Standard Directional Interchange Format

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LAS, WITSML, MMS, P7/2000, P7/17, OSDU, EDM.XML etc.

Halliburton, Landmark 30 years

Introduction

- Problem – need to exchange plan trajectory between systems
  - Planning structure and trajectory data in a way that we can continue working in any vendor neutral system.
- Problem – would like to add QA parameters for surveys
- P7/17 is very well defined wrt. exchanging Survey Data & well location, + error models, geodesy , reference points
- Not adopted by major software by planned to be adopted in the Elephant system in the next year.
- OSDU is a labyrinth – but allows for P7/17 data as a survey log.
- Would like the participation of other vendors to validate exchanges before loading into OSDU.

P7/17 & OSDU

WellboreTrajectory [Status: Accepted]

Work Product Component describing an individual instance of a wellbore trajectory data object. Also called a deviation survey, wellbore trajectory is data that is used to calculate the position and spatial uncertainty of a planned or actual wellbore in 2-dimensional and 3-dimensional space.

- Source `kind` (`x-osdu-schema-source`): `osdu:wks:work-product-component--WellboreTrajectory:1.3.0`
- Schema status: PUBLISHED
- First deployed with milestone M19, tag v0.22.0
- Governance Authorities: OSDU
- Supported formats: `WITSML`, `P7/17`, `P7/2000`, `LAS2`, `LAS3`, `csv`
- **Migration Guide (M19)** `osdu:wks:work-product-component--WellboreTrajectory:1.2.0` → `osdu:wks:work-product-component--WellboreTrajectory:1.3.0`
- Link to → Proposal workbook WellboreTrajectory.1.3.0.xlsx — (the link refers to a resource in the OSDU Member GitLab)
- Link to → Authoring Schema WellboreTrajectory.1.3.0.json
- Link to → Generated Schema WellboreTrajectory.1.3.0.json
- Link to → Community Schema Registration Resource WellboreTrajectory.1.3.0.json
- Link to → Example Record WellboreTrajectory.1.3.0.json **Note:** this is auto-generated and not intended to be meaningful from a domain perspective.
- Link to worked examples in context → Topic: Trajectory Usage
- Link to worked examples in context → Topic: Vertical References Usage
- Link to worked examples in context → Topic: Well Planning Worked Examples

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- Maybe OSDU is more of a transfer format rather than the content
- Is there an exchange between P7/17 and OSDU – particularly with header data.

P7/17 and OSDU Compared

	OSDU	P7/17
Header Data	YES	YES
Geodesy/CRS	YES	YES – OVER THE TOP
Survey Data	Weak – refers to other formats	YES + P7/M7/G7
Error Models		YES – OVER THE TOP
Trajectory/ turn points	As survey data	YES – USEFUL
Targets	YES + shape	? – O7 – position objects
Survey Program	YES	NO – needs this for plans
Readability	POOR	GOOD
Verbosity (overload)	POOR	GOOD

P7/17 for Transfer of Plan Trajectories

- Mostly OK – all the data fields are there,
- Codification for plan methods & is not standard but may not be needed.
- Would like to add targets & possibly even target shapes (addition)
- Would like to add survey program (new section).

