



BENEFITS OF A STANDARDS BASED APPROACH TO DAS DATA MANAGEMENT

DAS Webinar 2019-03-28

Presenters



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Consultant to Energistics

Energistics' Spectrum of Standards



← UNIVERSAL INTEROPERABILITY →

<WITSML/>[™]

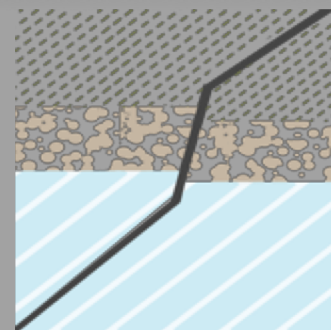
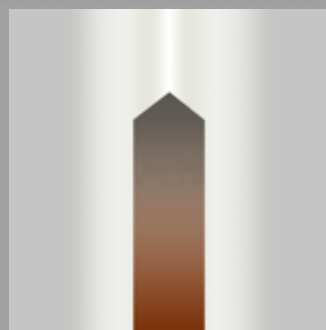
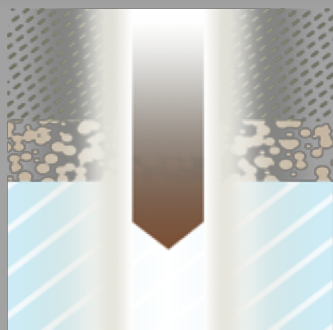
<PRODML/>[™]

<RESQML/>[™]

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

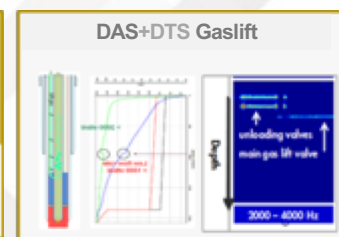
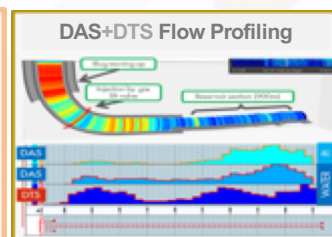
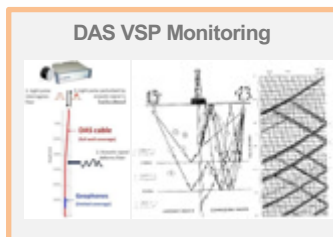
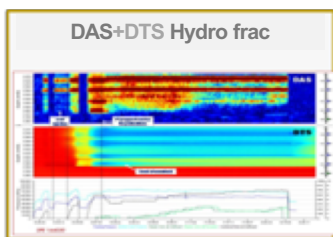
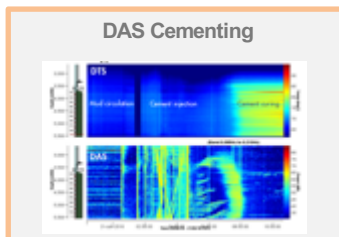
Type of DAS Data exchanged

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
- SEG/SEG/SEG for end-users GB/fiber/day



Drilling Cementing Completion Production Intervention Production Artificial Lift / EOR Abandonment

Business Case for a Distributed Acoustic Sensing Data Exchange Standard



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

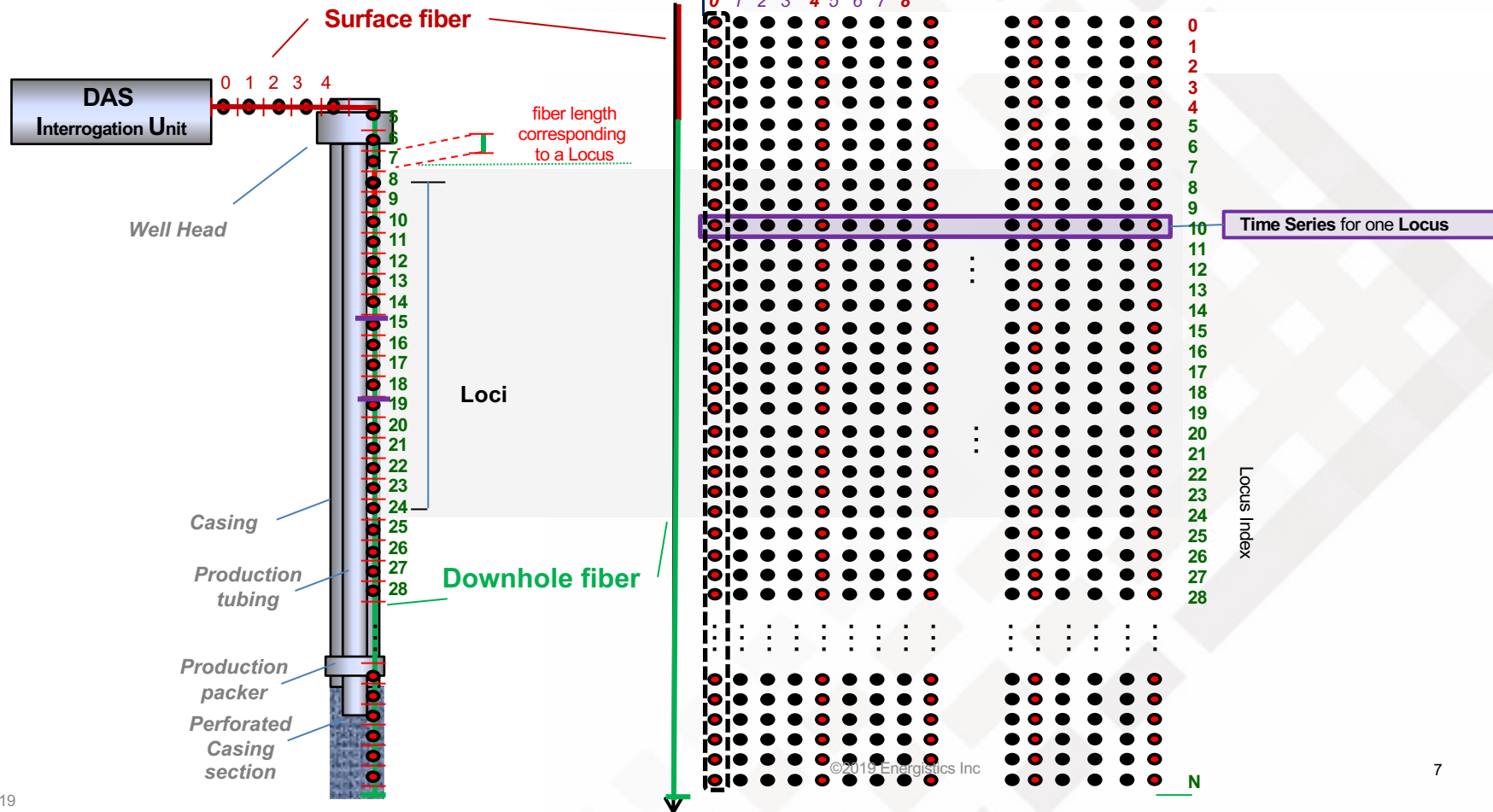
Slow uptake in the assets (complex, too much work, too difficult to visualize, problematic data nightmare ...)

