

Seafloor Mapping workflow in a Cloud environment – Mapping Cloud

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Abstract— KONGSBERG supports commercial and non-commercial customers with technical products and services to collect various types of data to map the seafloor. Today’s workflow is very much structured around collecting data offshore and performing processing and analysis of this data once the vessel is docked to shore. This imposes limitations with respect to collection and use of resources in general. To solve this, Kongsberg introduced the Cloud based platform Kognifai, an open digital ecosystem. The purpose of Kognifai is to level the playing field and let everyone participate; customers, partners, vendors, ISVs, industry clusters, and entrepreneurs alike, to ensure the best possible analysis of collected data. The platform is open to everyone who wants to contribute and transform the industry through digitalization. With Kognifai, sonar data collected with multibeam echosounders and other sensor systems can be stored and managed in this secure environment. The data can be processed in near real-time and made available for immediate distribution to personnel and teams with multidisciplinary skills and expertise. Consequently, various decision support information can be produced by combining sonar data with data from other sources giving the end-user a complete understanding of the mapped environment. This information can be available to everyone with permission, from anywhere in the world. It also enables true remote control of an ongoing operation and access to results from previous operations.

I. INTRODUCTION

(2)Kongsberg Maritime (KM) is a leading provider of solutions that require sound-in-water. Our product portfolio is significant and include amongst others underwater communication, positioning, surveillance, autonomous vehicles (e.g. Hugin, Munin, and Remus), single and multibeam echosounders, sonars, sidescan.

(3)Multibeam echosounders from KM, EMTM, was introduced in the late 80’s with the EM100. KM has since developed EMTM-systems from full ocean depth and 40km coverage to high frequency (500KHz) systems with shorter range and centimeter resolution.

Sub-bottom profilers have been added to the EMTM family, both as standalone products and as integrated solutions together with EMTM-systems, EM304 and EM124.

(4)The software that comes with the EMTM-systems has developed over the years with increasing demands for accuracy,

user friendliness, and integration across platforms and organizations. Today the demand for truly distributed access to data is increasing. They- clients, customers, academia, public services- all want easy access to data in near real-time from any geographical location. The data produced by EMTM-systems are thus being used in many different business areas, not only the traditional hydrographic map.

II. KOGNIFAI

(5)Kognifai is Kongsberg’s solution for a truly open cloud-based digital environment. Kognifai supports collaboration and knowledge sharing between and within organizations, enabling them to interact with each other in ways never previously possible. With the platform, customers, clients, academia, domain experts and developers are all invited to participate in finding good solutions to common problems.

(6.1)Large datasets can be stored in Kognifai. The user is the exclusive owner of all data uploaded to Kognifai unless otherwise arranged. Nobody else can read or make use of it unless the user grants them access. (6.2, 6.3)Additionally, access can be restricted to a user or a group of users, for a limited time or for a particular purpose. All kinds of data can be uploaded: multibeam echosounder data of all makes, not only from EMTM-systems, sonar data, and even data from other sources like video, weather, laser, etc. In our pilot project, Kongsberg stored data from our competitor, processed by software from our competitor. In Kognifai everybody’s welcome.

(6.4)Having easy access to large data volumes also allows for development of algorithms that use Machine Learning (ML) to gain deeper and automated insight. Today pattern recognition algorithms have proven to be efficient in finding various irregularities and artifacts in data: search for holes in pipelines, find free-spans, etc. With access to larger datasets, ML-algorithms can be developed to find patterns that are not so easily recognized by humans, and to gain deeper knowledge. E.g. answer questions like ‘Is there a correlation between the changes in the topography and oil production?’ ‘Has parts of the chalk rich areas in the North Sea the seafloor sunk due to reservoir depletion?’. ML can look through combinations of different dataset we have not yet considered.

(6.5)Computer resources in a cloud-environment are scalable. A simple task may require one CPU core that runs for a long time, e.g. when logging data from a slow sensor, while

other tasks require many CPU cores for a shorter period of time. Processing of large volumes of sonar data benefits significantly from using massive parallel processing to reduce the computing time. The pricing model using a cloud based solution also benefits the multi-parallel nature of bathymetric post-processing, as you only pay for the CPU time spent, running one CPU for four days can be the same price as running hundreds of CPUs in one hour.

