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Enabling IoT predictive maintenance for motors with vibration analysis

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There are motors all around us...

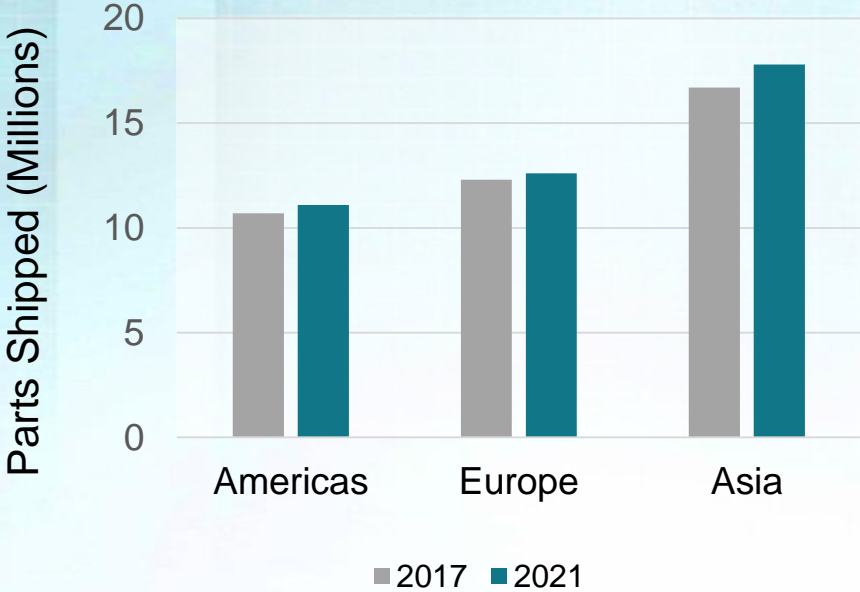


Industry

Residential &
Commercial



Motor Market Growth



Electric motors shipped (estimated)

2017

39.8
MILLION

2021

41.5
MILLION

*IHS Data as of Oct 2017



A case for predictive maintenance...

Cost



Safety



**Availability
& Reliability**



What is Motor Condition Monitoring?



Temperature monitoring

- Observable using simple sensors
- Not a primary indicator



Current monitoring

- More complex but provides insight into potential electrical issues
- Requires expert installations