Complexity of sharing data with partners

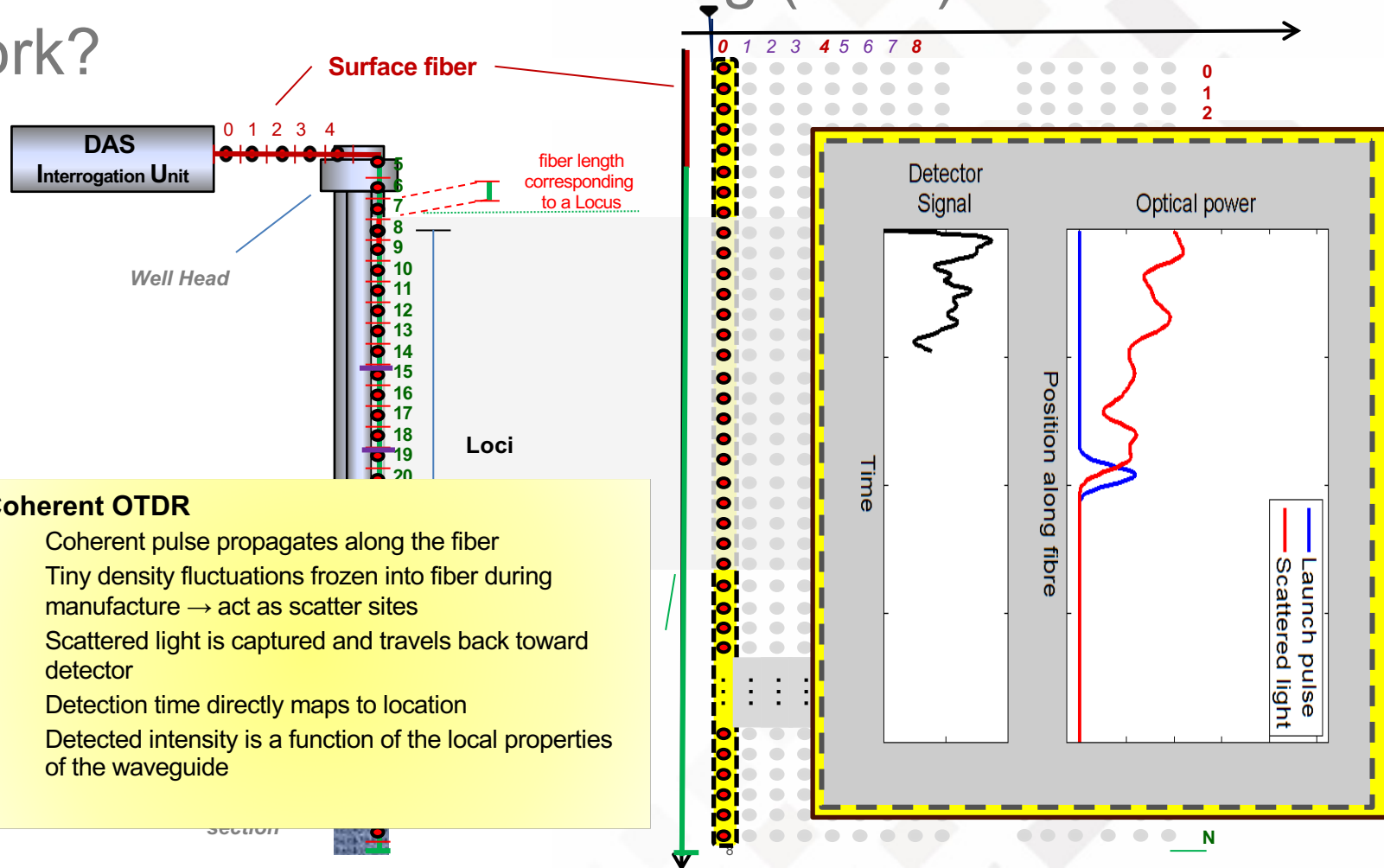
Difficult to leverage third party solutions and best practices

