A Domain-Specific Modeling for Monitoring Operations in a Smart field

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***Abstract*-The research focuses on data gathering in a typical oil and gas Smart field/Digital Oilfield and related experts in the oil and gas industry whose primary business line is tied to pipeline mechanisms. The software is domain-specific i.e., specific to Smart Field Oil and Gas Flow Station Operations. The software is a language similar to any programming language where in this case code generation and optimization and crude syntactic bottlenecks will not be necessary rather, interpretation through a parser (Translation Engine) will enable any stakeholder in the domain to easily manipulate data in the Smart Field without being encumbered with high technology acquisition to get the desired job done on the Smart Field.). The functional components will interact with the smart field specifications for operation and control through user input, representing the key performance Indicators (KPI). The information can be viewed on several large screens with interactive multi-touch desktops and portable devices showing the entire operation from sub-surface (Reservoir) and surface (Wells and Facilities) captured in real-time and displayed in trends. The development monitoring is an observation system designed to achieve a continuous operation and get the maximum performance of the remote production center. The system helps in monitoring & controlling numerous parameters: Pressure, Static pressure, differential pressure, temperature, liquid level, flow rate, and others. A graphical logical structure is suited to enable stakeholders to do inputs for relevant data gathering via the architecture with the functioning paths.**

Keywords: **Pipeline Engineering, Domain-Specific Modelling (DSM), Domain-Specific Language (DSL), Smart Field, Integrated Data Gathering, Real-time Operation Center (RTOC).**

I. INTRODUCTION

Domain concept describes salient aspects of the processes from which models are abstracted. The objective of modeling is to extract the meaningful properties of the design scenarios and reproduce their behavior in a metamodel [1][2][3]. Monitoring digital operations in a smart field require a programming Language or DSL notation to specify the model. This language description in this context is a domain-specific language with the attendant properties capable of gathering the intended integrated data. As shown in figure 1, the DSL formalism is housing the real-time operations center as the Programmable Logic Controller (PLC). The Real-time Operations Center (RTOC), which comprises the programmable components, the power supply, the memory, and the modules into a central processing unit is the place where well planning, real-time monitoring, well delivery, and a wide variety of operations execution workflows are performed [4]. The Real-time Operations Center is the catalyst in creating an environment where the key players can interact with team members and technologies to make critical decisions in a collaborative work environment (CWE). Real-Time" namely is the ability to gather the right data at the right time for the right person, team, or technology. The goal is to help ensure that any qualified person can access any data, and technology, any asset, anywhere, anytime with the proper expertise needed to do a job. With the advent of widespread real-time technologies and drastic cost reductions, the majority of international oil companies (IOCs) and national oil companies (NOCs) are learning to use this type of technology to take advantage of the global expertise [5].

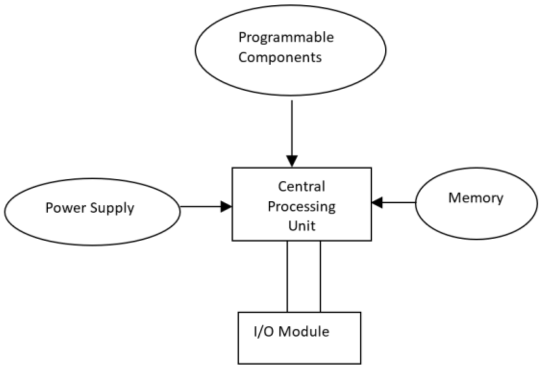


Figure 1: Programmable Logic Controller (PLC)