Example data in P7 format

Survey Definition = Program

```
CC,0,0,0,  ------------------------------------------------
CC,0,0,0,  Mandatory Entities
CC,0,0,0,  ------------------------------------------------
H7,1,0,0,Project Information                                ,BETA FIELD,BETA FIELD,Texas,United
        States,USA
H7,1,1,0,Structure Definition                               ,1,DELTA SITE,SRP,1,,1,Onshore,Ground
        Level,,
H7,1,2,0,Well Definition                                    ,1,1,WRP,2,4220112345,ALPHA 01,TRC,,,,As-
        built,SEC 20 TWP 30S R40E,2018:02:05
H7,1,3,0,Wellbore Definition                                ,1,1,422011234500,WB00,TRC,,,,Actual,SEC
        20 TWP 30S R40E,ST00,2018:02:05
H7,1,4,0,Rig/Workover ZDP Definition                        ,1,Rig A,ZDP,3,1,Derrick Floor,1,1

H7,1,5,0,Survey Definition                                  ,1,1,1,WIRELINE GYRO
        CONTINUOUS,Gyro,,,,,50.00,10950.00,ft,2018:02:05,,TP,2,,
H7,1,5,1,Survey Details                                     ,1,11,2,MD-Wireline, 1,Indicated
        depth,1,9,AZ_GRID,4,Calculated from AZ_TRUE,1,1.780,0,,,,
H7,1,5,2,Operator/Survey Contractor                         ,1,IOGP Exploration,Unknown
        Contractor,Unknown Job Number

H7,1,5,0,Survey Definition                                  ,2,1,1,MWD
        intermediate,Magnetic,,,,,11012.00,21262.00,ft,2018:02:05,,TP,4,,
H7,1,5,1,Survey Details                                     ,2,11,1,MD-Drillpipe,1,Indicated
        depth,1,9,AZ_GRID,3,Calculated from AZ_MAGN,1,1.780,1,2.51,2017:10:22,1,
H7,1,5,2,Operator/Survey Contractor                         ,2,IOGP Exploration,Unknown
        Contractor,Unknown Job Number
H7,3,0,0,Geomagnetic Model Definition
        ,1,,WMM2015,2015,
```

Position Objects = Targets

```
CC,0,0,0,  ------------------------------------------------
CC,0,0,0,  Mandatory Position Objects
CC,0,0,0,  ------------------------------------------------
H7,4,0,0,Position Object Definition                         ,1,DELTA SITE,   1,Structure Reference
        Point,depth at Ground Level,1,,,,,,26.00
H7,4,0,0,Position Object Definition                         ,2,Slot Delta_9, 2,Well Reference Point,
        on Wellpad, 1, 26.0,0.0,0.0, 0.00,0.00,26.00
H7,4,0,0,Position Object Definition                         ,3,DF Rig A,     3,Zero-depth
        Point,Derrick Floor,   1,    0,  0,  0, 0.00,0.00, 0.00

O7,0,1,SRP, DELTA SITE,   718541.26, 3151622.18, -2600.00, 29.7604000,-95.3698000, 29.7606281,-
        95.3700161,10.0,
O7,0,2,WRP, Slot Delta_9, 718535.81, 3151657.82, -2600.00, 29.7603820,-95.3696883, 29.7606101,-
        95.3699043,1.0,3.0
O7,0,3,ZDP, DF Rig A,     718535.81, 3151657.82, -2626.00, 29.7603820,-95.3696883, 29.7606101,-
        95.3699043,   ,3.0

CC,0,0,0,  ------------------------------------------------
CC,0,0,0,  The P7 Table
CC,0,0,0,  ------------------------------------------------
H7,5,0,0,P7 Table Definition                                ,1,Definitive Survey,,,,,,,0,
```

Stations = Planned

```
CC,0,0,0,-,----------,--,-,-,-----,-------,----,------,--------,--------,
CC,0,0,0,,,,Type,,Status,      MD,    INC, AZ_GRID,,,,,,,,

CC,0,0,0,,,,,,,                ft,    deg,     deg,,,,,,,,
CC,0,0,0,-,----------,--,-,-,-----,-------,----,------,--------,--------,
P7,0,1,1,,,3,ZDP,9,Other,        0.00,  0.000,   0.000, ,,,,,,,,
P7,0,1,1,,,2,WRP,9,Other,       26.00,  0.000,   0.005, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed,    50.00,  0.281,   4.800, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed,    75.00,  0.472,   4.596, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed,   100.00,  0.526,   4.183, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed,   125.00,  0.579,   3.847, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed,   150.00,  0.632,   3.567, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed,   175.00,  0.701,   1.336, ,,,,,,,,
...
P7,0,1,1,,, ,  D,1,Surveyed, 10850.00, 45.662, 229.134, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed, 10875.00, 48.697, 228.432, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed, 10900.00, 51.830, 228.287, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed, 10925.00, 55.016, 228.112, ,,,,,,,,
P7,0,1,1,,, ,  D,1,Surveyed, 10950.00, 58.301, 227.351, ,,,,,,,,
P7,0,1,1,,, ,BHL,6,Projected,10991.00, 58.301, 227.351, ,,,,,,,,

CC,0,0,0,   -- end of file -
```

