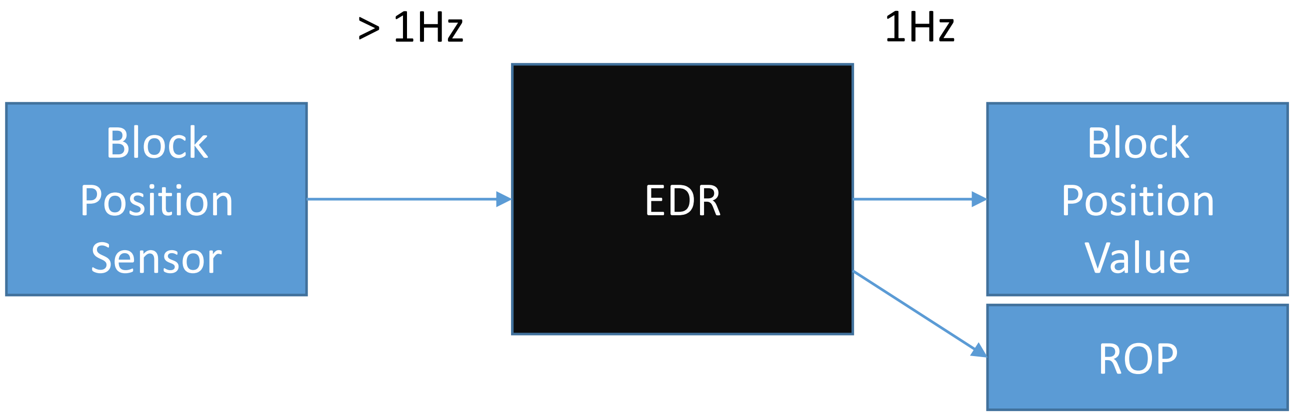
1. MSE Calculations $MSE = 0.35 * (\frac{WOB}{A_B} + \frac{120 * \pi * RPM * T}{A_B * ROP})$
2. Rig Controller/Auto Driller
3. Daily Drilling Summary (Morning Report)
4. Visualization



Fun Project: Finding What ROPA Means ?

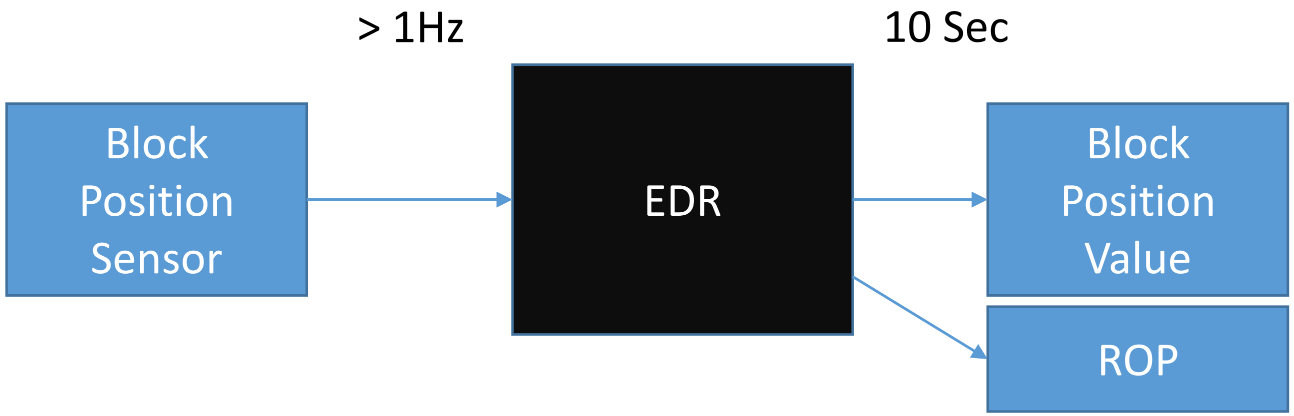


Variations In EDR Behavior



What is acceptable ?

- Filtered and averaged?
- Max value?
- Time interval value?



What is acceptable ?

- Filtered and averaged?
- Max value?
- Time interval value?

