White Paper

Fishbone's Remote Condition Monitoring and Data Analytics Platform

F.I.S.H.

Author – Dr. Craig Bower

ABSTRACT

The aim of this Fishbone white paper is to introduce the Fishbone Information Services Hub (FISH) as a remote asset condition monitoring solution using innovative approaches to real-time analytics, including AI and machine learning for predictive failure, maintenance optimisation and diagnostic applications on rail, road and construction vehicles and other assets.

Initial FISH solutions focus predominantly on rail asset and infrastructure management. However, insights into the architectural design enable many other transport applications to be integrated into the FISH.

For more information contact:

Fishbone Solutions
7 Pride Point Drive,
Pride Park,
Derby DE24 8BX

go-fish@fishbonesolutions.co.uk
www.fishbonesolutions.co.uk
Tel: +44(0)1332 899190
Fax: +44(0)1332 898560

TABLE OF CONTENTS

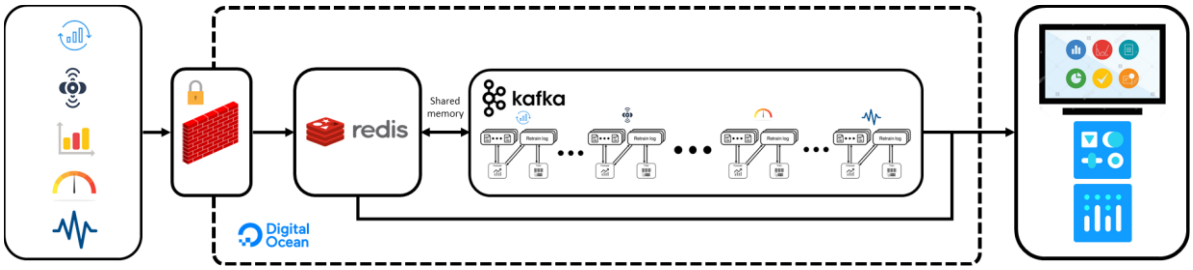
Abstract 1
Table of Contents 2
Introduction 3
Cloud host and Managed Database 3
Event Streaming 4
AI Analytics Engine 4
User Management, Protection and Security 5
Dashboards and Alerts 5
Customer Use-Case Applications 5
Conclusion 6

INTRODUCTION

Fishbone Solutions provide management and engineering consultancy-as-a-service to the transportation and energy sectors. Our vision is to be at the forefront of the transportation sector in providing Remote Condition Monitoring (RCM) solutions (predictive failure, maintenance optimisation, diagnostics, etc.) for assets such as rail cars & wagons, road vehicles, aircraft and infrastructure.

Fishbone has identified this as an area for growth as engineering providers often lack data expertise, whereas RCM companies lack Fishbone's engineering domain knowledge. Also, recent advances in IoT sensor technologies and edge-based data-processing are increasing the potential for real-time data analytics solutions.

Fishbone has now integrated these novel technologies into a cloud-based software product called the Fishbone Information Services Hub (FISH), to provide remote condition monitoring of rail assets. Edge-, Cloud and data-intensive distributed computing technologies are deployed to ensure that this level of sophisticated RCM occurs in real-time (for the first time on many rail applications), saving rail companies £millions each year by eradicating accidents and delays.



CLOUD HOST AND MANAGED DATABASE

DigitalOcean (DO) are our chosen cloud infrastructure-as-a service platform. DO provide a suite of products that allow Fishbone Solutions to manage FISH infrastructure at scale, including developing custom applications, implement contained-based methodologies and take advantage of their fully-managed platform-as-a-service environment for storage.

DO managed database solutions provide a high performance database cluster service. Using a DO Redis database engine ensures that installation, configuration, maintenance and security are fully managed. Clusters include daily backups with point-in-time recovery (PITR), stand-by nodes ensure high availability and end-to-end SSL encryption. Managed databases are multi-region and scalable, and their automated failover means even single-node plans add resiliency to your infrastructure. Redis is an open source, key-value database built with an in-memory design that emphasizes speed. It has support for rich data types, atomic operations, and Lua scripting.

EVENT STREAMING

Apache Kafka© is a distributed streaming platform used for event stream processing, real-time data integration and streaming data pipelines.

Publish – Subscribe. At Kafka's heart lies the humble, immutable commit log, and from theire you can subscribe to it, and publish data to any number of systems or real-time applications. Unlike messaging queues, Kafka is a highly scalable, fault-tolerant and distributed system, allowing it to be deployed for applications providing real- time analytics and predictive maintenance. This unique performance makes it perfect to scale from one app to company-wide use.

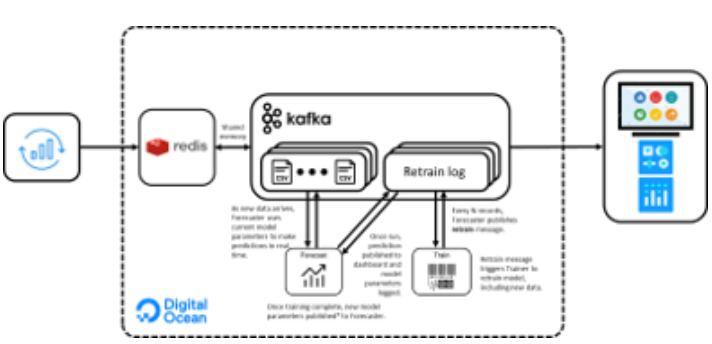
Durable, persistent storage. An abstraction of a distributed commit log commonly found in distributed databases, Apache Kafka provides durable storage. Kafka can act as a 'source of truth', being able to distribute data across multiple nodes for a highly available deployment within a single data centre or across multiple availability zones.

