Well Path Data Transfer Standard

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Presentation Outline

Introduction
Uses and Requirements for WellPath data
Coordinate reference systems
Prior Well Path data formats
Well Path data in WITSML 1.3
Conclusions

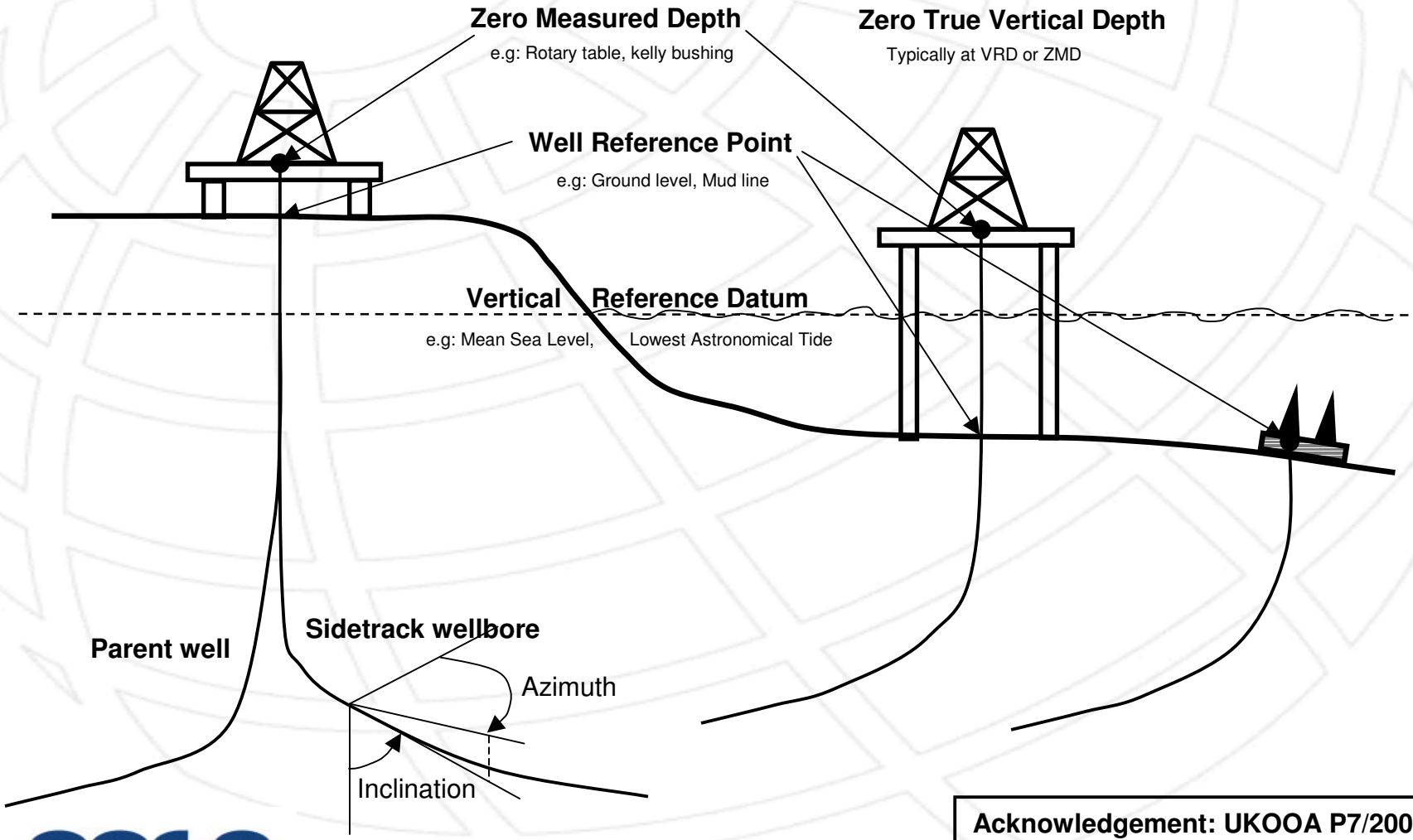
Glossary

- WITSML – the Wellsite Information Transfer Standard Mark-up Language
- Well – A well is a unique surface location from which wellbores are drilled into the Earth for the purpose of either (1) finding or producing underground resources; or (2) providing services related to the production of underground resources.
- Wellbore – A wellbore is a unique, oriented path from the bottom of a drilled borehole to the surface of the Earth. The path must not overlap or cross itself.

