BENEFITS OF A STANDARDS BASED APPROACH TO DAS DATA MANAGEMENT

DAS Webinar 2019-03-28
Wilfred Berlang, General Manager Reservoir Surveillance Technology, Shell Global Solutions International B.V.

Laurence Ormerod, PRODML Project Manager Consultant to Energistics
Energistics’ Spectrum of Standards

UNIVERSAL INTEROPERABILITY

DRILLING/WELL  PRODUCTION  RESERVOIR

Energistics Transfer Protocol (ETP)
Common Technical Architecture (CTA)
Production Standards: PRODML™

» Consistent, high-quality transfer of production-related data
  • Volumes reporting (intra company, partner to partner, company to regulator)
  • PVT fluid properties (acquisition, samples, lab analysis, fluid characterization)
  • Flow tests (production, pressure transient, formation testing)
  • Flow networks

➢ DTS and DAS exchange standards
DAS Data Exchange Use Cases

Type of surveillance

In-well monitoring applications
- Hydraulic Frac
- Zonal Injection and Production
- Artificial Lift
- Well Stimulation

Seismic Surveillance
- Vertical Seismic Profiling
- Microseismic and strain front

Type of DAS Data exchanged

DAS data types
- Raw >1 TB/fiber/day
- Processed MB - GB/fiber/day
  - Frequency filtered (frequency bands)
  - Fourier transformed (spectrum)

DAS and SEG data types
- Raw for R&D, ~1 TB/fiber/day
- SEGY/SEGD for end-users GB/fiber/day

- DAS Cementing
- DAS+DTS Hydro frac
- DAS VSP Monitoring
- DAS+DTS Flow Profiling
- DAS+DTS Gaslift

Drilling  Cementing  Completion  Production  Intervention  Production  Artificial Lift / EOR  Abandonment
A shared data exchange format will accelerate development, reduce cost and improve uptake of Distributed Acoustic Sensing (DAS) applications in the oil and gas industry.

**Costs of not having a DAS standard**

- Expensive in-house Software development to deal with non-standard formats
- Non productive staff time to deal with non-standard formats
- Delayed decisions, missed opportunities and diminished confidence in DAS technology
- Slow uptake in the assets (complex, too much work, too difficult to visualize, problematic data nightmare …)
- Complexity of sharing data with partners
- Difficult to leverage third party solutions and best practices
- Impossible to develop common toolsets and data management processes
DAS Measurement

- DAS Interrogation Unit
- Well Head
- Surface fiber
- Fiber length corresponding to a Locus
- Downhole fiber
- Loci
- Time Series for one Locus
- Surface fiber
- Casing
- Production tubing
- Production packer
- Perforated Casing section

©2019 Energistics Inc
Distributed Acoustic Sensing (DAS): how does it work?

**Coherent OTDR**
- Coherent pulse propagates along the fiber
- Tiny density fluctuations frozen into fiber during manufacture → act as scatter sites
- Scattered light is captured and travels back toward detector
- Detection time directly maps to location
- Detected intensity is a function of the local properties of the waveguide
DAS measurement – Raw data (1 Tb/day)
To record a DAS measurement we need to store both the data samples and the times.
DAS data types Raw to Processed

- Sine wave exciting a channel displayed as a wiggle plot
- Sine wave exciting a channel displayed using false color for amplitude
- Frequency band including sine wave frequency
- Frequency band excluding sine wave frequency
For many applications DAS data is filtered and downsampling
DAS measurement
Frequency Band Filtered & Down sampled (Gb/day)

**Data Arrays**

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>F1(L0,Tf0)</th>
<th>F1(L0,Tf1)</th>
<th>F1(L0,Tf2)</th>
<th>...</th>
<th>F1(L0,TN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1 Hz</td>
<td>F1(L1,Tf0)</td>
<td>F1(L1,Tf1)</td>
<td>F1(L1,Tf2)</td>
<td>...</td>
<td>F1(L1,TN)</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>F1(LM,Tf0)</td>
<td>F1(LM,Tf1)</td>
<td>F1(LM,Tf2)</td>
<td>...</td>
<td>F1(LM,TN)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>F2(L0,Tf0)</th>
<th>F2(L0,Tf2)</th>
<th>F2(L0,Tf2)</th>
<th>...</th>
<th>F2(L0,TN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10 Hz</td>
<td>F2(L1,Tf0)</td>
<td>F2(L1,Tf1)</td>
<td>F2(L1,Tf2)</td>
<td>...</td>
<td>F2(L1,TN)</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>F2(LM,Tf0)</td>
<td>F2(LM,Tf2)</td>
<td>F2(LM,Tf2)</td>
<td>...</td>
<td>F2(LM,TN)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>F3(L0,Tf0)</th>
<th>F3(L0,Tf3)</th>
<th>F3(L0,Tf3)</th>
<th>...</th>
<th>F3(L0,TN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 1000 Hz</td>
<td>F3(L1,Tf0)</td>
<td>F3(L1,Tf3)</td>
<td>F3(L1,Tf3)</td>
<td>...</td>
<td>F3(L1,TN)</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>F3(LM,Tf0)</td>
<td>F3(LM,Tf3)</td>
<td>F3(LM,Tf3)</td>
<td>...</td>
<td>F3(LM,TN)</td>
</tr>
</tbody>
</table>

