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

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INTRODUCTION

One engineering challenges in oil & gas industry was how to increase the efficiency for unconventional operations and increase potential for oil production. Those wells required an innovative technologies with a good technical guideline allowing maximizing the hydrocarbons extractions. Based on this, was identified that correct execution on hydraulic fracking during unconventional completions will provide a potential increasing in oil productions.

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

Couple of years ago, a shale type basin in Mexico increased 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 completions operations and specifically for hydraulic fracking (López, 2013).

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

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

METHODOLOGY

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

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

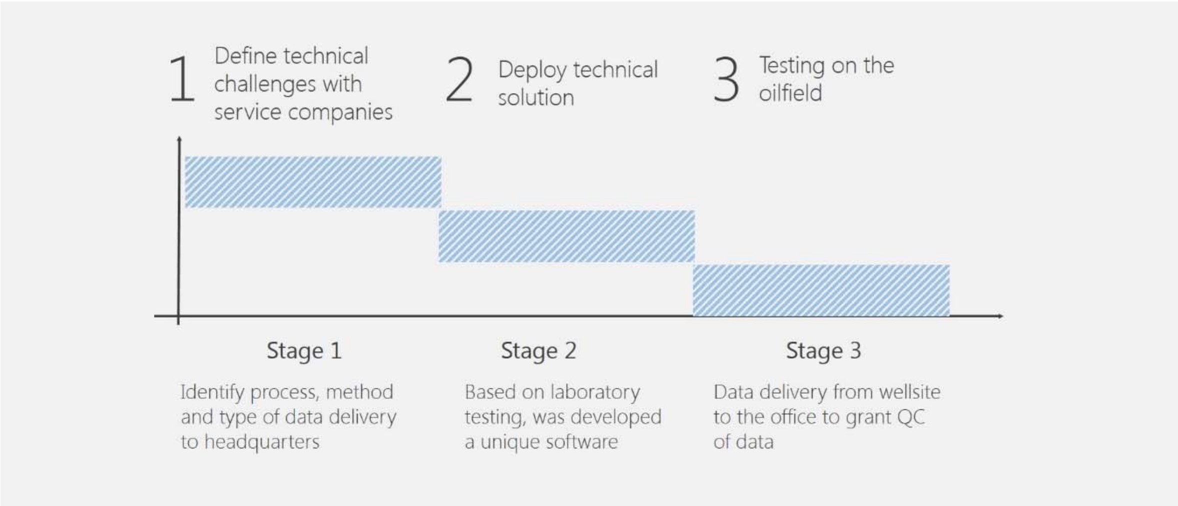
Knowing these situation, we prepare a plan to consider integrate all data in WITSML data format independent from who providers is generating data.

The solution was planned as show:

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

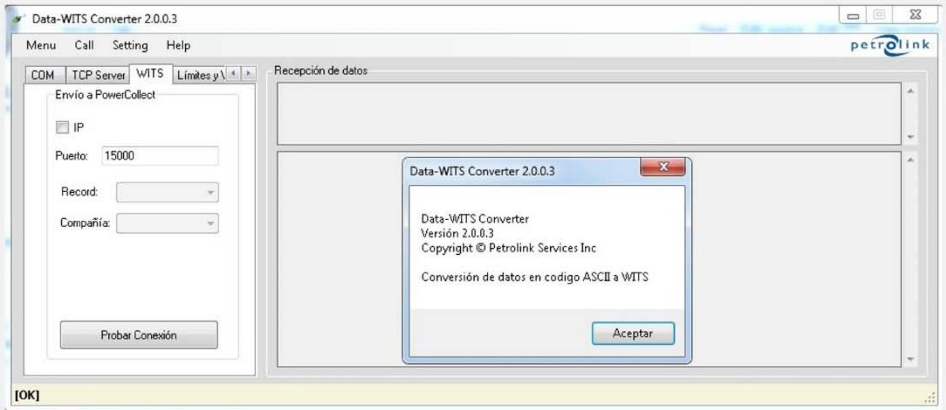
1. When we try to start the data transfer connection between remote server integrator and fracVan instrumentation, we find different data formats from different vendors, with several consequences to hinder integrate and RT transmission using international standard and transmission (WIITSML).

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



2. Software were developed that works as "coupler" to convert ASCII data into WITSML format. This software works in real-time, from our remote server

integrator, allowing receiving ASCII data in 2 different connection schemes, serial or Ethernet.

