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A Short History of the Last 15 year's Quest for IT Interoperability in the Petroleum E&P Industry

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Résumé — Histoire des quinze dernières années de quête à l'interopérabilité des données et des applications informatiques en exploration/production pétrolière — Ce papier propose un éclairage personnel de l'auteur sur les motivations et les actions menées ces quinze dernières années dans le domaine de l'interopérabilité entre données et application en exploration/production pétrolière par les différents acteurs (compagnies pétrolières, vendeurs de logiciels, organismes de certification). Son opinion est illustrée par une présentation synthétique des projets traitant de l'échange et du partage des informations caractéristiques de la description du sous-sol qui ont jalonné ces dernières années. En fait la profession a commencé à s'intéresser à ces sujets au début des années 1990 par la fondation du consortium POSC qui a conduit à la constitution de « Epicentre », le modèle logique de référence et son dictionnaire, clef de voûte de toute interopérabilité. Depuis cette époque, beaucoup de projets furent lancés pour exploiter cette base, conduisant à tous types d'applications (échange de données, interopérabilité entre applications, modélisation de processus), utilisant toutes sortes de technologies. Ceci, jusqu'à mettre en oeuvre des mécanismes exploitant une description XML/RDFS de la sémantique des informations à échanger.

Ce chapitre a pour ambition d'aider les lecteurs à trouver leur chemin dans la jungle des Acronymes des projets POSC, EpiCentre, RESCUE, OpenSpirit, EpiSEM et WITSML de ce domaine applicatif clef, qui n'en est qu'au début de son existence.

Abstract — A Short History of the Last 15 year's Quest for IT Interoperability in the Petroleum E&P Industry — This paper gives a personal view on the drivers of the different actors of the E&P petroleum Industry (companies, vendors, certification organisations) to obtain a good level interoperability between data and applications. This is illustrated by a synthetic view of several interoperability projects dealing with subsurface aspects (geology, geophysics, reservoir). In fact, the oil and gas profession started to address subsurface data interoperability problems back in the 1990's with the well-known POSC consortium, which led to the reference Epicentre model. Since those days, many projects have been undertaken, dealing with all sorts of applications (data exchange, software interoperability, workflow modelling etc.) and using all sorts of technologies, from conventional database technologies to more advanced semantic models on top of XML.

This article will help the reader find his/her way among the POSC, Epicentre, RESCUE, OpenSpirit, EpiSEM and WITSML projects for this key application domain which is only at the beginning of its life.

INTRODUCTION

During one of the last IT conferences of Summer 2004, the CIO of a major International Petroleum Company revealed that 59% of its company budget went on IT applications. Of this, 14% went on hardware, 14% on software, 29% on OPEX and the remaining 43% on integration.

This reveals two outstanding major issues:

- up to the present, software generally does not cover all of the business needs and requires customizing before roll-out;
- up to now, there is no stable platform available to ensure interoperability for best of breed applications. As a “single vendor” solution cannot really exist for all petroleum companies’ needs, interoperability between different vendor solutions is still the Holy Grail which the knights of industry are seeking.

This quest began in the early 1990’s.

Before the 1990’s, after a pioneer period marked by the emergence of data standards (SEGY, UKOOA) and their management by the “petroleum societies” (*SEG*, *SPE*, *AAPG*), Schlumberger was offering access to its software platforms and applications through a half link mechanism: Geoshare (see section 2.1). This vendor effort was followed by Landmark providing open access to its emerging Data store management system: Open Works.

But in 1990 the petroleum companies did not consider this situation viable and decided to create a collaborative organisation to set up true interoperability between data and even between applications of diverse vendors and oil companies.

At the beginning, this was a managerial decision based on two main aspects:

- a global budget analysis was showing the emergence of IT cost in the overall budget;
- the companies identified the risk of important “information loss” in Exploration and Production (E&P) petroleum business.

To fulfil this need POSC (Petrotechnical Open Software Corporation) was created by 5 major Companies each of whom decided to for three years contribute one million US \$ cash to the basket, including the participation of their best IT specialists. Many others joined the Consortium at diverse levels, including many vendors, and the global membership grew to over 100 organisations.

But, from the beginning, a struggle for life (and money) started behind the “flower power” idea of the overall benefit which companies, vendors and research institutes can gain by easy interconnection of data and even applications. In fact companies and vendors have different drivers for working in this direction.