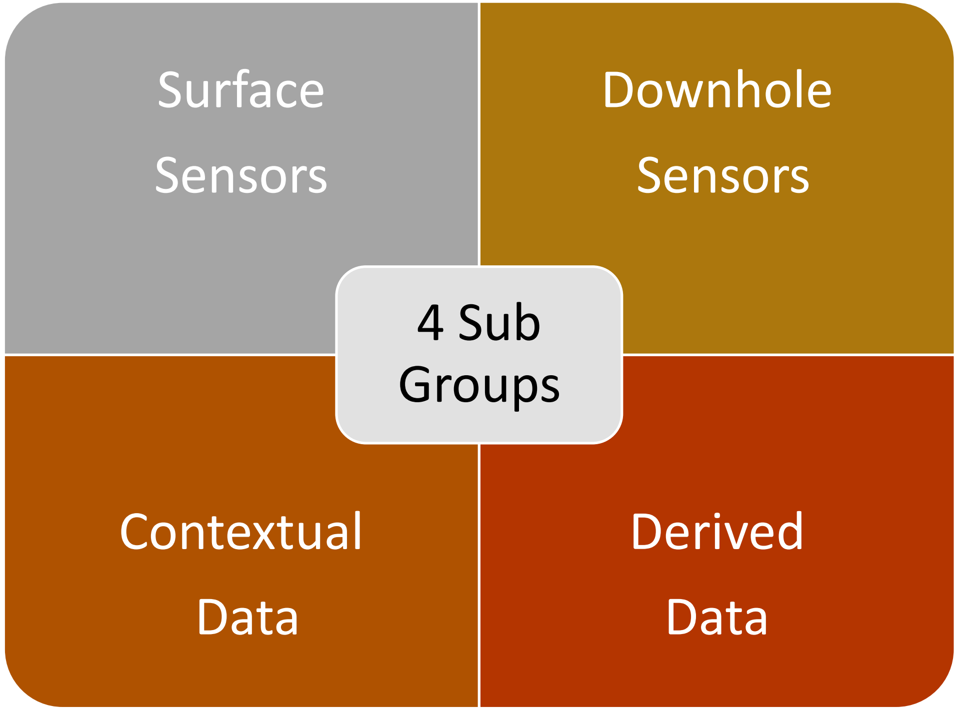
Is it time for new EDRs ?

SPE DSATS DQA Effort

The SPE DSATS DQA team was formed to complement the work done by the Operators Data Quality, and assist in improving drilling data quality

Develop recommendations for the selection of surface sensors, adequate for different automations tasks

Develop an open method for detailing the quality, transparency and integr-ability of data from downhole sensors and measurements.



Develop recommendations for contextual data that would be useful to be captured, and possible ways of capturing them

Develop guidelines for common critically derived measurements for use between different service providers

Transparency - Downhole Sensor Measurements

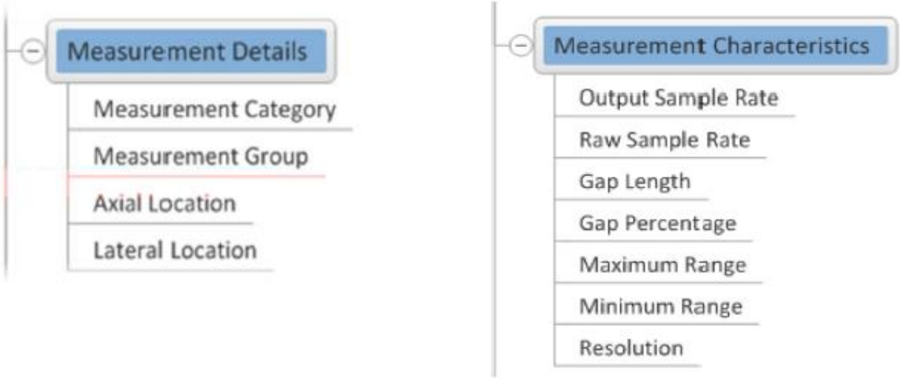
Society of Petroleum Engineers

SPE-174874-MS

A Framework for Transparency in Drilling Mechanics and Dynamics Measurements

John D. Macpherson, Baker Hughes; Pastusek Paul, ExxonMobil; Michael Behounek, Apache; Richard Harmer, Schlumberger

This paper was prepared for presentation at the SPE Annual Technical Conference and Exhibition held in Houston, Texas, USA, 28–30 September 2015.



	Metadata	Description	Example
INFO	Information: Name	Brief descriptive text describing measurement	Bending.Rate.Avg
INFO	Information: Units	As defined in WITSML Units of Measurement standards	Hz
DETAIL	Detail: Category	Acceleration, velocity, displacement, force, bending moment, torque, pressure, temperature, angle, frequency, power	frequency
DETAIL	Detail: Group	Bit, BHA, along-string, surface sub, surface rig, below sea level	BHA
DETAIL	Detail: Processing	Time series, statistic, diagnostic	statistic
DETAIL	Detail: Axial Location	Axial location of the measurement if located in the drillstring; measured from the drill bit (m)	15.6
DETAIL	Detail: Lateral Location	Lateral location of the measurement if located in the drillstring; radial distance for the center of the drillstring (mm)	82.6
CHARACTERISTIC	Char: Raw Sample Rate	Digital sample rate, in Hz, from the primary sampling system	1000
CHARACTERISTIC	Char: Output Sample Rate	Sample rate the time series, statistic or diagnostic is generated	0.2
CHARACTERISTIC	Char: Gap Length and Percentage	In snapshot sampling, the length in time when sampling is paused and not buffered, and the percentage of time that this occurs.	0
CHARACTERISTIC	Char: Maximum and Minimum Data Range	Valid limits of the measurement in sensor units.	0, 12.5
CHARACTERISTIC	Char: Resolution	Digital resolution of the measurement	0.005
BW	Bandwidth Details	Data describing the measurement bandwidth at the raw sample rate	-

