ACKCIO

Reliable Wireless Communication for Industrial Monitoring:

A Guide for Engineers and Decision-Makers

1 Why Wireless Communication for Industrial Monitoring?

Industrial monitoring is becoming increasingly important, given the rise in regulatory frameworks that mandate safe and risk-free operations. This requires industries to implement systems to monitor various physical parameters of a site to ensure that their operations proceed according to plan without compromises on quality or worker safety.

Most industries conduct stringent monitoring processes by deploying a range of sensors to monitor different parameters. For instance, construction and mining industries deploy thousands of sensors to monitor geotechnical and structural parameters like tilt, pore water pressure, strain and load. Other industries like oil and gas, energy, and agriculture, require similar sensor deployment and monitoring. Periodic readings from these sensors provide valuable insights to stakeholders that help them oversee site operations more clearly and efficiently, thereby enabling them to better manage risks and enhance safety.

However, many companies rely on traditional cable-based or manual (manpower-based) monitoring data acquisition systems to obtain data from sensors. This is considered problematic for a number of reasons.

1. Cable-based networks are now seen as cumbersome, labour-intensive, costly to deploy and maintain, and error-prone.

2. Deploying a cable-based network requires planning and implementing changes can be both costly and time-consuming in industrial projects.

3. Manual systems cannot provide frequent readings. Most industrial projects today require frequent readings (like every 10-15 mins) to comply with current regulations and ensure that a sufficient amount of data points are available to make well-informed decisions.

4. Manual monitoring is costly to implement and presents safety risks to workers in certain industries (like construction, mining, and oil and gas).

5. Manual monitoring may also be hindered by unforeseen situations like the COVID-19 outbreak (which disallowed manpower at work sites).

By contrast, a wireless data acquisition system is more cost-efficient to deploy and maintain as the extensive use of hardware components, such as cabling, is replaced by radio signals transmitted from sensors. Moreover, wireless data acquisition systems can collect data from harsh environments that are hard to access and hazardous for cables and workers.

The ultimate purpose of a good data acquisition system in industrial monitoring is to provide clear visibility into a work site for making timely data-driven decisions. This allows the managing team to better manage their facility, maintain assets, and improve worker safety. As such, deploying a wireless data acquisition system is the best way forward for addressing industrial monitoring requirements.

2 Why are LPWAN wireless technologies better suited for industrial monitoring?

With the advancements of Low-Power Wide Area Network (LPWAN) wireless technology, an increasing number of industries are turning to LPWAN technologies to satisfy their monitoring needs. There are several reasons behind this paradigm shift.

Reliable coverage

In some industrial monitoring projects (like construction), monitoring activity happens in areas that present challenging conditions for effective wireless communication. For other projects such as infrastructure development and mines, monitoring activities take place almost entirely underground . A wireless network for monitoring these environments should have signal transmission capabilities that are not limited by physical obstructions.

LPWAN technologies operate in the sub-GHz spectrum (e.g., 433 MHz, 868 MHz, 915 MHz) that provides superior obstacle penetration capabilities and longer communication ranges. In line-of-sight environments, the communication range would be in the order of 10-15 km. Even in non-line-of-sight environments, the achievable communication ranges would be a few kilometres.

Low power consumption

Many industrial monitoring systems are often located far from a stable power supply, requiring sensors to run solely on battery power. Hence, a wireless network should have a radio link that consumes a minimal amount of power to reduce maintenance costs and battery recharging/replacement.

Modern LPWAN technologies only consume small amounts of power. Hence, they can be powered even with button cells. This makes LPWAN a good choice for wireless data acquisition systems that need to be deployed in remote locations where the systems are expected to run for years on batteries.

Immunity to signal interference

Most wireless technologies operate within unlicensed Industrial, Scientific, and Medical (ISM) frequency bands, leading to a growing number of deployments in that spectrum. As such, a wireless network should be robust enough to withstand interference from other systems to ensure that crucial data is transmitted successfully when needed.

LPWAN technologies have engineered various methods of mitigating signal interference to enhance the reliability of wireless communications.