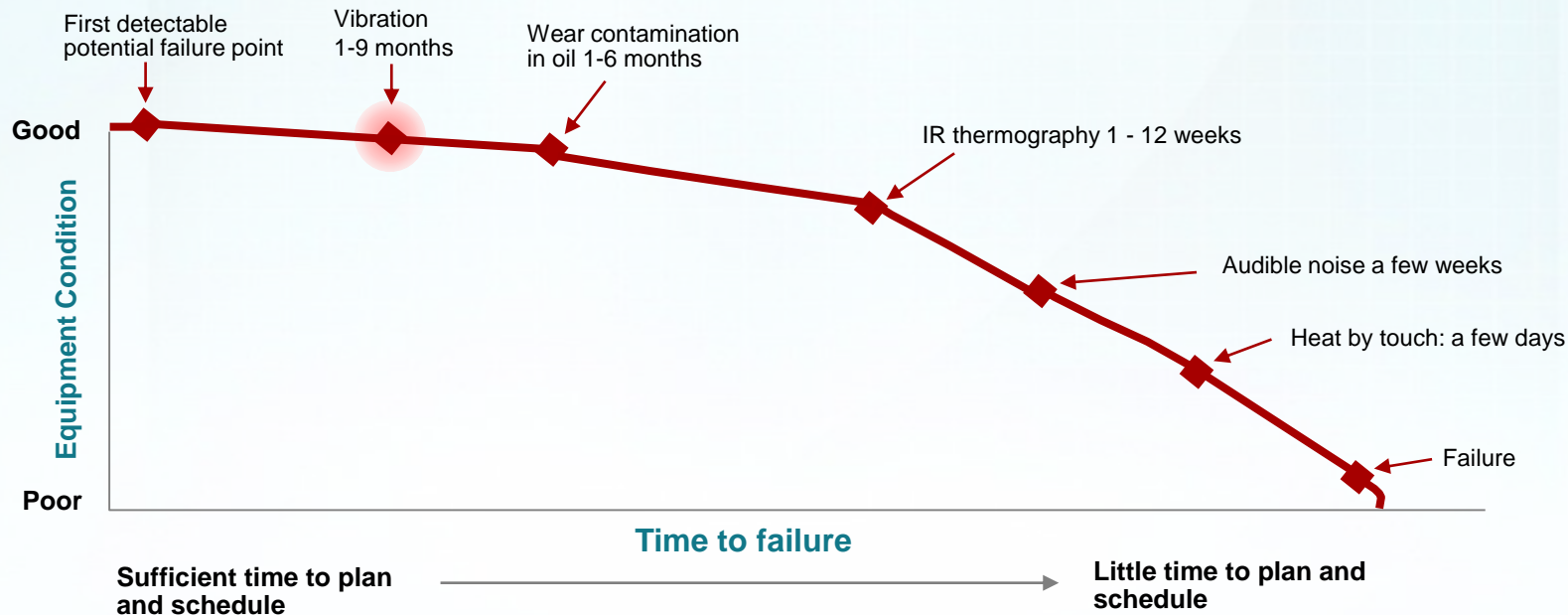


Vibration monitoring

- Primary indicator of potential failures
- Requires engineering/mathematical training

Where does vibration fit in the life cycle of the motor?

Motor Potential Failure Interval



Advantages of Vibration Monitoring



Non-invasive solution

- Allows the customer to strap-on the solution during regular operation
- Senses shock pulses internally without making contact with the moving elements
- Add more sensors to sense different aspects of the motors, like gears, shafts, etc



Primary Detection Mechanism

- Vibrations set in early, even before temperature changes can be detected due to faults



Lowers cost of maintenance

- With early detection, operators may schedule maintenance without downtime affecting crucial operations



What is needed to make a vibration monitoring system?

Vibration Monitoring System: Sensors



Parameters	Piezoelectric Sensor	Accelerometer Sensor
Sensitivity	High	Medium
Bandwidth	High (0-100 kHz)	Medium (0-10 KHz)
Range of Vibration	High (100s of g)	Low-Medium (40g)
Signal Conditioning	Yes	May be
Cost	High	Very Low
Output	Analog	Analog or Digital
Direction	Omni directional	Omni or tri-axis

Vibration Monitoring System: Data Acquisition and MCUs

Modern MCUs come with integrated SAR ADCs

- Enables ease of integration for data acquisition
- Higher precision with larger effective number of bits (ENOB) improves Signal-to-Noise ratio (SNR)
- Coupled with improved sensor provides at-par performance to Sigma-Delta ADCs with higher sampling rate

Ever expanding on-chip memory

- Enables longer Fast Fourier Transform (FFT) sequence required for higher resolutions
- Accelerates embedded machine learning algorithms

Vibration Monitoring System: Data Transmission

	RS232	Ethernet	Wi-Fi	Bluetooth low energy	Sub-1 GHz
Range	Few 100 feet	Few 1000 feet	Few 10 feet	Few feet	Long range
Data Rates	Low	High	High	Medium	Low
Ease of use	Low	Medium	Medium	Medium	Low
Home	No	No	Yes	Yes	No
Industrial	Yes	Yes	No	No	Yes



