Condition-Based Monitoring (CbM) with iCOMOX
Minimize downtime, boost productivity, and reduce cost through condition-based and predictive maintenance.

Each year, approximately 300 million electric motors are installed globally, with some 40 million new motors arriving each year. In most cases, each of these motors will receive additional support from ancillary mechanical systems, such as pumps, fans, gearboxes, compressors, and drive chains.
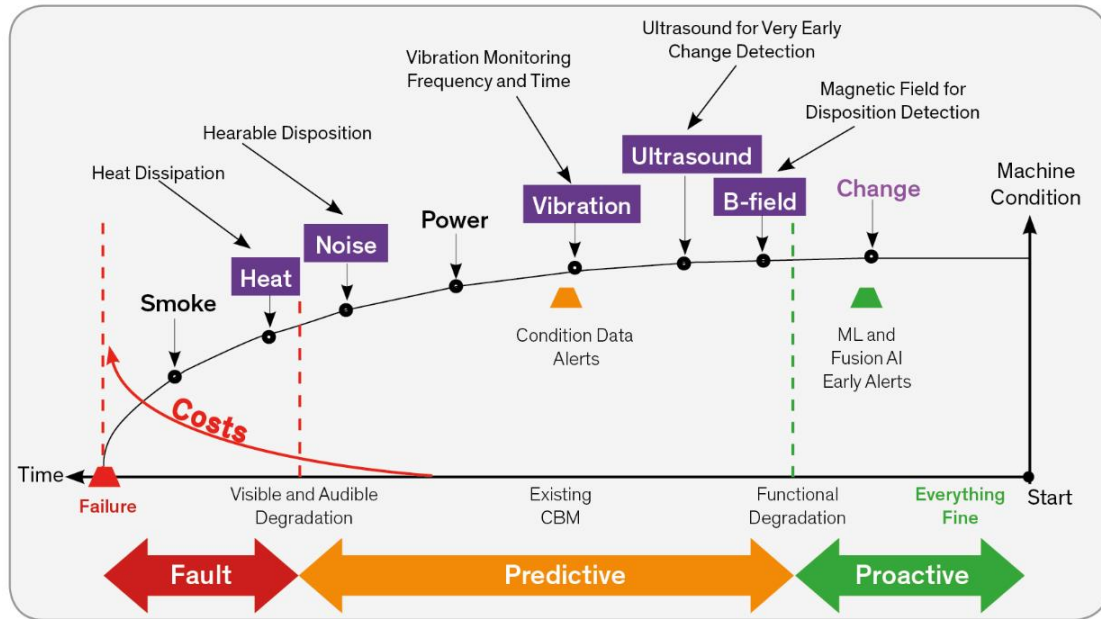
While motors are generally reliable, the fact that they're essential to many different industrial processes makes each of them a potential single point of failure. Whenever a motor or one of its key support systems breaks down, the result can be catastrophic, resulting in downtime and lost revenue. While diligent organizations always have suitable replacement components on hand, a substitute device can't anticipate a failure or eliminate the time needed to restore operation.

Fortunately, businesses spanning a wide range of industries now have access to condition-based monitoring (CbM). This important new technology offers multiple benefits, providing continuous monitoring of motors, pumps, gearboxes and many other types of key industrial assets which result in reduced downtime, increased productivity, and preservation of capital. Moreover, Predictive Maintenance (PdM) can forecast the future evolution of an asset – what failures may occur and what maintenance needs to be performed in order to prevent them from occurring. A rapidly growing number of enterprises are beginning to view CbM and PdM as nothing less than essential technologies and have begun adopting them.

A Game Changing Technology in Asset Maintenance
Smart Maintenance is a key enabler of Industry 4.0 and the game-changing smart factory concept. Condition-based maintenance technology continuously monitors assets to detect early-warning signals that indicate a failure may be imminent. Usually, condition-based maintenance is performed at the exact moment a monitored parameter reaches an unsatisfactory level, whereas predictive maintenance relies on formulas and models in addition to sensor measurements; maintenance work is conducted based on the analysis of these monitored parameters. Increased heat, high-level noise, and excessive vibration are predictive indicators of equipment malfunction. The ultimate goal here is the early detection and warning of equipment failures.

Ultrasound for Very Early Change Detection

Vibration Monitoring Frequency and Time

Magnetic Field for Disposition Detection

Hearable Disposition

Heat Dissipation

Ultrasound

Machine Condition

Change

Power **Vibration** **B-field**

Noise

Smoke **Heat**

Condition Data Alerts

ML and Fusion AI Early Alerts

Costs

Time

Failure

Visible and Audible Degradation

Existing CBM

Functional Degradation

Everything Fine

Start

Fault **Predictive** **Proactive**

Time really is money when it comes to the detection of failing industrial assets. This diagram shows how production costs rise the longer it takes to discover deteriorating machine conditions. It definitely pays to reveal lurking problems with a condition-based monitoring (CbM) tool before failure signs become apparent. In other words, take proactive measures based on advanced data analytics to predict and avoid asset failures rather than to consider maintenance solely as reactive necessity after a machine failure. The combination of different sensing modalities, so-called sensor fusion, if you will, allows for early, robust and efficient failure detection and recognition.