High network capacity and scalability

A scalable wireless network enables the user to efficiently manage multiple applications and expand the network on demand. This lessens the initial investment, streamlines the management of the network, and accelerates return on investments.

LPWAN technologies make it possible for hundreds of devices to participate in the same wireless data acquisition system. This makes monitoring operations cost-efficient and scalable.

Security

The security of a wireless network rests primarily on its wireless link. As any security breach can have lasting negative effects on a user's finances and reputation, a wireless network must be armed with robust cryptographic schemes for end-to-end communications, and possibly, the option of having a fully privatised network management.

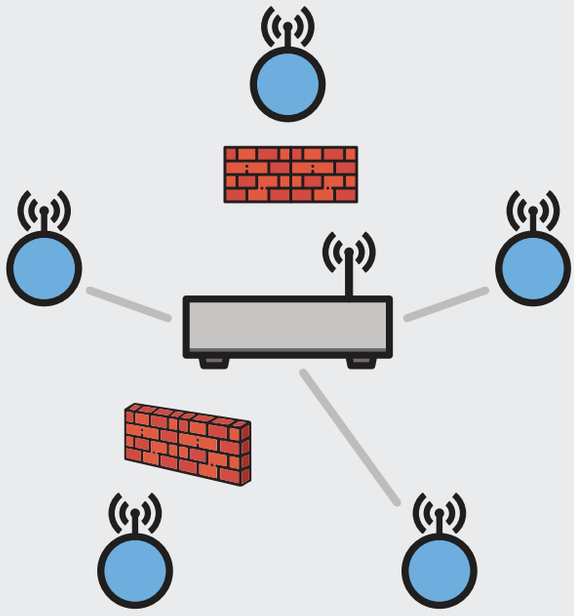
Modern LPWAN technologies use military-grade encryption techniques such as AES-128 that enable highly secure wireless data acquisition systems to be deployed for monitoring applications.

3 Some widely used LPWAN technologies

Having discussed why LPWAN technologies are better suited for industrial monitoring applications, let's review some well-known LPWAN technologies.

In recent years, many LPWAN technologies have been engineered and deployed for monitoring a wide range of applications. These technologies commonly use the Sub-GHz wireless spectrum, which is available worldwide under different rules depending on the country. LPWAN users of the spectrum generally fall under the U.S. 915 MHz ISM band or European 868 MHz ISM band.

Another common feature of these systems is that they typically form star networks, meaning that each transmitter or end-device should send their data directly to a gateway or a base station. These technologies do not support repeaters or relaying of data, and therefore, face challenges in highly obstructed environments where a direct link between a transmitter and a gateway or base station is unavailable.



sigfox

A French global network operator, Sigfox builds LPWANs to connect low-power devices (like electricity meters and smartwatches) that require small fragments of data to be periodically pushed to the internet. In some ways, Sigfox functions similarly to a telco given the requirement of installing Sigfox base stations before Sigfox devices can communicate.

Being a base-level LPWAN, Sigfox's proprietary communication technology is limited and only able to transmit a maximum of 140 messages per day to the base station. With each payload size of up to 12 bytes, applications are fairly restricted. Downlink communication is also restricted with only four messages guaranteed to be transmitted on any given day.

Geographical coverage is another challenge. Although Sigfox is present in up to 70 countries, its usability is limited to regions where its connectivity has been deliberately extended—typically urban areas. But even here, the star topology of the network, obstructions, and other interferences can disrupt connectivity with the base station. Furthermore, in remote locations as well as underground environments, Sigfox connectivity would be unavailable due to the lack of Sigfox base stations.

LoRaWAN

LoRaWAN[1] is a proprietary standard for LoRa-based networks promoted by LoRa Alliance. Its main features, in addition to low-power operation, include a low data rate and long transmission range. Furthermore, it does not require a fixed infrastructure by an operator, provides a considerably higher payload strength (up to 250 bytes), and can transmit an unlimited number of messages.

But like Sigfox, LoRaWAN's star topology, which requires all LoRa devices to send their data directly to a LoRa gateway, can cause unreliable communication links, particularly in urban and underground environments. Recent studies have indicated that a reliable communication range may be limited to a few hundred metres in urban deployments[2].

