

# Integrated solution for seafloor mapping, processing and distribution

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**Abstract**— KONGSBERG has developed a new digital platform Kognifai. The goal with the Kognifai open ecosystem is to level the playing field and let everyone participate; customers, partners, vendors, ISVs, industry clusters, and entrepreneurs alike. Whether you work for a small company with limited resources or a large multinational organization; whether you own industry assets or is a vendor delivering services to it, Kognifai is open to everyone who wants to participate and help transform the industry through digitalization. Kognifai allows sonar data from multibeam echosounders and other sensors to be stored in a secure cloud environment. The data can then be processed in near real-time and made available for immediate distribution. The Seafloor Information System is the logging system for Kongsberg Multibeams. Data stored in the cloud enables the features of the cloud, endless storage and scalability to your post-processing applications. From there, various products can be made by combining sonar data with data from other sources to provide the end-user with a complete understanding of the environment. These products can be available to everyone with access to Kognifai, from anywhere in the world, enabling both 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, Remus), single- and multibeam echosounders, sonars, sidescan.

(3)Multibeam echosounders from KM, EM<sup>TM</sup>, was introduced in the late 80's with the EM100. KM has since developed EM<sup>TM</sup>-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 EM<sup>TM</sup> family, both as standalone products and as integrated solutions together with EM<sup>TM</sup>-systems, EM304 and EM124.

(4)The software that comes with the EM<sup>TM</sup>-systems has evolved 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 EM<sup>TM</sup>-

systems are thus being used in many different application, 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 possible previously. 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 owns all data uploaded to Kognifai exclusively. Nobody else can read or make use of it unless the user grants them access. (6.2)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 EM<sup>TM</sup>-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.

(6.3)By combining data from different sources in one environment, new algorithms can be developed that can look at and investigate the problem in new ways. Pipeline surveys can combine multibeam, video and sidescan into one application, e.g. knowledge of the weather conditions can help processing data, sound speed profiles can be shared, AIS-information can help in survey planning, and so on.

(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 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 identified 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?' In parts of the chalk rich areas in the North Sea the seafloor has sunk considerably because of this. 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 4 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 the web browser of any modern device; Chrome, Firefox, Microsoft Edge. 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. Fire, theft, flooding is also be much better handled in a Cloud storage then 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 datacenters, 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 is 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. Kognifai@Subsea

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.

(10) The first application we have deployed in the Mapping Cloud solution is the File Manager. The File Manager looks like a file manager on a PC to ensure familiarity for the user. However, there are a few extra tricks in File Manager:

- 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.
- (11) 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.
- (12) 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.

- (13)Mount. A directory in Kognifai can be mounted like a hard drive. This makes it possible to process the data in that directory just like processing any other hard drive. This option is great if you want to use existing PC-programs to process data in the Kognifai cloud.

(14)Kognifai apps are based on one of the most popular web frameworks, Angular.js, and getting started requires no development license. Editors like Visual Studio Code or Sublime will have you developing within hours. Server side components are run in Microsoft Service Fabric, and this handles implementation in most popular languages (incl. C#, C++, Java) and can run on most popular operating systems.

(15)Virtual PC’s will also be available in Kognifai. Users can create virtual PC’s, install existing processing software, mount a directory as a hard drive, 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.

(16)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.

ESRI and their cloud-platform has been a great partner in the development of Kognifai@Subsea. The results in Kognifai have been made available as a RESTful service and ESRI users, Earth Analytic and Geodata users, 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.

#### IV. REMOTE OPERATIONS

(17)Ship-to-Ship Internet communication is today available in many different ways. Data from autonomous vehicles 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

#### V. DIGITAL OCEAN

(18)Collection, 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. Sharing data between different cloud solutions will further enhance the possibility for collaboration.

It is important to underline that Kognifai is open to everyone, with all kinds of data from any provider. It is in the sharing and collaboration the true value of the Digital Ocean lies.(19)

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