# GeoNet Wireless Network

## Applications

**GeoNet is a low power, wireless data acquisition network developed to more efficiently collect data from widely distributed instruments where cabling and cable trenching is difficult and time consuming (or not possible).**

**Typical applications include…**

- **Groundwater monitoring**
- **Tailings dams**
- **Structural monitoring of buildings, bridges, excavations and tunnels**
- **Historical structures**
- **Mining/slope stability**

*Model 8800-8-1 Multiplexer, shown with eight 2-pair cable connections.*

*Model 8800-6 Sensor Node connected to Model 6150E MEMS Addressable In-Place Inclinometer string.*

*Model 8800-2 Network Supervisor (center), surrounded by five Model 8800-1 Sensor Nodes.*

## Introduction

GeoNet is a low-power, wireless data acquisition network developed to more efficiently collect data from many points. The system consists of a Network Supervisor (8800-2) and up to 100 Single-Channel Sensor Nodes (8800-1), or up to 25 Nodes when used with Sensor Node Multiplexers (8800-8). The supervisor controls the network and is the aggregator of all the data collected by the nodes. The system is compatible with all **GEOKON®** Vibrating Wire instruments and addressable sensor strings (MEMS, VW and thermistor).

## Topology

The system topology takes the form of a mesh, or cluster tree, with an outdoor range[1] of 26 km or an indoor/urban range[1] of 1.2 km with line-of-sight between hops and a maximum of 4 hops.

Sensor Node Multiplexers expand the capacity at each node to 8 channels, thereby allowing clusters of closely spaced sensors to be added to the system, or to add vibrating wire load cells (which contain between 3-6 sensors), multipoint borehole extensometers (which contain between 3-8 sensors) or multilevel piezometers. Sensor cables are connected to the multiplexer through cable glands (Model 8800-8-1, 8800-8-3) or via 10-pin plugs (Model 8800-8-2). Multiplexers are connected to the nodes via a 3 m interconnect cable, with 10-pin plugs each end) and are supplied with mounting brackets for attaching to poles or backboards as required.

## Operating Principle

GeoNet is built on top of the IEEE 802.15.4 standard. The network is self-healing and will reconfigure itself, if possible, to tolerate disturbances to the physical environment (see insets on backside). Up to 12 networks can coexist by setting each to a different operating frequency (channel).

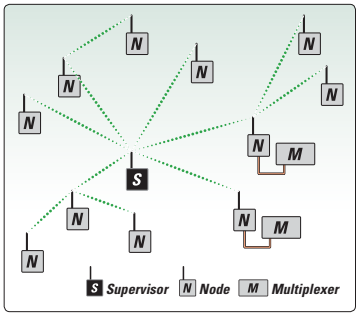
The nodes that comprise the network are synchronized so that they wake from deep sleep simultaneously to communicate or collect data, and then return to sleep when finished. Nodes separated from the network will continue to collect and store data autonomously until battery expiration. When network connectivity is reestablished, the data collected is transmitted to the supervisor where it is aggregated (a copy of all data, collected and sent to the supervisor, is stored on each respective node).

Configuration of the network and collection of data is accomplished via a PC client program by connecting to the network supervisor either directly, through cellular modems[2] or network serial servers. Each data array consists of the record date/time, battery voltage, node temperature, vibrating wire sensor reading, sensor temperature, array number and radio signal strength.

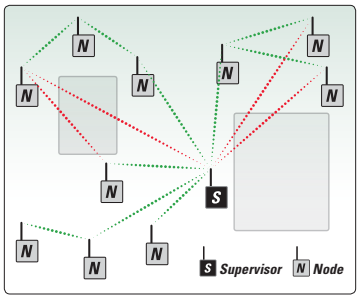
[1] *900 MHz (North America, Brazil, Singapore, Australia). Other countries: 2.4 GHz with a range of: 3 km (outdoor); 240 m (indoor/urban). Line-of-sight, maximum 4 hops.*

[2] ***GEOKON** offers cell modem compatibility for GeoNet Supervisors by way of the Model 8800-2-4A (please contact **GEOKON** for details).*

*Model 8800-1 Sensor Node, with 10-pin connector option and cover removed to show battery compartment.*




*Typical network.*




*Network with obstructions.*

## Communications

Communication between the Supervisor and the client software can be accomplished several ways. The Supervisor protocol is **Modbus®** RTU over RS-232 or USB as a virtual COM port. The software also supports network connections such as serial servers and cellular modems. Devices capable of functioning as a **Modbus** master can be programmed to collect data from the network.

