App-Based Solutions for Mining

Connectivity Without Complexity

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Technical white paper

Author:

Vincent Matthews
Director of Business Development for Mining and Minerals Technology, Bosch in North America

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1 Abstract

When you turn on any smartphone or tablet, you'll often be greeted by dozens of app icons. Like the legendary Swiss Army knife, our digital devices have become multi-faceted tools with solutions for many tasks. As the world of computing has become increasingly mobile, businesses have realized that apps are a convenient and less-complex way to use enterprise software outside the web browser.

Several industries have aggressively adopted apps for marketing and sales solutions. However, apps for operations and controls have been embraced at a much slower and more-conservative rate. While a car manufacturer is happy to share detailed information on new models or a customer's present model, sharing information about the plant manufacturing line is restricted to a very limited number of employees. Often, data is available only over an enterprise or digital control system (DCS). In addition, this data must often be customized and reformatted to provide value and relevance.

While the convenience and improved productivity of app solutions are gaining acceptance within several industries, data security is a major concern. This paper will discuss security issues that must be considered when deploying any app-based solution.

That includes app solutions for the mining industry. This paper will focus on the emerging use cases for mobile apps in mining, starting with a review of how apps must work in such a challenging environment.

2 Background

2.1 Application Architecture

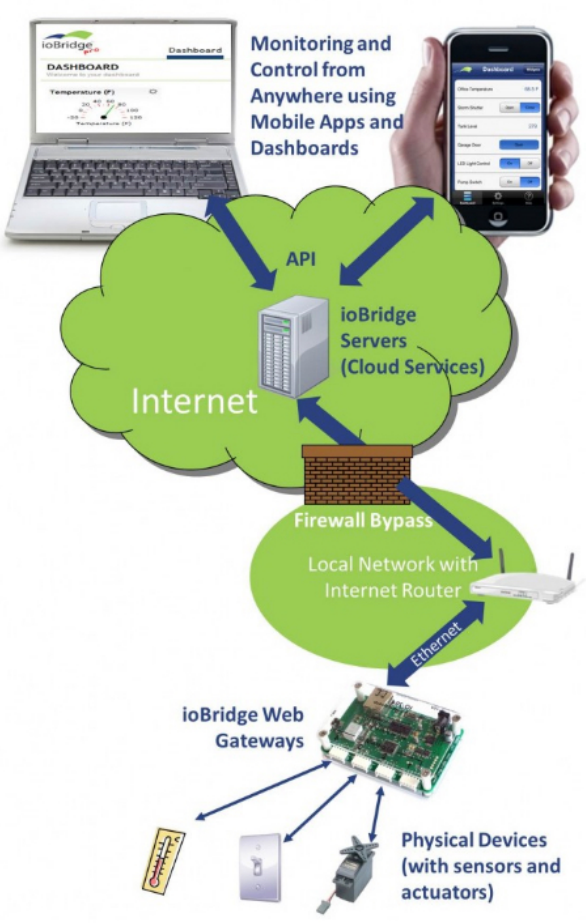

Figure 1: An industrial process application [1]

In order for an app to function at all, communication must occur. Data has little meaning in raw form, as basic binary code. To organize this data and make it understandable, an Application Programming Interface (API) must be developed. Within the API, structure is given to the data and the interaction of each software component is defined. The API also defines the Graphical User Interface (GUI), which presents both user-input data and system-output data understandable within the context of human-machine interaction.

It is important to understand that most of the API resides on a remote server and not within the device. For this reason, mobile apps are usually quite small in memory volume. Communication between the device and the server is accomplished via an internet or intranet protocol. The residency of this data and API is often referred to as the cloud.

2.2 Application Security

If only the API server and device existed, each user would see an empty dashboard or user interface, devoid of any data. Unless the server is provided with a way to collect data, the data itself won't exist on the server.

Data collection occurs through a web gateway, which is usually connected to physical devices such as sensors and actuators. In order for the server to collect data, a portal must be provided through the enterprise firewall. The firewall is a means of filtering information passing between the server and the mobile device.

Various methods of data protection exist [2], and it is often up to the end user or customer to decide on the means and level of protection. This requirement is commonly the primary concern among IT security specialists – and is frequently the largest contributor to delays in implementing a device-based solution.