Companies desire to develop technologies in order to spend less money at the end, and so spend less money to feed IT people. They have the business objective and the money,

but they don’t have the technology. In the end, they have a definitive weapon; they can merge to ensure interoperability.

Vendors have the technology and they want to keep their customers and their market shares. So, they agree on companies requirements of “added value”, but they are clever enough and able to play with the technology to keep their business alive. To ensure interoperability with other vendor’s products, they have also their definitive weapon; they can buy their competitors, and integrate their product lines.

As a plus, to avoid POSC entering in the IT business itself, it was decided that POSC would not be authorised to produce industrial code at all. Instead, POSC would produce specifications and proof of concept implementations.

The reader should understand the point of view of the author before starting the interesting story of interoperability in the E&P business. Sometime spectator, sometime actor, of this saga I am giving my own understanding of this picture and this is my personal view. First of all, I recognise that all people involved in this “adventure” are great professionals who have produced very good published material which I am reusing to keep as close to the truth as possible to illustrate my subject.

1 POSC: THE MAIN ACTOR IN FACILITATING INTEROPERABILITY IN THE E&P BUSINESS

Up to 1998, the Petrotechnical Open Software Corporation (POSC): www.posc.org was a not-for-profit membership organization focused on the E&P sector of the oil and gas industry. POSC members are oil companies, suppliers, government agencies, research organizations, and other consortia. Established in 1990, its mission is to deliver value to the E&P industry sector related to information sharing through the development and support of standards and specifications.

Now POSC is an international not-for-profit membership consortium. It is uniquely designed to unite industry people, issues and ideas to facilitate E&P information sharing and business process integration. POSC provides open specifications for information modeling, information management, and data and application integration over the life cycle of E&P assets.

The greatest strength of POSC is its status as a neutral forum for collaborative learning and sharing. This environment allows the E&P industry to focus on business solutions rather than on data processing problems.

2 THE E&P INTEROPERABILITY LEVELS: A FORMALISATION OF THE OBJECTIVES

POSC launched around 1996 the E&P Interoperability of Business Objects (IBO) Project. This project can be seen as

an example of what the role of POSC could be. This project proceeded through several stages from 1996 to 1999.

Over these years, POSC was organising member workshops, member workgroups, Request for Comments cycle, Request for Technology cycle, and the publication of a specification snapshot. The final deliverable (the goal) of this project should have been a complete formalisation of an agreed, workable definition of interaction behaviours, and specifications for mechanisms to support them. Those mechanisms would have enabled applications to share common behaviour and interaction services within and across disciplines, even when applications from diverse sources are used. Another goal was to provide a level of sophistication that ensures coherency across all active applications, *i.e.* that interactions make sense.

This project was stopped in 1999 because this scope presupposed an agreed long term collaboration between all sponsors and vendors. The original vision, in which the openness of the action was intended to open the way to new actors in the E&P business, was broken by multiple business interests, by the mergers between petroleum companies which were individually sponsoring POSC and by the only partial success of Epicentre (see section 4).

But... POSC published an interesting document describing what they called "interoperability levels" which can serve as a canvas to understand the different projects.

Six levels of application *interoperability* were organized according to how many of the characteristics of *interoperability* identified in the Request For Comments (RFC) are supported. Higher levels support more software *plug-and-play*, more *data sharing*, and more integrated *virtual applications*. Given the focus here on concurrent application *interoperability*, levels characterizing *data exchange* were not defined. To have a wider vision, I have added a Level (-1) which reflects this possibility, which is still widely used now, and a Level 6 which reflects updated possibilities in the 2000's.

The definitions of capabilities and requirements are not intended to be rigorous. They are intended to provide a starting point for specifying an extensible, workable *architecture* and used here to classify the projects realisations.

2.1 Level -1 - Half Link Mechanisms

Capabilities

Applications in work processes can access the same agreed standard *data representation* but allow data reformatting to be consistent with this representation. The variety of applications which can exchange is limited because *data stores* typically have different formats. Using this mechanism could not avoid lost of information and requires an effort by vendors to update their software.

Requirements

- Agreed Common *data model/access* within sets of *applications* and *data representation* which work together.
- Public description of which *applications* work with which *data representation*.

2.2 Level 0 - Data Model & Data Access Standardisation

Capabilities

Applications in work processes must access the same *data store* to avoid data reformatting overheads. The variety of applications which can interoperate is limited because *data stores* typically have different formats.