The thrust of (RTOCs) is: reducing non-productive time (NPT); personnel discharging (POB), reducing risks and uncertainties; improving decision making; and increasing performance. Real-Time Operation Centers (RTOCs) functions are: well planning: 24/7 monitoring; drilling optimization; continuous accompanying of drilling; monitoring reservoir parameters of flow intensification monitoring; cement flow monitoring; data management; real-time IT support [6]. The three (3) models of RTOC are: 1 - RTOC is an integral part of the oil and Gas Company, 2-RTOC is included in the infrastructure of the operating oil and Gas Company, but it is controlled by the contractor, and 3 - the remote RTOC which is included in the infrastructure of the contractor. The three above-described operational centers in real-time (RTOC) provide a more efficient operation and allow authorized personnel to control several exploration teams at the same time. The RTOCs create an environment of cooperation in which experts from a variety of multiple disciplines cross, thus providing the rapid mastering and the development of production skills both for the new employees and the young professionals thereby creating value for the company [7]. The RTOCs help the asset teams of the company share the gained experience in using the technologies in real-time for the development of new fields. The DSM for Smart field is a sub-model of the general pipeline engineering framework and its weaknesses also show in its lack of clarity in requirement specifications and software processes [8]. The framework is as described in figure 2.

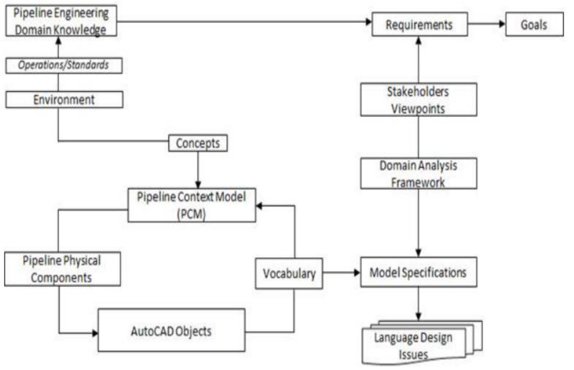


Figure 2: Requirements Engineering framework [8]

Furthermore, a metamodel defines the problem domain, that is, the Smart field in pipeline engineering design framework that sets the semantic space of the C-Sharp (C#) base language in which the DSL processor engine is built that compiles the builder files in Microsoft DSL [9]. The Domain Specific Model is shown in figure 3.

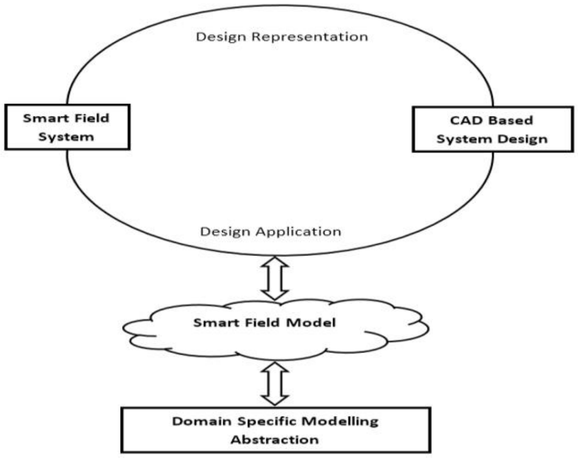


Figure 3: The Domain Model

II. RELATED WORK

The result of RTOC is that the fields are controlled from the remote-control centers; sensors for monitoring in real-time are installed in the wells, the equipment, and in the pipelines. The remote control and production optimization system were created, and a new concept of exploitation and maintenance was developed. A smart Field is a complex of new digital technologies for the control and management of hydrocarbon production facilities. A Smart field is an industry coined word and other variations exist in the Oil and Gas industry. These include Digital Oilfield (DoF), I-field, e-field, Integrated Operations (IO), or