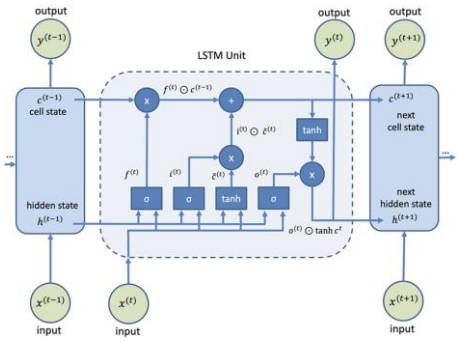
Real-time processing at scale. A data streaming platform would not be complete without the ability to process and analyse data as soon as it's generated. Kafka APIs are powerful, lightweight libraries that allow for on-the-fly processing, letting you aggregate, create windowing parameters, perform joins of data within a stream and more. Perhaps best of all, it is built as a Java application on top of Kafka, keeping your workflow intact with no extra clusters to maintain.

AI ANALYTICS ENGINE

As new events are ingested data is appended to its associated stream and stored in memory. A stack of Long-Short Term Memory (LSTM) Cells constitute the deep neural network model architecture of our AI analytics engine, providing state-of-the-art performance on time-series forecasting problems.

Recently ingested data is continuously used as input for the model, to make forecasts on future behaviour of the given metric. Periodically (or even given for a given number of new data points), the model is instructed to re-train including the recently collected data. If the measured forecast error is smaller with new data then the model parameters are updated. This ensures that the FISH AI Analytics Engine continually forecasts using the most accurate model parameters with no latency.





USER MANAGEMENT, PROTECTION AND SECURITY

The user experience and data security of every FISH applications is paramount to Fishbone and its' Customers. The FISH User Management API undergoes continual kernel and server hardening protocols and a range of application security tools ensure secure code scanning, allow for private repository version control and access token leakage scanning.

Additional compliance includes user logging and audit tracking, Multi-Factor Authentication, rotating SSL certificates, vulnerability watch-list monitoring and UK/EU GDPR compliance. Fishbone Solutions provided dedicated Data Protection Officers that manage and support your every need when it comes to keeping your data safe and readily available to the correct people. Our processes are designed to fit your specific requirements.

DASHBOARDS AND ALERTS

FISH User Interface (UI) solutions allow users to design bespoke dashboard interfaces in collaboration with or independently of Fishbone Solutions. Our FISH HeartBeat is a UI design library built using JavaScript, TypeScript, HTML5 and CSS3, containing all the necessary primitive components used to build user interfaces.

The FISH HeartBeat:

- Supports users and user groups with individual needs
- Builds on strong foundations and tested open-source components
- Customised to specific needs/preferences of each end user
- Supports design guidelines
- Includes drop & drop widget tools and UI component browser

The FISH User Management API allows for users to set specific requirements and decide what actions to take in the event that the FISH AI Analytics Engine forecasts the need for some intervention. Configuration and set-up of Alert Requirements is automatically controlled by the FISH User Management API once the relevant contact details are provided.

CUSTOMER USE-CASE APPLICATIONS

The FISH has already demonstrated its potential in a range of rail asset and infrastructure remote condition monitoring applications and is rapidly becoming an essential tool in predictive maintenance. Just a few of the use cases adopting the FISH include:

Overhead Line Electricity (OLE) Cable Height Monitoring	Ensuring that the OLE cable tension is sufficient for safe rail operation, using predictive AI and weather forecasts to inform managers and technicians with timely alert information.
Freight Wagon Vibration Monitoring for RCM	Real-time Machine Learning on high velocity accelerometer data streams, detecting, classifying and predicting potential anomalous behaviour for just-in-time predictive maintenance scheduling.

Heating, Ventilation and Air Conditioning (HVAC) Analytics	Real-time diagnostics of HVAC systems on passenger trains, using advanced data science techniques and Machine Learning algorithms to find faults in a system aimed at maintaining Carbon Dioxide and Temperatures to optimise passenger experience.
Compressor Diagnostics and On Condition Maintenance	Using Machine Learning and predictive AI to provide otherwise non-instrumented safety critical Compressors with diagnostic capability and on-condition maintenance.

This is just a flavour of what value the FISH can add to any RCM application. Our on-boarding procedures have the flexibility to cater for specific application requirements.

CONCLUSION

The Fishbone Information Service Hub (FISH) provides a democratised platform for any transport asset RCM application to be configured and managed by experts in the transport sector without needing to become a data expert.

This white paper demonstrates the fundamental components of the FISH, highlighting it's ability to ingest a variety of data streams at scale, with fault-tolerance, easy information retrieval and secure storage embedded.

Your remote condition monitoring and predictive maintenance needs are covered with Fishbone Solutions.