Real-Time Solutions to Increase the Efficiency in Workover Technologies for Unconventional Reservoirs

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INTRODUCTION

One engineering challenge in the oil & gas industry is how to increase the efficiency for unconventional operations and increase potential for oil production. Wells require an innovative technology, with a good technical guideline, allowing them to maximize hydrocarbons extractions. Based on this, it was identified that the correct execution on hydraulic fracturing, during unconventional completions, would provide a potential for increasing oil production.

Real-time surveillance for fracturing operations is an innovative concept where Petrolink, in collaboration with Pemex E&P, made a time and resource investment with the objective to provide a technological solution to aggregate several private data formats to WITSML standards helping with the storage, transmission, visualization and data exploitation on the client side. The potential to provide a technological solution in a standardized manner is "huge" by considering fracturing operations worldwide.

A couple of years ago, a shale type basin in Mexico increased the amount of horizontal wells with expectation of a 4x of potential oil production when compared to conventional wells. Someone said that unconventional problems needed unconventional solutions. Bear in mind that we are facing wells with low porosity and low permeability that needed a closed surveillance. Sanded wells, high costs, uncontrolled fluids, among other are some of typical problems during completion operations and specifically for hydraulic fracturing (López, 2013).

One of the reasons Pemex needed surveillance of the wells was for the control of proppant injected into the well. They suffered with sanded wells. There are several factors that affects end results in a successful fracturing intervention.

After some years and with the object to increase production of wells, re-fracturing is considered a solution to continue to exploit the potential of wells, considering that there are 830.000 wells drilled worldwide, the potential of this could be enormous (Dozier et al, 2003).

METHODOLOGY

One of the goals in real-time for fracturing is to find controls for activity, additives and ability to react for decision-making process by comparing fracturing design with real-time data. The first challenge is how to ensure real-time data from the wellsite with a multivendor scheme.

It is well known that most service companies can deliver data in real-time. The issue is whether you belong to a national enterprise needed to aggregate all information for multiple vendors. The special situation is presented when each service company has their own specific data format for submission.

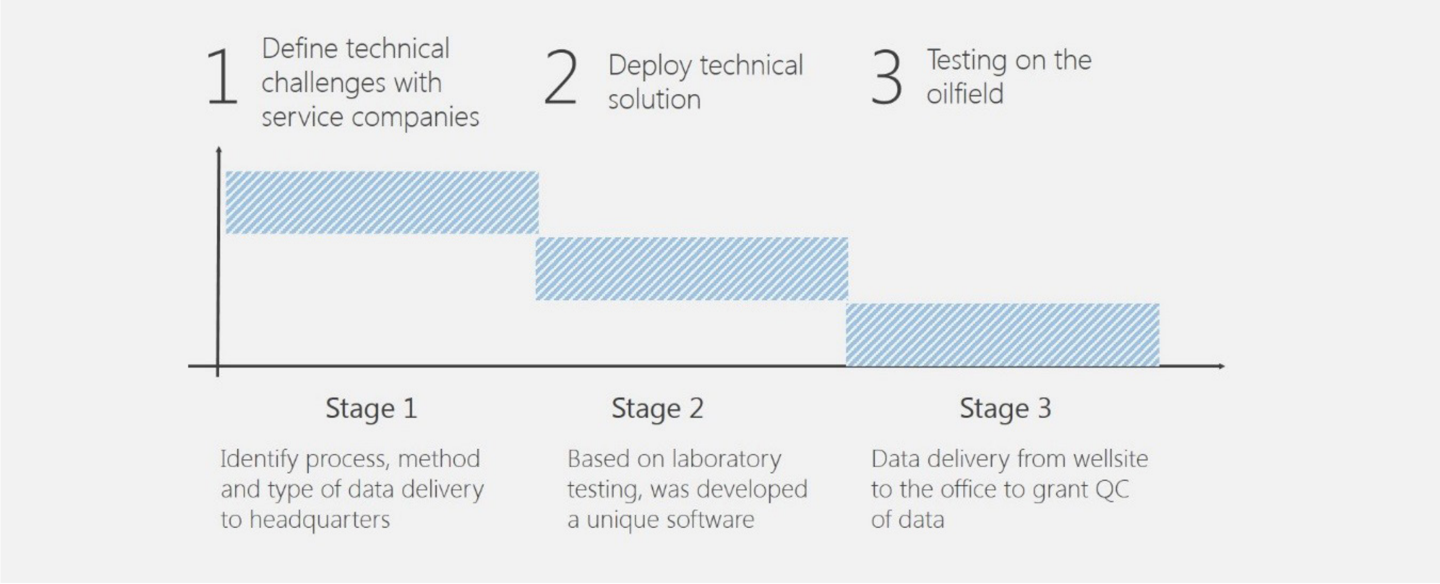
Knowing this situation, we prepared a plan to consider integrating all data in WITSML data format independent from the providers generating the data.

