

# Improving Downtime and Energy Efficiency with IoT-Connected Air Compressors

**Using Intel® IoT Gateways in IoT-based data acquisition and processing enhances predictive maintenance, equipment performance, and energy management.**

Fusheng connects its air compressors and compressed air systems to the cloud.

## Executive Summary

Air compressors are ubiquitous in modern-day life, found in all types of businesses ranging from dentist offices to factories and electrical power plants. They are used to power tools and equipment, as well as HVAC and refrigeration systems.

As a leading manufacturer of industrial and process compressors, Fusheng's customers place a high level of reliance on the company's machines, expecting them to run efficiently and without failure. To better meet these expectations, Fusheng uses Intel® processors and Internet of Things (IoT) technologies to help predict and detect maintenance needs. For example, a compressor can be serviced before it fails, thus avoiding downtime. In addition, Fusheng uses data analytics to help its customers understand how to operate the compressors more energy efficiently.

## Preventive versus Predictive Maintenance

A major responsibility of factory and operations managers is to minimize unplanned downtime that stops production. This can drive a lot of preventive maintenance (PM) to make sure equipment doesn't break down. At regular intervals, service engineers run diagnostics, grease parts, and swap out components that wear down, whether they need to be replaced or not.

But it is possible to do too much preventive maintenance. Given the Law of Diminishing Returns, increasing levels of PM can eventually decrease production output, according to Allied Reliability Group.<sup>1</sup> Although preventive maintenance is an insurance policy against unplanned downtime, too much can be counterproductive, as shown in Figure 1.



**Figure 1.** Preventive maintenance can have diminishing returns.

An alternative is to implement predictive maintenance, which uses data analytics to promptly identify the onset of equipment failure, thereby allowing a reduction in:

- PM frequency and duration
- PM man hours
- Spare parts usage

This is an option when a piece of equipment can send information about its health, like it is ... running hot ... vibrating a lot ... yielding less than normal ... or running just fine. When this data is monitored and analyzed, equipment issues can be detected, triggering a notification to be sent to service engineers.

### Solution Overview

The IoT is making it easier for equipment manufacturers to send operational data to the cloud (or private data centers), where it can be thoroughly analyzed to better understand how the equipment is functioning. For example, Fusheng air compressors continuously report the operating status of their internal parts (e.g., motor, belt, oil barrel, etc.) over a secure Internet connection. If an operating parameter indicates abnormal behavior, maintenance personnel are alerted via SMS or email to service the air compressor, and they are notified about the parts that need to be replaced. As a result, technicians can ship just the necessary component(s), thereby minimizing shipping costs, rather than having to bring all the possible components to the customer site.

Figure 2 shows an ADLINK IoT gateway (based on the [Intel® IoT Gateway](#)) collecting data from Fusheng air compressors designed into equipment. The data is filtered and sent to Fusheng GoService\*, a cloud-based solution that supports many applications, including predictive maintenance. Maintenance technicians can review the air compressor data and receive alerts when corrective action is needed.

This cloud-based IoT solution provides enhanced security protection through root-of-trust technology, consisting of hardware security mechanisms in Intel processors and software security mechanisms, whereby the Linux\* kernel and the entire file system are protected from malicious attacks. Furthermore, the connection between the gateway and cloud is secured using 128-bit, AES-based SSL encryption. The out-of-the-box security features of the IoT gateway can reduce the coding effort for developers, thus significantly accelerating time to market.

### Use Cases

Fusheng's IoT-connected air compressors and GoService cloud-based applications can be used by end users in a wide variety of ways.

#### Predictive maintenance

Prevent unexpected downtime and achieve “worry-free operation” with easy access to unique equipment information, such as maintenance consumables and contract details.

#### Status overview

Reduce on-site maintenance time by monitoring the operating status of compressors and reprocessing equipment deployed across regions and factories—anytime, anywhere.

#### Real-time service

Initiate urgent repairs immediately by detecting unusual operating conditions (e.g., temperature, pressure, and current) and automatically sending SMS and email messages to the concerned parties, thus minimizing equipment downtime.

#### Data analysis

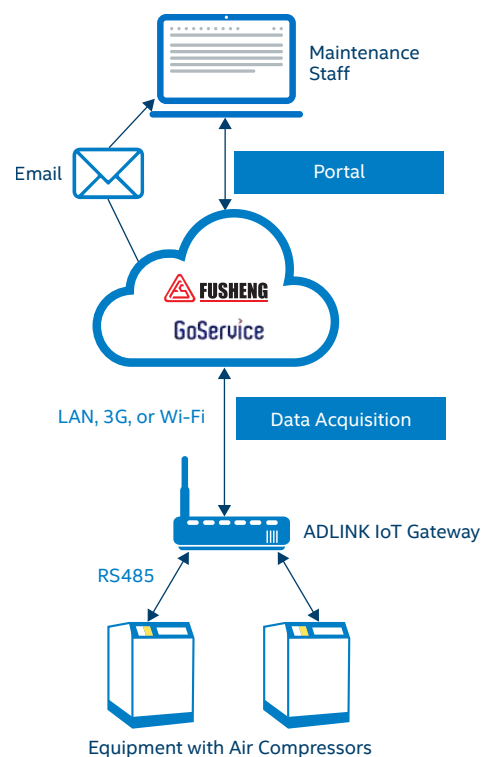
Gain insights on compressor operation by analyzing real-time data and trend charts.