Plan Trajectories – special features

- Did some research into what methods were used in the directional system.
- Mostly 3D (that is minimum curvature), is very useful because plan methods can be compatible.
- Awkward methods that are not universal like Radius of Curvature (build/turn), Constant Toolface methods and Online to target.

Trajectory Plan Methods

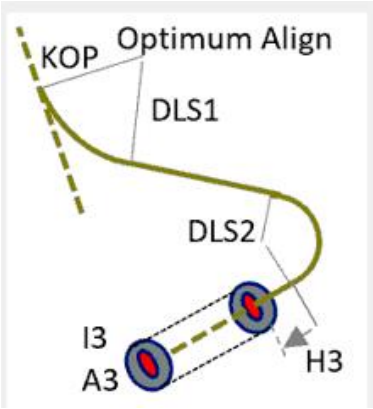
- Codification specific to the Elephant
- Frequent use of 3D S (opt align)

plan_method	count(*)	code	description
30	33450	MIAMD	Inclination, Azimuth projection to MD (same as min curve survey calculation)
1	24790	MADD	Additional line for a defined multi-line method (see below)
10	13817	MSLMD	Straight line projection to MD (measured depth) or CL (course length)
2910	8782	MOPTDLS	Optimum Align with given dogleg severity
0	7965	MNOMETH	No method on this line (don't know why)
-20	6293	MBAKSCL	Backwards from target to course length
20	4357	MSLTVD	Straight line projection to TVD (true vertical depth)
50	4198	MIADLS	Inclination, Azimuth projection by dogleg severity
920	3570	MDTCTT	Dogleg Toolface Curve to Target (computes minimum dogleg severity)
-40	3513	MBAKINC	Backwards from target to Inclination
1910	2457	MDTSCH	Dogleg Toolface sidetrack by curve then hold to target
2	2046	MTIE	Tie-on line (normally 1st line in a plan)
100	1829	MDTMD	Dogleg toolface projection to MD
115	949	MBTTVD	Build turn projection to TVD
140	784	MSLSEC	Straight line projection to Vertical Section
1940	560	MOPTCC	Optimum Align with no intermediate tangent length
40	460	MIATVD	Inclination, Azimuth projection to TVD
3334	431	NULL	SLANT OR S
120	401	MDTINC	Dogleg toolface projection to inclination

