Estimating node location using wireless metadata

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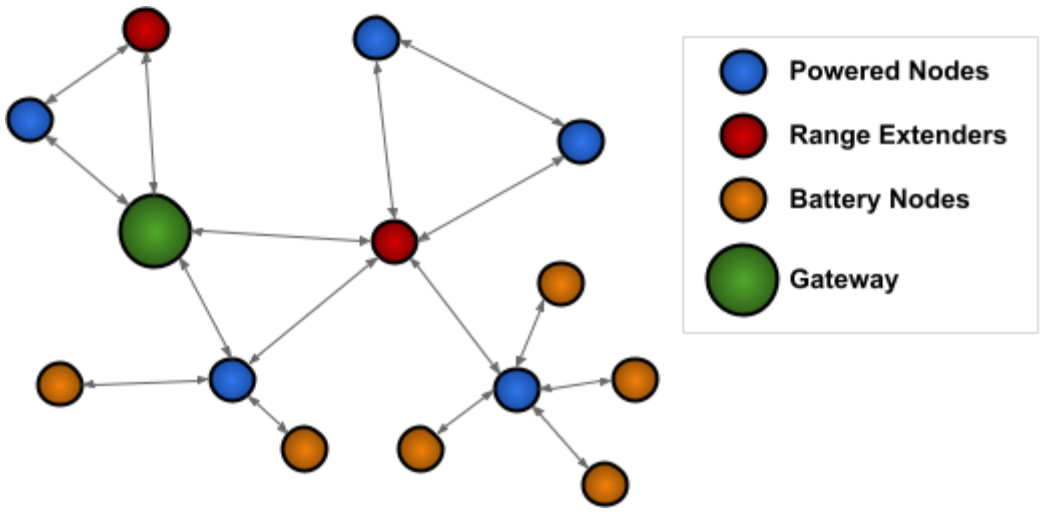
Introduction

This document describes how nodes in EpiSensor's platform communicate, the metadata available about the health and performance of the wireless network, and how this data can be used to approximate the location of a battery powered node in a built environment.

Wireless Communications

All EpiSensor products use IEEE 802.15.4 ZigBee Pro for wireless communications operating at 2.4GHz. This is a secure, scalable mesh networking communications protocol designed for transmitting small amounts of data reliably, and at low power levels.

There are two types of nodes in the EpiSensor wireless mesh network: powered nodes and battery nodes. Powered nodes on the wireless sensor network are capable of routing data from any other type of wireless nodes.



Range extenders are powered nodes where the main function is to route data. Any node with a mains power supply will act as a routing node in the network, and each node has a unique serial number which is used to uniquely identify it on the wireless network.

Battery nodes do not route data – they spend most of the time 'asleep' in a low power mode. All EpiSensor nodes for monitoring temperature and humidity are battery powered. These nodes also have unique serial numbers.

Each powered node can have up to 32 ‘neighbours’ which are nodes with a mains power supply that can Route data back to the Gateway. They can also have up to 32 ‘children’ which are nodes that are battery powered and cannot participate in any routing in the network.

The range that can be achieved with ZigBee will depend mainly on two factors: the power level of the ZigBee radio module and the environment that the device is installed in.

All communications over the ZigBee wireless network is AES 128-bit encrypted. For more detailed information on ZigBee security features, contact EpiSensor support.

Available Metadata

EpiSensor nodes produce the data that relates to the health of the hardware or the topology and signal strength of the wireless network. Most of this data can be either be queried via an API or exported from the Gateway at regular intervals, and used by 3rd party software applications to monitor the performance and topology of the wireless network.

The types of metadata available are as follows:

Data	Description
Battery Level	Battery voltage measurement used to remotely monitor battery health
LQI and RSSI	Wireless signal strength
Neighbour Count	The number of routing nodes currently communicating with that node
Child Count	The number of battery powered nodes communicating with that node
Neighbour List	A list of neighbours connected to that node, with additional metadata
Child List	A list of children connected to that node, with additional metadata

For each item in the “Neighbour List”, the the following information is provided:

Option	Description
serial_number	The neighbour node serial number

name	The neighbour node name
lqi	Link Quality Index Incoming to the node from the neighbour.
in_cost	The inbound cost between the node and the neighbour. This value is computed from the average LQI. Values will be in the range [1, 7] with 7 being the worst link quality.
out_cost	The outbound cost between the node and the neighbour. This value is computed from the average LQI. Values will be in the range [0, 7] with 7 being the worst link quality. A value of 0 means no messages have been exchanged.
aging_periods	The number of aging periods which have elapsed since the last message exchange between the node and this neighbour. An aging period is 16 seconds. Any value greater than 3 (48 seconds) is stale.

