University of
South-Eastern Norway

Faculty of Technology, Natural Sciences and Maritime Sciences, Campus Porsgrunn

FMH606 Master's Thesis

Title: Cloud solution for vessel fuel consumption monitoring

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External partner: KROHNE Marine

Task background:
EcoMATE by KROHNE Marine is a vessel fuel monitoring system. It consists of Coriolis flow meters for measurement of fuel flow into consumers (Engines, incinerators, generators, boilers, etc.) and in/out of tanks. A computer running the EcoMATE software gathers data from the flow meters and calculates consumption and emission data. Data is stored for historical reporting. At the end of 2017 this product was extended with a centralized cloud based reporting tool. Where the EcoMATE installations on the various vessels communicate with a shore based application to store historical data. This enables the ship owners located on shore to access fleet wide fuel consumption data directly in their web browser. The main storage requirement in the central database is for time series data. Each vessel has ~ 100 data points that should be stored at 1-minute resolution in the cloud. Data must be retained for 5 years. Example of timeseries data to be stored: mass flow rate, total mass, density, speed, distance, position, etc. In addition to time series data, the system handled events from the vessels, such as: Voyages, fuel bunkerings, fuel changes, etc.
A plan to extend the system is in place, however the current solution is not easily extendable. Particularly the database for storage of timeseries data. Currently the database in use is MongoDB and is hosted in the cloud.

Task description:
The main task is to develop a flexible database for storage and retrieval of the required event and time series data using MongoDB. Other database can be selected, but an important criterion is that it is widely adopted and must be available as PaaS (Platform-as-a-Service) in preferably multiple cloud providers. Evaluation of existing time series databases should also be performed. The database must be able to scale from ~10 GB to ~10 TB (5 years' worth of data for 1000 vessels).

- Evaluate existing time series database for usage in this scenario. Criteria's include but not limited to: Software cost, hosting & maintenance complexity, storage efficiency and performance.
- Develop a flexible database schema for storage of the required data in MongoDB (or other if found more suitable).
    - Support for various datatypes (floating point, integer, GPS position)
    - Currently all data are stored and aligned at 1-minute resolution – Evaluate use of flexible resolution/alignment
- Develop an API for storage and retrieval of data
    - Develop in ASP .Net Core, Node.JS or similar.
    - Retrieval queries should support various additional functionality, e.g.:
        - Aggregation of multiple tag values
        - Down sampling of data when long time timespans are requested
        - Average/Max/Min queries (daily/hourly average)

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        - GPS location/time queries
        - Correlation of events with locations (and other time series data)
- Develop a web front-end for proof-of-concept testing
    - Frontend in React for interfacing the API
    - Graph historical data according to user defined time periods, etc.
- Perform testing on developed solution
    - Create a test plan to verify functionality
    - Test and document performance

Student category: IIA students employed at KROHNE Marine.

Practical arrangements:

No particular.

Supervision:

As a general rule, the student is entitled to 15-20 hours of supervision. This includes necessary time for the supervisor to prepare for supervision meetings (reading material to be discussed, etc).

Signatures:

Supervisor (date and signature):

Student (write clearly in all capitalized letters):

Student (date and signature):