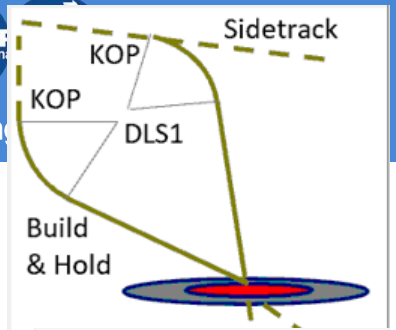
LISTING OF PRESCRIBED PLAN METHODS		
code	plan_meth	description
MNOMETH	0	No method on this line (don't know why)
MADD	1	Additional line for a defined multi-line method (see below)
MTIE	2	Tie-on line (normally 1st line in a plan)
MSLMD	10	Straight line projection to MD (measured depth) or CL (course length)
MSLTVD	20	Straight line projection to TVD (true vertical depth)
MIAMD	30	Inclination, Azimuth projection to MD (same as min curve survey calculation)
MIATVD	40	Inclination, Azimuth projection to TVD
MIADLS	50	Inclination, Azimuth projection by dogleg severity
MIADCT	51	Inclination, Azimuth projection by dogleg severity (constant toolface)
MMDIDR	60	MD Projection to inclination & dogleg - Right (ouija board)
MMDIDL	180	MD Projection to inclination & dogleg - Left (ouija board)
MMDIT	70	MD Projection to inclination & toolface (ouija board)
MMDADH	80	MD Projection to azimuth & dogleg - high (ouija board)
MMDADL	160	MD Projection to azimuth & dogleg - low (ouija board)
MMDAT	90	MD Projection to azimuth & toolface (ouija board)
MDTMD	100	Dogleg toolface projection to MD
MCTMD	101	constant toolface projection to MD
MDTTVD	110	Dogleg toolface projection to TVD
MDTINC	120	Dogleg toolface projection to inclination
MDTAZI	130	Dogleg toolface projection to Azimuth
MSLSEC	140	Straight line projection to Vertical Section
MDATVD	150	Dogleg Azimuth projection to TVD (hzlan)
MBTMD	105	Build turn projection to MD
MBTTVD	115	Build turn projection to TVD
MBTINC	125	Build turn projection to inclination
MBTAZI	135	Build turn projection to azimuth
MCTMD	101	constant toolface projection to MD
MCTTVD	111	constant toolface projection to TVD
MCTINC	121	constant toolface projection to inclination
MCTAZI	131	constant toolface projection to azimuth
code	plan_meth	description
MDTOLI	910	Dogleg Toolface on-line to target by inclination
MDTCTT	920	Dogleg Toolface Curve to Target (computes minimum dogleg severity)
MCTCTT	921	Constant Toolface Curve to Target (computes minimum dogleg severity)
MBTCTT	925	Build Turn Curve to Target (computes minimum dogleg severity)
MDTCTMD	930	Dogleg Toolface Curve to NS, EW, MD
MBTCTMD	935	Build Turn Curve to NS, EW, MD
MHZLANC	950	Horizontal landing calculation to formation plane
MDTSCH	1910	Dogleg Toolface sidetrack by curve then hold to target
MBTOLI	1915	Dogleg Toolface on-line by inclination
MDTSHC	1920	Dogleg Toolface sidetrack by Hold then curve
MDTOLT	1930	Dogleg Toolface on-line to target by TVD
MBTOLT	1935	Build Turn on-line to target by TVD
MOPTCC	1940	Optimum Align with no intermediate tangent length
MHZLAN	1950	Horizontal landing calculation to formation plane
MOPTCD1	1960	Optimum Align curve curve specify 1st dogleg
MOPTCD2	1970	Optimum Align curve curve specify 2nd dogleg
MBTSCH	2925	Build Turn Sidetrack by curve then hold
MDTHOLI	2930	Dogleg Toolface sidetrack to given inclination
MOPTDLS	2910	Optimum Align with given dogleg severity
MOPTTAN	2940	Optimum Align given intermediate tangent length
MOPTTVD	2950	Optimum Align using intermediate TVDs
MBAKTAR	-10	Backwards from target to target
MBAKSCL	-20	Backwards from target to course length
MBAKTVD	-30	Backwards from target to TVD
MBAKINC	-40	Backwards from target to Inclination
MBAKSUR	-50	Backwards from target to SURFACE
MBAKINAZ	-60	Backwards from target Inclination azimuth
BACKTARGE	-9999	Insert line marker, should not end up in the database
MINSERT	9999	Insert line marker, should not end up in the database

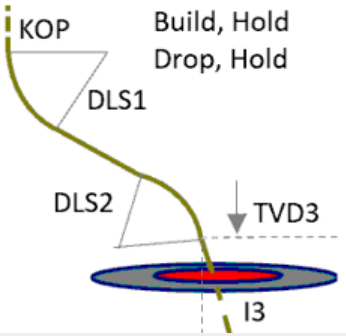
Popular Combinations

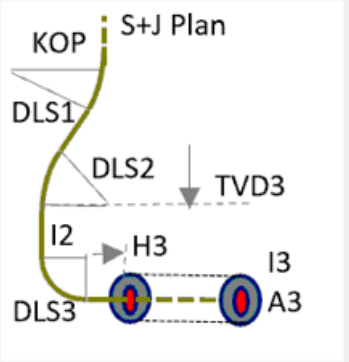
- 10,000 primary plans
- Lots of imported plans
- 99% are standard 3D methods