Real-time operations. This complex includes multiple fiber optic sensors that can withstand high pressure and temperature, which are placed in the well and are connected to a single control center [10]. The main objectives of the control centers are production monitoring in real-time; integrated interaction in production operations; adaptation of development history; optimization of the operation control system. The main part of the information on oil reservoirs comes from seismology, geophysics, geology, and development [11]. The data processing, the interpretation of the results, the modeling of the development processes, and the storage of the mass of constantly updated information require high-performance computer systems that can load, process, and unload meta volumes of geological field data in real-time. Different systems are deployed to monitor and analyze different parameters of well in real-time. The virtual analyzers acting as the conventional measuring devices can be used or in conjunction with others. As the immeasurable parameter often characterizes the performance of the entire automation system and wider the process facility in general, such may be included as optimization objective function (e.g., quality of the output product, the dew point temperature, etc.) the virtual analyzers are a basis of the construction of the optimization system. Technical and economic optimization is usually calculated for the whole unit (for example, distillation, catalytic cracking, etc.) and is implemented as a larger unit that controls a set of multiple regulators [12]. The control through the system is used to solve the problems of two classes: high-quality stabilization process based on the minimization of the integral criterion of the quality of the transition process and the optimization of the process as the higher-level tasks. The field preparation is to extract moisture and mechanical impurities from the formation gas and to ensure 20 and -10 degrees Celsius temperatures respectively for dew point in summer and winter according to the requirements [13]. Duration of operation of the deposits, the main sources is a very significant period. Over such a period there was a significant drop in reservoir pressure, which led to the need to transfer the field to the compressor stage of development. Due to the significant increase of the gas temperature after the compressor station the conditions of glycol dehydration are deteriorating and it becomes more problematic to achieve the required quality factors of the gas dehydration determined by the dew point temperature.

III. METHODOLOGY

The methodology deploys the domain Specific Modeling (DSM) paradigm of Smart field operations based on the pipeline user requirements and guidelines. The methodology incorporates users or stakeholder design intent or viewpoint into the subset of the semantic model. Next, common and distinct functions are identified in the structure of the modeling language and abstracted and represented as specific design frameworks that can be adapted or refined for further modeling. The DSM conventional platform contained in the design includes The Adaptability and Usability materials including the Screen organization, System information, System capabilities, Accessibility, Real-time, and others.

IV. SMART OPERATIONS ARCHITECTURE

A. Performance Indicators (KPIs)

The KPIs are measurement indicators that evaluate the system's success or implementation and such targets are readily visible. The development monitoring is an observation system designed to achieve a continuous operation and get the maximum performance of the subsea production center. The system helps in monitoring & controlling numerous parameters including temperature, pressure, flow rate, and other relevant parameters. A graphical logical structure is suited to enable stakeholders to do inputs for relevant data gathering via the architecture with the functioning paths [14] as shown in figure 4.

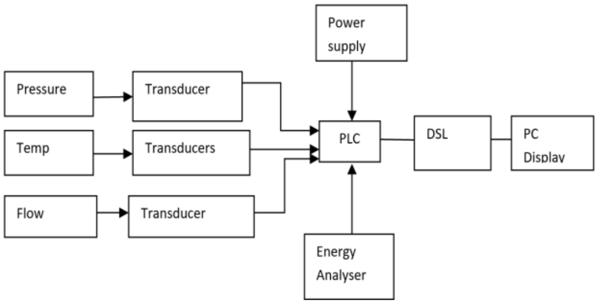


Figure 4: Operations Architecture

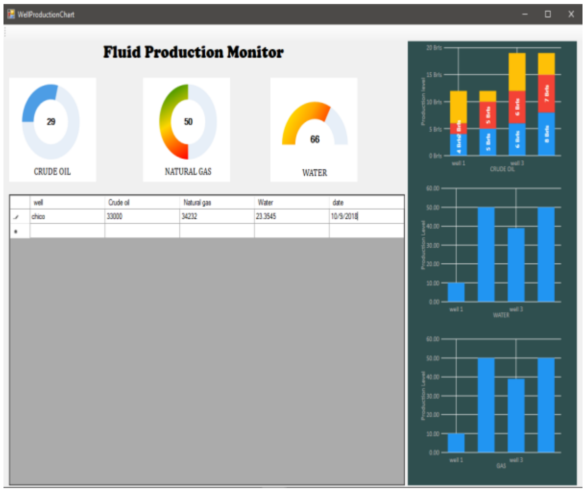
The availability of reliable information on the production process and the underwater complex and also the continuous information update is critical to timely and right decision making. The monitoring of the development allows to receive the information on the status of the sensors and equipment (checking the basic functioning of the sensors and testing the reserve devices); to ensure the collaboration with subsea control module (communication, distribution of hydraulic and power generation and analysis of hydraulic and electrical parameters) and for the detection and prevention of hydrocarbon leaks; to monitor the subsea equipment (compressors, multiphase pumps, separators, coolers); to monitor the state (the integrity of the system, deposits of sand, erosion); to create a database (history of the data, event log, and documentary support) [15]. The systems of early prevention of potential failures offer opportunities to improve the efficiency of the use of the equipment and the impact of the planned maintenance. The support control center of subsea field development is made up of specialists in fluid extraction technology, cybernetics, hydrodynamics, and providing continuous production.