Requirements

- Common *data model/access* within sets of *applications* and *data stores* which work together.
- Public description of which *applications* work with which *data stores*.

2.3 Level 1 - End-Users Can Run the Same Application Against Different Data Stores

Capabilities

End-users can run the same application against different *data stores* because servers act as intermediaries. Because the server interfaces are standardized, more applications within the work process can share the servers. The servers can achieve *plug-and-play*.

Requirements

- Interfaces for servers (*data objects*) have to be standardized.
- *Data Types* (covering all data types used in Epicentre) must be standardized.
- Standard unit and coordinate transformations for data.
- Method(s) for locating servers and specific *data objects*.

2.4 Level 2 - Application Components Can Request to be Notified when the Contents of Data Objects Encapsulated by Servers Change

Capabilities

Application components can request to be notified when the contents of *data objects* encapsulated by servers change. From a users perspective, actions taken in one application can dynamically cause actions to take place in another. This is the beginning of realizing *virtual applications*.

Requirements

- Standard definitions of events as business objects.
- Common event service.
- Minimum level of concurrency control support.
- Standard *object identifiers*.

2.5 Level 3 - Applications Can Share Process or Presentation Objects/Servers

Capabilities

Applications can share *process* or *presentation objects/servers* such as Graphical User Interfaces. Users can control aspects of multiple applications through a common interface. Because the interfaces are standard, users can expect *plug-and-play* for some *process objects* as well as *data objects*. Users get a standard look and feel from applications developed by different suppliers.

Requirements

- Standard types and interfaces for *process* and *presentation objects*.
- High level of concurrency control support.
- Messaging support.
- Extended standard *data types*.
- Unique *object identifiers*.

2.6 Level 4 - System Integrators Can Create Virtual Applications which Have Components from Different Vendors

Capabilities

System integrators can create *virtual applications* which have components from different vendors and may be customized to end-user work processes. Once created these *virtual applications* can be reused.

Requirements

- Standardize meta-data describing *application components*.
- Expose information necessary to compose *virtual applications*.
- Ability to create/modify composition of *virtual applications*.

2.7 Level 5 - End-Users Can Produce Virtual Applications which Have Components from Different Vendors

Capabilities

End-users can produce virtual applications as in Level 4 either directly or using composition tools.

Requirements

Be able to determine both interface definitions and behavior at run-time.

2.8 Level 6 (new) - Systems Can Automatically React to a Business Need Declaration to Produce Virtual Applications

Capabilities

Systems can automatically react to a business need declaration to produce virtual applications as in Level 4 either directly or using composition tools.

Requirements

Be able to model business knowledge and interactions to compose both interface definitions and behaviour at run-time.

3 LEVEL –1 - HALF LINK MECHANISMS

Three main projects can be classified in this category, GEOSHARE, started by *Schlumberger* and transferred to POSC in 1998, RESCUE facilitated by POSC from 1998 and WITSML, the last child of this family, based on HTML-HTTP acting as *loosely-coupled middleware technology* between the web client (browser) and the business logic layer (web server).

3.1 Geoshare

Geoshare is a public standard for communication of information between computer systems and application programs used in the oil and gas industry. This consists of exchange of data, whose content and encoding are an integral part of the standard. Systems using Geoshare import and export data through use of programs called «half-links», whose behaviour is also specified by the standard. Geoshare was originally developed by Schlumberger owned companies in the 80's as an internal way of communication between their applications.

Since Geoshare is based on a common exchange view of data (as opposed to a common application interface view, or internal database view of data), it can be used to communicate between systems whose internals are potentially very different from each other, without disruptive changes to system internals.

The success of this approach comes from the fact that the information on one business object consists in three different parts: the header, the data descriptor and the data itself. Once an application can understand the header and the data descriptor, it could be able to understand the context and then

interpret the data. Use of Geoshare as part of an interoperability strategy is proving especially useful in light of the technical and organizational difficulties seen when (sometimes competing) groups try to agree on common data models, to write or modify applications to use those models, and to integrate them with legacy applications and data formats.

Today, decisions about the content and future of the Geoshare standard are made by the POSC Geoshare Special Interest Group (refer to the website at:

<http://w3.posc.org/GeoshareSIG/> for more information). Geoshare met the *American Petroleum Institute (API)* recommended practice 66 (RP66) adopted by *API* in 1991. This is a data exchange standard for moving digital oilfield exploration and production (E & P) data between data processing systems. Responsibility for the administration of the RP66 standard was passed to POSC in 1998. This RP66 standard provides a general syntax for encoding arbitrary scientific data and also applies this general framework to the encoding of selected wellsite data. The result of this application is often called DLIS, an acronym for Digital Log Interchange Standard, since well logs are part of the data handled.