Appendix [3] defines the five most-common app-security issues as:

1. **Unsecure data storage:** Lack of encryption for sensitive data and/or password storage on the mobile device.
2. **Secure Sockets Layer (SSL) issues:** SSL, an encrypted layer between the server and client, may have an expired or revoked certificate.
3. **Data leakage:** Personal data may be unintentionally available to marketers and/or hackers.
4. **Untrusted inputs:** If the app accepts data from external sources, then all inputs used to build the app must be checked and verified to ensure proper security access and encryption.
5. **Weak server-side controls:** Inadvertent "backdoor access" to the data server through the app.

Although an app may be designed with simplicity in mind, security concerns are equally important. Security should be a top concern when developing any program that uses a communication protocol.

3 Applications in Mining

3.1 Mining in a Digital Environment

In today's world, large mines are digital environments. Programmable Logic Controllers (PLC) typically control mining machines, and PLCs interface with each facility's Digital Control System (DCS). Select data from the DCS may be exported to an enterprise system to manage finances, supply chain, inventory and more.

With all this data available, what is the need for a mobile app? The clearest answer lies in the need for improved productivity [4] [5].

With a smaller workforce than ever, mines have empowered employees to make decisions more quickly and frequently. Enterprise and DCS systems lack the ease of access to time-sensitive information that a mobile app system can deliver. In addition, enterprise and DCS interfaces often require a PC, leading to higher costs, less portability and inferior ruggedness as compared with a mobile phone or tablet.

Applications tend to be very specific tools, designed to do one or a few tasks. For example, an application may provide a live video feed from several cameras, but the same app is unlikely to give you power-consumption information. Adding complexity to an app moves it in the direction of an enterprise program, defeating the simplicity and agility for which the app was originally intended.

Several reasons drive the decision to select an app-based solution:

- Quickly changing conditions require rapid decision making
- Events or services required for non-standard or support operations
- Troubleshooting or monitoring a temporary condition
- Controlling the distribution of information to specific employees
- Time constraints that require quick development of a software solution
- Desire to outsource condition monitoring or another service to a third party

3.2 Case Study: Connected Lock Out

Maintenance is a regular part of a mine's operating protocol. While a necessity, extended maintenance time is not desirable; it usually means part – or all – of a mine's standard operation are interrupted.

As safety is the primary concern of every mine, a rigorous lock-out/tag-out protocol is enforced. This ensures that maintenance personnel will not be adversely impacted, injured or killed by any live or stored electrical, hydraulic or kinetic energy.

As mines often cover large areas, it is not uncommon for a disconnecting means to be located several kilometers from the maintenance site. This is a scenario often experienced with overland conveyors.

3.3 Case Study: Traditional Lock Out

Traditional lock-out methodology has changed very little over the decades. Each member of the maintenance team is issued a lock and tag, which is applied to the disconnecting means, open in a safe position at both ends of service. This means that all maintenance personnel must physically travel to each location to apply the lock and key.

With rugged terrain – and in the case of precious materials mining, the requirement to pass through several security check points – this can add hours of non-productive time to the maintenance task. This can translate into hours of process interruption to the mine.

As part of Bosch's Connected Mine™ portfolio, Bosch has developed a unique connected Lock Out/Tag Out system that retains the traditional required features of a physical lock and key. However, it also saves significant hours of maintenance downtime and costs by eliminating the need to physically transport a lock between service locations.

Instead, transportation is accomplished via electronic communication over various protocols (Ethernet, Wi-Fi, 4G, satellite). There is a physical lock and key at all the service and disconnect locations, ensuring that this new system complies with traditional and existing mine-safety standards.