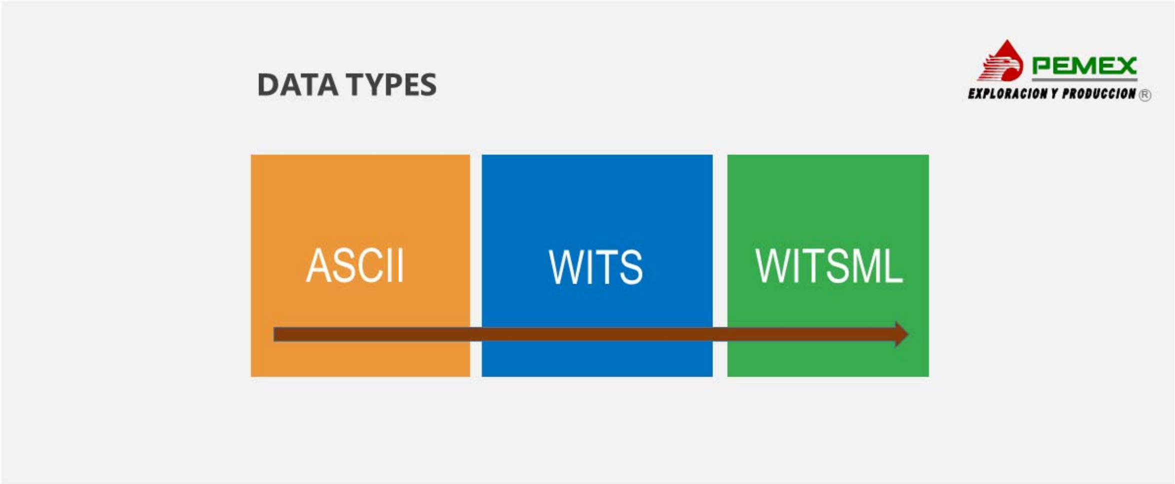


3. The field trial to validate the solution provided to collect, transmission and RT visualization data as a formal services, applying successfully the international standard WITSML administrate from Energistics. The RT data display was considered by final user to monitoring status and advanced during fracking operations.
   Several plots was developed to data visualization with object to show flexibility and 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 have 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 problem 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 need to much time and also require money into the industry of the information management is the data type conversions. Taking into account this limitation and after doing the data formats analysis, we start working taking 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 on this solution.



Situation before apply WITSML standard.

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 at shorter 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. In Client/Server mode, WITSML data objects are "pushed" on-demand by a Client to a Server.

Patterns	Sequentially data of franking operations using the white space, comma, tab as delimiter in the data stream.
Line terminators for data transmission	o A newline (line feed) character ('\n'), o A carriage-return character followed immediately by a newline character ("\r\n"), o A standalone carriage-return character ('\r'), o A next-line character ('\u0085'), o 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 do comma, tab and white space mainly.

Conversion to WITSML

Phase 1: doing the conversion from ASCII to WITS data, as there is not any WITS channel dedicated for fracking operations; 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

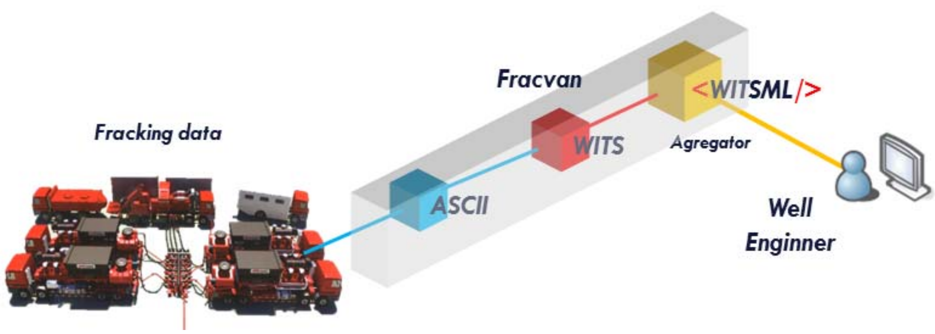
2611	AD3	gal/Mgal	Additive 3
2612	AD4	gal/Mgal	Additive 4
2613	AD5	gal/Mgal	Additive 5
2614	AD6	gal/Mgal	Additive 6
2615	AD7	gal/Mgal	Additive 7
2616	AD8	gal/Mgal	Additive 8
2617	AD9	gal/Mgal	Additive 9
2618	AD10	gal/Mgal	Additive 10
2619	VOL_ACUM	%	Proppant volume

Phase 2: implementation 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

In the following diagram shows the cycle used to convert the ASCII data in the standard WITSML, before to be share with decision makers