Geoshare extends the RP66 syntax and provides usage rules to support the exchange of other types of geoscience data, including seismic data, surfaces, maps, etc.

Geoshare has been totally open since 1998, but its formal design by *Schlumberger* and the necessary investment to realise a complete Geoframe Access tool is still heavy for a developer.

3.2 RESCUE

RESCUE is a Joint Industry Project managed by the Petrotechnical Open Standards Consortium. The acronym "RESCUE" stands for *REServoir Characterization Using Epicentre*.

At its inception the purpose was to provide a forum for the development of an open standard for the transfer of data from geomodels to upscalers, specifically through the use of the Epicentre data model. As the project moved forward, and a data standard for the transfer emerged, it became apparent that testing of the standard could best be achieved through the use of binary flat files. To ensure a common implementation it was evident that a set of Class Libraries to read and write these files was required. These Libraries were developed under contract to the RESCUE project, and are the vehicle of choice for implementing an Application Program Interface to the RESCUE standard.

Tests conducted in 1998 demonstrated that attempting to read and write all data to Epicentre at the level of primitive entities was several orders of magnitude too slow. Accordingly, the RESCUE membership decided to release

commercial products using the flat file exchange mechanism, which is built around domain specific business objects.

While the Class Libraries remain under active development the latest versions are restricted to use by project members. Nevertheless, the group remains committed to an open standard, and a tested version of the Class Libraries is available to any non-member company that wishes to develop RESCUE compliant applications. Members of RESCUE endeavor to maintain backward compatibility to the latest public version of the Libraries.

Today RESCUE is sponsored by 6 major petroleum companies and used by more or less all vendors expecting to exchange Geological and reservoir Earth Models. The Class Library is maintained independently of the vendors and is now commonly used by professionals to transfer models from one proprietary data model to another. Every year two ILAB's ("Interoperability Lab") are organised to test the efficiency of the tools.

3.3 WITSML

The WITSML project is an oil industry initiative sponsored by *BP* and *Statoil*, and later by *Shell*, as a new standard for drilling information transfer. Initial participation includes the major service companies *Baker Hughes*, *GeoQuest*, *Halliburton*, *Landmark* and *Schlumberger*.

In fact WITSML inherits from another project: "WITS: Well site Information Transfer Standard", roughly the "Geoshare" competitor. WITS was designed, implemented, and established as an industry standard in the mid eighties as a binary file format for transferring wellsite drilling data.

This format was used by a number of petroleum companies (*Amoco*, *Chevron*, *Mobil*, *Baker Hugues*, *Halliburton*) in the field. But with no standard programming interface and only limited data objects this was not a universal standard.

The limitation of WITS were:

- outdated MWD data records;
- restrictions on the number of drill string and casing sections;
- inflexibility for handling data in different units of measurement;
- very limited capacity for handling static well information;
- The use of binary data formats is not platform independent;
- WITS records are extensible but not self-describing;
- limited bi-directional (pull) capability;
- no standard programming interface.

Started in 2000 by *BP*, *Statoil* and the three major service companies, the WITSML project decided to use *XML*—as an encoding format (instead of binary code) and exploit SOAP and XML-based middleware. In this policy HTML-HTTP acts as *loosely-coupled middleware technology* between the web client (browser) and the business logic layer (web

server). HTTP can be viewed as a simplified Remote Process Control (RPC) middleware.

Technical decisions were taken to use Web Based methodology & W3C standards, XML data formats and SOAP for the Programming Interface. This use of *loosely-coupled middleware technology* between the web client (browser) and the business logic layer (web server) was really efficient and after only 4 years a lot of business objects are now standardised, their Application Program Interface stabilised and they are used in real operation condition.

Since the completion of WITSML V1.2 in March 2003, POSC has custody of WITSML and is managing the support and future evolution of WITSML through the WITSML Special Interest Group. The aim of the WITSML standard is: the “right time” seamless flow of well site data between operators and service companies to speed and enhance decision-making.

In March 2005, WITSML V1.3 was released and the WITSML community has grown to over 40 companies representing the entire range of E&P players. The WITSML framework and existing infrastructure is being adapted for other uses – including regulatory reporting and production operations.

