Propulsion Analytics

Technical
BULLETIN

Number: PA-TB-10
Date: May 2025

Digital **E**ngine **M**anagement platform DiEM

ABSTRACT

The Digital Engine Management platform DiEM for Condition Based Maintenance CBM of all types of combustion engines was developed by Propulsion Analytics initially for LNG fleets and progressively for all types of vessels. DiEM is a Class certified platform which supports decisions to extend the operational lifetime of “healthy” components beyond time-based maintenance intervals. DiEM is using digital-twins of engines for performance assessment, and Machine Learning for fault pattern recognition, and merges diagnostic methods including thermodynamic models, engine lubricant analysis, vibration data and thermography data, for increased diagnostic accuracy. The DiEM platform allows cross comparisons of performance of individual engines, engines of groups of vessels, engine types across the fleet. DiEM connects to Planned Maintenance Systems PMS and Spares purchasing, to allow timely procurement of overhaul services, which further optimizes asset management, for reduced Total Cost of Ownership.

BACKGROUND

The maintenance of machinery has evolved from a reactive process, performed after a functional failure, to a preventive maintenance activity, where items are overhauled or discarded according to a time-schedule. To reduce the uncertainty resulting from preventive maintenance, new approaches, based on the continuous assessment of machinery condition, have emerged, which are collectively known as Condition Based Maintenance -CBM.

"IN-HOUSE" ENGINE CONDITION BASED MAINTENANCE (ECBM)

To reduce Total Cost of Ownership (TCO) a shipping company needs to optimize the procurement of engine maintenance, inspections, overhauls, and spares.

A company may thus decide to procure an Engine Condition Based Maintenance (ECBM) scheme for the various engines fitted in its vessels, endeavoring to combine a cost-effective supply of spares, 24/7 specialist support, and maintenance services from the open market, with the prolonged overhauling intervals permitted by CBM. Cost savings can also be expected from improved equipment performance leading to decreased fuel consumption.

An approach which utilizes the in-house experience and knowhow for maintenance optimization, necessitates access to advanced software tools and diagnostic applications for performance monitoring, assessment, and decision-making support. Such tools and applications

- should be able to support a diverse fleet of ships and engine types
- should be linked to other enterprise applications within the shipping company, to retain the existing communications and command structure of main office and vessel crews.

A related business case for an in-house ECBM, for an LNG carrier company, indicated an impressive 25% reduction in maintenance cost fleet-wide.

DIGITAL ENGINE MANAGEMENT PLATFORM- DiEM

Propulsion Analytics has developed a platform named Digital Engine Management platform – DiEM, incorporating an Engine Condition Based Maintenance (ECBM) scheme for monitoring the performance of any combustion engine type, fitted in any vessel. The DiEM platform builds on Propulsion Analytics' Engine Hyper Cube® application, which carries out continuous engine performance analysis, using data from onboard engine sensors.

Since 2015 Propulsion Analytics has fielded the very advanced engine performance analysis application Engine Hyper Cube®, featuring a thermodynamic model-based digital-twin, providing high quality reference and reliable benchmarking of "expected" engine condition and operation, which is used in the assessment of the actual performance of all types of marine engines. By fusing thermodynamic modelling of engines with machine learning on operational data, the condition and the remaining useful life of various components can be determined (Figure 1). By 2024 the EHC® application had been installed in more than 450 ships of more than 30 shipping companies worldwide. In 2022, Det Norske Veritas DNV issued an attestation for applicability of the EHC® as a new method and diagnostic tool for Condition Based Maintenance -CBM.

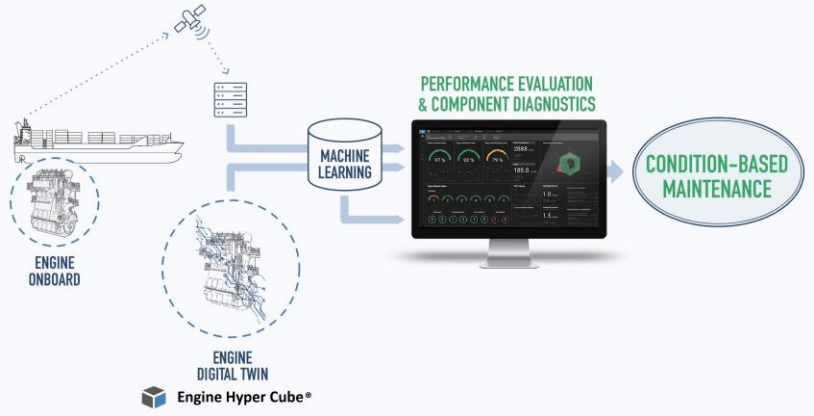

Figure 1. Combining engine digital twin and Machine Learning

DiEM FRAMEWORK

The objective of the DiEM Platform is to use CBM (Condition Based Maintenance) and extend the operational lifetime of components assessed as "healthy" by postponing their replacement beyond time-based maintenance intervals. An important challenge of CBM is the accuracy of predictions. DiEM combines multiple diagnostic methods to arrive at integrated assessment results, which has the benefits of firstly increased diagnostic quality, leading to positive predictive values and secondly of increased

diagnostic accuracy, leading to earlier detection of faults. Thus, DiEM integrates several existing methods of engine condition monitoring and fault detection, including (Figure 2):

- Engine Hyper Cube® diagnostics,
- lubricant sample analysis results,
- engine and turbocharger vibration data,
- component thermography data,
- cooling water chemical analysis,
- component wear measurements,
- endoscopic inspections.