A Vibration Monitoring System solution

Components of a VCM System

Hardware

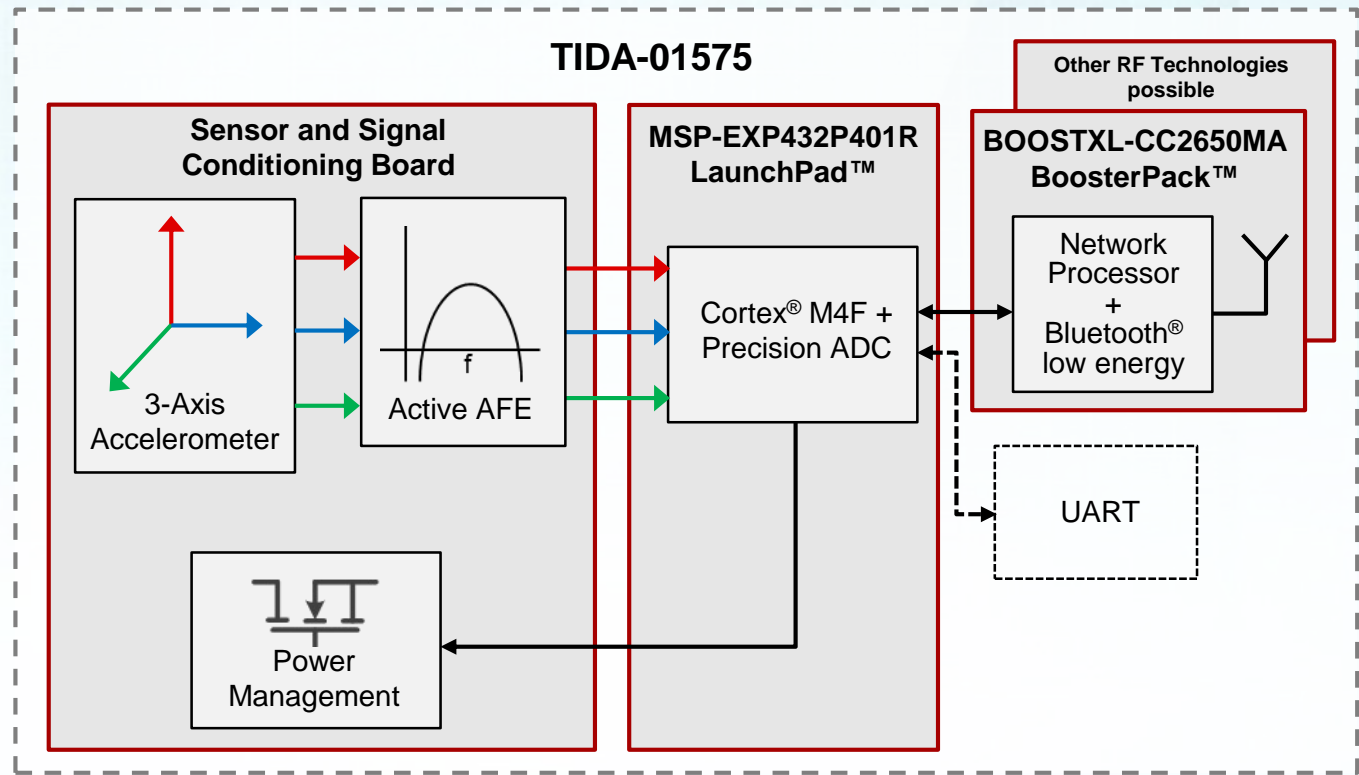
- Sensors that scale with requirements
- Ultra Low Power devices and architecture to conserve battery life for the system
- On-demand High performance MCU to acquire, process and make sense from data
- IOT compatible communications component

Software

- Provides device-aware power management software components
- Integrates different Data Transmission options and scales seamlessly
- Supports for Industrial and Building Automation Protocol Stacks so that system can be adapted to different use-environments

TI's reference design for predictive vibration monitoring

- Industry's highest precision integrated SAR ADC for data acquisition
- Scalable memory footprint from 128KB to 2MB
- Broadest range of wireless and wired solutions for any possible deployment