Data Transfer Standards for Downhole Data

IADC/SPE-178900-MS

Efficiently Transferring and Sharing Drilling Data from Downhole Sensors

Theresa Baumgartner, Yang Zhou, and Eric van Oort, The University of Texas at Austin

- Published paper proposes *solution for downhole data transfer*
  - Standardized format of data
  - Metadata structure
- Goal
  - Work towards *automated data processing*
  - Minimize *processing* time for data provider and end user
  - Maximize *transparency* and thus *value* of data

General Structure of the Metadata Header

- Structure that helps to make the process of collecting metadata most efficient

SPE 178900

File Info
- Version Number
- Generation Date
- …

Well Info
- Well Name
- Company Info
- …

Run Info
- Start Time
- Bit info
- Section
- …

Device Info
- Tool info
- E.g. EMS or DSS
- Length
- Nr. of Sensors
- …

Sensor Info
- Multiple sensors in 1 device
- 3 strain gauges
- …

Measurement Info
- Short most important Channel Description
- Header
- Unit
- …

Channel Info
- Description for sophisticated analysis
- For each channel
- Filter data
- …

Excerpt from Theresa et al. Paper

Tag	Metadata	Unit	Description

Well Inf. Block

Run Inf. Block

Device Inf.

```
~Well Information Block
#TAG                    Data                              Unit      Description
#-------- ---------------------------------- ------    --------------------------------------------------------------
 WellName                          Rapid-1-2H:                Descriptive name of well
 WellUID                   42-501-20130-03-00:                Unique well identifier
 Wellbore                         Sidetrack 2:                Identification of borehole
 OperatorName                      OilCompany:                Operating company
 ContractorName               FastDrillers Inc:               Ending Depth
 ServiceCompanyName           DrillQuants Inc:                Drilling contractor company
 SpudDate                     11:11:2015 18:30:               Spud date
 Field                           HighPerm East:               Name of field
 State                                   Texas:               State
 Country                                   USA:               Country
 Latitude                            30.290191:               Wellhead position latitude (north is positive)
 Longitude                          -97.736534:               Wellhead position longitude (east is positive)

~Run Information Block
#TAG                    Data                              Unit      Description
#-------- ---------------------------------- -----     --------------------------------------------------------------
 numBitRun                                   2:               Bit run number
 numStringRun                                2:               The BHA (drilling string) run number
 RunStartTime                 15:11:2015 04:31:               Date and time that activities started
 RunEndTime                   16:11:2015 16:09:               Date and time that activities stopped
 StartDepth                              9,232: ft            Depth of data recording start
 EndDepth                               10,123: ft            Depth of data recording end
 WellType                             vertical:               Wellbore trajectory shape (vertical,curve,horizontal,tangent,...)
 BitSize                                   8.5: in            Diameter of drilled hole
 BitType                                   PDC:               Type of bit
 SurfaceDataReference                  Amphion:               Surface data collection system/company (e.g. Amphion, Pason,…)
 TimeCorrection         (dh-0.00342)*1.00043: sec             Time lag compared to surface data reference, both shift and stretch of dh data
 OperationsComments             Sensor 3 failed:              Irregular operational event occurring in this run

~Device Information Block
#TAG                    Data                              Unit      Description
#-------- ---------------------------------- -----     --------------------------------------------------------------
 DeviceName                           BlackBox:               Commercial name of device
 DeviceVendor                              NOV:               Unique identifier for data service company (e.g. stock code)
 VendorContactName           Firstname Lastname:              Contact person within data service company
```