This allows improved maintenance scheduling in line with Classification Society requirements. Further, the DiEM Platform can include all vessels of a shipping company and allows cross comparisons of performance of individual engines, engines of groups of vessels, engine types across the fleet. Links to other enterprise applications such as the ERP, the Planned Maintenance System PMS, and Spares procurement, allows timely procurement of overhaul services and components, which further optimizes asset management, towards reduced Total Cost of Ownership.

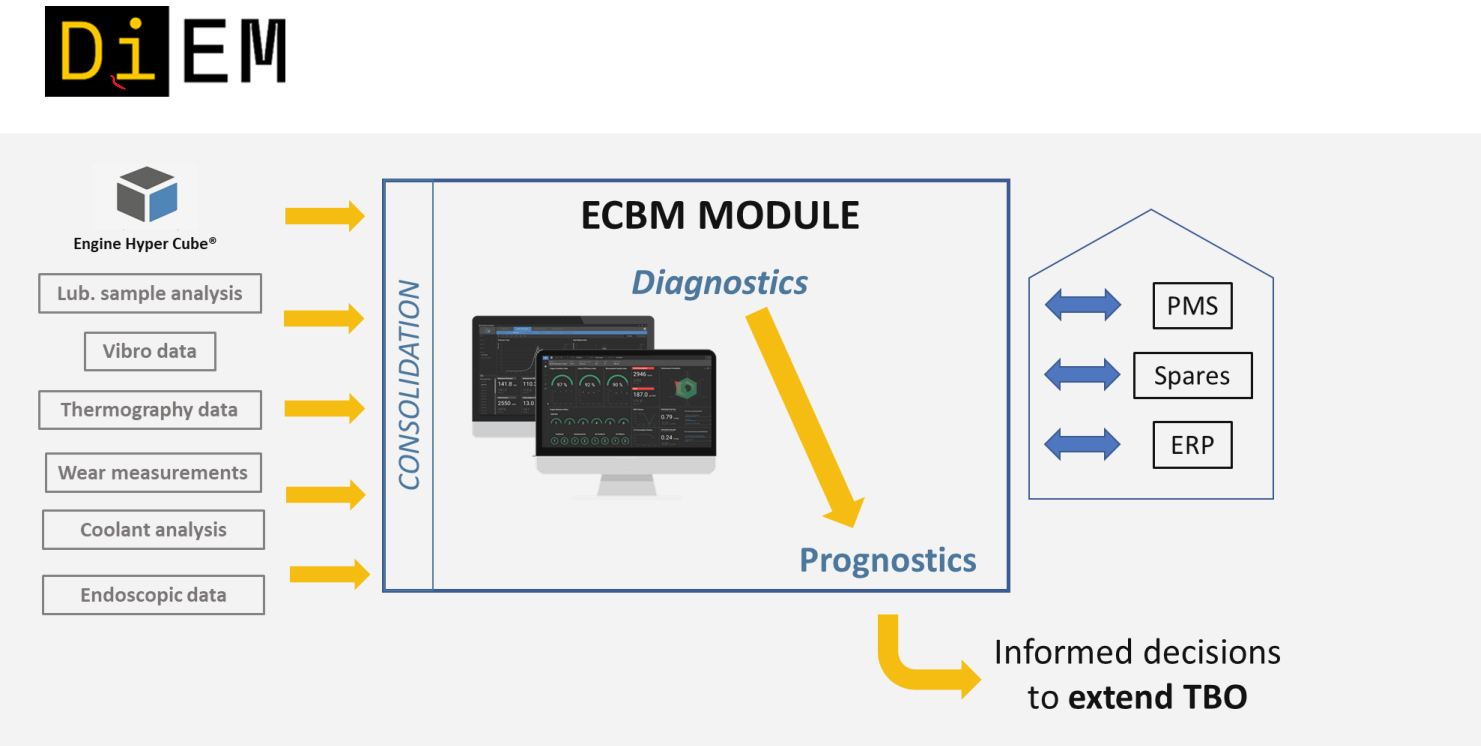

Figure 2. Overview of using multiple diagnostic methods for CBM in the DiEM platform and connection to existing enterprise applications

In all, the DiEM platform provides:

- Engine Performance Monitoring: Continuous monitoring of engine performance with high-frequency data and a state-of-the-art thermodynamic digital twin model.
- Optimizing Engine Performance: optimize engine performance via adjustments in engine operation
- Enhanced Troubleshooting Capabilities: Realtime key engine parameters monitoring along with advanced diagnostics using multiple methods with Automated Performance Reporting.
- Fault Pattern Recognition & Early Warning System: With machine-learning, detect in advance patterns leading to engine underperformance and faults.
- Overhauling Forecasting: with advanced prognostics, forecasting of spares and services, associated to actual component condition and links to company PMS
- Engine Condition Based Maintenance (ECBM) Scheme: overhauling interval combinations and extensions in line with the engine's actual condition, aiming at concurrency with major overhaul and survey events.

DiEM

Propulsion Analytics is an innovative software company in ship engine performance management, energy efficiency optimization and maintenance decision support. Our thermodynamic model-based Digital-twins in conjunction with machine learning diagnostics are used in more than 450 vessels worldwide. The DiEM platform by Propulsion Analytics is presently (2025) in gradual application across the GASLOG fleet of 34 LNGC vessels. www.propulsionanalytics.com