Glossary – 2

- obj_trajectory: the WITSML construct that contains contextual information about the trajectory and the trajectoryStation data objects
- obj_trajectoryStation: the WITSML construct that references the containing well, wellbore and trajectory objects AND the inclination/azimuth and location data plus much (optional) instrument, acquisition and processing data

Deviated Well Terminology



Acknowledgement: UKOOA P7/2000

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Life-Cycle Uses of WellPath Data

- Planning – can result in many well paths, some of which may be drilled
  - Define intersections with geological and reservoir targets
  - Ensure safety and collision avoidance
  - Support well engineering design in- or out-of-house
  - Regulatory permitting
- Drilling
  - Initial Drilling: Geosteering, MWD acquisition and near-real-time processing
  - Sharing and integration with specialist wellsite services
  - Lateral and infill drilling: Tie-in to existing wellbore
  - …

Life-Cycle Uses of WellPath Data - 2

- E&P Operations
  - Provision and maintenance of Asset data resources for users and applications
  - Static and dynamic reservoir modelling, analysis and visualisation
  - Regulatory reporting
- Asset Disposal
  - Sale, relinquishment, or decommissioning

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Coordinate Reference Systems

"Having spent the greater part of the last three months trying to spatially coordinate several disparate data sets, I have no doubt whatever that adoption of an Industry standard for Coordinate Reference Systems is a thoroughly sound proposal"

- *Matthew Kirkman, Portfolio Manager, Drilling and Well Services Applications, BP and Chairman, WITSML SIG following a presentation to the WITSML SIG recommending adoption of the European Petroleum Survey Group (EPSG) geodetic parameter set*

Insert ~4-6 Roel Nicolai slides

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Prior Well Path data formats

- WITS EDI (1980 and subsequently)
- LAS version 3 (2000)
- UKOOA P7/2000 (2002)
  - POSC WellPathML (2003)
- Minerals Management Service NTL2004-N03 (2004)
- WITSML Version 1.3 (early 2005 release)
  - Trajectory and Trajectory Station – updated
  - WellPath Composite Object – new capability

Well Path Data Categories

- Well, Wellbore identification and context
  - Name, Field, Lease/Licence, Basin, Country etc
- Survey information and context
  - Operator, acquisition and processing contractor(s)
  - Dates, depth ranges
  - Survey tools, algorithms, corrections, gravity and magnetic field models, …
- Coordinate Reference System data
  - Geographic and projected coordinates and transformations
  - Vertical datums: permanent and drilling related
- Well Path Trajectory and Trajectory Stations
  - Measured depth, inclination and azimuth
  - True vertical depth, geographical, projected and engineering coordinates

Strengths of UKOOA P7/2000

- Supports multiple contractors, roles and survey phases, including wireline and MWD/LWD
- Supports multiple Vertical Datums and relationships between them
- References EPSG geodetic and coordinate system standards
- Supports post-acquisition life-cycle usages