Metadata can be Required or Optional

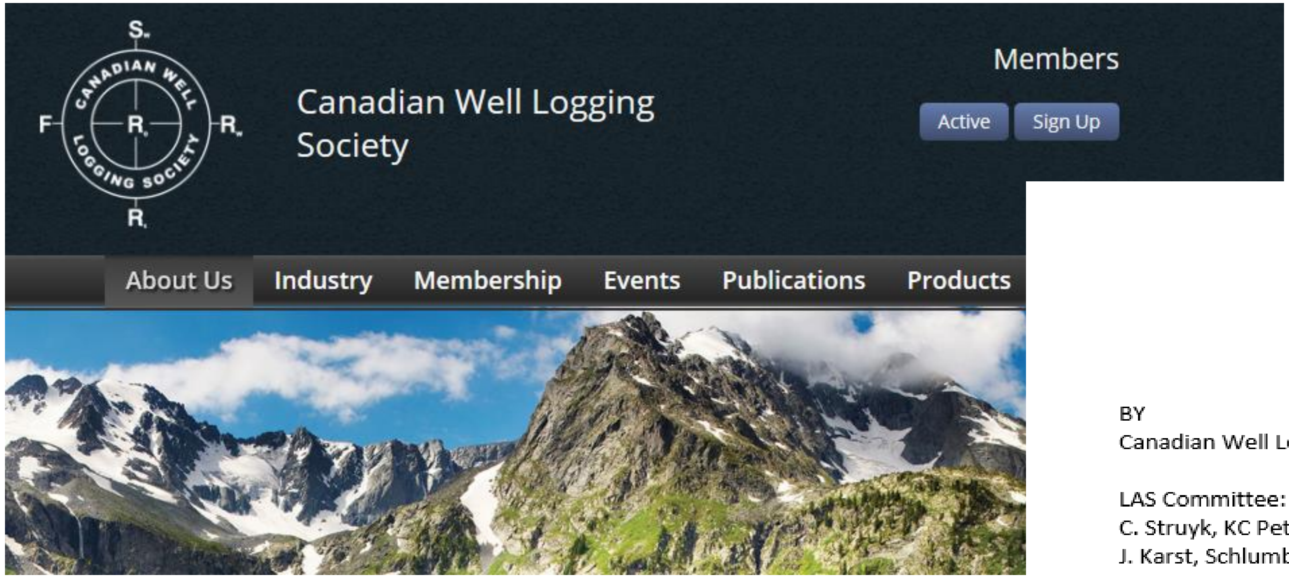
Examples: Required	Examples: Optional
• Sampling frequency • Data frequency • Calculated vs measured data • Offset time to surface data • Sensor failure during run • Position of Sensor • …	• Equations • Failure rate indicator • Sensor accuracy • Calibration information • Type of Sensor • Contact person of vendor • …

SPE 178900

A Similar Framework for Surface Data ?

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	FILE_INFO																	
2	ListSeparator=comma																	
3	DecimalSeparator=period																	
4																		
5	SESSION_INFO																	
6	TimeZone	GMT																
7	TimeZoneOffset	0																
8	DateTimeFormat	yyyy-MM-ddTHH:mm:ss																
9	StartTime	2014-12-06T17:35:17																
10	TimeFormat	Absolute																
11	TimeSource	PC																
12																		
13	WELL_INFO																	
14	Name	SPE DSATS DQA Well																
15	ID	AB12347																
16																		
17	CHANNEL_INFO																	
18	Channel	Number	Type	SampleR	Equation	Coefficients	CalibrationDate	Unit	WhereSensed	Accuracy	Precision	RangeMin	RangeMax					
19	Bit Position	1	Derived	10 sec	SPE DQA Approach # A1			feet		Unknown	Unknown	Unknown	Unknown					
20	Block Height	2	Measured	10 sec	result = data			feet	Drawworks	Unknown	Unknown	0	120					
21	Diff Press	3	Derived	10 sec	SPE DQA Approach # D4			PSI		Unknown	Unknown	Unknown	Unknown					
22	Flow Out Percent	4	Measured	10 sec	result = data			%		Unknown	Unknown	Unknown	Unknown					
23	Hook Load	5	Measured	10 sec	result = data			Klbs		Unknown	Unknown	Unknown	Unknown					
24	ROP - Average	6	Derived	10 sec	Propreitary					Unknown	Unknown	Unknown	Unknown					
25	Pump SPM 1	7	Measured	10 sec	No Information					Unknown	Unknown	Unknown	Unknown					
26	Strks - Pump 1	8	Measured	10 sec	result = data					Unknown	Unknown	Unknown	Unknown					
27	Pump SPM 2	9	Measured	10 sec	No Information					Unknown	Unknown	Unknown	Unknown					
28	Strks - Pump 2	10	Measured	10 sec	result = data					Unknown	Unknown	Unknown	Unknown					
29	Top Drive RPM	11	Measured	10 sec	result = data				Top Drive	Unknown	Unknown	Unknown	Unknown					
30	Top Drive Torque	12	Derived	10 sec	result = ([slope] * data) + [	[slope]=0.11718	1/10/2014			Unknown	Unknown	Unknown	Unknown					
31	Pump Pressure	13	Measured	10 sec	result = data					Unknown	Unknown	Unknown	Unknown					
32	Total Mud Volume	14	Derived	10 sec	result = data					Unknown	Unknown	Unknown	Unknown					
33	Flow In Rate	15	Derived	10 sec	No Information					Unknown	Unknown	Unknown	Unknown					
34	Bit Weight	16	Derived	10 sec	No Information					Unknown	Unknown	0	Unknown					
35																		
36	DATA_START																	
37	Date Time	Hole Dep	Bit Position	Block He	Diff Press	Flow Out Perce	Hook Load	ROP - A	Pump SPM 1	Strks - Pump 1	Pump SPM 2	Strks - Pump	Top Drive RPM	Top Drive	Pump Pre	Total Mu	Flow In R	Bit Weight
38	2014-12-06T17:35:17	3087.8	3086.64	66.91	21.91	75	160.5	0	103	255656	104	279457	30.1	0	1977.8	309	794	-0.7
39	2014-12-06T17:35:27	3087.8	3086.65	66.9	59.37	76	159.9	0	103	255673	104	279475	30.1	0	2016.5	309	795	0.3
40	2014-12-06T17:35:37	3087.8	3086.77	66.78	109.38	75	153.9	0	103	255690	104	279492	30.1	0	2049.8	310	795	5.3
41	2014-12-06T17:35:47	3087.8	3086.87	66.69	153.92	76	150.4	0	103	255707	104	279509	30	0	2108.7	311	795	10
42	2014-12-06T17:35:57	3087.8	3086.91	66.64	153.84	76	150.6	0	103	255725	104	279527	30	0	2091.6	312	795	10.2
43	2014-12-06T17:36:07	3087.8	3086.95	66.6	142.38	77	150.6	0	103	255742	104	279544	30	0	2092.8	314	795	10.1
44	2014-12-06T17:36:17	3087.8	3086.99	66.56	156.39	77	150.6	0	103	255759	104	279561	30	0	2120.6	314	794	10.1
45	2014-12-06T17:36:27	3087.8	3087.03	66.52	153.47	78	150.7	0	103	255776	104	279578	30	0	2094.8	315	794	10.2
46	2014-12-06T17:36:37	3087.8	3087.08	66.48	143.98	77	150.6	0	103	255793	104	279596	29.9	0	2090.1	315	793	10.1
47	2014-12-06T17:36:47	3087.8	3087.12	66.43	129.98	78	150.6	0	103	255811	104	279613	29.9	0	2075.1	316	794	10.1
48	2014-12-06T17:36:57	3087.8	3087.16	66.39	129.76	78	150.6	0	103	255828	104	279630	29.9	0	2079.6	317	796	10.1
49	2014-12-06T17:37:07	3087.8	3087.2	66.35	129.42	78	150.6	0	103	255845	104	279648	29.9	0	2079.7	317	794	10.1
50	2014-12-06T17:37:17	3087.8	3087.24	66.31	130.16	79	150.6	0	103	255862	104	279665	29.9	0	2074.4	319	793	10.1
51	2014-12-06T17:37:27	3087.8	3087.29	66.26	132.31	79	150.6	0	103	255879	104	279682	29.9	0	2078.7	319	794	10.1
52	2014-12-06T17:37:37	3087.8	3087.33	66.22	130.37	79	150.6	0	103	255896	104	279699	29.9	0	2099.1	318	794	10.1