**Time array (shared between Frequency Bands)**

<table>
<thead>
<tr>
<th>Tf0</th>
<th>Tf1</th>
<th>Tf2</th>
<th>...</th>
<th>TfN</th>
</tr>
</thead>
</table>
The data and times arrays are very large and are stored in HDF files.
What metadata do we need for the acquisition?

**DasAcquisition**
- AcquisitionID: UuidString
- GaugeLength: LengthMeasure
- PulseRate: FrequencyMeasure
- PulseWidth: TimeMeasure
- SpatialSamplingInterval: LengthMeasure
- TimeZone: String64
- MeasurementStartTime: TimeStamp
- Triggered Measurement: Boolean
- TriggeredTime: TimeStamp
...

**DasRaw**
- RawID: String64
- NumberOfLoci: long
- StartLocus: Long
- StartTime: TimeStamp
...

**DasFbe**
- OutputDataRate: FrequencyMeasure
- NumberOfLoci: long
- StartLocus: Long
- StartTime: TimeStamp
...

Essential data is stored in the HDF files
Equipment Meta Data

Metadata Equipment

DAS Instrument Box

Surface Cable

Connector

Defect

Maps Between Fibre distance/ facility length/ Measured Depth

Conveyance method: Cemented on casing

Tap test location

Loci 0-4

Loci 5-101

DAS Acquisition Tables of locus locations

28-Mar-19

©2019 Energistics Inc
Architecture

- **Optical Path**
- **Instrument Box**
- **DAS Acquisition**

XML Files: Metadata

XML Proxy Files: Navigation

Raw Data

Processed Data: FBE

Processed Data: Spectrum

HDF5 Files: Array Data

EPC Container (zip file)
PRODML DAS from Inception to Adoption

» DAS Scope (build on DTS PRODML)
  • Raw data & processed data: frequency and spectrum

» Status
  • June 2014 - First proposal to develop DAS exchange standard to Energistics
  • December 2016 - PRODML v2.0 exchange standard – first schema published
  • January 2017 to date - PRODML DAS adoption project – real world deployments
  • August 2018 PRODML v2.1 draft – update based on adoption experiences
  • April 2018 to date - ETP for DAS streaming – new activity, charter drafted, preliminaries
  • Team (Development/Review): Shell, Chevron, Total, BP OptaSense, Silixa, Baker Hughes, Enthought, FoTech, Ziebel, Schlumberger, Halliburton, Weatherford, Petrabytes, ISP & others
DAS Streaming: lower cost using remote instead of field support; safer operations - reduced exposure; low cost on-line monitoring as needed

Use Cases
DAS frac - live monitoring of frac job (~100kB/s)
DAS flow - real-time flow monitoring (~5 KB/s)
DAS raw – raw DAS data collection (~80 MB/s)

» PRODML is a data exchange standard, but XML overhead makes less suitable for real-time data streaming

» Energistics Transfer Protocol - ETP – provides layer that enables ‘Netflix’-like data streaming
Key Take-Aways

» DAS PRODML v2.0 released December 2016

» DAS Adoption project 2017 - 18
  • Test data sets provided by Shell (synthetic samples) and Silixa (real lab data)
  • Adopted by several operators and service providers, growing user base

» DAS PRODML v2.1 review release Q3 2018 (publication Q2 2019)
  • Optimizations and bug-fixes based on feedback from adoption project
  • Schemas, worked examples and datasets, fully documented, limited open source
  • Adoption team continues for support, issue resolution etc.

» Clear business benefits using a standardized approach

» DAS ETP streaming activity has been kicked off … open for participation
Q&A

» PRODML DAS Technical Webinar 24 April 2019

» More information: https://www.energistics.org/
Thank you

Next Webinar on DAS - PRODML Technical Information April 24th 2019

www.energistics.org