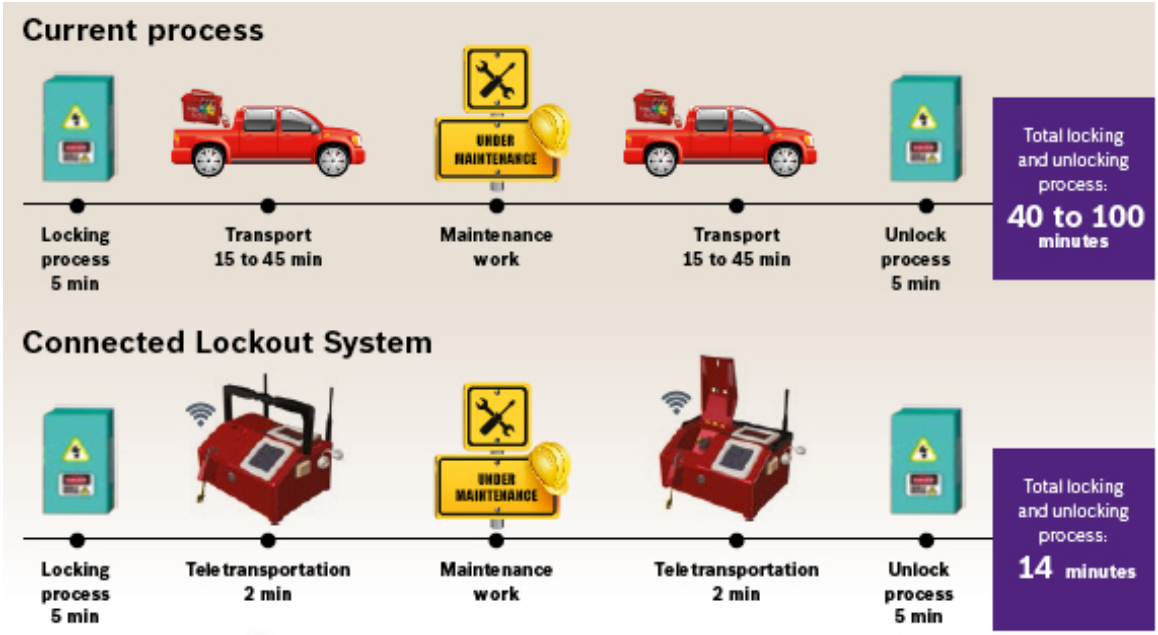

Figure 2: A comparison of Connected Lock Out system performance vs. traditional performance [6]

Unlike most mobile apps that reside on a phone or tablet, the Connected Lock-Out interface is built directly into the locking control box

3.4 Case Study: Connected Conveyor

Conveyors are commonly used for transporting ore across a mine's operating footprint. These conveyors often extend for several kilometers, and in overland conveyor design, the conveyor belt usually moves on rollers. Roller construction consists of a metal cylinder that rotates via bearings; failure of these bearings causes the roller to cease, resulting in excessive friction between the stationary roller and the moving belt. The resulting high temperature can melt the belt or even start a fire. Either way, the potential interruption and damage to mining operations is significant.

The quantity of rollers can number into the thousands for long conveyors. Traditionally, the process of locating rollers with bearing issues has been to periodically scan rollers with an infrared thermometer. This method fails to provide continuous monitoring, and there is a high likelihood that a roller issue may be missed in the scanning process. While bearing-temperature monitoring has existed for decades, the technology has relied on a wired thermocouple. This may be practical for individual large motors, but it is not practical to interconnect the wiring for thousands of conveyor roller bearings.

Fortunately, modern wireless technology enables simultaneous communication from multiple sensors. One system utilizes the inertia of the roller to power a temperature sensor [7]. However, this system requires complete roller replacement and cannot be retrofitted to an existing conveyor roller.

As part of Bosch's Connected Mine ™ portfolio, Bosch has developed a unique Connected Conveyor system that utilizes low-energy wireless transmitters to report roller-bearing temperatures to an app-based solution. This solution features a proprietary algorithm that can predict imminent roller-bearing failure, enabling proactive maintenance of the conveyor prior to damage.

What's more, this solution can be added to a conveyor's existing roller assembly. The Connected Conveyor system can be provided as a service or as an integrated solution that is owned, maintained and operated by the mine.

Figure 3: Bosch Connect Conveyor App-Based Solution [8]

4 Maintenance Benefits of Connected App-Based Solutions

4.1 Data-Based Maintenance

Mine DCS systems primarily focus on real-time plant operations. In parallel with operations and operating departments, the maintenance staff is responsible for the continuous operation and repair of mine equipment. The goal of any mine maintenance team is to prevent operational interruption through proactive and preventative maintenance.

