

PRODUCT SPECIFICATIONS 2018



**ACKCIO
BEAM**

**RELIABLE, REAL-TIME,
Wireless Monitoring Solution
for Geotechnical and
Structural Sensors**

www.ackcio.com

ACKCIO BEAM

Wireless Monitoring Solution



Ackcio Beam is an end-to-end solution that automates the process of monitoring geotechnical and structural sensors in challenging environments like construction sites and mines. The solution is built upon three main components:

ACKCIO DEVICES

Ackcio Nodes connect with geotechnical and structural sensors and transmit their data to the Ackcio Gateway.

ACKCIO MESH

A patent-pending wireless mesh protocol that allows Ackcio Nodes to send their sensor data to the Gateway with over 99% reliability.

ACKCIO CLOUD

A cloud-hosted software suite that manages the network and the sensor data gathered from the deployment sites.

Key Features

With the real-time data gathered by Ackcio Beam, you can be aware of the slightest of changes in your projects. This allows you to make informed real-time decisions, increase safety, reduce project delays, cut costs and be more productive in your work.



DEVICES

- + Plug and play style setup and easy to use system.
 - + Compatible with most geotechnical and structural sensors from all major instrument manufacturers.
 - + Noise-free readings from sensors.
 - + Battery life of over 10 years.
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WIRELESS MESH NETWORK

- + Innovative wireless mesh-based data collection protocol that provides seamless connectivity in large sites and tunnels.
 - + Low-power, long-range wireless radios that provide a range of up to 15 km in each hop of the mesh network.
 - + Over 99% reliability in collecting sensor data.
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CLOUD SOFTWARE

- + Always-on data management software through cloud-hosted software.
 - + 24x7 access to deployments and their sensor data.
 - + Ultra-low latency for data acquisition and pushing updates to the Nodes.
 - + Automated alerts and reports.
 - + Ability to integrate with third-party servers via FTP or Web APIs.
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Why Use Ackcio Beam?

An end-to-end system that provides complete automation of geotechnical and structural monitoring.

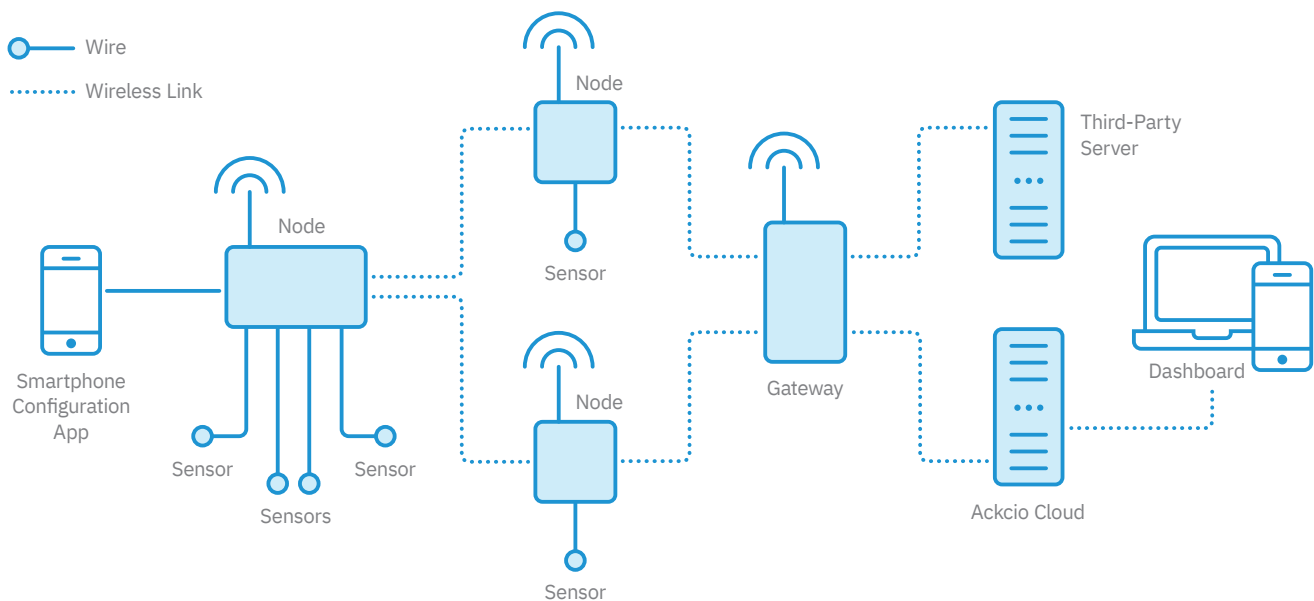
- 1.** Reliable, real-time delivery of sensor data for real-time decision making.
- 2.** Fully-transparent system that provides access to all stakeholders of your projects.
- 3.** Monitor hard-to-access sites and tunnels remotely.
- 4.** Eliminate the need for manpower-heavy traditional monitoring solutions.
- 5.** Stay updated all the time through our cloud-hosted data management platform.
- 6.** Easy to deploy and intuitive to use.