Impossible to develop common toolsets and data management processes

DAS Measurement



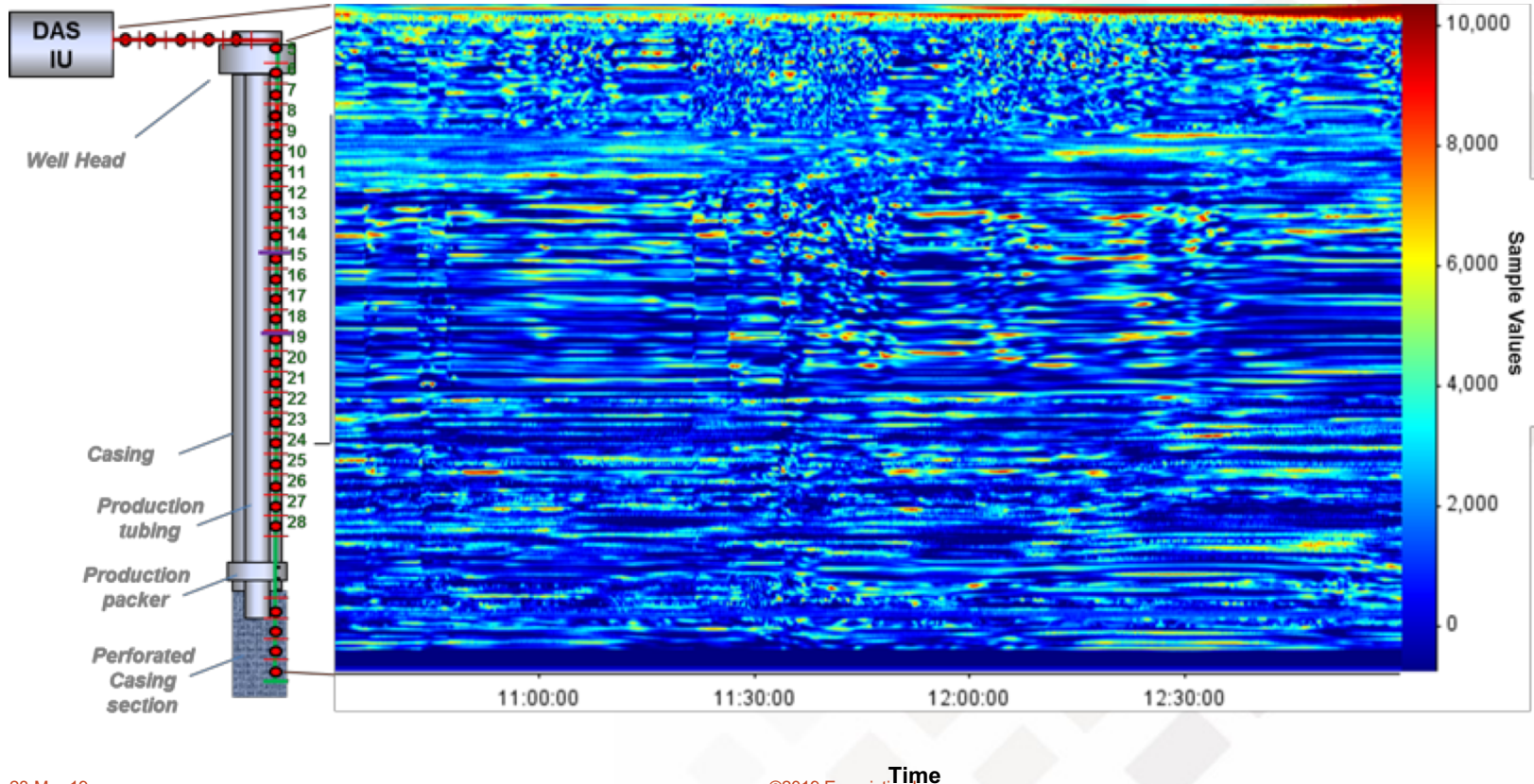
Distributed Acoustic Sensing (DAS): how does it work?



