



Remote Monitoring Solutions for Tunnel Construction

Tunnelling for a new transport route isn't as simple as boring away at the earth. It requires the constant monitoring of geotechnical and structural parameters to maintain a safe and efficient work site. Ackcio Beam fully automates this process and makes critical data from various sensors remotely accessible to decision makers in real-time. Here's how that works.

01 INTEGRITY OF SURROUNDING BUILDINGS

On nearby buildings, Ackcio **BEAM-AN-S1** (1 channel) and **BEAM-AN-S4** (4 channels) Nodes ensure real-time monitoring of crack meters and displacement sensors to ensure the safety of the surrounding infrastructure.

02 ACKCIO GATEWAY

The Ackcio **BEAM-GW** receives sensor data from the Nodes within the network. Ackcio's Snape software that runs on the Ackcio Gateway is used to configure and manage the project. It also provides the option to push the data via FTP and/or API server hosting a software (selected) of client's choice.

03 TILT MONITORING

Ackcio **BEAM-TM** Nodes bundle Ackcio's long-range wireless mesh technology with Sisgeo's trusted bi-axial self-compensated MEMS inclinometer, measuring the horizontal and vertical movement of the surrounding buildings.

04 SLOPE STABILITY MONITORING

Ackcio wireless tiltmeter Nodes **BEAM-TM** can be used to monitor the slope stability in and around the influence zone of tunneling and construction activity.

05 ACKCIO NODES

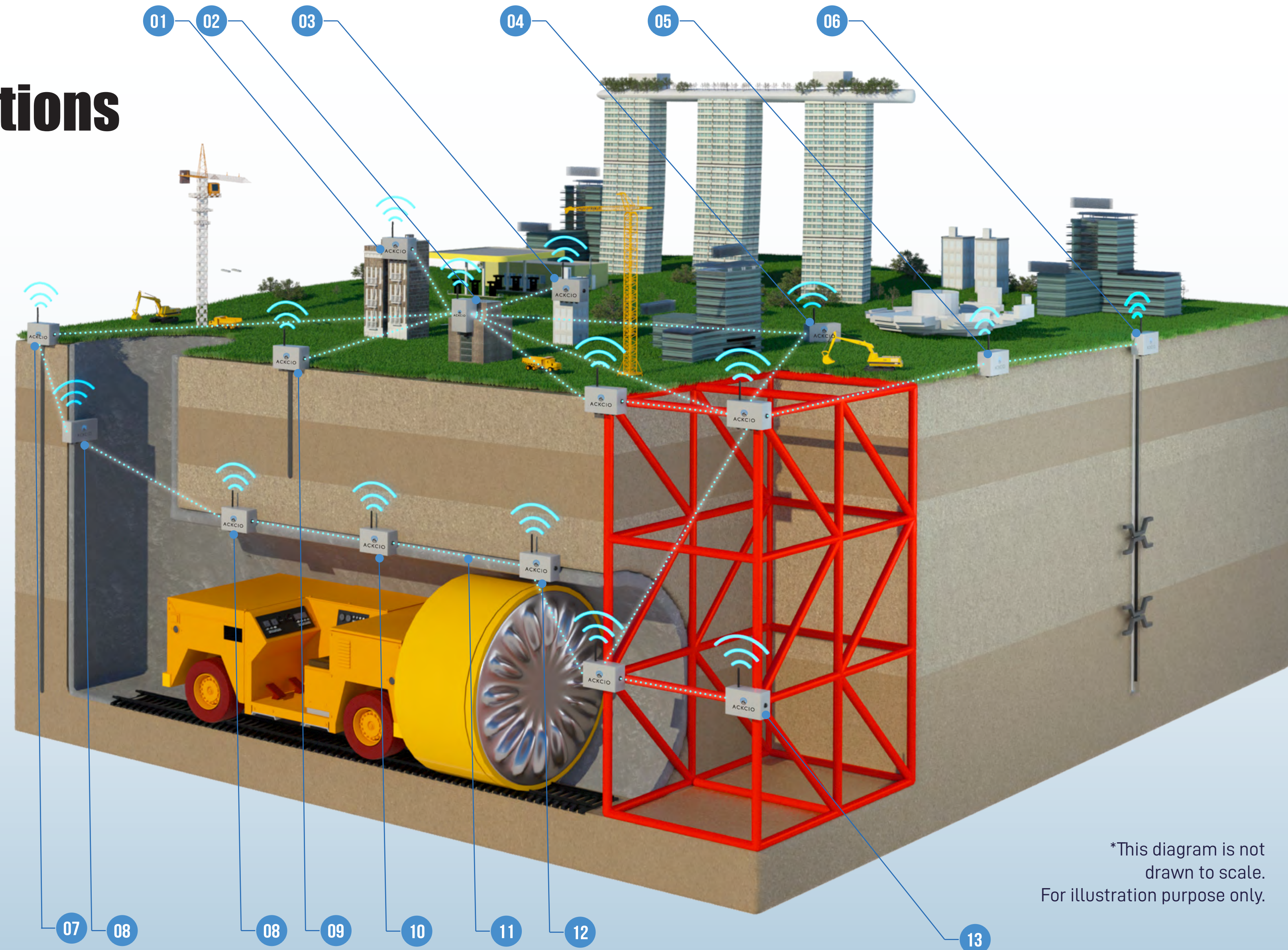
Each battery-operated Node acquires data from various sensors and transmits the sensor data wirelessly through the Ackcio Mesh network to the Ackcio Gateway.

06 GROUND SETTLEMENT MONITORING

Ackcio **BEAM-AN-S4** (4 channels) Nodes automate the monitoring of a multi-point borehole extensometer (MPBX) that measures vertical deformation at various depths.

07 IN-DEPTH GROUND DISPLACEMENT

Settlement displacement around the tunnel shaft is monitored by leading brands of digital in-place-inclinometers (IPI's)/MPBX/SAA's/ extensometers in real-time using Ackcio **BEAM-DG** Nodes.



08 INTEGRITY OF THE TUNNEL LINING

Ackcio **BEAM-VW-S1** (1 channel) and **BEAM-VW-S8** (8 channels) Nodes monitor strain gauges and load cells fitted throughout the tunnel shaft along with convergence instruments and settlement cells through the tunnel.

09 MONITORING PORE WATER PRESSURE

Piezometers measuring the pore water pressure are monitored in real-time using Ackcio **BEAM-VW-S1** (1 channel) and **BEAM-VW-S8** (8 channels) Nodes.

10 TUNNEL DEFORMATION MONITORING

Measurand ShapeArray instruments monitor tunnel deformation in real-time using Ackcio **BEAM-DG** Nodes.

11 ACKCIO MESH

Ackcio's patented long-range wireless **MESH** network connects the Ackcio Nodes to the Ackcio Gateway. The mesh network is self-healing, enhancing the transmission reliability. The ability to 'hop' up to 12 times significantly increases the aggregate communication range, especially in underground deployments. The system is highly flexible and scalable.

12 REPEATER NODES

If deployment challenges reduce the range of Ackcio Nodes, Ackcio **BEAM-RN** Nodes assist in extending the wireless range of other Ackcio Nodes within the network.

13 MONITORING CUT AND COVER EXCAVATION

Layers of strutting are equipped with Ackcio **BEAM-VW-S1** (1 channel) and **BEAM-VW-S8** (8 channels) Nodes to monitor strain gauges and load cells.