Reduce your cap-ex and op-ex in your monitoring projects by

70%

How It Works

Ackcio Beam is easy to setup and use. All types of geotechnical and structural sensors can be connected with the system for automated monitoring.



The Ackcio Nodes take period readings of the sensors they are interfaced with and transmit them via Ackcio Mesh – a long-range, low-power, patent-pending, wireless data collection protocol – to the Ackcio Gateway. The Gateway then uploads all the gathered sensor data to the Ackcio Cloud.

Ackcio Cloud, our cloud-hosted data management and configuration software, can then be used to visualize and analyze the data. The software system also allows you to manage the sensor network, automate reporting, get smartphone push notifications / email alerts if readings cross pre-set thresholds, and even upload the sensor data to a third-party server via FTP or API push, among many other things.

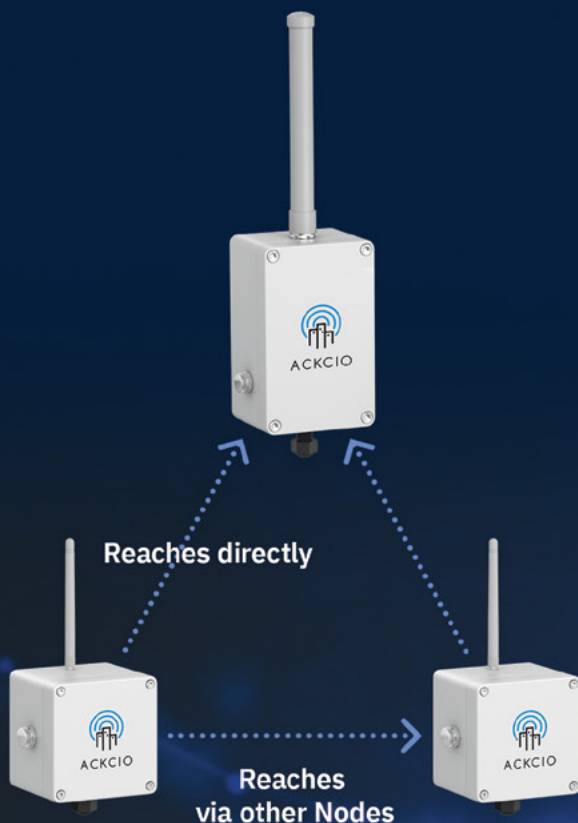
Reliable Wireless Sensor Data Collection

Ackcio Nodes are equipped with long-range wireless radios that allow them to talk to each other, as well as the Ackcio Gateway.

Even if a Node can't reach the Gateway directly, it can still send its data to the Gateway via other Nodes in the network. This is possible with Ackcio Mesh, a patent-pending, wireless mesh data collection protocol that ensures reliable sensor

data collection even in the harshest of environments. It automatically mitigates well-known wireless problems like signal blockages and interference, allowing the Nodes to reliably send their data to the Gateway every time.