The solution was planned as show:

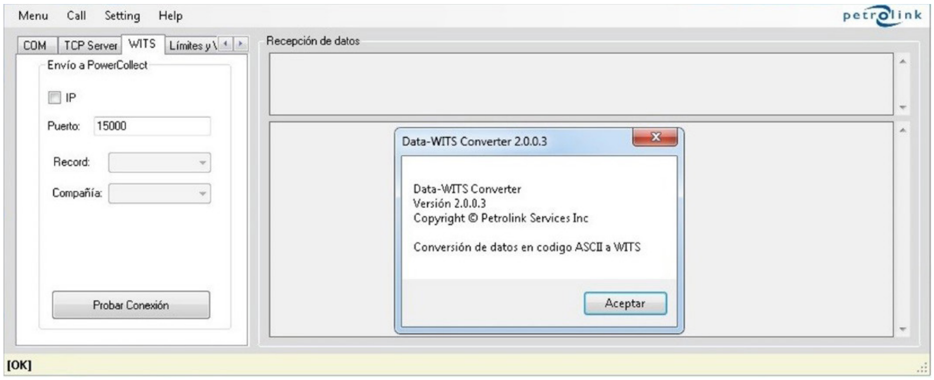
1. Define technical challenges to collect data from service companies.
2. Deploy technical solutions
3. Testing and confirming in the oilfield

1. When we began the data transfer between the remote server integrator and the Data Van instrumentation, we found different data formats from different vendors. The consequences hindered the integration and real-time transmission of the data using the WITSML standard as written by the Energistics Standards Committee.

   This was considered the main challenge due to a complex format structure and the time to provide a solution.



2 Software was developed that worked as a “coupler” to convert real-time ASCII data into the WITSML format. This software works in real-time, from our remote server integrator, allowing us to receive ASCII data in 2 different connection schemes, serial or Ethernet.

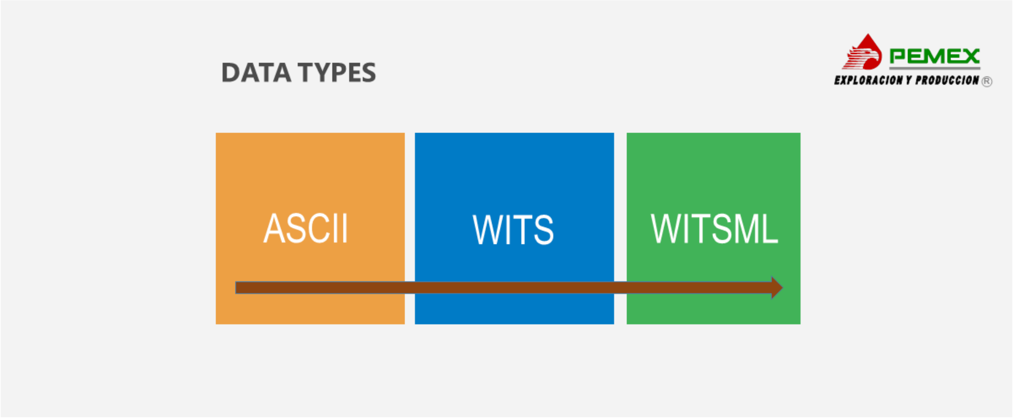


3. The field trial, to validate the solution, enabled us to provide for the collection and transmission of real-time visualization data as a service; successfully applying the WITSML standard data format. The real-time data display was considered by the end-user for the monitoring of status and advanced functions during the fracturing operations. Several plots were developed for data visualization with the objective to show flexibility and a customized solution.