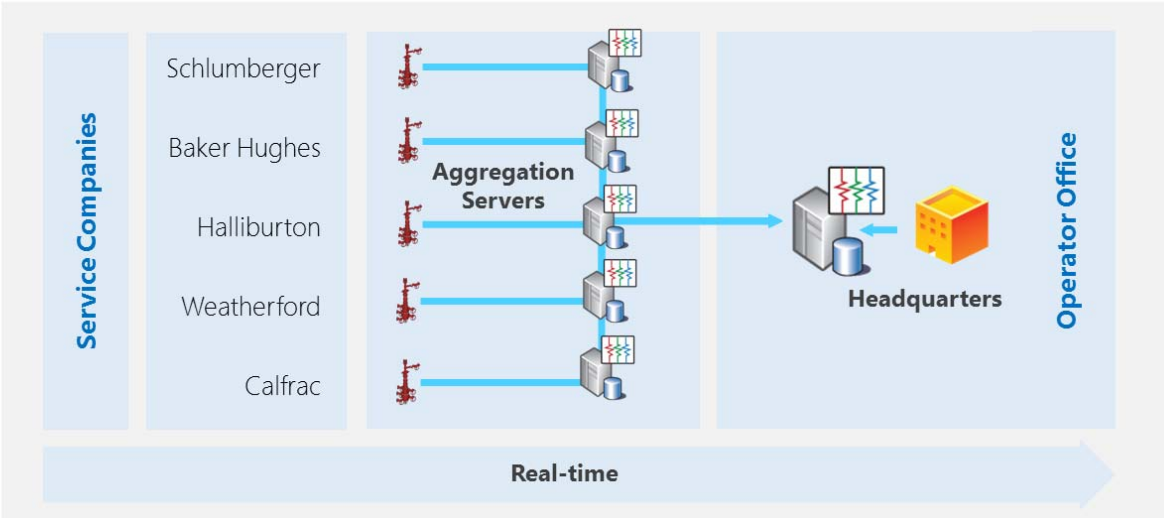


Standardization of Real – Time Data

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

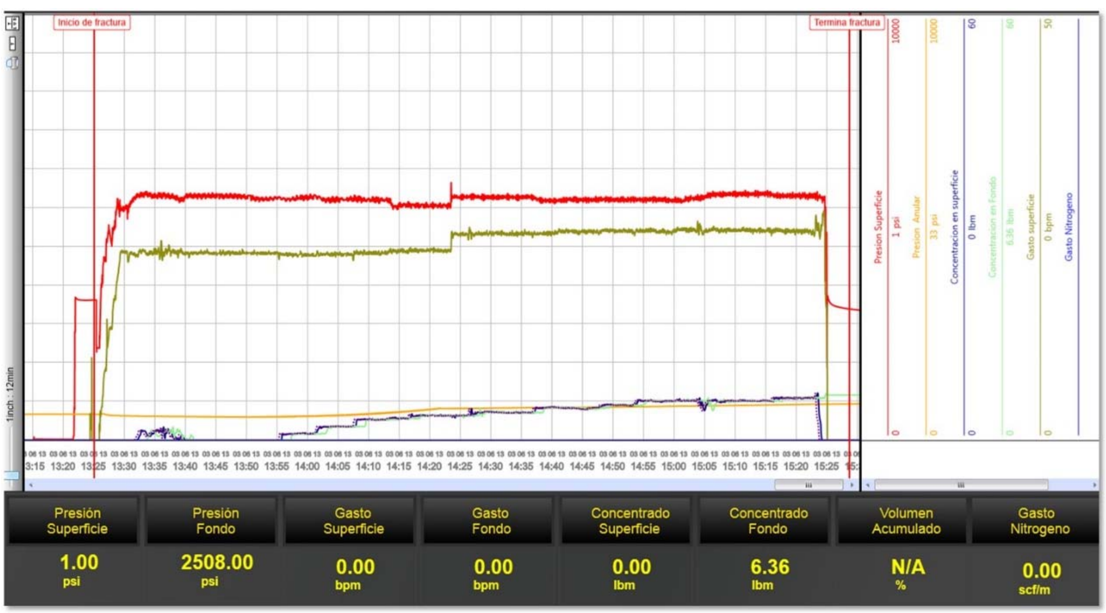
- Reduces dependence on technology – exploitation of the data with the required technology application, regardless of the company that generated the data.
- Reduce the costs associated with the conversions formats
- Preserves the data according to a standard accepted by the industry
- Constantly evolves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

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



VISUALIZATION

After WITSML integrator the facility to offer display information in real time depend on the customer requirement, as we can see in next plot, this permit show the main information considered to include in display, with potential to increase scale and consider more details per unit time and storage this information as was collect during the operation.



ANALYSIS AND RESULTS

One of benefits for closed real-time surveillance in fracking it is a rational usage of proppant material, water reduction and management of fluids in whole operation.

Additional operational benefits with these best practices in fracking will helps to:

- Assurance well design
- Prevent sanded wells
- Identify technical failures on pumps, dropballs, and blender

With this information in real-time can be adjusted some issues such as:

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

Main data in real-time for surveillance

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

The facility to collect, integrate and visualize data generate during frac operations will be transform in information to decisions makers support through this advantages:

- All data generate during hydraulic fracking activity was integrate in WITSML standard
- Data available for all operative and services companies for its use and exploitation in field and offices.
- Allows data exchange technologies and applications to monitor and manage the information
- Promotes interoperability of multiple software products
- Reducing costs associated with conversion of formats
- Provides seamless data integration functionality
- Data availability in RTOC ready to take decision from multidisciplinary teams
- Data availability to confirm the activity design and post-mortem analysis
- This has resulted in lack of stability and standardization in real time information flow

CONCLUSIONS

- Real-time fracking provide a potential to maximize efficiency as well as oil production by applying correct execution with real-time data and effective communications between wellsite and headquarter
- A good surveillance of real-time data provide a powerful tool for undesirable events
- Remote monitoring reduce personnel exposition to risks or wellsite and promote safety
- Excellent fracking execution, allows rational usages of proppant, water management and save costs by control fluids injected to the well.
- Resolves real-time configuration issues.
- Allows multiple vendors project participation.

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