Every single radio transmission in the system is secured using AES-128 encryption to maximize security of the sensor data gathered by the system.



Radio bands

Sub-1GHz band
– complies with unlicensed ISM band specifications in most countries

Transmission distance

Up to 4km (non-LoS), up to 15km (LoS)

Mesh hops

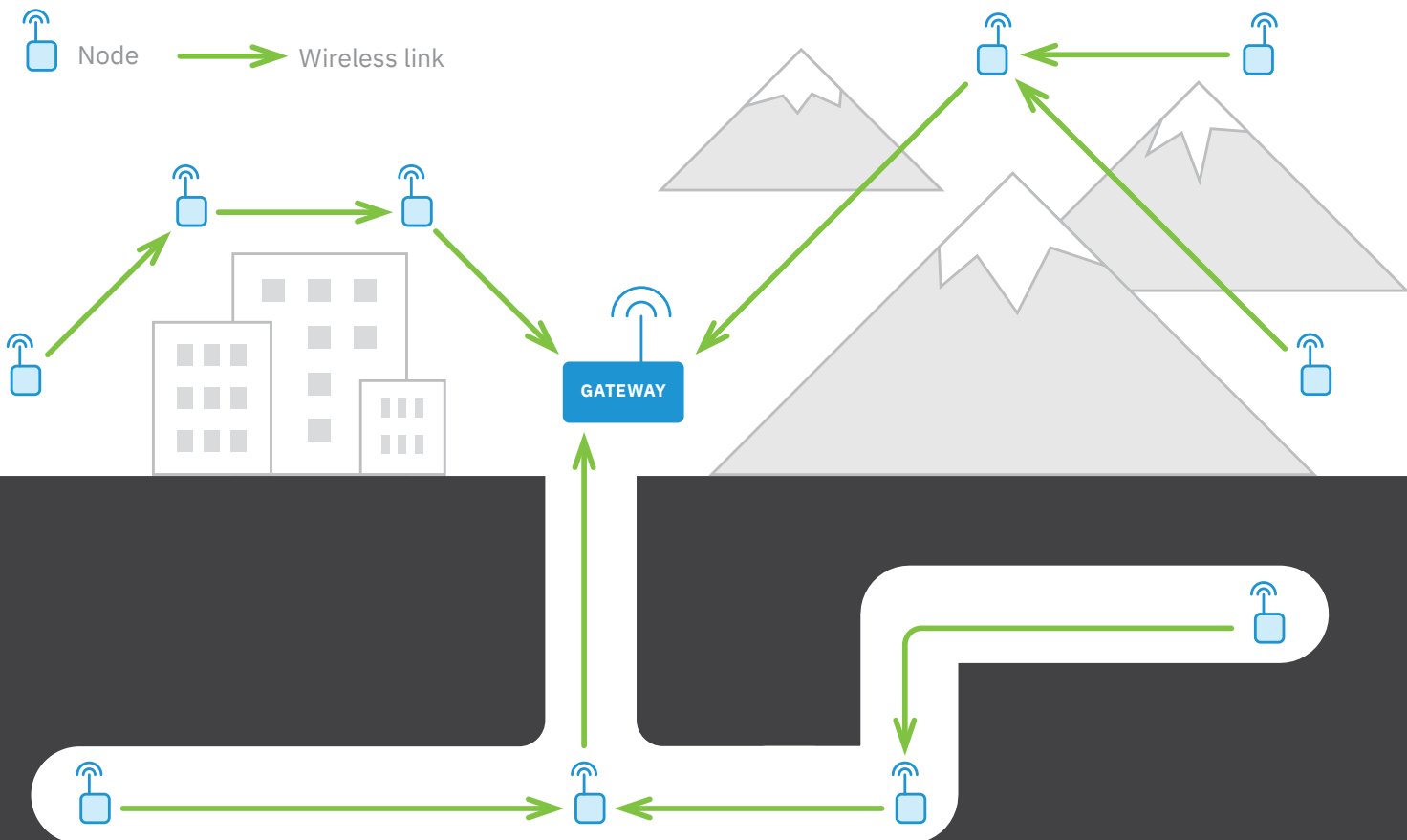
Up to 10

Nodes per gateway

Up to 150

Why Use a Mesh?