TECHNICAL SOLUTIONS DEVELOPED

Over the early years of evolution of digital technology in the oil and gas industry, many operating and services companies developed their own formats for electronic data exchange. When wellsite data needed to be transferred between a data acquisition company and an operator, new software often had to be written, followed by extensive testing and debugging before the data collection and analysis systems of the two entities could communicate with one another correctly. This often led to problems in start-ups with the resulting loss of time and data. The ongoing development and maintenance of these formats represented a significant expenditure (Khudiri, 2008).

One of the tasks that needed too much time and money, in the information management industry, was the data-type conversion. Taking into account this limitation and after doing the data formats analysis, we took full advantage of the features of the WITSML standard. *"The standards provide requirements, specifications, and guidelines that are used to ensure that processes, products and services are fit for purpose"*. The following scheme shows how the conversion of data types was developed for this solution.



Situation before WITSML standard was applied.

The information transmitted is a character-encoding scheme, encoding 128 specified into 7-bit binary integers. All the characters encoded are numbers from "0" to "9", lowercase letters from "a" to "z", uppercase letters "A" to "Z", basic punctuation symbols and a space. ASCII was the most common character encoding on the World Wide Web until December 2007, when it was surpassed by UTF-8, which includes ASCII as subset.

Communications protocols and ports	
TCP/ IP	One of the most important protocols for communications used is TCP/IP.
Serial	Serial communication sending data one bit at the time, sequentially, over communication channel or computer bus, the most common for short distances.
Input data type	ASCII
Output data type	WITS0 and WITSML
Data input transmission	The most common delivery method is a data frame (stream) in a serial communication.
Data output transmission	WITSML data objects being transported between systems must be represented as XML documents.
Patterns	Sequential data of fracturing operations using the white space, comma and/or tab as delimiter in the data stream.
Line terminators for data transmission	• A newline (line feed) character ('\n'), • A carriage-return character followed immediately by a newline character ("\r\n"), • A standalone carriage-return character ('\r'), • A next-line character ('\u0085'), • A line-separator character ('\u2028'),

Data delimiters for data transmission

A delimiter is a sequence of one or more characters used to specify the boundary between separate, independent regions in plain text or other data streams. These separator can be mainly a comma, tab and white space.

Conversion to WITSML

Phase 1: doing the conversion from ASCII to WITS data, as there is not any WITS channel dedicated for fracturing operations; a new spark channel was used for this proposed, channel number 26.

WITS0: WITS is a multi-level format which offers an easily achieved entry point with increasingly flexible higher levels. At the lower levels, a fixed format ASCII data stream is employed, while, at the highest level, a self-defining customizable data stream is available.

A WITS data stream consists of discrete data records. Each data record type is generated independently of other data record types and each has a unique trigger variable and sampling interval. The rig activity usually determines which records are applicable at any given time such that only appropriate data is transmitted.

Mapping: into the following curves its mention the principal parameters used into the real-time transmission data.