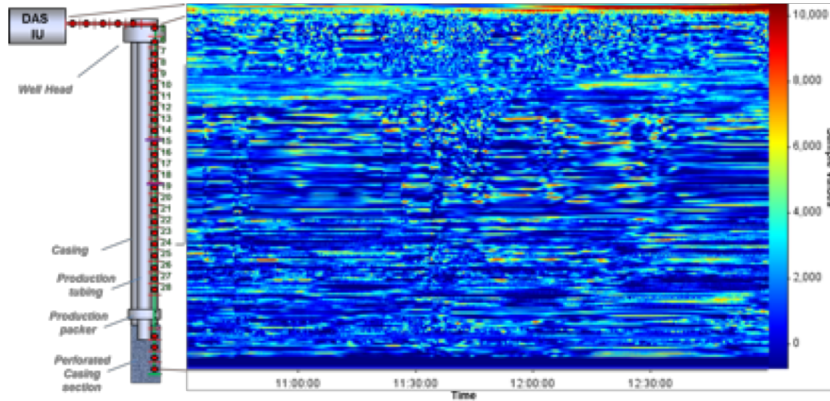
Coherent OTDR

- 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)



DAS measurement – Raw data array Mapping



Data Array

$M(L0,T0)$	$M(L0,T1)$	$M(L0,T2)$	$M(L0,T4)$...	$M(L0,TN)$
$M(L1,T0)$	$M(L1,T1)$	$M(L1,T2)$	$M(L1,T4)$...	$M(L1,TN)$
$M(L2,T0)$	$M(L2,T1)$	$M(L2,T2)$	$M(L2,T4)$...	$M(L1,TN)$
...
$M(LM,T0)$	$M(LM,T1)$	$M(LM,T2)$	$M(LM,T4)$...	$M(LM,TN)$