TI's SimpleLink SDK components for vibration monitoring



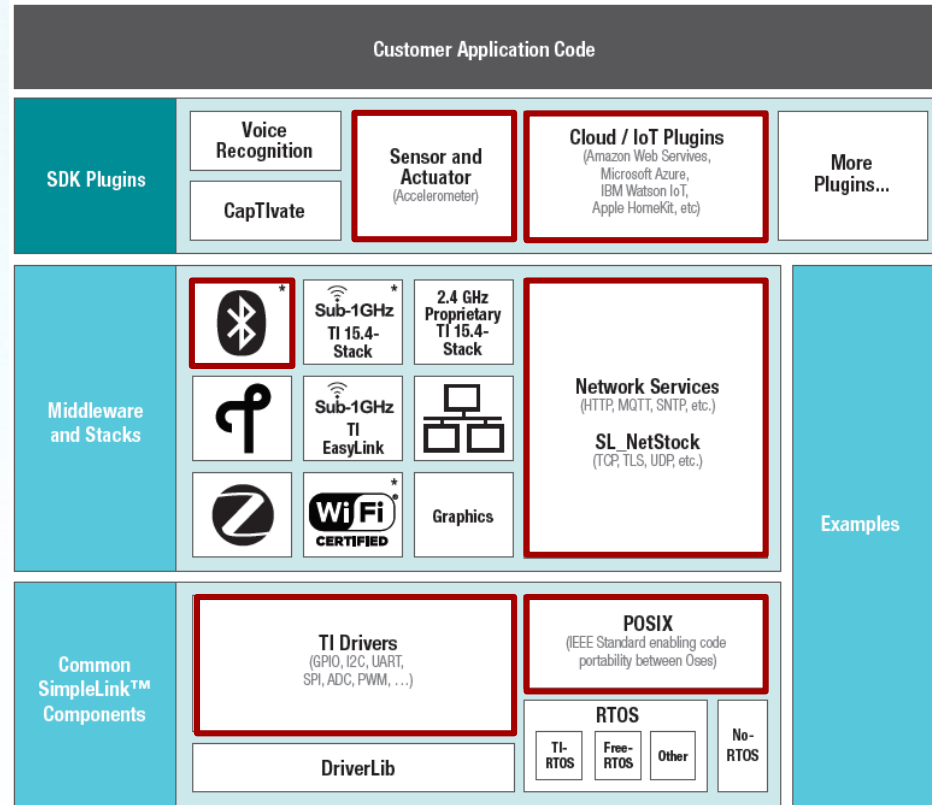
Integrated Software Development Kit (SDK) for both Host MCU and Wireless MCU



Cloud connectivity plugin for home automation



Wireless and Wired plugins for industrial automation



- Customer code
- SDK plugins
- Indicates components included in each SDK

*Plugin versions available

Summary: Vibration monitoring is “Predictive”



Motor driver and motor manufacturers can move from a bi-annual service model to monitoring models that add more value to their products (and \$\$\$)



Customers can now drive increased productivity of their machines without having to worry about unexpected downtime

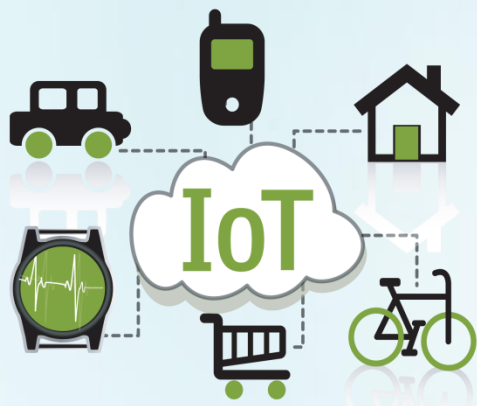
What's Next?



As machine information is collected over time, it makes data analysis on motors/pumps intelligent to develop deep learning algorithms that can be moved to edge nodes



Cloud intelligence and condition monitoring work hand-in-hand, providing visibility into machine trends and relieving manufacturers from having to base time-to-failure on computation of individual components



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