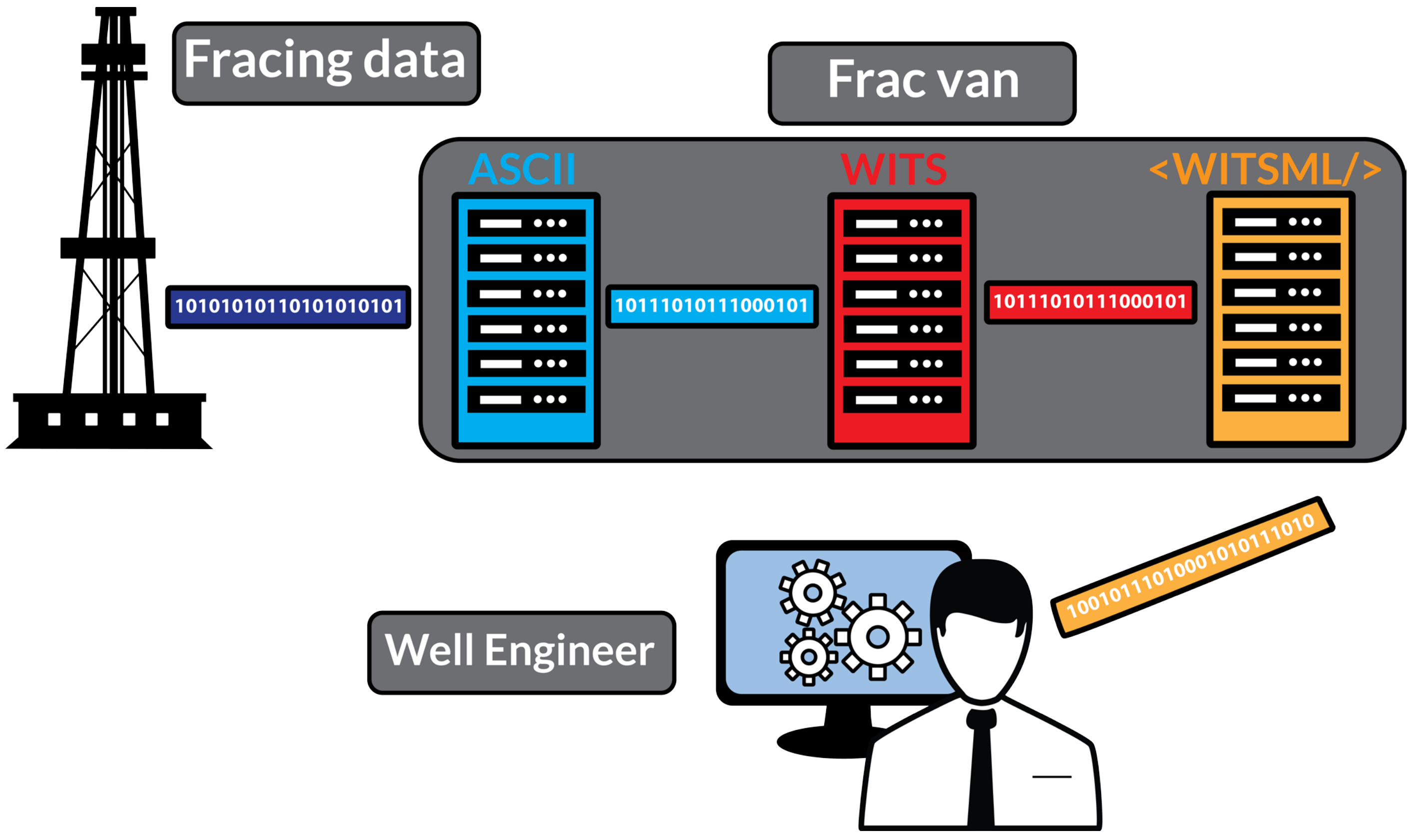
Code	Mnemonic	Unit	Description
2601	PRES_SUP	psi	Surface pressure
2602	SLUR_RATE	bpm	Slurry rate
2603	CONC_SUP	ppg	Surface concentration
2604	PRES_AN	psi	Annular pressure
2605	PRES_FONDO	psi	Bottom pressure, calculated
2606	CONC_FONDO	lbm/gal	Bottom concentration, calculated
2607	PRES_N2	psi	Pressure Nitrogen
2608	RATE_N2	bpm	Flow rate in Nitrogen
2609	AD1	gal/Mgal	Additive 1
2610	AD2	gal/Mgal	Additive 2
2611	AD3	gal/Mgal	Additive 3
2612	AD4	gal/Mgal	Additive 4
2613	AD5	gal/Mgal	Additive 5
2614	AD6	gal/Mgal	Additive 6
2615	AD7	gal/Mgal	Additive 7
2616	AD8	gal/Mgal	Additive 8
2617	AD9	gal/Mgal	Additive 9
2618	AD10	gal/Mgal	Additive 10
2619	VOL_ACUM	%	Proppant volume

Phase 2: implementation of the WITSML standard.