Until recently, only major, high-end installations such as nuclear power plants had the financial resources to take advantage of CbM technology. Today, thanks to advances in technology, CbM and PdM are finding its way into a growing number of industrial sectors offering deeper insights into machine health.

CbM technology is evolving from a fault detection platform into a system which can actually forecast issues and suggest the best possible course of action. In the years ahead, artificial intelligence (AI) and machine learning (ML) methodologies will provide even greater prediction and remediation skills so that the maintenance systems, processes, and plans will become smarter

Resolving Manufacturing Challenges
CbM augmented by AI and ML is a powerful toolset capable of resolving complex manufacturing problems at a level of expertise that lies beyond the skill sets of most industrial operators and their system integrator partners. Continuous CbM offers enormous advantages in terms of safety, availability, and efficiency of all technical systems and industrial machines.

Flexible and adaptable CbM technology allow organizations to roll out one or more trial systems. This enables monitoring of different industrial assets simultaneously to determine the best technology for the application. Low upfront capital expenses (CAPEX) and compatibility with in-house processes opens a path to painless deployment after a use case has been proven.

More and more machines and assets are able to communicate their operating conditions on an ongoing basis and are therefore only replaced when they are really worn out – not when a fixed maintenance plan stipulates. Maintenance is becoming more intelligent, supported by a growing pool of software, AI, ML, and back-end solution (BES) providers. These organizations are an essential part of the maintenance ecosystem and provide the foundation for complete and adaptable CbM and PdM platforms. This includes hardware, software, and associated services.

Introducing iCOMOX
iCOMOX from Shiratech Solutions stands for Intelligent Condition Monitoring Box and is an open embedded development platform for Condition-Based Monitoring (CBM) of industrial equipment, assets and structures. iCOMOX silently and continuously monitors operating conditions from equipment surfaces to identify actual and potential faults using embedded intelligence based on fusion of different sensing modalities – vibration, magnetic field, temperature, and sound. Sensor fusion can help to further improve the performance of embedded intelligence, as well as compensate for the low performance of individual sensors. As a result, it is able to detect and identify machine faults faster and more reliably.
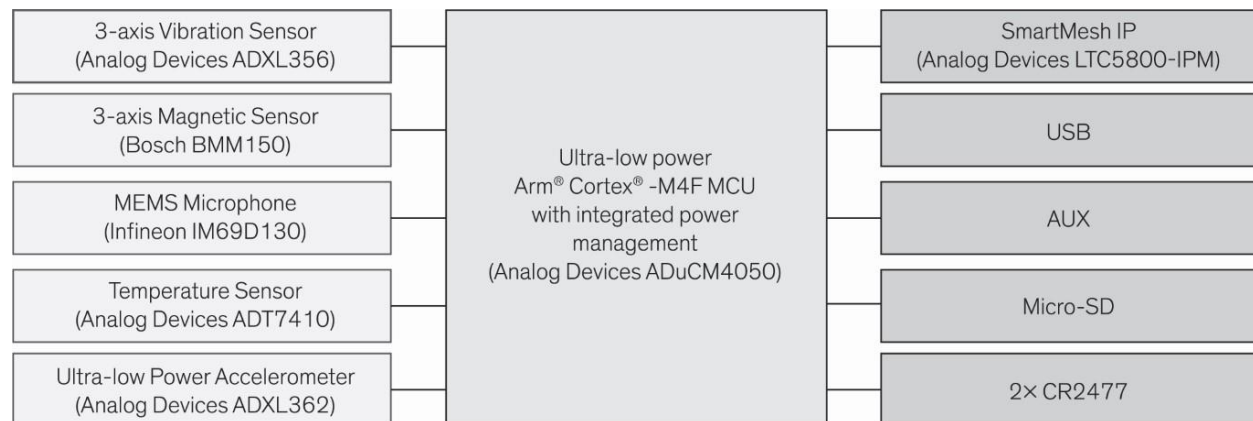
iCOMOX block diagram ([Source](#)).

The iCOMOX platform leverages an array of cutting-edge low power technologies. At the platform's heart lies an ultra-low power Analog Devices ADuCM4050 ARM Cortex M4 microcontroller unit (MCU) with integrated power management capabilities. A low noise Analog Devices ADXL356 3-axis accelerometer with analog bandwidth of 1.5kHz serves as a low power vibration sensor and an Analog Devices ADXL362 accelerometer operates as an ultra-low power, low-G wake-up trigger. Other low power key components include an Analog Devices ADT7410 temperature sensor with ±0.5°C accuracy and 16-bit resolution, a Bosch BMM150 3-axis magnetic field sensor, and an Infineon IM69D130 high-performance digital dual backplate MEMS microphone. On demand, additional sensors might be connected directly to the MCU.

