# An Industrial Cloud: Integrated Operations in Oil and Gas in the Norwegian Continental Shelf

Chunming Rong

Department of Electrical Engineering and Computer Science
University of Stavanger, N-4036 Stavanger, Norway
chunming.rong@uis.no

**Abstract.** Cloud computing may provide the long waiting technologies and methodologies for large scale industrial collaboration across disciplines and enterprise boundaries. Industrial cloud is introduced as a new inter-enterprise integration concept in cloud computing. Motivations and advantages are given by a practical exploration of the concept from the perspective of the on-going effort by the Norwegian oil and gas industry to build industry wide information integration and collaboration. ISO15926 is recognized as a standard enabling cross boundaries data integration and processing.

**Keywords:** cloud computing, integrated operations.

## 1 Introduction

In a large scale industrial operation, making the right decisions depends on the accurate overview of the current operation status built upon the received operational data flow. The challenge is to deal with the information flow in an *integrated*, *cost efficient?*, *secure* and *reliable* way, while confronting the following: the data flow increases in both quantity and complexity; the received information may often cross disciplines and even company or enterprise boundaries; new information may also be data-mined or extracted from existing information. Furthermore, consistent views of the situations among different involved members should be maintained to avoid conflicts and errors. For real time operational control, the accurate overview must be constantly maintained during the operation. In addition, before being used in a decision making process, information quality should be ensured for both retrieved and extracted data, by consulting related information, e.g. historic events, or current statuses of the other connected components. To exchange, process and analyze the increasing digital data flows from industrial operations, an integrated information platform should be established in an industry wide effort.

Cloud computing technology has the potential to meet the above mentioned challenges. The general goal of cloud computing is to obtain better resource utilization and availability among connected entities. Existing cloud computing models have been focused on providing cost effective services for enterprise, or small and medium businesses. Within an enterprise, information may be interpreted and classified according to the organizational authority of the enterprise. On the other

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hand, due to political and social differences, information integration efforts in the public domain have often met with difficulties in reaching consensus for large scale data interpretations. For an industry wide collaboration, the involvement of an industry wide authority or association is essential for leadership and consensus on information classification, standardization and interpretation. An industrial wide collaboration has its unique characters and challenges. Applying cloud computing across enterprises has many implied obstacles, but the benefits and potentials encourage us to explore applications of the concept. Existing general solutions such as the information grid [1] are not adequate to deal with the complexity involved. To facilitate the information convergence across enterprises, an industrial cloud is introduced in our paper [2] as a new inter-enterprise integration concept in cloud computing, providing a convenient, integrated and cost efficient? solution in large scale industrial collaborations.

## 2 Integrated Operations in the Norwegian Continental Shelf

The global energy situation has been dependent on oil and gas products for the last decades. The recent energy crisis occurs in a combination of increasing demand and reduction of production reserves. The Norwegian Continental Shelf (NCS) is a case in point. Many of the oil and gas fields on the NCS had their peak production periods in the 1990s. The situation reflects on both less volume and higher unit costs in their oil and gas production. Consequently, the rise of consumer energy prices was inevitable in order to keep up with demand, while production from such fields on the NCS was approaching the limit for what was profitable. To prevent many of the fields from planned shutdown, the oil and gas industry in Norway recognizes the needs to apply new technologies and methodologies to improve the production process with a cheaper, faster, automated and collaborative solution. Better access to relevant data and tighter collaboration between geographically distributed personnel should lead to faster and better decisions.

Furthermore, the reduction in oil reserves has pushed the exploration of new oil and gas fields further north and even into the arctic region, e.g. the recent Snow-White field is currently the north-most field in operation on the NCS. In addition to the remoteness of the area, rough weather and oceanic conditions are obviously associated with such operations in the high north. Hence, asset and resource management through remote and distributed control is preferred. However, it leads to heavy demands on the communication links and information flow. Additional complexity comes from the connecting and integrating business processes and information sources across organizational boundaries. Furthermore, the environmental vulnerability of the high north areas requires special attention in such operations, and the tolerance for environmental hazards should be approaching zero as a commitment for such exploration licenses. Therefore, the capability of real time monitoring and control is essential for a successful remote operation, between fields and operation centers located elsewhere. Heavily instrumented facilities must be installed for remote data retrieval and control. Key work processes must also be renewed with automated real time data handling embedded.

To meet all the requirements and at the same time maintain profitable operations, the Norwegian Oil Industry Association (OLF) and its associated members have joined forces on a vision of large scale industrial collaboration on the NCS, called Integrated Operations (IO) [3], defined as "collaboration across disciplines, companies, organizational and geographical boundaries, made possible by real-time data and new work processes, in order to reach safer and better decisions – faster". The key element in IO is the integrated digital information platform to provide industrial services and solutions for those interconnected entities. The goal is to increase the amount of oil extracted from the reservoir while reducing the cost, and to be able to operate safely and sustainably in remote, vulnerable and hazardous areas. According an OLF study [4], the effort of IO is predicted to add value of USD 50 billion to the NCS operations, based on the reduced costs and increased production. Integrated operations are recognized as a key element in the future of the oil and gas industry, e.g. the on-going IO in the High North (IOHN) project [5] consists of key members from both IT, defense, and oil and gas operator and service companies in NCS.