B. Adding the Monitoring Components

When the modeling system is launched, the user is presented with a user-friendly dialog subsystem. The user needs to add the data-gathering attributes components by clicking on the flow monitoring concrete syntax to begin a data-gathering session. Thereafter, the guided notations for the pipeline flow components will be displayed for the input parameters, giving the user the freedom to input pipeline components attributes and the corresponding values for view and loading. After adding the attributes and values to the destination boxes, the user has to build on each component by clicking on the appropriate build button. The system will then load from the data model into the view logic for the necessary modeling actions to be taken. After these operations, the pipeline engineer often referred to as the stakeholder can now run the system by obeying simple prompts to come up with a system curve that pertains to the design scenario adopted by the engineer to solve that particular pipeline modeling intents [16].

C. Relationships and Attributes

The modeling system was designed to gather oil and gas pipeline data that is input from domain experts and stakeholders to a domain module [17]. The domain model contains value relationships and attributes of the oil and gas flow attributes from the smart field to ascertain steady operational parameters measurements; validation of values and model transformation takes place at this point being synchronized with the data model and then loaded for processing. When the user clicks on the add values and attributes for modeling action in different successions; and then the first one will close and multiple interfaces are displayed. Either the attributes or values can be input into the corresponding boxes with the defined parameters such as inner dimensions, outer dimension, length, slope, etc. Each component can now be built with the captured data through the build functions in the appropriate buttons. This is completed for all the chosen components for a particular design scenario and intent. Typically, if new design intent has been specified, the system allows the user to load new attributes and values, corresponding to the selected component types. Figure 5 displays the attributes and values for the fluid production monitor, depicting different monitoring scenarios according to the particular viewpoint of a stakeholder in solving that particular data to be monitored and gathered [18]. The fluid monitor tracks the fluid production level. It monitors how much crude oil, natural gas, and water is being produced by a certain well at every point in time. It also gives an alert if the water production level is too high or crude oil production level is too low concerning either test well or bulk.



	well	Crude oil	Natural gas	Water	date
	chico	33000	34232	23.3545	10/9/2018

Figure 5: Fluid Monitor

The modern information systems allow you to get in a convenient form for the operator the data from the wells, gathering station, storage tanks, primary oil treatment plants, the booster group pumping stations in real-time. The data gathering from sensors is through the modern controllers and database management systems that are responsible for the storage and processing of data in real-time and from relational databases. As part of the monitoring functions of production processes and the dispatch management in modern information systems, the following tasks are solved. The user gets the basic values of the monitored parameters (flow rate, pressure, temperature, etc.) of the wells, group metering stations, processing plants of surface facilities, storage and delivery of products, etc. in real-time. This removes the visualization bottlenecks and the screen provides the current values in comparison with their established limits in controlled processes. The Well operation data is processed and issued on request in specified formats. The user is supplied with the rich opportunities the report generator provides that enable standard design formats and several field reports. Some of the common reports are changeover and daily production reports, production reports, injector volumes, the status of wells, and others. The monitoring of events that triggered emergency shut down (ESD) valves and the event sequence is properly analyzed and recorded and continuous surveillance on potentially hazardous areas are the hallmark of the operators' business. The monitoring and the analysis of all the equipment shut-downs directed, fixing, the reasons for shut-downs, the shutoffs based on restoration, and history of the process of all the actions that led to a shut-down is conducted as highlighted in the process.

V. TRACKING THE PARAMETERS

A. Functions of the Process Control

The function of the well monitor as shown in figure 6 is to keep track of the well's temperature, pressure and flow rate, and other critical parameters. If the temperature of a certain well is getting too high the system gives off an alarm notifying users or operators of potential danger which will activate the emergency shutdown valves that shuts down the plant abruptly if corrective measures are not taken immediately.