4 LEVEL 0 - DATA MODEL & DATA ACCESS STANDARDISATION: EPICENTRE

The major project in this category is the POSC Epicentre project starting in 1990. The original idea was to set up a database design and a dictionary which could drive the set up of all vendors’ databases and propose a standardised access, the DAE (Data Access and Exchange), which could be commonly used.

4.1 What did POSC propose for Data Base Design Standardisation?

Epicentre is a Logical Data model for upstream E&P information. POSC has developed Epicentre through an open process of information exchange with the petroleum industry, its related service industries, other computing standards bodies and various regulatory bodies. The open process has provided a forum for interested parties to contribute ideas, requirements, and recommendations of solutions to meet the requirements. POSC has evaluated suggestions with careful deliberation and produced these specifications based on sound technical reasoning.

Because Epicentre is a logical data model, it is not *directly* implementable as a physical database. Epicentre is documented precisely in the Express language but Express is not the equivalent of a data definition language (DDL), like Structured Query Language (SQL) DDL. To build a POSC data store, it is necessary to transform Epicentre Express into

a set of DDL statements using **rules** consistent with the target data store’s database management system (DBMS). POSC refers to this process as **projection**.

Creating a physical implementation of the Epicentre Logical Data Model can be divided into three main steps.

4.2 What did POSC propose for Standard Data Access and Exchange?

The POSC Epicentre Data Model (Epicentre) and Data Access and Exchange (DAE) specifications define a set of data types in which E&P data is defined for (logical) storage and access. The data types defined for the domain proposal should relate to these data type definitions by reference to one or more architecture proposals.

The POSC Epicentre Data Model (Epicentre) defines Reference Entities and Reference Values which serve as controlled sets of E&P values. Domain proposals should define and relate similar features and/or relate to their definition in one or more architecture proposals.

The POSC Epicentre Data Model (Epicentre) and Data Access and Exchange (DAE) specifications define fundamental E&P structural concepts and operations used to qualify and represent data type values. These include grids, units of measure, coordinate systems, quantities, etc. Domain proposals should define and relate similar features and/or relate to their definition in one or more architecture proposals.

4.3 What is the current status in mid-2005 for Standard Interoperability Level 0?

The Epicentre Logical data model was used as a base for several successful implementations (Petrosystems, CNPC) but as the DAE was not really implemented, no real application business started on this basis. The two major vendors, Landmark and Schlumberger, had no specific reasons to migrate their application portfolio on this data access. They were keeping their own datastore policy, keeping the hand on their own Data Base Design and connecting their own products with the products acquired year after year.

Today, unfortunately, there is no market for a portfolio of applications able to use the Epicentre DAE. As a consequence, this interoperability level does not exist between different vendors.

4.4 What is the current status of proprietary Interoperability Level 0?

All major vendors have their own product: Open Works for *Landmark*, *Geoframe* for *Geoquest Schlumberger*, *Epos 3D* for *Paradigm*, a proprietary one for SMT. These ensure this level 0 interoperability between their proprietary offerings.

5 LEVEL 1 & 2: OPEN SPIRIT

End-users can run many applications against different *data stores and application components* can request to be notified when the contents of *data objects* encapsulated by servers change.

Development of the OpenSpirit application framework began in 1997 as a project funded by the OpenSpirit Alliance, a consortium comprised of oil companies and software vendors seeking to address inefficiencies and high costs related to the poor integration capabilities of E&P applications and their related data stores.

With research and development funded by consortium members, a multidisciplinary team of technologists delivered a prototype of an application integration framework in 1999. While it met with strong support among consortium members and the E&P community as a whole, it became apparent that to best serve the industry, it would need to be offered by a commercial entity responsive to market needs.

The *OpenSpirit* Corporation, based in Houston, Texas, began operations in July 2000 as an independent software company. An off-the-shelf, standards based middleware product, the OpenSpirit application integration framework allows interoperability between multiple vendors' applications and data. To date, over 28 software vendors have licensed the OpenSpirit developer's kit. Additionally, there are now over 1000 oil company end-users in over 45 countries taking advantage of the framework to speed up critical workflows and enhance analysis in the geotechnical space, with more adopting the solution every day.