Adopting / Adapting LAS 2.0/3.0 ?



LAS Version 2.0: A Digital Standard for Logs

Update January 2014

BY
Canadian Well Logging Society (www.cwls.org)

LAS Committee:
C. Struyk, KC Petrophysics Inc
J. Karst, Schlumberger Canada Ltd.

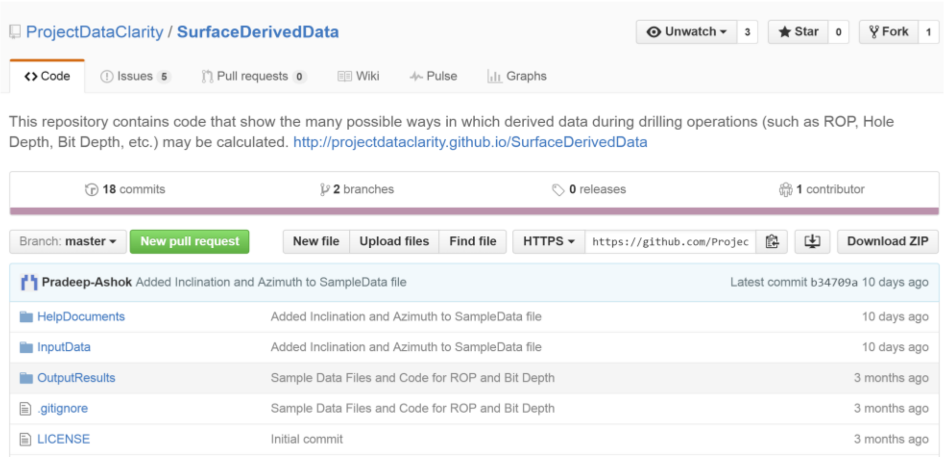
1.0 Abstract:

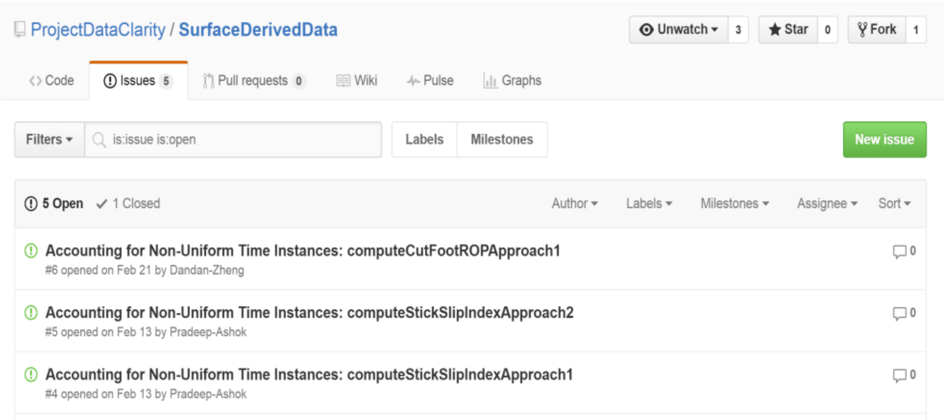
The LAS 2.0 log data standard was introduced in 1992 and continues to be popular. This paper updates the LAS 2.0 documentation and makes a minor change to the LAS 2.0 specifications to better reflect the technological advances made since its introduction.

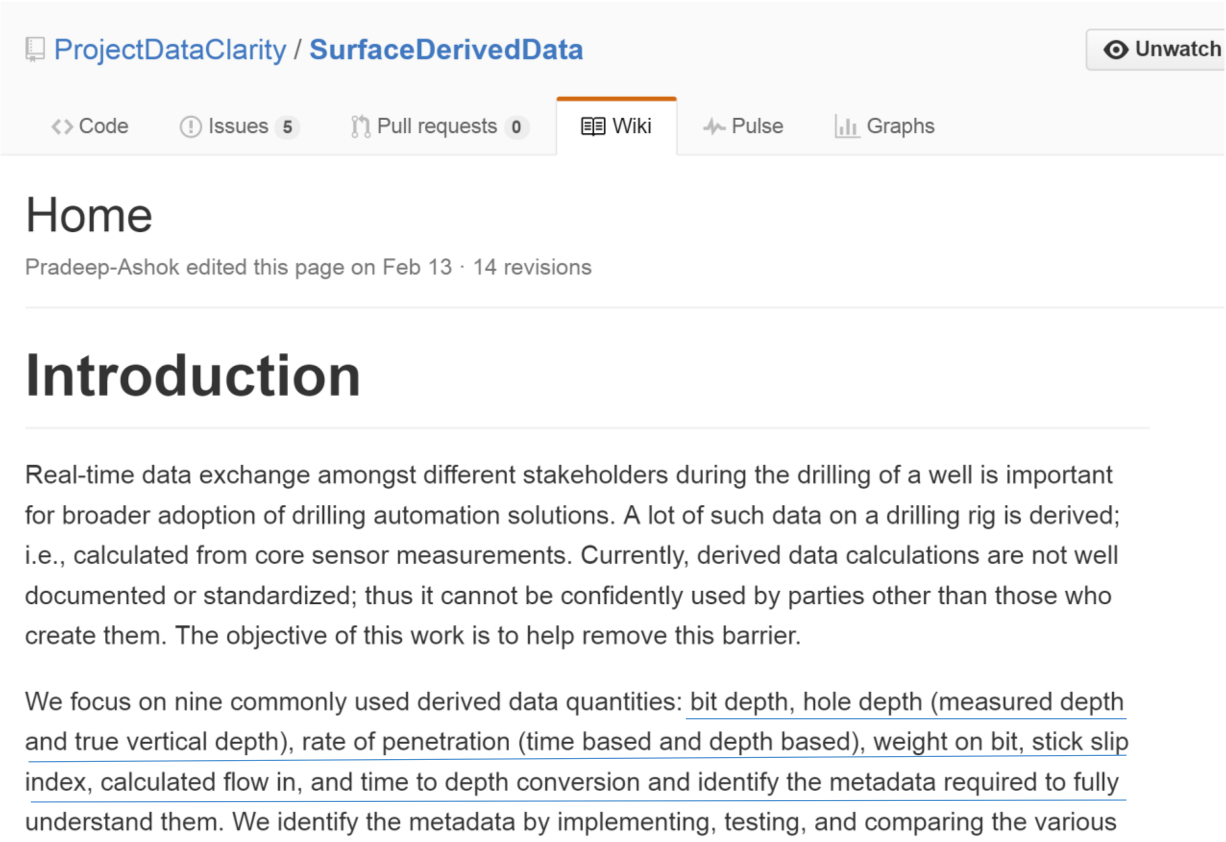
The changes and clarifications are as follows:

- Line length is unrestricted in unwrapped mode (change)
- The depth value divided by the step value must be a whole number (clarification)
- Rounding of depth values is not acceptable. (clarification)
- The delimiters in a non-comment line are the first dot in the line, the first space after that dot and the last colon in the line. (clarification)
- Most LAS 2.0 files have a depth based index however a time based index is permitted (clarification).