Having a reliable, long-range, wireless mesh-based data acquisition system allows for monitoring of sensors that are deployed in deep tunnels and very large construction sites without using multiple gateways and signal repeaters.



This significantly reduces the investment needed to setup a wireless monitoring system. The Ackcio Wireless Mesh network allows all Ackcio Nodes to talk to each other, thus allowing them to relay other Nodes' data to the gateway.

Up to
15km
in line-of-sight
environments

Up to
3km
in tunnels and
underground settings

Up to
4km
in cities and urban
environments

Why Use a Mesh?

Challenging sites like deep tunnels and large mines can be monitored easily with a multi-hop wireless mesh network.



LONG-RANGE TRANSMISSION

Each hop in the wireless mesh has the same long-range distance of 1 to 15km depending on site conditions.



AUTOMATIC CONFIGURATION

Automatic configuration of network paths in the mesh, which dynamically evolve with site conditions.



RELIABLE DOWNLINK

Reliable downlink to send updates like sampling interval changes to the Nodes.



LOW-POWER CONSUMPTION

Ultra low-power consumption to ensure that Nodes last years on batteries.



Analogue Nodes

Analogue Nodes can be used to monitor all types of sensors like MEMS tilt meters and EL beams that have analogue outputs.



Ackcio Analogue Nodes come in two formats: 1-Sensor (BEAM-AN-S1) and 4-Sensor (BEAM-AN-S4), based on the number of sensors the Nodes can be connected with. The nodes are compatible and have been field tested with analogue sensors from all the major instrument manufacturers.

Sensor supply voltage
12 V / 24 V

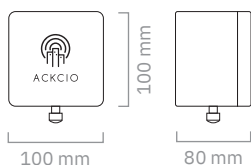
Measurement range
 ± 5 V / ± 2.5 V / 4-20 mA

Resolution
24-bit ADC

Operating temp.
-40°C to +85°C

Accuracy
0.05% FS

BEAM-AN-S1



BEAM-AN-S4



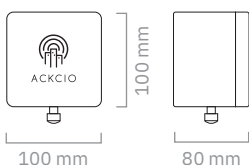
Vibrating Wire Nodes

Vibrating Wire Nodes can be used to monitor all types of vibrating wire sensors like strain gauges, load cells, piezometers, crack meters, etc.



Ackcio Vibrating Wire Nodes come in two formats: 1-Sensor (BEAM-VW-S1) and 8-Sensor (BEAM-VW-S8). The nodes are compatible and have been field tested with vibrating wire sensors from all the major instrument manufacturers.

BEAM-VW-S1



BEAM-VW-S8



Operating temperature

-40°C to +85°C

Frequency range

100Hz to 8000Hz

Frequency resolution

0.1Hz

Frequency accuracy

0.01% FS

Thermistor range

-20°C to +80°C

Thermistor resolution

0.1°C

Thermistor accuracy

0.1% FS

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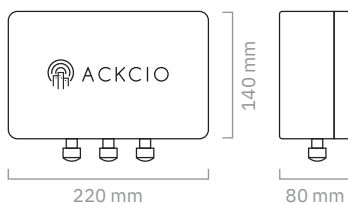
Digital Nodes

Digital Nodes can be used to monitor digital sensors like IPIs that follow RS232, RS485 and SDI-12 protocols.



Ackcio Digital Nodes come in a single format (BEAM-DG) that contains three individual sensor channels for RS232, RS485, and SDI-12. Each channel can be interfaced with up to 32 sensors.