Technically, *OpenSpirit* (2004) is an industrial software platform based on the CORBA architecture that offers a standard access to multiple persistence solutions in the petroleum upstream domain. OpenSpirit allows independent applications to interoperate by sharing data and services. Through OpenSpirit, business applications can reach distributed data and dynamically share these data with the other connected applications, whatever the hardware, the programming language used or the software supplier. Given that integrated studies in the petroleum upstream domain require many applications from different vendors managing huge amounts of data, OpenSpirit allows end-users to significantly improve their business workflows. Petroleum engineers and geoscientists may integrate multi-vendor applications into a kind of "virtual application".

Figure 1 shows the global architecture of the product. OpenSpirit is made up of:

- a *Base Framework* which offers a set of CORBA services and a set of specific objects (session, links, coordinate system, etc.). Figure 1 shows CORBA services in the OpenSpirit base framework.
- *Data Modules* which are domain specific (drilling, subsurface, seismic). Each implements a set of standard objects relevant to that domain. One or more data servers are

developed for each data module and each data server is specific to a particular physical project data store or corporate data repository. Data servers are responsible for managing data access between the data repository and the business objects.

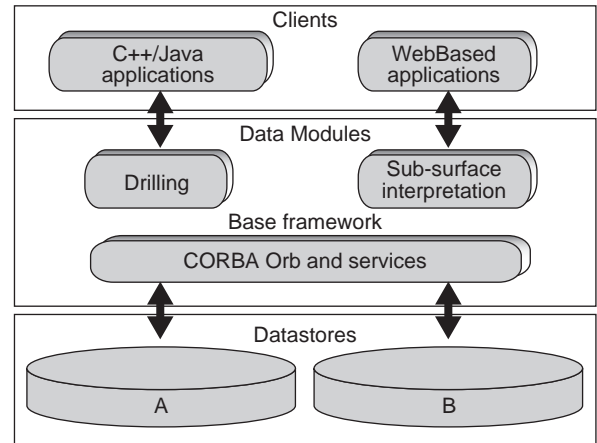


Figure 1
OpenSpirit architecture.

6 EPISEM: INTEROPERATION AT ANOTHER LEVEL (META INFORMATION)

The Epicentre Shared Earth Model (EpiSEM) project was a collaboration between the following sponsoring companies: *Agip (ENI Spa), Chevron, Institut Français du Pétrole, Landmark Graphics, Mobil, Petrotechnical Data Systems, POSC, Schlumberger/GeoQuest, Shell and Statoil*. These sponsors have developed an understanding that a shared modeling environment is one in which the individual computer views of the subsurface, obtained through a series of disparate scientific analyses, can be made to reinforce each other through iterative and interactive processes of experimentation and comparison. They believe that innovations in shared earth modeling resulting from this project will bring benefits to two communities: to oil and gas companies and to vendors of technical computing software for the E&P industry.

For oil companies, the goal of the POSC EpiSEM project is to enable the earth models constructed by engineers and earth scientists to be developed more efficiently and to be used more effectively to support better decision making. As a result, this community will benefit from:

- increased well success;
- reduced time to first oil;

- reduced operating costs;
- and increased recovery rates.

For the E&P vendors, the goal of the project is to define the framework for an open computing platform for shared earth modeling. This community's benefits include:

- the establishment of an effective mechanism for integrating current products;
- reduced infrastructure costs;
- a lowered barrier for entry to the market for niche vendors;
- a vehicle for building the next generation of earth modeling software.

After having experienced that interoperability issues face multiple marketing interests, the group tried to start on the following new policy.

“Too often we tend to get distracted by the technology, and lose our sense of perspective. Effective sharing of earth models should provide the means to keep perspective: to balance the facts, the findings and the views of the asset team members.” For these reasons, the team agreed to adopt a lightweight route to standardization. This means initially collaborating on specifications that provide added value to end users by enabling integration of established and emerging products from different problem domains and developing specifications for software components that are widely viewed as “near-term” commodity.

As a result, a commonly accepted “high level” Shared Earth Model and the way to access it were specified at the beginning of 2001 and then reused “partially” by some of the partners in their WEB integrating solution.

The resulting specification is named EpiSEM-IS (Epi – Shared Earth Modelling Information Services). It reflects the initial focus on earth model meta-data management. Services were designed to enable applications to capture, codify and re-use information about the context and results of the analytical work performed by teams of discipline-focused modeling experts responsible for the optimal development and management of hydrocarbon reservoirs. EpiSEM-IS captures who made the analysis, when, what data (images) were used, what interpretation software was used, and what geological and other assumptions and thought processes were applied. The effectiveness and efficiency of these teams, and the ability of their organisations to make optimal technical, operational and strategic decisions can be significantly enhanced through improved management and availability of such knowledge-asset metadata, through improved inter-disciplinary teamwork, and through improved communication between sets of discipline-focused, specialist application suites.