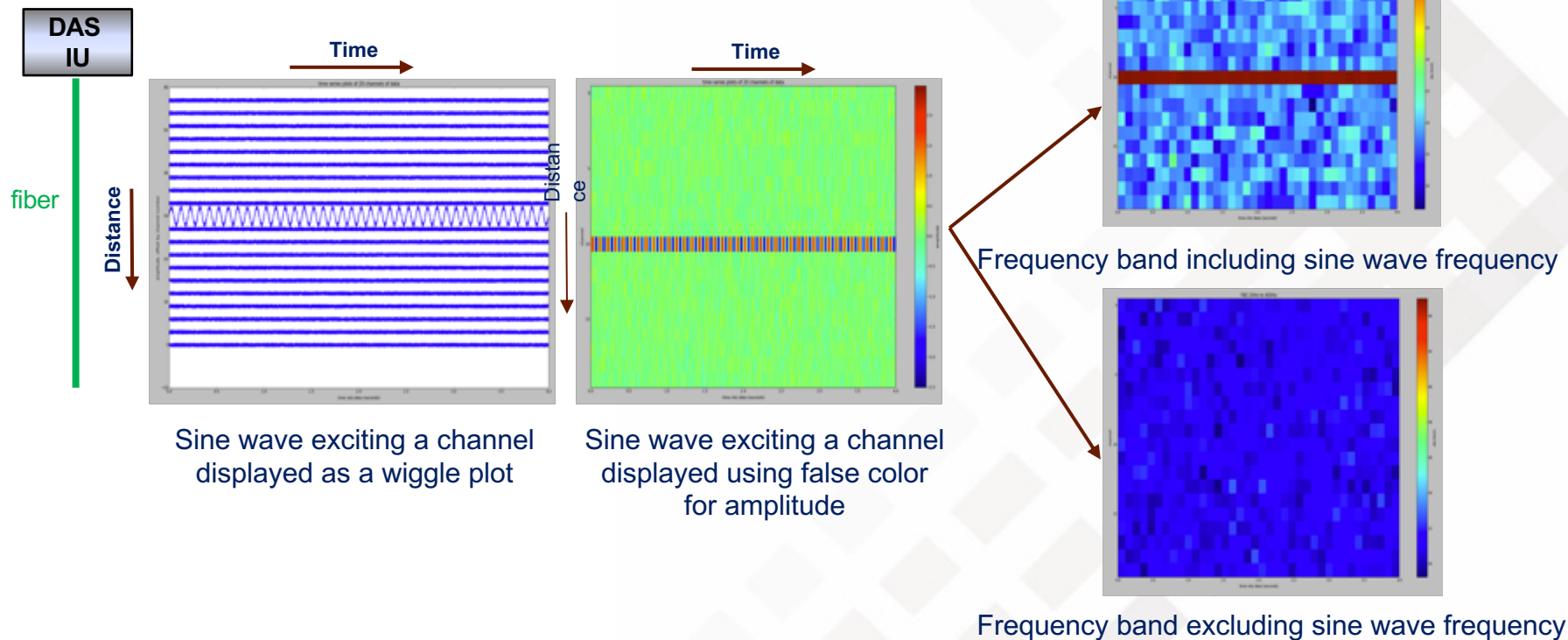
Missing scan

Time array

$T0$	$T1$	$T2$	$T4$...	TN
------	------	------	------	-----	------

To record a DAS measurement we need to store both the data samples and the times

DAS data types Raw to Processed

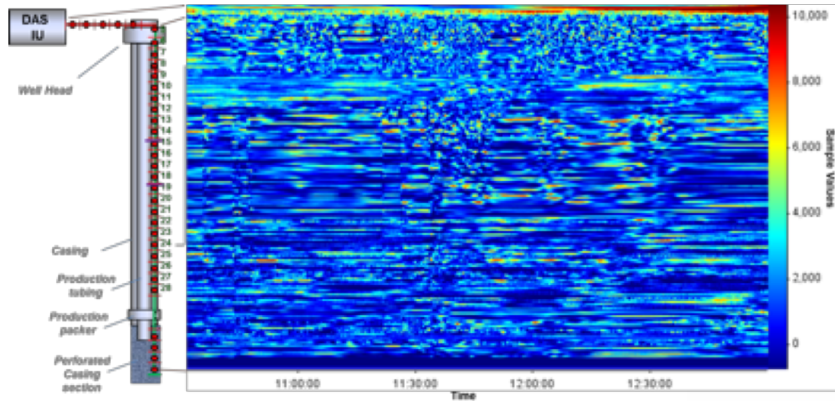


DAS data types Raw to Processed

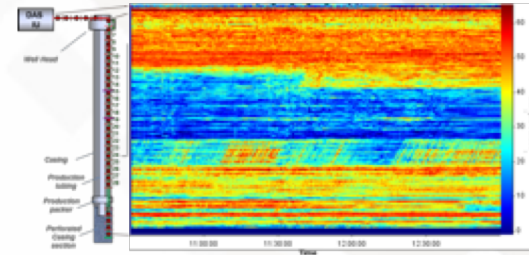
Frequency Band filtered



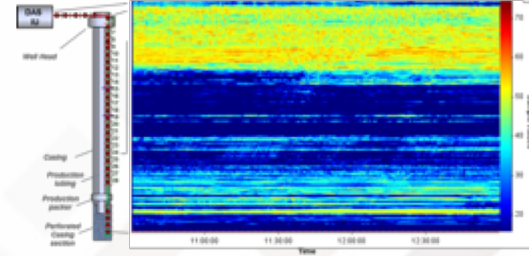
For many applications DAS data is filtered and downsampled



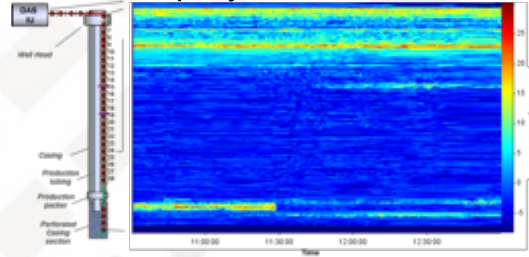
Frequency Band filtered 0 - 1 Hz



Frequency Band filtered 1 - 10 Hz



Frequency Band filtered 10 - 1000 Hz

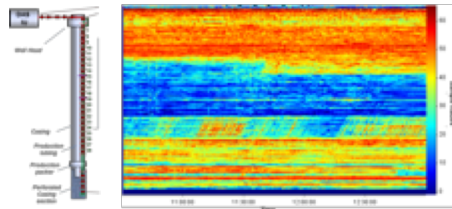


DAS measurement

Frequency Band Filtered & Down sampled (Gb/day)



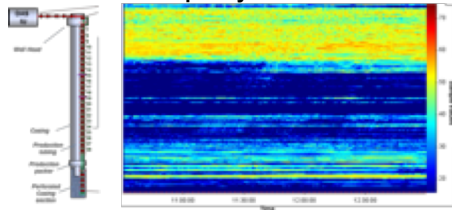
Frequency Band filtered 0 - 1 Hz



Data Arrays

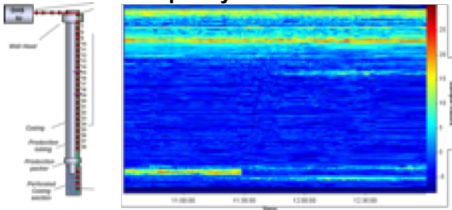
F1(L0,Tf0)	F1(L0,Tf1)	F1(L0,Tf2)	...	F1(L0,TN)
F1(L1,Tf0)	F1(L1,Tf1)	F1(L1,Tf2)	...	F1(L1,TN)
...
F1(LM,Tf0)	F1(LM,Tf1)	F1(LM,Tf2)	...	F1(LM,TN)

Frequency Band filtered 1 - 10 Hz



F2(L0,Tf0)	F2(L0,Tf2)	F2(L0,Tf2)	...	F2(L0,TN)
F2(L1,Tf0)	F2(L1,Tf2)	F2(L1,Tf2)	...	F2(L1,TN)
...
F2(LM,Tf0)	F2(LM,Tf2)	F2(LM,Tf2)	...	F2(LM,TN)