[1] https://lora-alliance.org/

[2] LoRa: Known and Unknown Facts of LoRa: Experiences from a Large Scale Measurement Study, ACM Transactions on Sensor Networks, Vol.15, Issue 2, Article 16

WEIGHTLESS™

Weighless[3] is an open standard that believes that open software innovation can lead to the adoption of a global standard. It is designed and used to connect Smart Machines to the internet and provides three different standards with varying levels of service. For example, Weightless-N offers a simple one-way directional standard with a very long (10-year) battery life. Weightless-P provides a downlink to acknowledge successfully received data, thus increasing the reliability of transmissions. Weightless-W runs off of unused television broadcast wireless spectrums.

[3] http://www.weightless.org

4 What is Ackcio Mesh and how is it different from other LPWAN technologies?

Ackcio Mesh is a primary component of the Ackcio Beam wireless data acquisition system. It is a unique LPWAN wireless communication technology that combines the best of LPWAN technologies and traditional 2.4 GHz-based mesh networks. As such, it provides each device with the same long-range and low-power communication abilities as in LPWAN technologies with the added benefit of forming a reliable mesh network on top of the long-range links to provide unparalleled connectivity in any monitoring environment. This makes Ackcio Mesh an attractive choice for industrial monitoring applications where reliable data collection is required in very challenging environments like construction, mining, and oil-and-gas projects.

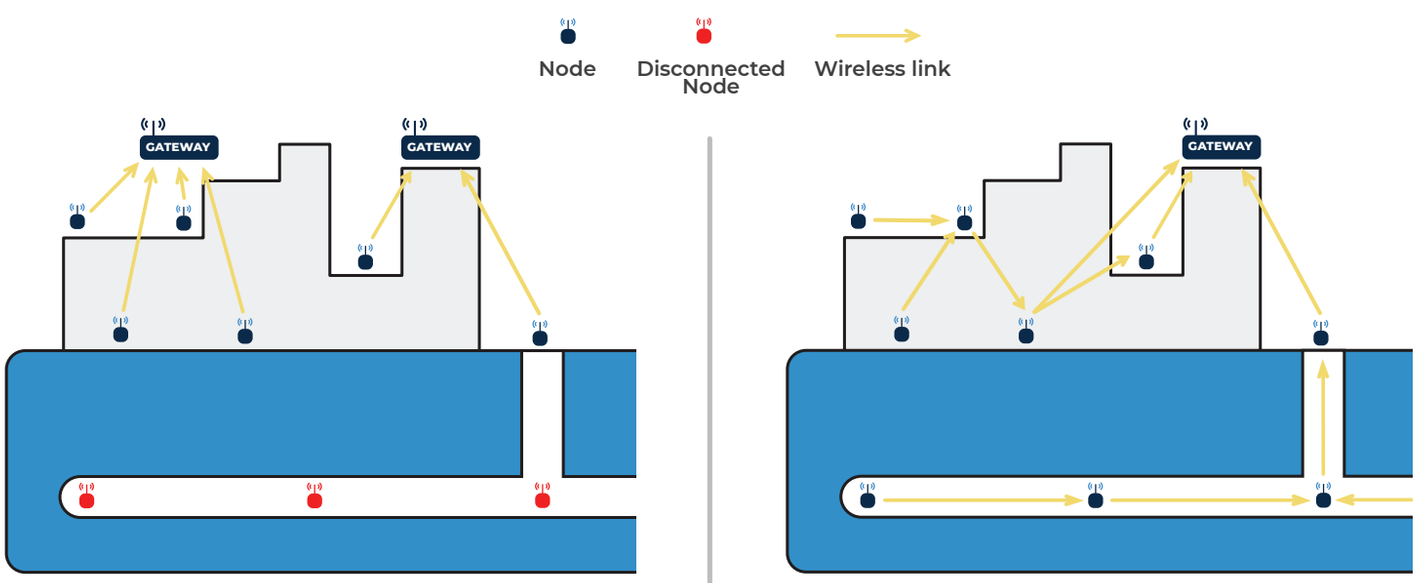
5 Why is Ackcio Mesh a better LPWAN option for Industrial Monitoring?