BEAM-DG



Sensor supply voltage
5 V / 12 V

Protocols
Modbus RTU (RS485, RS232) and SDI-12

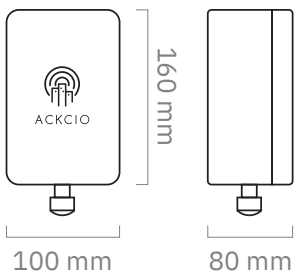
Operating temp.
-40°C to +85°C

Relay Nodes

Relay Nodes can be used in settings where Nodes are beyond the range of the Gateway. Ackcio Relay Nodes can be used to extend the wireless range of Nodes.

Ackcio Relay Nodes can be deployed in settings where Nodes are deployed in isolated locations, and hence unable to find a network path to reach the Gateway. A Relay Node can be placed between Nodes and the Gateway to allow the Nodes to communicate with the Gateway via the Relay Nodes through the Ackcio Mesh Network.

RELAY NODE



Operation modes

Always ON / Duty Cycled

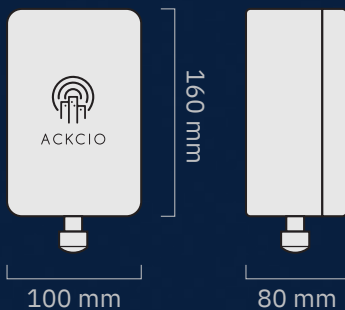
Operating temp.

-40°C to +85°C

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Gateway

Ackcio Gateway (BEAM-GW) receives sensor data from Ackcio Nodes and uploads them to the Ackcio Cloud or third-party servers. The Gateway can be powered both by solar power or a 12V DC power adapter plugged into a 230V / 110V power socket.



Battery life

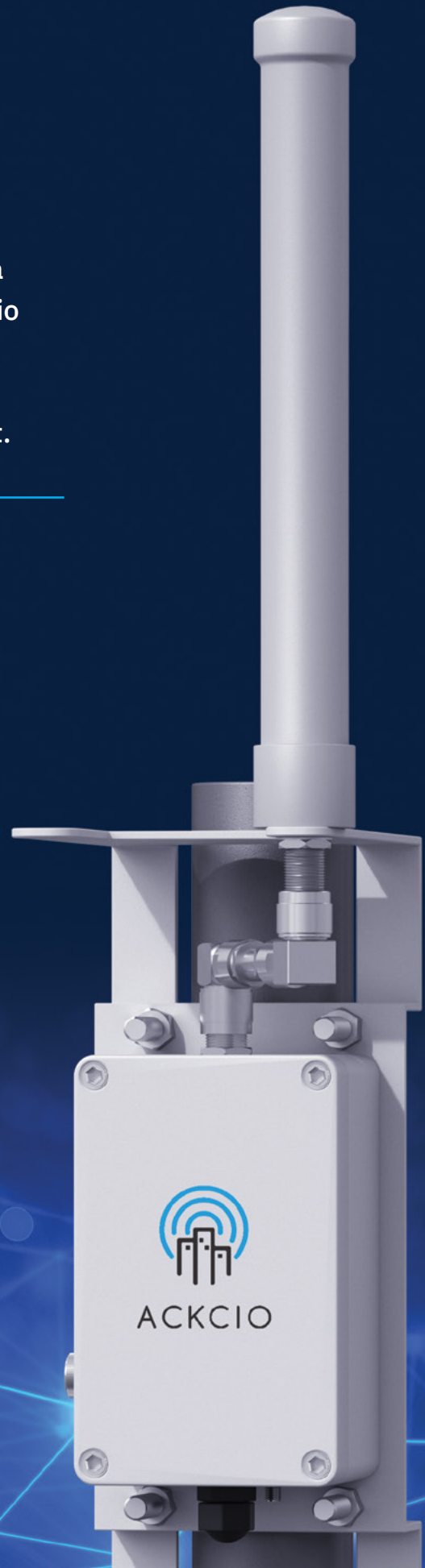
- Unlimited if powered by direct power supply.
- 1 week on an 18AH car battery (if there is no sunlight).
- Real-time battery voltage monitoring.
- Internal storage to store readings when Internet connectivity is not available.
- In-built backup battery that provides 4 months of additional lifetime.