Frequency Band filtered 10 - 1000 Hz

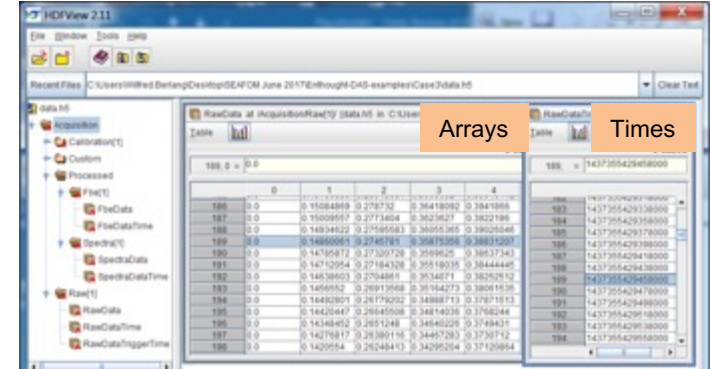
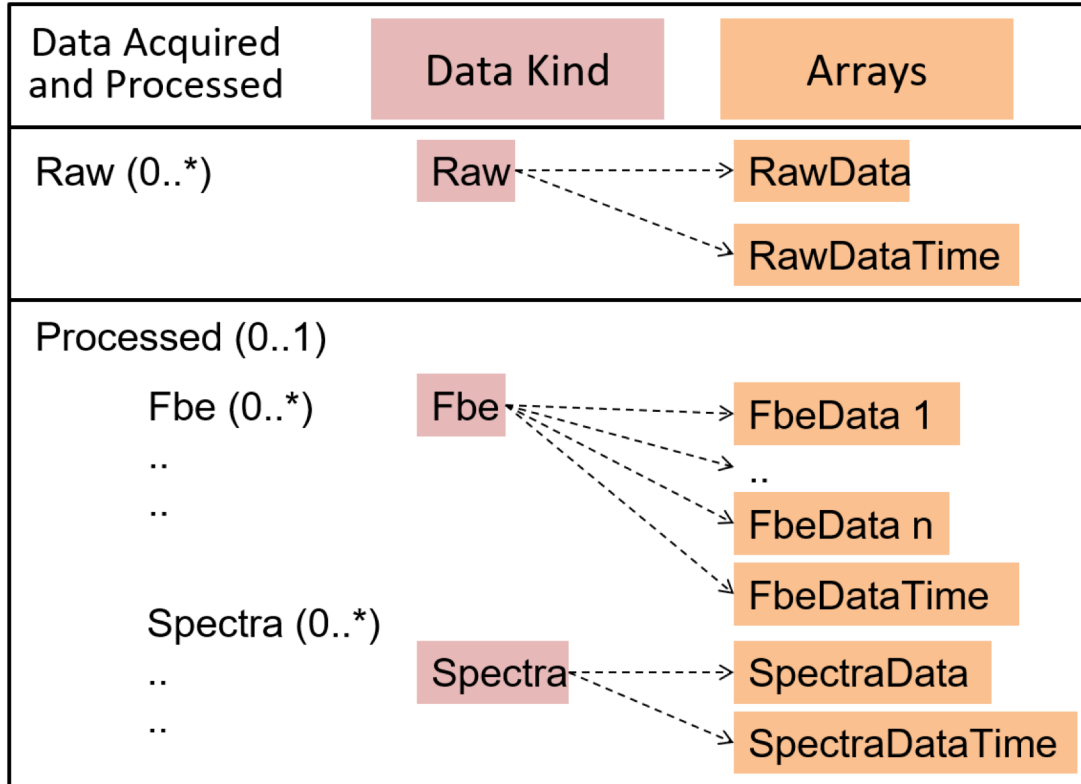


F3(L0,Tf0)	F3(L0,Tf3)	F3(L0,Tf3)	...	F3(L0,TN)
F3(L1,Tf0)	F3(L1,Tf3)	F3(L1,Tf3)	...	F3(L1,TN)
...
F3(LM,Tf0)	F3(LM,Tf3)	F3(LM,Tf3)	...	F3(LM,TN)

Time array (shared between Frequency Bands)

Tf0	Tf1	Tf2	...	TfN
-----	-----	-----	-----	-----

DAS Conceptual Model for Raw & Processed Arrays



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
NumberOfLoc: long
StartLocus: Long
StartTime: TimeStamp
...

DasFbe

OutputDataRate: FrequencyMeasure
NumberOfLoc: long
StartLocus: Long
StartTime: TimeStamp
...

	0	1	2	3	4
186	0.0	0.15084869	0.278732	0.36418092	0.3941866
187	0.0	0.15009557	0.2773404	0.3623627	0.3922186
188	0.0	0.14934622	0.27595583	0.36055365	0.39026046
189	0.0	0.14860061	0.2745781	0.35875356	0.38831207
190	0.0	0.14785872	0.27320728	0.3569625	0.38637343
191	0.0	0.14712054	0.27184328	0.35518035	0.38444445
192	0.0	0.14638603	0.2704861	0.3534071	0.38252512
193	0.0	0.1456552	0.26913568	0.35164273	0.38061535
194	0.0	0.14492801	0.26779202	0.34988713	0.37871513
195	0.0	0.14420447	0.26645508	0.34814036	0.3768244
196	0.0	0.14348452	0.2651248	0.34640226	0.3749431
197	0.0	0.14276817	0.26380116	0.34467283	0.3730712
198	0.0	0.1420554	0.26248413	0.34295204	0.37120864

	0-based
182	1437355429318000
183	1437355429338000
184	1437355429358000
185	1437355429378000
186	1437355429398000
187	1437355429418000
188	1437355429438000
189	1437355429458000
190	1437355429478000
191	1437355429498000
192	1437355429518000
193	1437355429538000
194	1437355429558000