Optimum Align	
10, 2910, 1, 1, 920	167
10, 2910, 1, 1, 10	163
10, 2910, 1, 1, -20, 920	134
10, 2910, 1, 1, -20, 10	131
20, 2910, 1, 1, -20	87
30, 2910, 1, 1, -20, 920	67
20, 2910, 1, 1, 20, 50, 1910, 1	50
10, 10, 2910, 1, 1, -20, 920	45
	844
10, 1940, 1, 10	102
10, 1940, 1, -40, 10	75
10, 1940, 1, -20, -40, -20, 10	46
20, 50, 20, 1940, 1, 10, 910, 140	32
	255







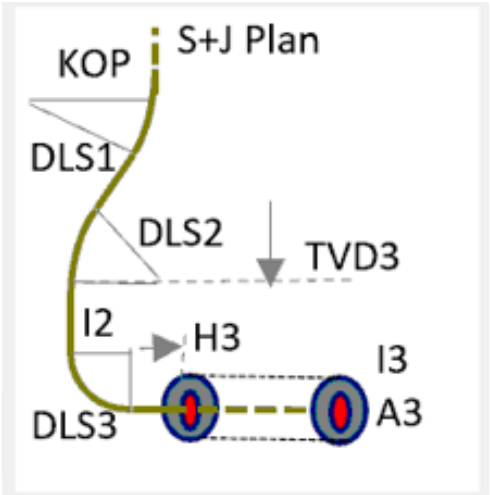
Curve Hold	
1910, 1	108
20, 50, 20, 50, 20, 120, 10, 1910, 1	56
20, 1910, 1	35
10, 50, 10, 50, 10, 1910, 1	33
10, 50, 10, 50, 1910, 1	30
10, 1910, 1	18
10, 1910, 1, 20	18
	298

Build Hold Drop Hold		E
3334, 1, 1, 1, 20, 910, 10, 910, 140	104	Y
3334, 1, 1, 1, 20, 50, 10, 50, 140	95	Y
3334, 1, 1, 1, 1960, 1	64	Y
3334, 1, 1, 1, 20	62	Y
3334, 1, 1, 1, 920	18	Y
	343	

S+J Plan (typical land pad plan)		E
10, 2910, 1, 1, -40, 10	215	
10, 2910, 1, 1, -20, -40, 10	192	Y
10, 2910, 1, 1, -20, -40, -20, 920	126	Y
20, 20, 2910, 1, 1, -20, -40, -20, 10	124	Y
20, 20, 10, 2910, 1, 1, -20, -40, -20,	98	Y
10, 10, 2910, 1, 1, -20, -40, -20, 920	77	Y
10, 2910, 1, 1, -40, -20, 10	74	
20, 20, 2910, 1, 1, -20, -40, -20, 920	73	Y
20, 20, 2910, 1, 1, -20, -40, 920	60	Y
10, 2910, 1, 1, -20, -40, -20, 10	56	
30, 30, 2910, 1, 1, -20, -40, 10, 2910,	52	Y
10, 2910, 1, 1, -20, -40, 10, 2910, 1,	51	Y
20, 20, 2910, 1, 1, -20, -40, 10	49	Y
	1247	

Decomposing a plan into turnpoints/ skeleton/ knots

- Given a plan interpolated to 100'/30m intervals.
- Can decompose the plan into straight and curve sections
- If a point is highlighted as a target – can interpret this to get target plan methods.



Looking for partners to implement P7/17

- A small working group of software vendors
- Test data for exchange – say 10 wells
- Exchange files for import /export ready in 2 months – import a bit later
- Import should be able to merge/reconcile existing data & highlight conflicts
- Want to effectively complete the exchange in 1 year

- System of record and exchange mechanism managed through OSDU

The end