Internet connectivity

In-built 3G/4G modem, Ethernet

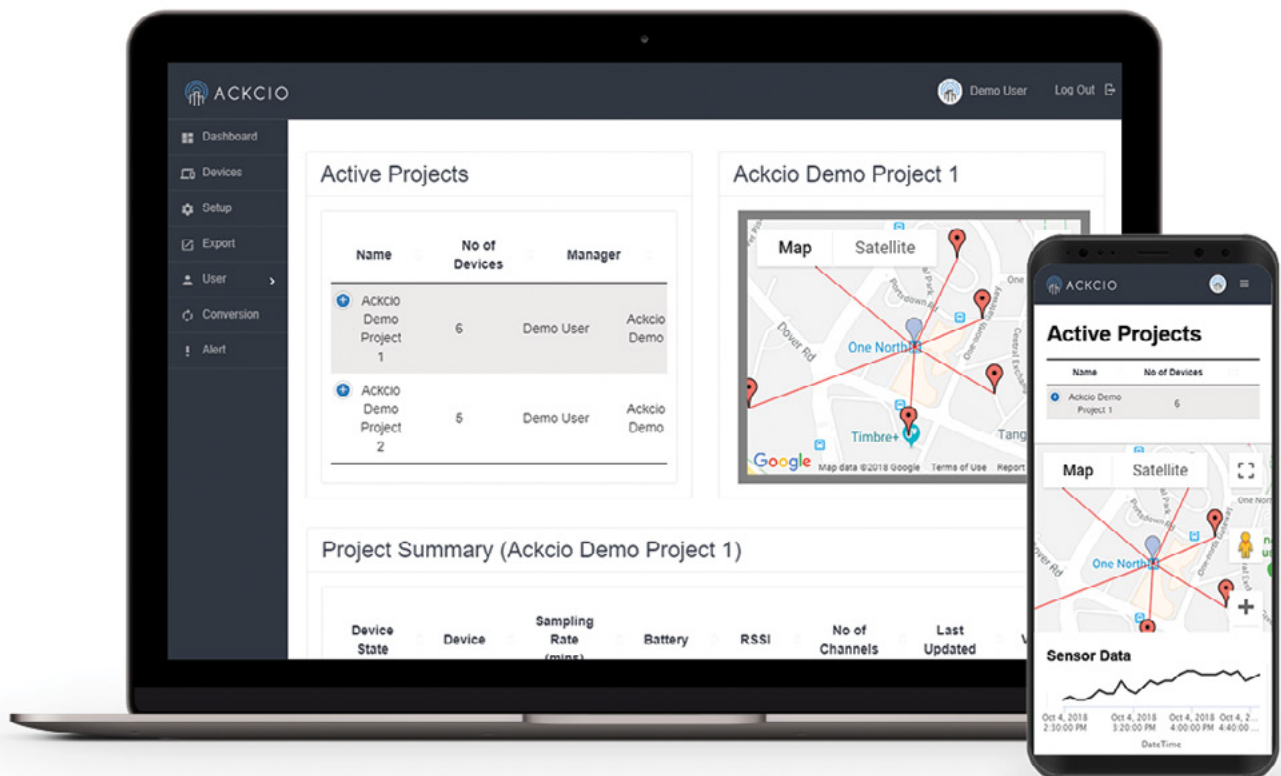
Operating temp.

-40°C to +85°C






Cloud

Ackcio Cloud is a cloud-hosted software system that helps you to both configure your deployments as well as to manage the sensor data collected by the system.



Ackcio cloud provides 24x7 access to all stakeholders of your projects for real-time decision making. Since they have real-time access to every single data point collected from your projects, they can take informed and collective decisions. This increases productivity, reduces delays, and increases safety.

-  Increases productivity
-  Reduce delays
-  Increases safety

Cloud Benefits



Built on top of trusted Microsoft Azure infrastructure to ensure super-high reliability and availability.