For wireless communication in tough industrial environments, the iCOMOX provides a solution with high reliability and robustness as well as extremely low power consumption. The SmartMesh®IP network is built with a highly scalable, self-forming and -optimizing multi-hop mesh of wireless nodes based on LTC5800-IPM 2.5GHz, IEEE 802.15.4e System-on-Chip (SoC). That means each iCOMOX as a node might collect and relay data simultaneously. A network manager monitors and manages the network performance and exchanges the iCOMOX data with a host application. NBIOT and Ethernet IP POE (Power-over-Ethernet) solutions are expected to be released early 2020.

iCOMOX installation is fast and easy. Housed in a CE- and FCC-certified IP66 enclosure, the iCOMOX offers a highly compact form factor. Included are various mounting adapters designed to accommodate a wide range of equipment. iCOMOX can be retrofitted to existing assets or integrated into OEM equipment.

Real-time reporting and dashboards are integral to a user-friendly interface that can be accessed from anywhere. Whether it's a computer or mobile device, staff members located anywhere in the world can visually track the condition of equipment and other assets, and receive instant alerts when a potential threat is detected. Users also have the ability to configure warning and alarm levels and time-stamp events for each sensor.

Embedded AI can help to extract the full added value for wireless, battery-operated condition monitoring systems such as iCOMOX. Local conversion of sensor data to smart data by the AI algorithms embedded in the iCOMOX results in a lower data flow and consequently less power consumption than is the case with direct transmission of raw sensor data to the edge or cloud.

On demand, advanced data analysis can be performed in the cloud and iCOMOX supports a variety of cloud platforms and solutions.

Multiple Use Cases
iCOMOX addresses a wide range of customers that includes start-ups, small-to-medium size companies, system integrators, large enterprises and research institutions.

Enterprises in a wide range of industries can use iCOMOX to continuously monitor multiple assets including:
- Manufacturing Facilities:
  - Motors, pumps, gear boxes, and other assets routinely used in production and shipping processes.
- Construction Facilities:
  - Drills, motors, and other types of heavy equipment located at building sites.
- Buildings:
  - Elevators, moving walkways, escalators, refrigeration, and HVAC systems.
- Healthcare:
  - Many different types of large, motor-equipped medical equipment.
- Petrochemical Plants:
  - Pumps and drills.
- Transportation:
  - Car, truck, bus, rail, and aviation fleet management.
- Structures:
  - Bridges, buildings, towers, pipelines

iCOMOX Solution Benefits
- Enable digitalization of maintenance systems.
- Improve uptime and cost factors via condition-based and predictive maintenance.
- Extend asset life with real-time asset health monitoring and forecast.

- Streamline operations with remote management and automatic work orders for proactive repairs.
- Optimize and tune manufacturing process for maximum yield.
- Easy to install, use, and maintain with minimal upfront investment.

Getting Started

Getting started with iCOMOX is easy and inexpensive. An organization doesn't have to be an international giant to take advantage of this state-of-the-art monitoring technology. iCOMOX provides a low-impact, low-risk starting point for organizations beginning their CbM journey.

An iCOMOX rollout requires minimal enterprise resource support in terms of money, time, staff knowledge, and support. iCOMOX also supplies a base platform that's adaptable and scalable, allowing organizations to reconfigure and expand their monitoring resources whenever the need arises.

iCOMOX can be deployed out of the box or a customized solution can potentially be developed working with Shiratech Solutions, Arrow, and Analog Devices.

Tapping into CbM benefits is simple with the iCOMOX Evaluation Kit (part number: SRT-ICOMOX-KIT). This is an open development and evaluation platform which lets users get up and running quickly and easily. The kit includes an iCOMOX, wireless USB dongle, mounting kit, USB cable, free available Software Development Kit (SDK), and iCOMOX Monitor PC software. This kit demonstrates sensor data acquisition capabilities while providing basic signal processing analysis in the time and frequency domains.

Contact Arrow for support with more complex use cases requiring cloud connectivity.

Summary

Modern production facilities are challenged to meet tight delivery schedules imposed by increasingly demanding customers in today's extremely competitive business world. The failure of a single motor or other essential asset can quickly lead to idle workers, disappointed business partners, and substantial financial losses. Embedded CbM platforms like iCOMOX can help to improve productivity and increase profitability of existing and new assets.

Smart sensors report critical asset conditions before a component finally fails and trips.
More importantly, a sudden, violent, equipment failure can result in serious injuries and even death. iCOMOX allows enterprises to create safer workplaces that meet industry and government safety standards by providing continuous monitoring and instant alerts.

Enterprises can take control of their key industrial assets by minimizing production uncertainty, increasing production yield, reducing capital and operational expenditures (CAPEX and OPEX), while improving workplace safety with iCOMOX-based solutions.

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Resources:
- NEXT-GENERATION CONDITION-BASED MONITORING: Technologies and Solutions for Industry 4.0
- Industry-4-0-Executive-Guide

- [Condition Monitoring](#)