WITSML: the Wellsite Information Transfer Standard Markup Language (WITSML) version 1.3.1 consists of XML data-object definitions and a web services specification developed to promote the right-time, seamless flow of well data between operators and service companies, as well as regulatory agencies, to speed and enhance decision-making and reporting.

Conversion data diagram

The following diagram shows the cycle used to convert the ASCII data into standard WITSML, before it is shared with decision makers

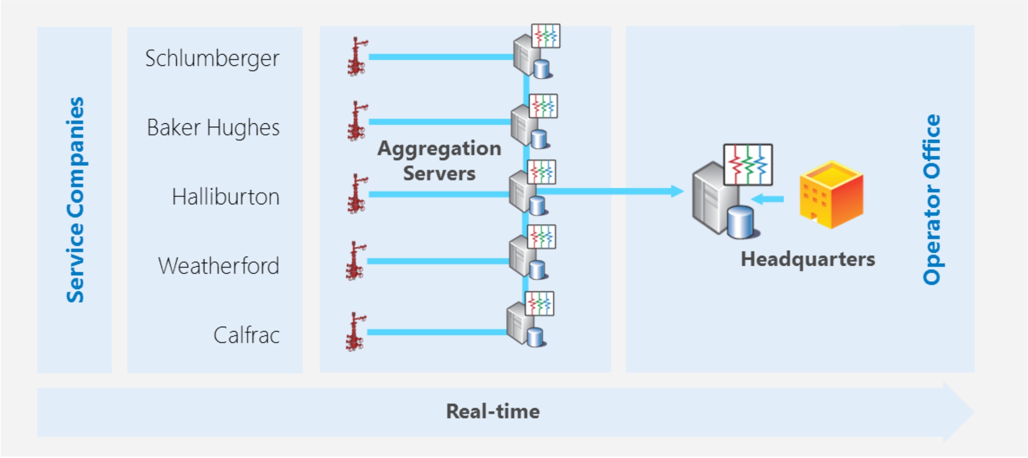


Standardization of Real – Time Data

The technology used to manage real-time data is ruled by a set of standards called WITSML (Wellsite Information Transfer Standard Markup Language), as sanctioned by Energistics (www.energistics.org). The standardization of the real-time data process has the following advantages:

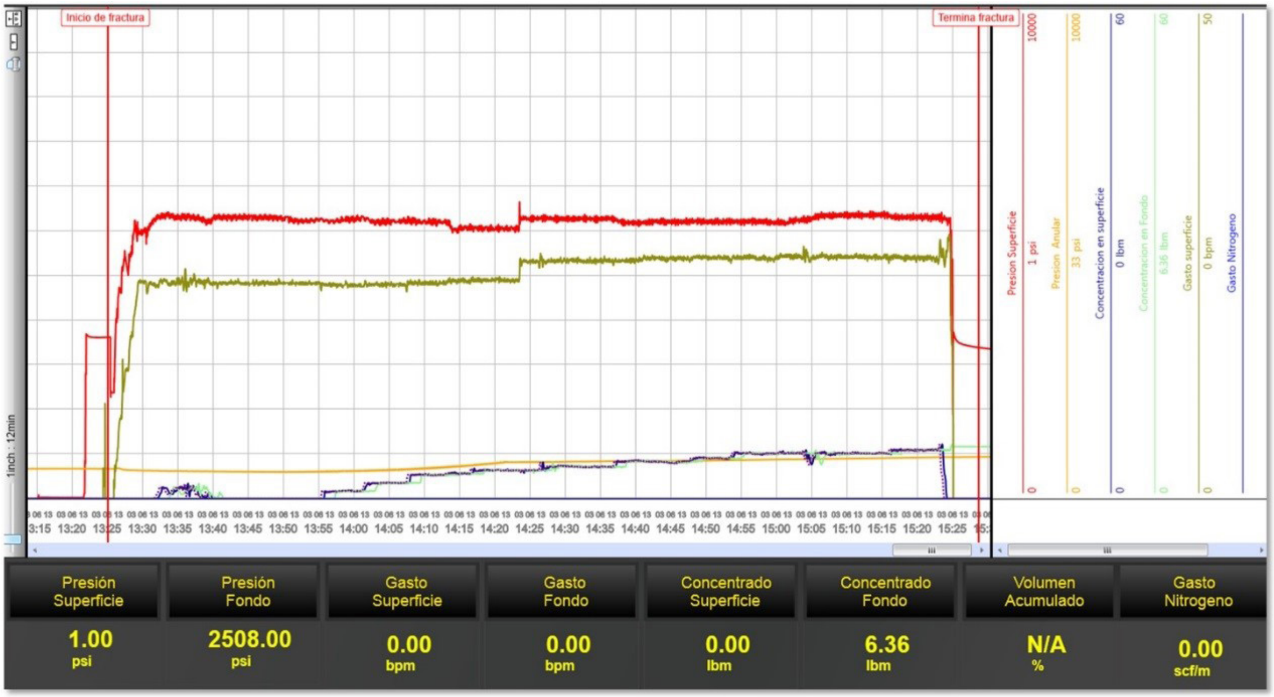
- Reduces dependence on technology – exploitation of the data with the required technology application, regardless of the company that generated the data.
- Reduces the costs associated with the conversion formats
- Preserves the data according to a standard accepted by the industry
- Constantly evolves to include all the families of data generated during completion and workovers process.

Some companies we found with a technical solution were Schlumberger, Baker Hughes, Halliburton, Weatherford and Calfrac.



VISUALIZATION

After the WITSML conversion we offered, with the collaboration of the end-user, the ability to display information in real-time. We can see in following plot, the display of the main data with tools to allow the user to increase the scale of the plot in order to see greater detail and all data storage information.



ANALYSIS AND RESULTS

One of benefits for closed real-time surveillance in fracturing is the rational usage of proppant material, water reduction and management of fluids in the operation.
Additional operational benefits with these best practices in fracturing will help to:

- Assure well design
- Prevent sanded wells
- Identify technical failures on pumps, dropballs, and blenders

With this information provided in real-time, controls can be adjusted for issues such as:

- Adjust nominal pressures accordingly to mini frac results
- Ensure security the sting on pump's pipelines
- Verify does not overload maximum pressure e.g. 7000 psi
- Surveillance data frac testing prior commencing fracturing operation

Main data in real-time for surveillance

- Surface pressure (psi)
- Bottomhole pressure (psi)
- Barrels per minute on surface (bpm)
- Surface concentration (lb/gal)
- Bottomhole concentration (lb/gal)

The facility to collect, integrate and visualize and transmit real-time data, generated during fracturing operation, will provide the following advantages to the decision-makers supporting the fracturing operation:

- All data generated during hydraulic fracturing activity was integrated in WITSML standard
- Data is made available for all operators and services companies for their use and exploitation in the field Allows data exchange technologies and applications to monitor and manage the information. The data exchange technologies and applications allows for the monitoring and management of the information
- Promotes interoperability of multiple software products
- Reduces costs associated with conversion of formats
- Provides seamless data integration functionality
- Data availability in the Real Time Operating Center (RTOC) is made available to assist in the decision-making process from multidisciplinary teams
- Data is available to confirm the activity design and post-mortum analysis
- This has resulted in stability and standardization in real-time information flow

CONCLUSIONS

- Real-time fracturing provides a potential to maximize efficiency and oil production by applying correct execution of real-time data and effective communications between the wellsite and headquarters
- A good surveillance of real-time data provides a powerful tool for preventing undesirable events
- Remote monitoring reduces personnel exposure to risks or wellsite and promotes safety
- Excellent fracturing execution allows rational usages of proppant, water management and save costs by controlling fluids injected into the well
- Resolves real-time configuration issues
- Allows multiple vendors to participate in the projects

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