(6.6) Access to data in Kognifai only requires Internet access. Once the data has been uploaded, either in real-time through Kognifai connectors installed on the ship or in batch after the survey, the data can be handled in Kognifai through a web browser (Chrome, Firefox, Microsoft Edge) on any modern device. This makes it possible to work with the data from any geographical location. An organization can start working on the survey in Singapore, continue in London and finish in San Francisco. In a cloud environment, many people can access the same data at the same time and share the workload in the processing stage.

(6.7) Cloud services providing data storage also provides secure storage. Data backup is handled by the storage provider. In the case of Kognifai it is handled by Microsoft. Risks related to fire, theft, flooding is also much better mitigated in a Cloud storage setup compared to when each organization has to do all this on its own. Major cloud vendors, like Microsoft, offer geo-redundancy of the data, this reduces latency when accessing the data on different parts of the globe, and stores backups in different parts of the world if this is required. National Security may still require that the physical storage is done within a country's borders, and that all cables leading in to the storage is secured. Such requirements will limit some of the benefits from a true Cloud computing environment, but it will still be possible to run all the applications developed in Kognifai in a local Cloud in such an environment. Kongsberg could be one provider of local Cloud storage should the request be made.

(6.8) Microsoft Azure support Hybrid Cloud usage, to combine data stored in the cloud with data stored in local data centers, in many applications this capability simplifies the task of keeping the most sensitive data close, while still utilizing the power of the cloud.

(6.9) Kognifai runs on Microsoft Azure, and this makes it easy for developers to create applications that can run in Kognifai. In addition to this, Kongsberg Digital offers several Software Development Kits, SDKs, to further assist in software development. These SDK provides excellent examples to show how common tasks are easily solved, so the road to deploying applications in Kognifai is rather easy for most developers. The Kognifai portfolio contains edge connectors, 3d tools, application framework support, authentication and authorization systems, dashboard widgets, database solutions, routing and queue support features.

(6.10) Existing PC programs can also be run in Kognifai without any alteration at all. Kognifai supports virtual PC's which can be configured to a specific task: CPU, RAM, GPU resources can be configured. Then PC processing software can be installed and run on data stored in Kognifai. This solution is a good way to move existing desktop solutions quickly into a Cloud environment without any alteration

III. EXISTING KOGNIFAI USAGE

(7) Kongsberg has a footprint on more than 18000 ships. Our Kongsberg Division for Vessel & Fleet Performance alone has more than 1000 ships from Europe, USA and Asia in their portfolio. Reports are generated on demand for the ship owners making it possible to monitor the ship's status from any web-browser at any geographical location.

(8) Kongsberg Renewables, responsible for windmill parks, use Kognifai to monitor and control the energy production. Data are gathered, monitored and analyzed in near real time, providing complete control to the owners through a web-browser.

(9) Other divisions in Kongsberg are now developing solutions based on the Kognifai platform. The quantity of cloud enabled applications will increase and span into most industries that Kongsberg are involved in.

IV. MAPPING CLOUD

(10) KM, Subsea Division has started developing applications and solutions for the Kognifai platform. This development is done in close collaboration with partners and customers. KM benefits from all the work already put into the Kognifai platform by other divisions in the KONGSBERG Group.

Our vision is a Mapping Cloud solution with a set of tools and applications making the handling of survey operations run smoother than today. As more and more sensors are connected to the Mapping Cloud, new applications and processing tools will be made available. Since Kognifai is a truly open environment, we also encourage software developers to use and extend the Software Development Kit (SDK) to further enhance the toolbox. New application written for Kognifai can make better use of the benefits of cloud computing such as access to multiple CPU-cores providing massive parallel processing, direct access to storage in Microsoft, etc.