Change deployment settings like sensor sampling intervals and network parameters remotely.



Automatic conversion of raw sensor data to engineering units like degrees, kN, etc.



Option to redirect sensor data to third-party servers via FTP or API push.



Obtain sensor data readings on-demand from the Nodes.



Cloud-based platform that works on any device.



Automatic email/app alerts if and when readings exceed pre-set thresholds.



Automatic generation of data reports.



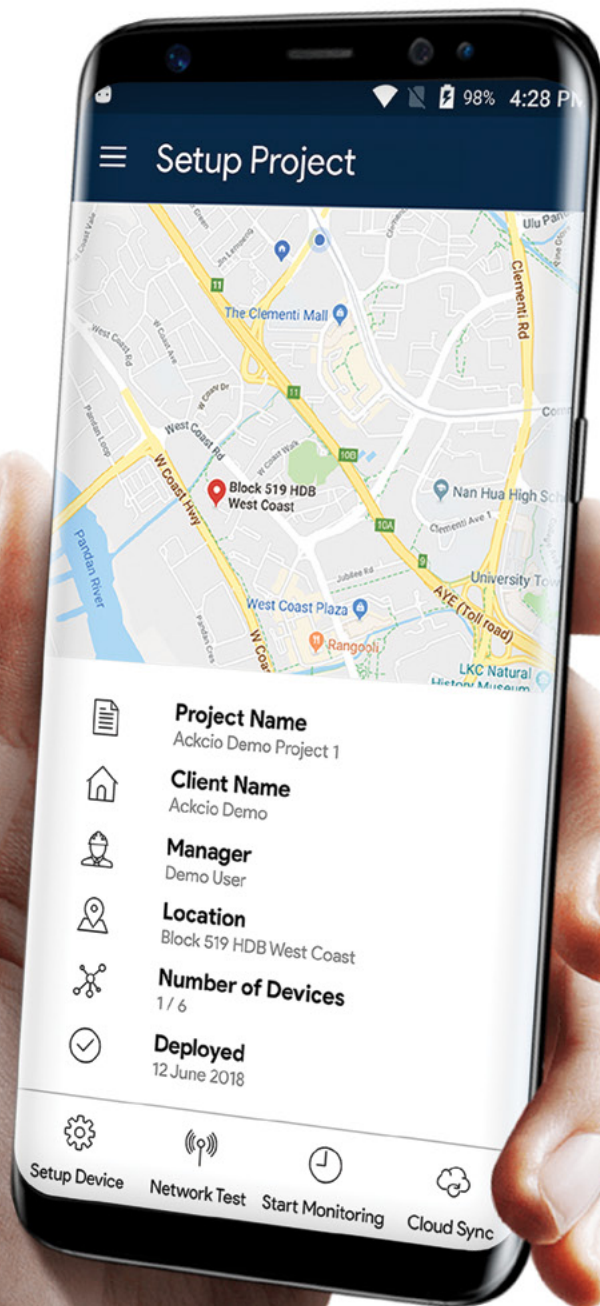
Collect and visualize health metrics of the Gateways and Nodes.



Add any number of users and control their access levels.

Configuration Mobile App

All Ackcio Nodes can be setup at the deployment site with an easy-to-use smartphone application that comes free with the system.



1

Provides step-by-step instructions on setting up sensors.

2

Displays whether the radio signal is good enough for Nodes to reach other Nodes or the Gateway.

3

Takes on-site sensor readings to help with sensor verification and recording initial sensor readings.

4

Shows the battery conditions of the Nodes.

5

Automatically obtain the geo-coordinates of the Nodes in the site while setting up.

Battery Life

The expected battery life of nodes for different types of sensors is given in the tables below. All tests were carried out with Lithium Thionyl Chloride (Li-SOCl₂) 3.6V 19Ah batteries.