The development of IO can be characterized as an industrial effort on cloud computing. A prerequisite for the development of next generation of IO is a robust digital infrastructure and a platform for effective and efficient information exchange. For the oil and gas industry on the NCS, all production platforms and most of other installations are connected with communication fibers and some with redundant communication links through e.g. radio or satellite. The available communication infrastructure is modern and unique. Above physical level, there is the so called SOIL Network (Secure Oil Information Link) to provide the inter-enterprise information exchange network. The infrastructure makes possible further development of a robust industry-wide digital platform using the cloud computing concept, providing not only effective and efficient information exchange but also enabling service delivery.

Information integration is essential to allow the data exchange and sharing across boundaries, and to support data interpretation, information validation and related web services for data mining. Many sub-domain standards exists side by side, e.g. within the sub-domain of drilling and completion alone, there are more than five different communication standards to relate to, e.g., WITSML [6] or OPC-UA [7]. The development of the ISO 15926 [8] based oil and gas ontology has provided opportunities to unify and integrate different data standards and to apply information validation and reasoning methodology. Together with the POSC Caesar organization [9], the work of realizing IO has encouraged the implementation of many enabling technologies and standards such as semantic web and ISO15926 by the members of OLF.

Many fields on the NCS have been modernized with heavily instrumented facilities. The advance in sensor and actuator technologies allows increasing amount of data to be retrieved and delivered in real time over the information infrastructure. Different kinds of data are retrieved from the instrumented installations and stored in distributed databases. Both current and historic data are available from these databases for decision making. The databases may also be available cross enterprise boundaries. This huge amount of data may now be made accessible in real-time for personnel located far away from the offshore platform. However, humans have a limited ability to deal with large amounts of data, especially when it arrives constantly

and simultaneously. Hence, it is important to automate the data processing, and filter out unnecessary information and present what is relevant for the tasks at hand. Among the related efforts in IO, the TAIL IO project [10] is most noticeable.

Real time operational control is a significant part of the proposed IO architecture. Recent developments in information and communication technologies enable a more cost efficient utilization of real-time data from the offshore installations, allowing a tighter integration of offshore and onshore personnel, operator companies and service companies.

By integrating and presenting relevant data, new work benches and visualization solutions have been developed to provide an overview of the current state of various systems at the remote installation. Personnel collaborate across a distance sharing this common view of the data. This may result in improvements within fields such as production optimization, process optimization, better work planning, better risk and personnel safety management.

## 3 Conclusion

Collaboration between different companies in an industry is important to meet the challenges of the future. The effort of realizing the vision of IO in NCS has explored many enabling technologies and methodologies such as cloud computing and semantic web with implementation and field tests. However, there remain many challenges, e.g. unified industry wide data standards (of which ISO15926 is recognized as a strong candidate), work flow and work processes renewal, security, reliability and availability. To establish an industrial cloud, the involvement of industry wide authorities or associations, like OLF and POSC Caesar is essential for leadership and consensus reaching. Implementation of IO on the NCS shall enable real time data decision-making worldwide and provide new collaboration models that link offshore installations, onshore headquarters and service companies. The related innovations in technologies, methodologies and work processes have great potential to create new value and opportunities and to lead us to safer, faster and better decisions.

## References

1. Alonso, O., Banerjee, S., Drake, M.: The Information Grid: A Practical Approach to the Semantic Web, http://www.oracle.com/technology/tech/semantic_technologies/pdf/informationgrid_oracle.pdf
2. Wlodarczyk, T., Rong, C., Thorsen, K.A.: Industrial Cloud: Toward Inter-Enterprise Integration. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 460–471. Springer, Heidelberg (2009)
3. OLF, Website on Integrated Operations, http://www.olf.no/io
4. OLF, Potential value of Integrated Operations on the Norwegian Shelf, OLF report (2006), http://www.olf.no/getfile.php/zKonvertert/www.olf.no/Aktuelt/Dokumenter/Potential%20value%20of%20Integrated%20Operations%20on%20the%20Norwegian%20Shelf.pdf

5. Integrated Operations in the High North (IOHN), http://www.posccaesar.org/wiki/IOHN
6. Energistics, http://www.witsml.org
7. POSC Caesar Association, http://www.posccaesar.org
8. ISO, ISO 15926: Industrial automation systems and integration – Integration of life-cycle data for process plants including oil and gas production facilities, http://www.iso.org
9. OPC Foundation, http://www.opcfoundation.org
10. StatoilHydro and consortium consisting of ABB, IBM, Aker Solutions and SKF, TAIL IO, http://www-05.ibm.com/no/solutions/chemicalspetroleum/tail.html