Essential data is stored in the HDF files

Equipment Meta Data



Metadata Equipment

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<prodml:DasInstrumentBox xmlns:prodml="http://www.energistics.org/energyml/data/commonv2" xmlns:eml="http://www.energistics.org/energyml/data/commonv2" xmlns:xs="http://www.w3.org/2001/XMLSchema-instance" uid="df9447a1-8c6b-4634-88eb" http://www.energistics.org/energyml/data/prodmlv2 ..../..../xsd_schemas/DasAcquisition.xsd">
  <eml:Citation>
    <eml:Title>Instrument Box</eml:Title>
    <eml:Originator>Fred Hertz, Field Tech</eml:Originator>
    <eml:Creation>2015-07-20T01:00:00.000000Z</eml:Creation>
    <eml:Format>Vendor:ApplicationName</eml:Format>
  </eml:Citation>
  <prodml:SerialNumber>12645A</prodml:SerialNumber>
  <prodml:Parameter>
    <eml:Name>Parameter1</eml:Name>
    <eml:Value>10.0s</eml:Value>
    <eml:MeasureClass>time</eml:MeasureClass>
  </prodml:Parameter>
</prodml:DasInstrumentBox>
```

DAS Instrument Box

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<prodml:FiberOpticalPath xmlns:eml="http://www.energistics.org/energyml/data/commonv2" xmlns:prodml="http://www.energistics.org/energyml/data/prodmlv2" xmlns:xs="http://www.w3.org/2001/XMLSchema-instance" schemaVersion="2.1" uid="bfd164f4-f9e3-41c0-a74e-37" http://www.energistics.org/energyml/data/prodmlv2 ..../..../xsd_schemas/DasAcquisition.xsd">
  <eml:Citation>
    <eml:Title>Fiber Optical Path</eml:Title>
    <eml:Originator>Fred Hertz, Field Tech</eml:Originator>
    <eml:Creation>2015-07-20T01:00:00.000000Z</eml:Creation>
    <eml:Format>Vendor:ApplicationName</eml:Format>
  </eml:Citation>
  <prodml:Inventory>
    <prodml:OpticalPathNetwork uid="OPN1">
      <prodml:FacilityMapping uid="FM1">
        <prodml:Defect defectID="OPTDEFECT1">
          <prodml:Otdr>
            <prodml:InstallingVendor>
              <prodml:FiberOpticalPath>

```

Fiber Optical Path & OTDR

```
<prodml:Inventory>
  <prodml:OpticalPathNetwork uid="OPN1">
    <prodml:FacilityMapping uid="FM1">
      <prodml:Defect defectID="OPTDEFECT1">
        <prodml:Otdr>

```

```
<prodml:FacilityCalibration>
  <prodml:FacilityName>ABC Well 1 Surface Cable</prodml:FacilityName>
  <prodml:FacilityKind>generic</prodml:FacilityKind>
  <prodml:OpticalPathDistanceUnit>m</prodml:OpticalPathDistanceUnit>
  <prodml:FacilityLengthUnit>m</prodml:FacilityLengthUnit>
  <prodml:Calibration>
    <prodml:Remark>ABC well 1</prodml:Remark>
    <prodml:LastLocusToEndOfFiber uom="m">12.43</prodml:LastLocusToEndOfFiber>
    <prodml:PipelineDatum>
      <prodml:LocusDepthPoint xsi:type="prodml:CompoundExternalArray">
        <prodml:Columns>
          <prodml:Columns>LocusIndex</prodml:Columns>
          <prodml:Columns>OpticalPathDistance</prodml:Columns>
          <prodml:Columns>FacilityLength</prodml:Columns>
          <prodml:Values>
            <eml:ExternalFileProxy xsi:type="eml:ExternalDatasetPart">

