Node-Based Tracking Using Received Signal Strength Indication

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Overview

- **Node-Based Tracking**
  - Handset = Tracking Device
  - Node = Reader

- **Received Signal Strength Indication (RSSI)**

- **Central Server Considerations Before and During Emergencies**

- **NIOSH Wireless Mesh Communication & Tracking Contract**
Node-Based Tracking
Handset = Tracking Device
Node = Reader
Handset Network Connectivity

- Unless powered off, communication handsets used with node-based networks will transmit periodically to maintain network connectivity.

- The miner does not need to key the handset for tracking purposes.
Received Signal Strength Indication (RSSI)

- RSSI measurements are arbitrary indications of the signal power
- Relationship to actual signal power and range of reported RSSI values are vendor specific
- Supported by Zigbee (IEEE 802.15.4) and WiFi (IEEE 802.11) standards
- A similar metric also supported by WiFi is Received Channel Power Indicator (RCPI), with defined levels of power accuracy and resolution
Tracking via RSSI

- Takes advantage of line-of-sight signal power fade over distance
- Anything that affects the received signal strength influences the accuracy:
  - Around coal pillars
  - Through stoppings
  - Body absorption
  - Equipment in the entries
  - Antenna orientation
  - Multipath constructive or destructive interference
RSSI Error Correction Techniques

- There are ways to improve the accuracy, including:
  - Time averaging of the received signal
  - Considering the rate of travel
  - Mapping movement to the mine map
  - Time-of-arrival
Tracking – Radio Contact With One Node

- Location accuracy based on radius around node (omni directional antenna)
- Worst case accuracy is maximum radio range from the handset to the node (radius from node)
Tracking Between Two Nodes
Tracking Between Two Nodes
Tracking Between Two Nodes
RSSI Error Test

- Transmitters spaced every 100 ft
- Miner walks along entry for 500 ft

- True position and RSSI estimated position recorded at regular intervals along path
Comparison of Actual and RSSI Calculated Displacement as a Miner Walks 500 Feet Down an Entry
RSSI Tracking Error Distribution (Example)
Probabilistic nature of radio measurements is inherent to radio location systems.
Node-Based Tracking
Handset = Tracking Device
Node = Reader
Node failure puts miner in radio contact with one node. Here? Or Here? Recording last known location before event can help.
Central Server

- Calculates and displays handset location
- Node placement on display must be updated frequently
- Last known location before emergency will be saved per MINER Act
- Detailed network status must be easily accessible post-event
NIOSH Contract: Wireless Mesh Mine Communication and Tracking System

- L3 Communications Global Security & Engineering Solutions
- ICG-Wolf Run Mining Co. Sentinel mine