#### Energy diagnosis

Get professional advice and services from Fusheng when analyzing energy consumption data.

#### Historical information

Ensure the integrity of historical operations data with automatic electronic data recording and spreadsheet downloading.



**Figure 2.** Fusheng's solution keeps maintenance technicians well-informed about air compressor operating status.

### Improved Downtime and Energy Efficiency

Fusheng's solution provides maintenance staff with a wealth of information about how the company's compressors are operating. This information can be used to service air compressors at the right time, thereby helping improve mean time to repair (MTTR) by as much as 15 percent, according to Fusheng. Since field service engineers receive useful data about the performance of individual air compressor components, the first-time fix rate can be increased by up to 20 percent. Given that air compressors work longer without repairs, and fixes are more effective, downtimes can be reduced by as much as 25 percent, as shown in Figure 3.

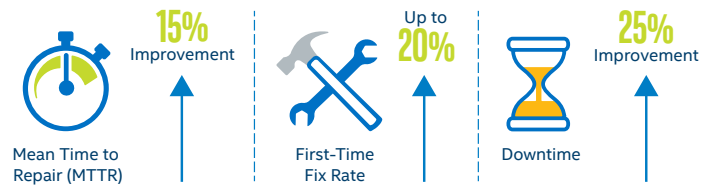


Figure 3. Fusheng's IoT solution improves productivity.<sup>2</sup>

Moreover, when air compressors are consuming more energy than necessary due to poor operating behavior, Fusheng offers professional advice about how to improve energy efficiency.

### Solution Architecture

Fusheng developed an end-to-end IoT solution that connects its air compressors to its cloud-based GoService platform, which provides actionable data to end users. The solution's four major areas are shown in Figure 4 and are described in the following sections.

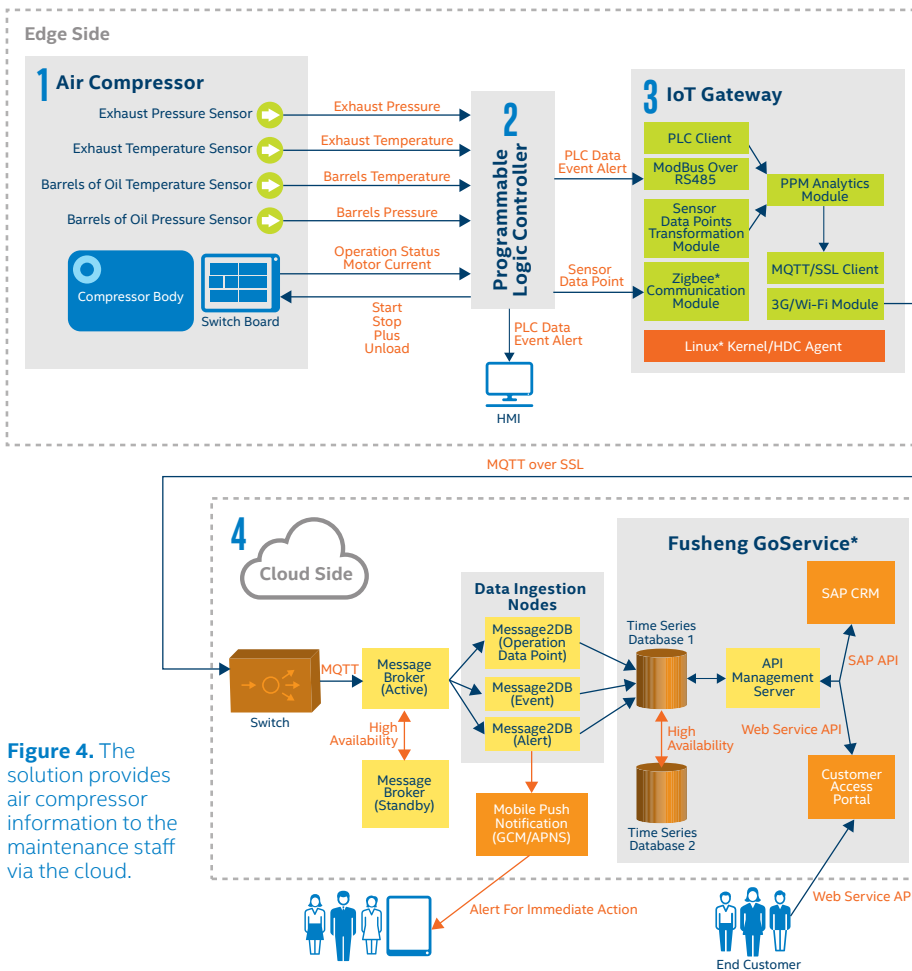


Figure 4. The solution provides air compressor information to the maintenance staff via the cloud.