```

DAS Acquisition
Tables of locus locations

Surface Cable

Tap test location

DAS Instrument Box

Loci 0-4

0.0

23.50

Connector

Downhole cable

Conveyance method:
Cemented on casing

Loci 5-101

Defect

352.80

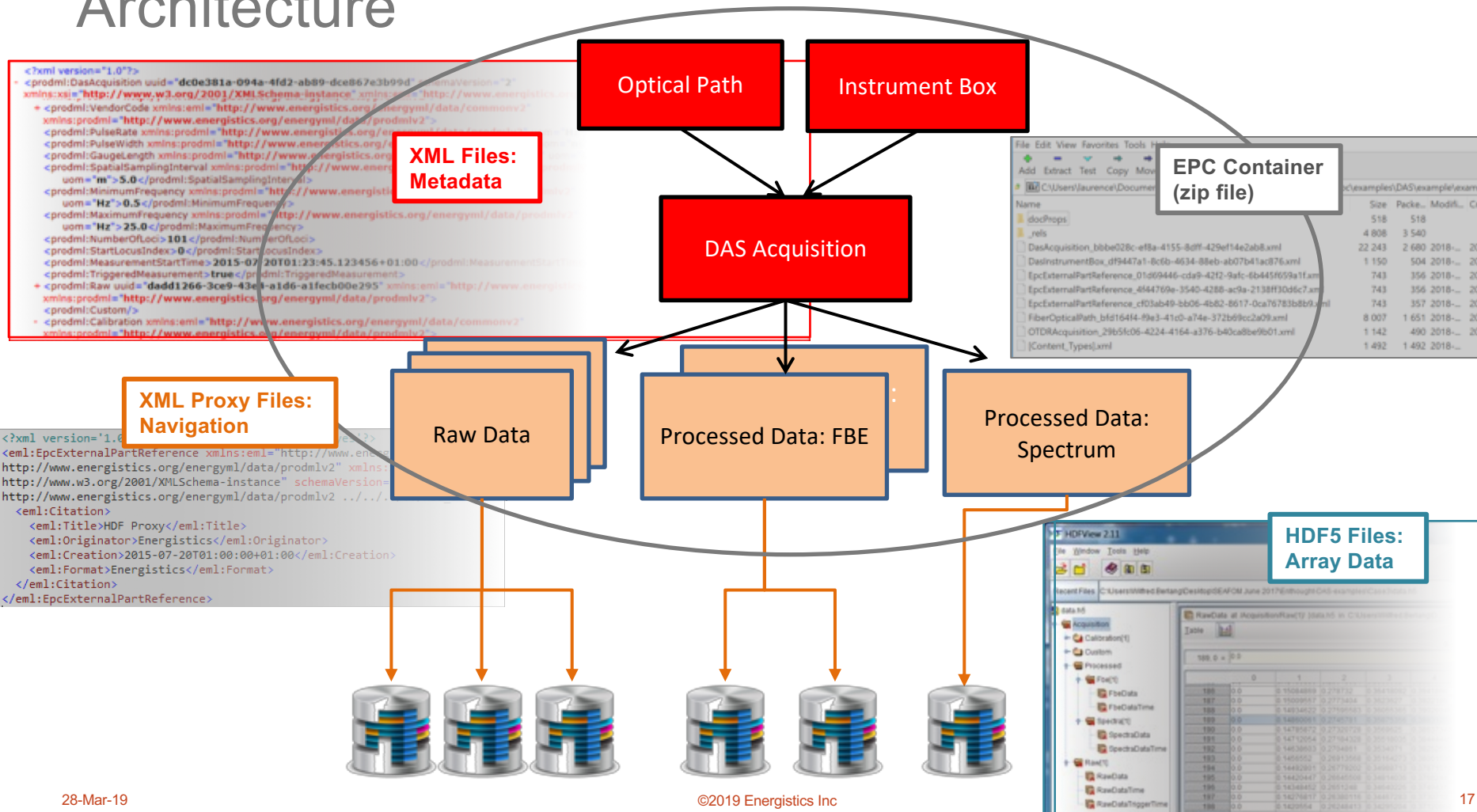
505.00

517.43

Terminator

Maps Between
Fibre distance/
facility length/
Measured Depth

Architecture



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

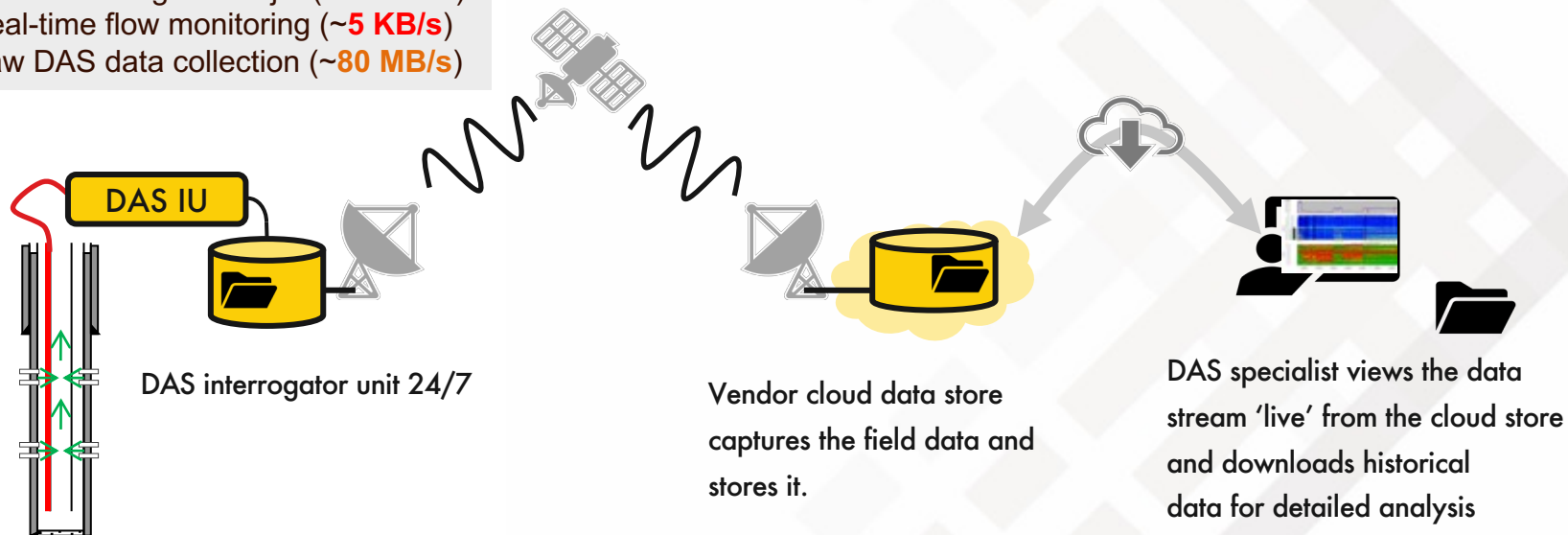


Use Cases

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.energestics.org/>

Thank you

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

www.energistics.org