Industrial monitoring applications have strict monitoring requirements. As such, they require a highly reliable system of data collection from sensors to keep operations risk-free and safe. Ackcio Mesh is well-designed to meet these requirements due to its many advantages, as explained below.

Reliable Data Acquisition

Ackcio Mesh allows redundant paths in the network to be utilised for data transmission. This means each device in the network has multiple communication paths to choose from when it wants to transmit data. This prevents data loss due to obstructions and the creation of dead zones within the network.

Furthermore, the unique multihop mesh networking architecture eliminates a single point of failure and makes the network more reliable. Therefore, when compared to star networks like LoRaWAN and Sigfox, Ackcio Mesh offers superior reliability in sensor data acquisition.



Star Networks suffer from obstructions and loss of connectivity in urban and underground environments.

Ackcio Mesh Network offers superior connectivity in any type of environment.

Scalable Networks

Ackcio Mesh is easily scalable. Adding new devices to the network is as easy as turning them on. In addition, they also create more pathways towards the gateway and enhance network coverage. This allows users to set up large network deployments with a single gateway and perfect load balancing.

Resilient Communication

The widespread adoption of LPWANs, as well as a lack of licensing, have made the sub-GHz spectrum increasingly saturated. This, in turn, leads to severe interference, enough to cause a reduction in bandwidth and an increase in latency. Ackcio Mesh uses multiple transmission frequencies to avoid such interferences, thereby avoiding repetitive transmission failure.

Self-healing Deployments

Building a Mesh networking protocol is a complicated task as is its deployment and maintenance. Ackcio Mesh uses a self-healing routing protocol to make its deployment as simple as switching on the devices with the network automatically running on them to find the best route to the gateway. As such, deploying the network involves virtually no user interaction or configuration.

Synchronised Data Collection

Ackcio Mesh offers network-wide time synchronisation down to a few milliseconds, allowing sensor data from different devices within a multi-hop network to be captured simultaneously. This is particularly beneficial to industrial monitoring applications that require correlated readings from multiple sensors.

Energy-efficient Operations

Ackcio Mesh runs intelligent algorithms to reduce energy consumption of its devices. This allows devices to only wake up when they are supposed to and for a very small amount of time. As a result, they only draw close to a 20µA current for over 99% of the time, making them last for years on batteries. This greatly benefits industrial monitoring applications since data acquisition systems are required to run for years with unattended operations.

Bidirectional Communications

Based on IEEE 802.15.4g and IPv6 industry standards, Ackcio Mesh offers multi-hop bidirectional links that allow users to reconfigure devices remotely and collect data on demand. The latter allows users to immediately verify whether an outlier reading is true or a false positive instead of waiting for the next scheduled data transmission. This also allows for other features such as remote firmware updates, which cannot be done in star LPWAN technologies like LoRaWAN.

6 Conclusion

Many industries are adopting stringent industrial monitoring systems to enhance their operational safety and risk management efforts. Due to many problems associated with cable-based and manual monitoring systems, wireless technologies have become a far better methodology to implement data acquisition systems for industrial monitoring applications.

Amongst all available wireless technologies, LPWAN technologies are becoming increasingly popular for developing competent data acquisition systems. However, due to their star-network mode of operations, they have several drawbacks that reduce data collection reliability in certain applications, such as monitoring sensors in urban and underground environments.

Ackcio Mesh, a primary component of the Ackcio Beam product suite, is a new LPWAN mesh networking technology that provides superior reliability in sensor data collection. It enables the Ackcio Beam system to be a reliable wireless sensor data acquisition system for industrial monitoring applications.

Want to know more about Ackcio Beam and Ackcio Mesh?

Talk to us today

+65 6802 7392

75 Ayer Rajah Crescent, #03-01/02,
Singapore 139953

linkedin.com/company/ackcio

sales@ackcio.com

www.ackcio.com

BEAM-WP-1-EN-2020-06