Figure 6: Well Monitor

The well monitor is tailored to the functions of the advanced process control, which is a set of software and algorithmic tools for centralized management and the technical-economic optimization of complex systems. The advanced control includes three main concepts: multi-coupling regulation (Model predictive control), Virtual analyzers (inferential measurements), and empirical - neural network or regression - models that reflect the relationship of the immeasurable parameter and the indirect factor, technical and economic optimization in real-time. The multi-coupling control unit (for example, a column with a coupled heat exchanger, process furnace, etc.) can be realized with single multiple controllers regulating the PID control knobs that represent the basic automation system or the actuators directly [19].

B. Reference Analysis

Careful observation shows that, besides other factors, evaporating gas also affects the quality of gas treatment. When reducing the flow through the device (at a constant contact pressure) the linear gas velocity through the device decreases and consequently the velocity factor, and reducing the intensity of the mass transfer, the coefficient of the testability of the nozzle and the deterioration of the dew point temperature. Since the deposits of the field have long entered a stage of declining production and are characterized by high water invasion, the engineers, from the 25 C tries to find solutions for the effective modernization of the field gas treatment to adapt to the change (and continues to change) field conditions. Reference analysis tries to modernize field options, all of them being associated with significant capital costs because they assume new construction and/or reconstruction of old facilities. Therefore, individual controls can be implemented based on a Programmable Logic Controller System that compares the increased complexity of the operation with the process of the process plant or refinery. This can be achieved through the following approaches: 1. Implementing Virtual analyzers which data serve as a basis for constructing multiply regulators and the optimization process, will allow the operator to judge the flow process in real-time. They have the following disadvantages: a significant duration of one measurement cycle of about 10-15 minutes, a fast drift of readings that requires constant maintenance of the device, and the complexity of such services. The virtual analyzers of dew point temperature improve the efficiency of data collection and provide the necessary systems collection frequency measurements. Moreover, their readings can reflect the drift of real measuring device reading. 2. The implementation of a multiply regulator gas dehydration plant to stabilize the absorption dehydration process, characterized by multi-connected complex dynamics of flow generates considerable inertia and fluctuations in raw material input flow rate and composition.

C. Storage Accuracy

The accuracy of stored fluid is a key issue in the oil and gas business and mostly third-party tools or equipment are used. For the proper functioning equipment quality checks and volume of stored or dispensed fluids, virtual analyzers are deployed. They could be process, statistical or empirical models and either be software or hardware and they find patterns after examination of data. Instrument analyzers carry out comparisons between field reading in the instrument and calculated values in real-time for instrument malfunction.

Figure 7: Tank/Storage Monitor

This system enables to conduct of the flow in the pipe in the desired mode and avoids plugging. The function of the tank monitor as shown in figure 7 is to give you an accurate reading of the fluid storage tank levels at every point in time. Since the fluids collected from the wells are being sent for storage, it is important to know what quantity of fluid is available at every point in time. If the tank is full the system ought to let the user know. The equipment monitoring section generally will give the status of the equipment used at the oilfield. If a certain part of the well is getting worse the system should alert the user to prevent further damage.

VI. CONCLUSION AND FUTURE WORK

The crux of Digital oilfield application is to model the behavior of the oilfield showing the deliverable on a PC. The digital oilfield or Smart field elements may include visualization, Collaboration, Data management, workflow automation, and so on. The software is domain-specific i.e., specific to Smart Field Oil and Gas Flow Station Operations. The software is a language similar to any programming language where in this case code generation and optimization and crude syntactic bottlenecks will not be necessary rather, interpretation through a parser (Translation Engine) will enable any stakeholder in the domain to easily manipulate data in the Smart Field without being encumbered with high technology acquisition to get the desired job done on the Smart Field.). The functional components will be interacting with the smart field specifications for operation and control through user input. Further work is detailed to incorporate industry recommendations with a principal business interest in the oil and gas industry.

The focus of this research is about how data can be gathered in a typical oil and gas smart field and related experts in the oil and gas industry whose primary line of business is tied to the field of pipeline mechanisms.

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