Sensors now enable real-time measurement of critical equipment parameters such as vibration and temperature. Machine manufacturers have defined the limits of normal operation, which have helped create predictive failure algorithms. These algorithms naturally lead to preventative – rather than reactive – maintenance. This data-based maintenance helps each mine prioritize maintenance tasks and can result in significant cost savings through avoiding excessive maintenance.

Requirements for data-based maintenance:

1. Identification of critical variables
2. Measurement of critical variables
3. Defined limits of critical variables
4. Measured trends of critical variables
5. Communication of critical variable trending toward defined limit(s)
6. Communication of critical variable outside of defined limit(s)

Connected sensor technology, whether under the umbrella of Internet of Things (IoT), Industry 4.0 or Connected Mine, shares a common platform of collecting massive amounts of data from a variety of wired or wireless sensors. While having more data is beneficial, the inherent value of the data lies in the knowledge of what to do with it. Therefore, it is critical that the app developer understand the process being monitored.

For example, in the Connected Conveyor solution previously summarized, it is rather easy to build a notification system that informs a mine when a roller stops. Rollers can stop due to loss of inertia, temperature or simply because the conveyor is not running. However, it is far more difficult to predict that a roller will soon fail.

The latter situation requires knowledge based on experience, extensive data collection and expert analysis of the conveyor roller's operation. This is the true value proposition of an app-based solution.

5 Summary

Enterprise, DCS and PLC systems are designed with the ability to do many things. This criterion renders these systems complex, expensive and often difficult to customize or change.

In addition, these systems often connect to modules or other software systems that contain sensitive business data. These interconnections require substantial time, effort and investment to protect adequately with IT security measures. The same reasons also force companies to limit access, putting data out of reach of employees who could benefit from the information and contribute to operational efficiency.

Rather than a one-tool-for-all approach, apps focus on a specific solution for a specific problem. By limiting the scope of the solution, it is possible to quickly develop and deploy the app. Critical to the success of the application is the expert knowledge of what data to collect, how to analyze that data and how to communicate the resulting information effectively with the user.

With an app-based solution, the data, data analysis and application instructions reside on a server. This is usually located outside of the mine and accessed via the internet or intranet, but if required, a server inside the mine can be used.

Because the heavy-duty processing is done at the server, the mobile device only needs to contain a template to display information in a coherent user interface. Likewise, if the user needs to enter data, it is generally a simple command string transmitted in real-time back to the server.

This dependency on the server means that a loss of communication between the mobile device and server provides a temporary interruption of monitoring capability. However, no data is lost, as the data dependency is determined by connection of the server to smart sensors or I/O bridges (Figure 1), not between the server and mobile device.

A mine must decide what the degree of ownership should be for an app-based solution. If the mine is dependent on the app for the core competency of ore processing, full ownership should be considered. If the mine plans to use the app intermittently – as part of a planned maintenance shutdown, for instance – it may be preferable to purchase the app as a service. If the mine uses the app to monitor a continuous operational process, either approach should be considered.

6 Appendix A: About Bosch

Having established a regional presence in 1906 in North America, the Bosch Group employs nearly 34,500 associates in more than 100 locations, as of December 31, 2017. In 2017 Bosch generated consolidated sales of $13.7 billion in the U.S., Canada and Mexico. For more information, visit twitter.com/boschusa, twitter.com/boschmexico and www.bosch.ca.

The Bosch Group is a leading global supplier of technology and services. It employs roughly 402,000 associates worldwide (as of December 31, 2017). The company generated sales of 78.1 billion euros ($88.2 billion) in 2017. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT company, Bosch offers innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life." The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiary and regional companies in 60 countries. Including sales and service partners, Bosch's global manufacturing, engineering, and sales network covers nearly every country in the world. The basis for the company's future growth is its innovative strength. At 125 locations across the globe, Bosch employs some 64,500 associates in research and development.

Additional information is available online at www.bosch.com, www.iot.bosch.com, www.bosch-press.com and www.twitter.com/BoschPresse.

Exchange rate: 1 EUR = $1.12968

7 Appendix B: References

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