#### 1. Fusheng Air Compressor

The air compressors send exhaust pressure and temperature, barrel pressure and temperature, motor current, operation status, etc. to the programmable logic controller (PLC).

#### 2. Programmable Logic Controller (PLC)

The PLC controls the air compressors and sends their data to the IoT gateway. A human machine interface (HMI) allows end users to track the operation of the PLC and air compressors.

#### 3. ADLINK IoT Gateway

The ADLINK MXE-100i Series IoT Gateway\* connects to the PLC using the Modbus\* protocol, and to the cloud side using the MQTT (formerly MQ Telemetry Transport) protocol via Ethernet, Wi-Fi, or 3G connectivity, and is protected by the Secure Sockets Layer (SSL) protocol. Based on the Intel® IoT Gateway with the Intel® Quark™ SoC X1021, the IoT gateway is a fully integrated and optimized hardware and software system for connecting machines to the cloud over the Internet. It supports I/O interfaces to field bus or sensor networks on the machine side, and to the Internet over Ethernet, Wi-Fi, Ethernet, or 3G connectivity on the cloud side.

Integrating the Wind River Intelligent Device Platform (IDP) XT\* 2.0, the gateway includes a multi-protocol software stack for data forwarding and provides a manageable and secure runtime environment for code execution. To help integrate gateways and cloud-side applications, Intel offers the software development kits (SDKs) and APIs needed to efficiently design a complete, end-to-end IoT system.

#### 4. Cloud Side

The cloud side is hosted by the Microsoft Azure\* cloud computing platform and consists of big data infrastructure and the Fusheng GoService:

##### Big data infrastructure

Data comes into the cloud-side switch, which sends it to a message broker server that relays the data to remote clients that are subscribed to receive it. The remote clients digest the data, can send alerts based on the data, and forward the data to the Fusheng GoService platform.

##### Fusheng GoService platform

The platform stores and reports the real-time operating status of compressors and reprocessing equipment, thereby allowing for convenient browsing and eliminating time-consuming data entry (Figure 5). The data includes hours of unloading and loading, voltage, current, power consumption, pressure, airflow rate, temperature, and dew point, as well as maintenance history, unusual signals, etc.

When unusual trips or alarm signals occur, Fusheng service technicians quickly contact customers to assist them in identifying the problem and resolution in order to avoid damage on production lines. The platform also sends maintenance reminders to end users and the Fusheng service center.

End users who already have their own centralized motoring system and internal applications (e.g., SAP and PLM) may still want to integrate some GoService functions. This is possible with standard APIs used to access energy consumption, real-time information, dashboard, service orders, or other data.

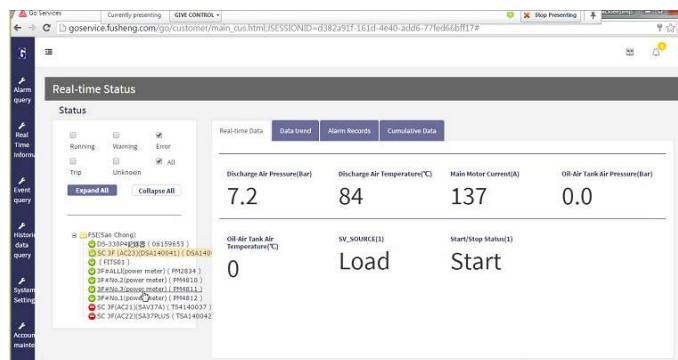


Figure 5. The Fusheng GoService\* platform displays air compressor data in real time.

#### Key Solution Benefits

Fusheng's IoT solution has many important capabilities, including:

- Detects equipment malfunction, energy consumption, and component deterioration
- Reports equipment performance and recommendations—anytime, anywhere
- Improves service delivery by allowing Fusheng to remotely monitor its machines
- Allows end users to realize higher operational efficiencies

#### IoT-Enabled Predictive Maintenance

Fusheng is taking advantage of the latest IoT technologies to help its customers achieve improved downtime and energy efficiency. Its end-to-end IoT solution has predictive maintenance capabilities that provide an alternative to often more-expensive and less-effective preventive maintenance. With air compressors connected to the cloud using Intel IoT technologies, Fusheng customers can keep their facilities running smoothly while reducing operational costs.

**For more information about Fusheng IoT-connected air compressors, visit [fusheng.com](http://fusheng.com).**

**For more information about Intel solutions for industrial, visit [intel.com/industrial](http://intel.com/industrial).**



1. Allied Reliability Group, "Are You Doing Too Much PM?," 2013, pg. 5, [alliedreliability.com/reports/are-you-doing-too-much-pm/](http://alliedreliability.com/reports/are-you-doing-too-much-pm/).

2. Fusheng.

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