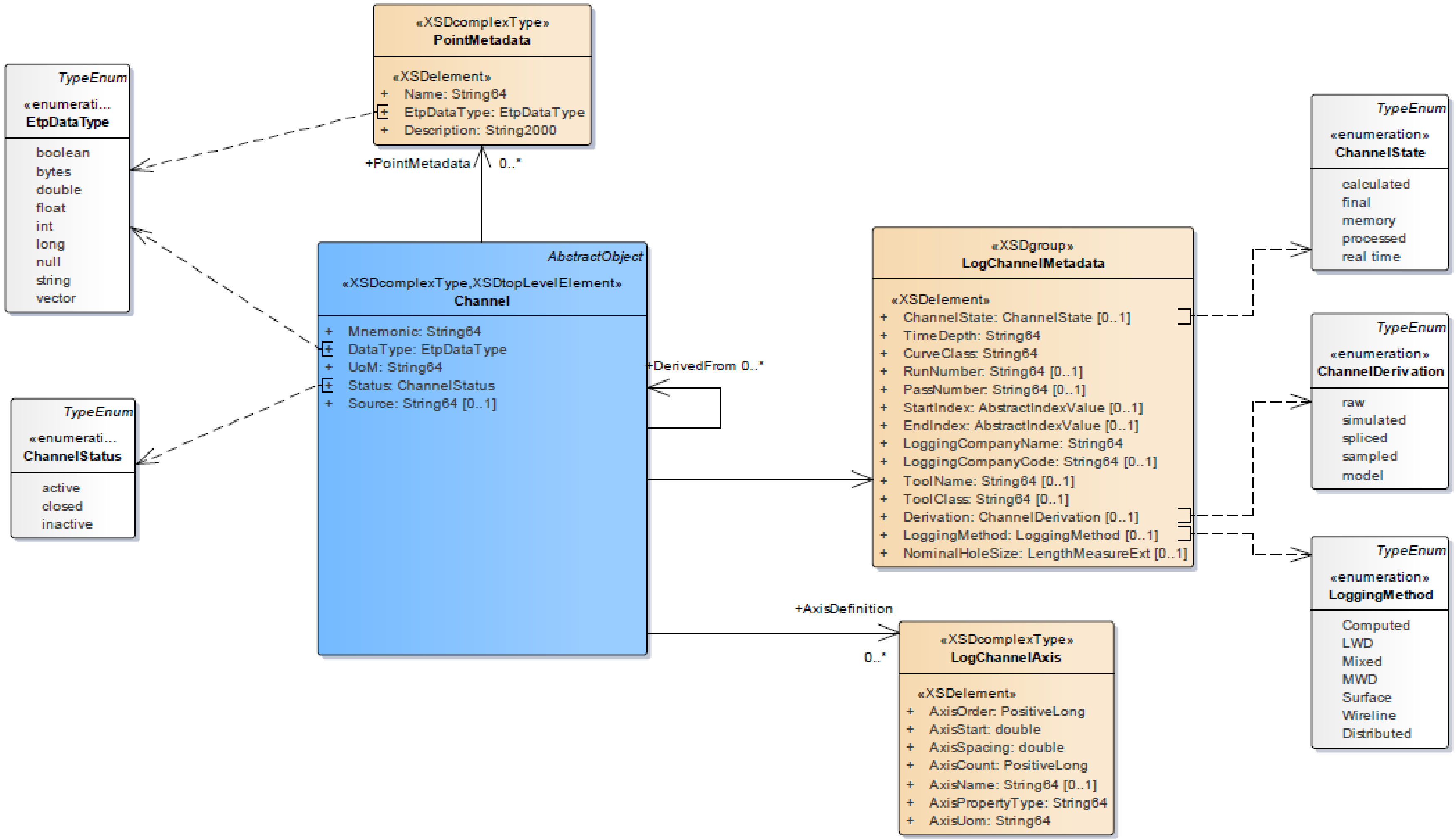
Open Sourcing Common Calculations







Where is WITSML 2.0?