## Advantages and Limitations

The system is non-obtrusive, simple to deploy, has a long battery life and is self-healing to accommodate disturbances in the network environment. Nodes continue to collect and store data autonomously if separated from the network, then transmit the data to the supervisor when network connectivity is reestablished. Sensor readings are synchronized across the entire network; the minimum sample interval is 10 minutes and the maximum is 24 hours.

## Technical Specifications

| | 8800-1 (Node) | 8800-2 (Supervisor) |
|---|---|---|
| Measurement Accuracy | ±0.025% F.S. (400-5000 Hz) | |
| Thermistor Accuracy | 2% F.S. | NA |
| Thermistor Resolution | 0.4 °C | NA |
| Data Memory | 32 MB | |
| Storage Capacity | > 1.04 M Arrays | |
| Communication Type | NA | USB, RS-232, RS-485 |
| Communication Speed | NA | 115 k Bits/Second |
| Communication Parameters | NA | 8, N, 1 (data bits, parity, stop bits) |
| Communication Protocol | NA | **Modbus** RTU |
| Scan Interval | 10-1440 Minutes | |
| USB Driver | NA | FTDI |
| Power Supply | D Cell Alkaline or Lithium (2×) | |
| Operating Time | Please contact **GEOKON** | |
| Operating Temperature | –40 °C to +85 °C | |
| L × W × H | 122 × 120 × 91 mm | |

## Environment

GeoNet nodes, multiplexers and supervisors are enclosed in fiberglass NEMA 4X enclosures, which are suitable for harsh environments. The enclosures are treated with a conductive coating, that protects the internal components and signals from outside interference, and offers protection from transient events caused by nearby lightning strikes. Operating temperature range is from –40 °C to +85 °C.

## Power

The Supervisor and Nodes[3] are powered by either Lithium or Alkaline "D" cell batteries, or an external source up to 12 V. For information regarding Battery Life versus number of Nodes, or additional power options, including internal and external 12 V batteries and solar panels, please contact **GEOKON**.

## Software

"Agent" software is used for network configuration and data collection. A database, on a local host PC, stores the data, which can be viewed and easily exported for use in other data management applications. The Agent manages the conversion of raw data to engineering units and can be configured to collect and export data automatically.

*[3]Nodes connected to either Multiplexers or addressable sensor strings will require Lithium batteries.*

## Multiplexer Specifications

| | 8800-8-1/2/3 (Multiplexers) |
|---|---|
| Supply Voltage (Nominal) | 2.8 V - 3.6 V (3.3 V) |
| Quiescent Current (Typical) | 50 µA |
| On-state Current (Typical) | 10 mA (varies with temperature) |
| Switch Resistance (Maximum) | 10 Ω added in series to each VW coil |
| Datalogger Cable | 3 m |
| L × W × H | 260 × 160 × 91 mm (8800-8-1/3)<br>360 × 160 × 91 mm (8800-8-2) |

## Network Specifications

| | 900 MHz | 2.4 GHz |
|---|---|---|
| Topology | Mesh/Cluster Tree | Mesh/Cluster Tree |
| Radio Technology | IEEE 802.15.4 FHSS | IEEE 802.15.4 DSSS |
| Radio Frequency, ISM Band | 900-928 MHz | 2.4 GHz |
| Channels | 12 | 12 |
| Range[1] (Outdoor)<br>(Indoor, Urban) | 26 km (6500 m × 4 hops)[2]<br>1220 m (305 m × 4 hops)[2] | 3 km (750 m × 4 hops)[3]<br>240 m (60 m × 4 hops)[3] |
| Receiver Sensitivity | –101 dBm | –100 dBm |
| Network Throughput | 78, 50, 22 kbps (1, 2, 4 hops) | 78, 50, 22 kbps (1, 2, 4 hops) |
| Antenna (Half-Wave Dipole) | 2.1 dBm | 2.1 dBm |
| Transmit Power | 24 dBm (250 mW) | 10 dBm (10 mW) |

*[1]Line-of-sight, maximum 4 hops. | [2]North America, Brazil, Singapore, Australia | [3]Other countries*

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