Analogue Nodes with Voltage Output Sensors

Node Type	Number of Batteries	Expected Battery Life		
		@ 5 min Sampling	@ 15 min Sampling	@ 1 hour Sampling
BEAM-AN-S1	1	6 months	2 years	5 years
BEAM-AN-S4	2	6 months	2 years	5 years

Analogue Nodes with Current Loop Output Sensors

Node Type	Number of Batteries	Expected Battery Life		
		@ 5 min Sampling	@ 15 min Sampling	@ 1 hour Sampling
BEAM-AN-S1	1	6 months	2 years	5 years
BEAM-AN-S4	2	6 months	2 years	5 years

Vibrating Wire Nodes

Node Type	Number of Batteries	Expected Battery Life		
		@ 5 min Sampling	@ 15 min Sampling	@ 1 hour Sampling
BEAM-VW-S1	1	1 year	3 years	>5 years
BEAM-VW-S8	2	8 months	>2 years	>5 years

Digital Nodes

# Sensors (Geokon IPI)	Number of Batteries	Expected Battery Life		
		@ 5 min Sampling	@ 15 min Sampling	@ 1 hour Sampling
10	2	6 months	1.5 years	5 years
20	2	4 months	10 months	2.5 years
30	2	2 months	6 months	1 year

Case Studies

Common Services Tunnel Monitoring Project – Singapore



Our client opted to use the Ackcio Beam solution in this project since it saved them costly manpower expenses that they would have had to bear to obtain manual readings.

The Common Services Tunnel (CST) in the Central Business District of Singapore is located 50m below ground and carries water and electricity to the city. Since it was in close proximity to two new MRT tunnel construction projects, government authorities wanted to monitor tilt sensors placed inside the CST to

ensure that it was not getting impacted due to the nearby construction work. Since the CST was deep underground and full of thick concrete walls and slabs, the Ackcio Mesh Network allowed all the Nodes to send their data to a single Gateway that was placed above ground near the tunnel entrance. This would have been infeasible with a Star Network-based system since some Nodes could not reach the Gateway directly.

Bedok Canal Improvement Project – Singapore

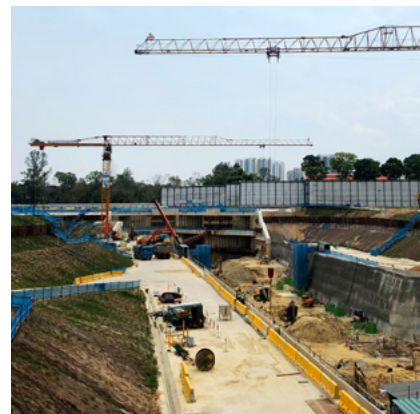


The Ackcio Beam system was used to monitor strain gauges and load cells mounted on I-beams along a 1.2km-long canal segment in Bedok, Singapore.

The canal banks were expanded to increase the canal's capacity. Therefore, it was necessary for the load on the I-beams to be monitored in real-time to ensure that the site work proceeded without compromising safety and integrity of the site.

Since the site works spanned over 1km, cabling sensors or using manpower take manual readings is not cost effective. So our client used the Ackcio Beam system to automate the monitoring process. With the Ackcio Beam system, our client always had the data they needed right at their fingertips for real-time decision making.

Thomson-East Coast MRT Line – Singapore



The Ackcio Beam system was used to monitor strain gauges affixed to a thrust frame that was bearing a tunnel boring machine (TBM).

The load imposed on the thrust frame by the TBM was monitored in real-time to ensure that the TBM drilled through the earth without affecting the integrity of the thrust frame.

Our client opted to use the Ackcio Beam system because the tunneling work happened ~20m below ground. So cabling or manual reading of the strain gauges becomes too costly. The TBM drilling work was completed safely with the help of the Ackcio Beam system, and the project stakeholders used the Ackcio Cloud to be aware of the project status 24x7.



ACKCIO

Tel.: +65 6802 7392
81 Ayer Rajah Crescent,
#03-69/70, Singapore 139967

[linkedin.com/company/ackcio](https://www.linkedin.com/company/ackcio)
sales@ackcio.com
www.ackcio.com