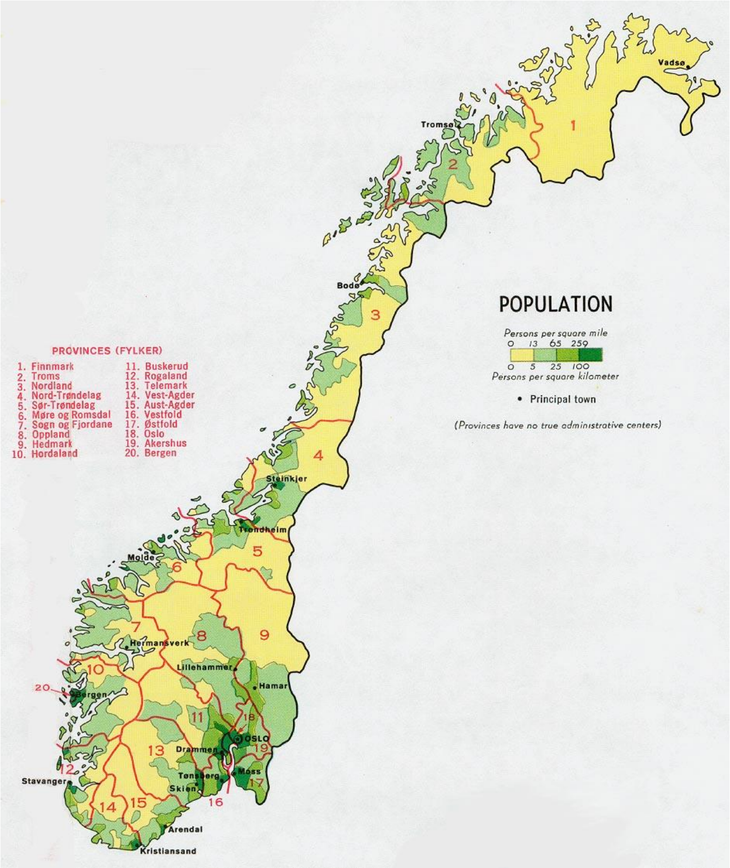
Summary: Metadata is Important

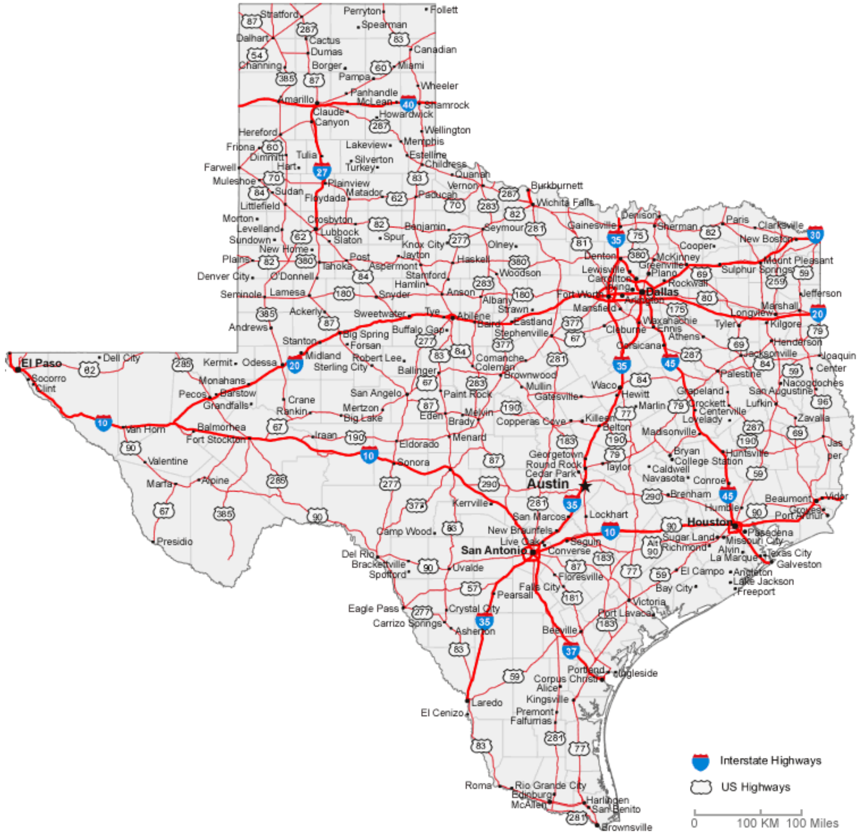
- Facilitates data reuse and sharing
  - More easily interpreted and analyzed
  - Can be processed by others
- Reduces “Garbage In Garbage Out”
  - More trust in analysis
- It allows for data longevity
  - More useful in the long term
  - Historical record keeping

We are not there yet !!!

- No standards yet
  - Debate on standardization versus innovation continues
  - If standardization is desirable, who can facilitate it ? Energistics is one option?
- Existing legacy systems do not facilitate metadata transfer
  - Stuck on WITS Systems
- Operators not asking “enough” for metadata ?
- WITSML 2.0 has capability
  - Slow adoption due to existing standards (1.3/1.4)
- Value to end user (Third Party, Operator)
  - Cost of change borne by data provider

NORTEX Effort?





Acknowledgement

John Macpherson, Richard Hammer, Martin Cavanaugh, Theresa Baumgartner, Alex Zhou, Eric van Oort, Michael Behounek, Taylor Thetford, Jacob McNab, Brian Nelson, Kyle Goncalves, Hans Uwe Brackel, Nathan Zenero, Jay Hollingsworth, Dandan Zheng, Deep Joshi, and many more…

Questions