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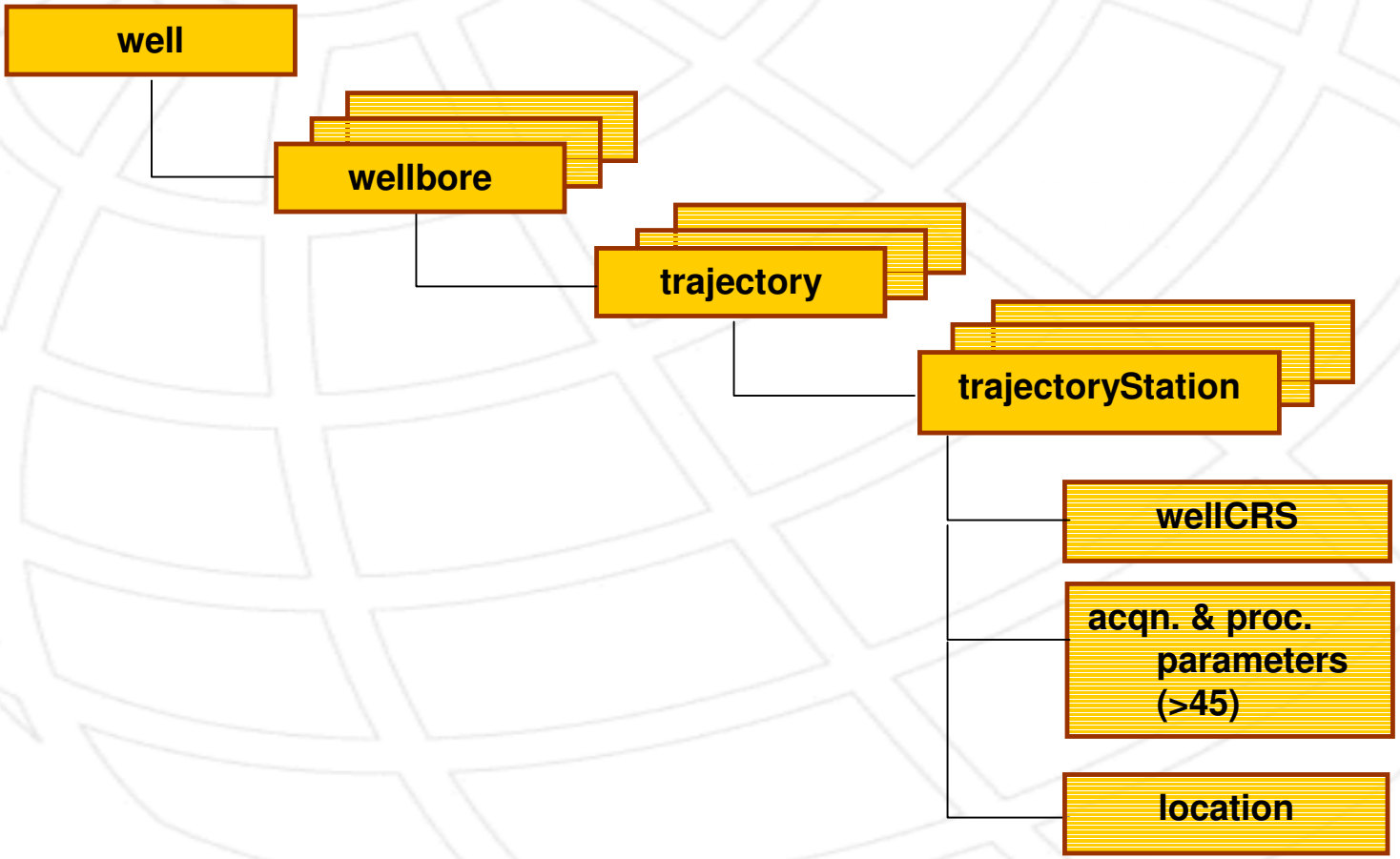
Well Path data in WITSML

- Objectives in WITSML V1.3
  - Extend previous capabilities from WITSML V1.2 for reporting raw measurements to also support planned well paths and calculated well paths
  - Reuse WITSML specifications and objects as far as possible

Well Path data in WITSML



obj_well Example

```
<wells>
<well uid="w1">
  <name>207/29-A6</name>
  <nameLegal>207/29-A6Z</nameLegal>
  <numGovt>207/29-A6Z</numGovt>
  <field>Saltire</field>
  <country>GBR</country>
  <block>207/29</block>
  <timeZone>0.00</timeZone>
  <operator>Highland Oil</operator>
  <waterDepth uom="ft" datum="VRD1">118.40</waterDepth>

<!-- well location: the location of the well reference point -->
  <wellLocation>
    <nameWellCRS uidRef="proj1">ED50 / UTM Zone 31N</nameWellCRS>
    <easting uom="m">425353.84</easting>
    <northing uom="m">6623785.69</northing>
    <description>location of well reference point in proj system</description>
  </wellLocation>
   …
</well>
</wells>
```

wellCRS Example (geographic)

```
<wellCRS uid="geog1">
  <name>ED50</name>
  <geographic>
    <nameCRS namingSystem="epsg" code="4230">ED50</nameCRS>
    <geodeticDatumCode>ED50</geodeticDatumCode>
    <xTranslation uom="m">-89.5</xTranslation>
    <yTranslation uom="m">-93.8</yTranslation>
    <zTranslation uom="m">-123.1</zTranslation>
    <xRotation uom="seca">0</xRotation>
    <yRotation uom="seca">0</yRotation>
    <zRotation uom="seca">-0.156</zRotation>
    <scaleFactor>1.200</scaleFactor>
    <ellipsoidName namingSystem="epsg" code="7022">International 1924
    </ellipsoidName>
    <ellipsoidCode>INT24</ellipsoidCode>
    <ellipsoidSemiMajorAxis uom="m">6378388</ellipsoidSemiMajorAxis>
    <inverseFlattening>297.0</inverseFlattening>
  </geographic>
</wellCRS>
```