For each child node, just the serial_number and name are provided. The additional information is not available for child nodes.

Estimating Location

Depending on the application and environment where the EpiSensor system is deployed, it is possible to determine the location of a node (to varying degrees of accuracy) by determining what the Gateway or range extender a node is connected to.

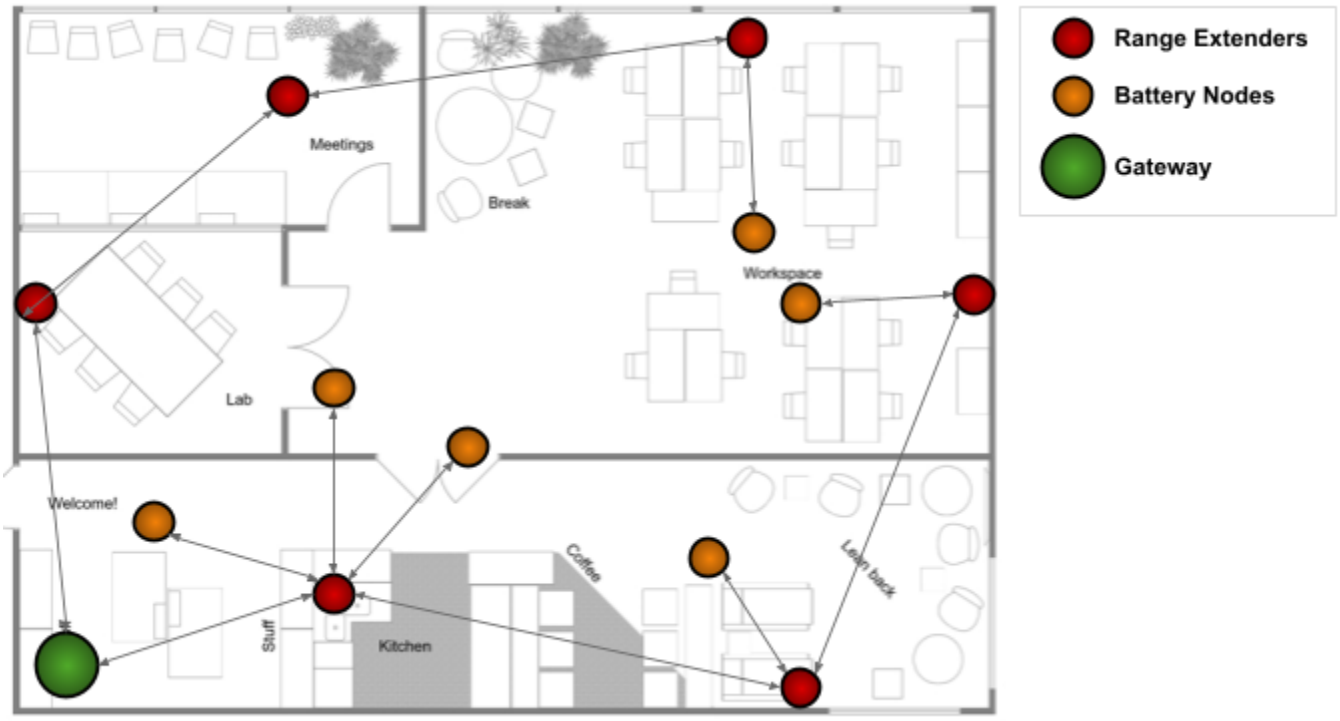
Each powered node in the network will have a serial number, and known location where it is installed. In the diagram below, all ‘red’ and ‘green’ items are stationary and will have known locations associated with their serial numbers.

When a battery powered node (for example a temperature sensor) wakes up and sends a data point, it will communicate with a parent device that has the best signal strength. However, this will not always be the node that is closest to it.

On the Gateway, the Child List table will be updated for each powered device, and can be queried via the API to show a list of the node serial numbers that are communicating with that node.

The coverage provided by the Gateway and range extenders varies depending on the fabric of the building that it is installed in, and is also not uniform in a building, similar to Wi-Fi performance in any home or office. On average

(for nodes configured for EU power limits) each powered node will provide coverage for up approximately 1000m^2, or a radius of about 30m in a typical commercial / industrial environment.



It is important to note that location data that is inferred from wireless sensor network metadata in this way is an estimate, and can vary significantly based on the variables noted above.