(11) The first application we have deployed in the Mapping Cloud solution is Storage. Storage looks like a file manager on a PC to ensure ease of use. However, there are a few additional Storage tricks:

- Data upload. The file manager has cloud connectors that can be installed on ships, automatically pushing data to the cloud. It also makes it is easy to copy large volumes of data from an office PC to a data storage in Kognifai.
- Data sharing. Sharing between Kognifai users. Others may be allowed to read data and process them, and to put the results back. This is performed in a few clicks, there is no need to send physical hard drives or set up ftp-servers to share large volumes of data between clients.
- Archiving. Data stored in Microsoft can be "hot", in which case data can be accessed immediately like a hard drive. However, this has a higher cost than

“cold” storage. Data in “cold” storage are cheaper than “hot”, but cannot be accessed directly. This option is great for saving money on storing large data volumes that do not have to be online at all times.

(12)Virtual PCs is also available in Kognifai. Users can install existing processing software and process the data just like before. This solution makes it easy to benefit from using a cloud solution while still using familiar software. Collaboration between several people during the processing, distribution of the results to clients and customers, access from any geographical location will still be there.

V. REMOTE OPERATIONS

(13)Ship-to-Ship Internet communication is today available in many different ways. Data from autonomous vehicles (e.g. USV) relatively close to the mother-ship can send large amounts of data during a survey operation, enabling one surveyor to be physically located on the mother-ship while controlling data from several other survey vessels. This makes the total survey operation both more cost-effective and safer as USVs can go where others cannot.

Ship-to-Shore Internet communication is also available, but typically more expensive and with less bandwidth. However, this does mean that with clever processing on the boat, enough data can be sent to shore to allow one surveyor to control the operation from the office.

Remote control rooms can then be used to monitor survey operations. With near real-time data from one or many ships, on-shore surveyors can do the quality control, adjust configuration and give advice while the survey takes place. The geographical location of the control room becomes irrelevant as long as the cloud-services provides access to the data and processing tools.

This access to ongoing survey operations through an Internet connection will also allow the end-user of the survey to monitor progress and quality, and to take immediate action if needed. In this way the overall customer satisfaction improves and the feedback latency is reduced

VI. DIGITAL OCEAN

(15)Collecting, analyzing and processing, and finally distributing data in a cloud solution like Kognifai, makes the whole value chain digital, available from everywhere, and enabling collaboration and knowledge sharing in a completely new way. Data from other sensors such as ship performance, weather, AIS, seismic etc., provides an environment where easy access to all kinds of oceanographic related data can be shared. This will bring new possibilities and business opportunities. New products can be developed where the right customer gets the right information at the right time.

Sharing data between Kognifai and other cloud solutions is one of the strengths of cloud computing. The most used connection is data sharing through a RESTful service and a

REST interface using standard protocols. This is great for low-volume datasets and typically used to send the processing results to data consumers that make use of the data in various other products.

Direct access to the data storage is also possible. This requires a more integrated setup with Kognifai and ESRI, and provides more possibilities related to processing of sonar data.

(16)ESRI and their cloud-platform has been a great partner in the development of Mapping Cloud. The results in Kognifai have been made available to ESRI users. Earth Analytic and Geocap have picked them up and made great use of it in several applications. Both near real-time displays of surveys and post-analysis have been performed through this cloud-to-cloud connection.

ESRI's cloud solutions for combining data from different sources, processing and publishing the results in the right way to the right customer has proven to be of great values to Kognifai. The data from Kongsberg EM™-systems can now be put to good use in many different industries, in many different applications, and always available from anywhere on the Internet.

VII. FUTURE DEVELOPMENT

Future development will continue the integration between Kognifai's and ESRI's Cloud solutions. Interfaces between the two clouds will be standardized, more datatypes will be made available (depths, sidescan, processed watercolumn measurements, terrain models, real-time data), and new processing tools will be developed. The need for VM's will decrease as new applications will be web-applications in the Cloud, taking full advantage of the extended possibilities Cloud computing has to offer: multiple cores, RAM, and all this available when needed.

Kongsberg has also started to see increasing interest from customers to store all kinds of data in Kognifai, like environmental data (weather, plastic, etc.). This offers great opportunities for creating new products, and to use existing data in new business areas.

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