wellCRS Examples (projected, local)

```
<wellCRS uid="proj1">
  <name>UTM31N</name>
  <mapProjection>
    <name>UTM Zone 31N</name>
    <nameCRS namingSystem="epsg" code="23031">ED50 / UTM Zone 31N</nameCRS>
    <projectionCode>UniversalTransverseMercator</projectionCode>
    <zone>31N</zone>
  </mapProjection>
</wellCRS>

<wellCRS uid="localWell1">
  <name>WellOneWSP</name>
  <localCRS>
    <usesWellAsOrigin>true</usesWellAsOrigin>
    <northDirection>Grid north</northDirection>
    <yAxisAzimuth uom="dega">0</xAxisAzimuth>
    <xRotationClockwise>true</yRotationClockwise>
  </localCRS>
</wellCRS>
```

obj_trajectory Example

```
<trajectorys>
<trajectory uid="trajacq1" uidWell="w1" uidWellbore="wb1">
  <nameWell>207/29-A6</nameWell>
  <nameWellbore>207/29-A6Z</nameWellbore>
  <name>Acquisition trajectory #1</name>
  <dTimTrajStart>1972-06-28T00:00:00</dTimTrajStart>
  <mdMn uom="ft">0.</mdMn>
  <mdMx uom="ft">1824.</mdMx>
  <serviceCompany>Tain Drilling</serviceCompany>
  <definitive>false</definitive>
</trajectory>
<trajectory uid="trajacq2" uidWell="w1" uidWellbore="wb1">
  <nameWell>207/29-A6</nameWell>
  <nameWellbore>207/29-A6Z</nameWellbore>
  <name>Acquisition trajectory #2</name>
  <dTimTrajStart>1972-07-09T00:00:00</dTimTrajStart>
  <serviceCompany>AC Surveys
  <mdMn uom="ft">1915</mdMn>
  <mdMx uom="ft">3584</mdMn>
</trajectory>
</trajectorys>
```

obj_trajectory Example 2

```
<trajectory uid="trajgeometry" uidWell="w1" uidWellbore="wb1">
  <nameWell>207/29-A6</nameWell>
  <nameWellbore>207/29-A6Z</nameWellbore>
  <name>Wellbore Path Geometry</name>
  <dTimTrajStart>1994-04-15T00:00:00</dTimTrajStart>
  <mdMn uom="ft" datum="ZMD1">173.09</mdMn>
  <mdMx uom="ft" datum="ZMD1">4380.15</mdMx>
  <serviceCompany>Directional Services Inc.</serviceCompany>
  <magDeclUsed uom="dega">-1.42</magDeclUsed>
  <gridCorUsed uom="dega">-1.15</gridCorUsed>
  <definitive>true</definitive>
  <finalTraj>true</finalTraj>
  <aziRef>Grid north</aziRef>
  <trajectoryStation uid="row1">
    <typeTrajStation>O</typeTrajStation>
    …
```

obj_trajectoryStation Example

```
<trajectoryStation uid="row1">
  <nameWell>207/29-A6</nameWell>
  <nameWellbore>207/29-A6Z</nameWellbore>
   <typeTrajStation>O</typeTrajStation>
   <md uom="ft">173.09</md>
   <tvd uom="ft" datum="ZTVD1">173.00</tvd>
   <tvd uom="ft" datum="VRD1">117.00</tvd>
   <incl uom="dega">2.190</incl>
   <azi uom="dega">292.15</azi>
     <location>
       <nameWellCRS uidref="geog1">ED50</nameWellCRS>
       <latitude uom="dega">59.74384167</latitude>
       <longitude uom="dega">1.67197806</longitude>
     </location>
     <location>
       <nameWellCRS uidRef="proj1">ED50 / UTM Zone 31N</nameWellCRS>
       <easting uom="m">425353.84</easting>
       <northing uom="m">6623785.69</northing>
     </location>
     <location>
       <nameWellCRS uidRef="localWell2"> WellOneOffsetOrigin</nameWellCRS>
       <localX uom="m">-12.63</localX>
       <localY uom="m">3.74</localY>
     </location>
 </trajectoyStation>
</trajectory>
</trajectorys>
```

Note: many non-mandatory attributes have been omitted

Conclusions

- WITSML V1.3 public comment period: mid-December through January. Feedback is currently being evaluated.
- WITSML V1.3 release is anticipated soon. The next feedback, evaluation, and enhancement cycle will follow.
- Use of V1.3 in pilot testing and commercial products anticipate during the first half of 2005.
- Well path uses cases to include: raw measurement reporting, planned well path transfer, and post-processing wellpath transfer.

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