But again, commercial interests hindered effective communication between partners, even at a higher level.

This is why a few survivors of the EpiSEM project (*IFP, SHELL, POSC, PDS*) decided to develop Open Source tools

enabling automatic metadata server development and automatic adaptation of communication between applications to facilitate the access for any type of application. This was prototyped through an EU funded project: The EpiSEM ACTION project EPIcentre Shared Earth Model Activity Collaboration Through metadata Interoperability Over the Net: www.epiSEM-Action.org. The result of this project is a development framework, enabling the production of collaboration platforms facilitating interaction between applications.

In contrast to the many different frameworks that are available, this one is focussed on components for the development and exploitation of computer-based models in business work processes. This innovation involves facilities to:

- disseminate knowledge and information about computer based models (including the meaning of domain concepts, implicit and explicit assumptions, implicit and explicit hypotheses and inferences, purpose, scope, limitations, architecture, and evolution);
- facilitate and improve the way in which different disciplines create interdependent models;
- leverage the information provided by models to improve collaborative workflows and decision-making.

The technical innovation of this project is that an EpiSEM Action platform is configured and driven by semantic networks (ontology). The domain specific configuration is based on ontology, which can be replaced to support different domains. This involves not only ontology being used to improve computer based searching, but also ontologies which are used to store meta-data about the information content, design, relationships and business usage of computer based models. The framework also enables dynamic reconfiguration of runtime computing facilities.

CONCLUSION: WHERE ARE WE NOW?

As one can see, the petroleum Exploration & Production effort towards interoperability is still in the beginning of its history. After a first five year period of intensive development, most of the efforts have been slowed down by market interests. Nevertheless, thanks to the action of POSC and all software industry leaders, most of the tools and the technologies exist, and the level of understanding is a lot better. We are very far from reaching the level 6 of interoperability.

Today, Open Spirit looks to be the most advanced initiative. With this exception, the situation is not now actually better than ten years ago. *Open Spirit* itself can be seen as a success because *Schlumberger, Shell, and Chevron* took equal shareholdings in the company to energize the process. But “others” are considering now that this participation has too much influence on the future of the product, and *Open Spirit* initiative may be seen as an initiative of *Schlumberger*.

Occasionally, with *Open Spirit*, inside one vendor solution, one can find very good interaction levels (up to interaction level 3).

But if we consider a more “universal multi-vendor approach”, level -1 of the interoperability is the only one effectively available. Using flat format as SEG-Y, LAS, LIS, half link mechanisms as Geoshare, RESCUE, WITMSML, the data itself can be translated from one application to another one. In most cases, the data will be reintroduced in a proprietary data store and then degraded, duplicated, disconnected from the workflow, and made available for a number of other applications. We can illustrate this by the use of WITMSML by the major vendors. These vendors developed very efficiently WITMSML accessors able to load information while drilling in their proprietary data store, on which their applications are running. As a consequence, we can go now from one proprietary workflow to another, but we are not really able to set up a workflow using applications of diverse vendors.

To obtain real interoperability in the long term, new ideas can be proposed such as indicating the need to separate information on several layers: workflow, application domain, applied rules and data (coming from EpiSEM projects). In this case, XML based semantic “meta information” can be used to represent historical data management, workflow, application domain and applied rules and this information (whose semantics have to be shared between all organisations) can be shared or exchanged between applications on

internet and intranet. Data transfer itself can be based on “interoperability level 1” standard and tools or proprietary accesses.

At the end, in the very conservative petroleum Exploration and Production world, the real interoperability between applications must be orchestrated by the companies themselves. The messages have to be clear and the solutions proposed easy, practical, cheap and shared with other industries. Today POSC, which is able to provide the foundations for the development of a knowledge based interoperability semantic, is increasingly working as a facilitator to help the development of several on-going interoperability initiatives (WITMSML, RESCUE, X/FIELDS, EpiSEM). If our petroleum Exploration & Production industry wants to obtain a good leverage for multi-vendor application interoperability, a new wave, driven by the companies, must come with new solutions, partners and proposals.

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