Carnegie Mellon

Location Tracking System & Sensor Based Communications For Mining

Response to RIN 1219-AB44

Targeted Technologies

- **Wireless Networks**
- **Sensors**
- **Applications (Software)**
- **Robots**
- **Communications**
- **Integrated Systems**

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Wireless Mesh Networks

- **Distributed Self Configuring**
  - Fully distributed and autonomous setup for easier deployment

- **Distributed Self Healing**
  - Fully distributed and autonomous alternative route generation

- **Heterogeneous Wired / Wireless Mesh Network**
  - Multiple network types

- **Location Tracking**
 - Nearby Triangulation

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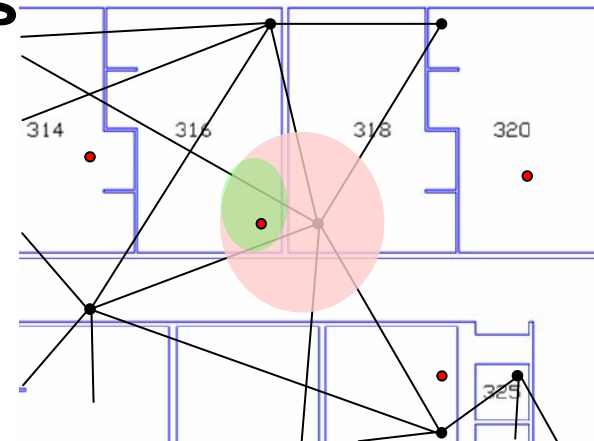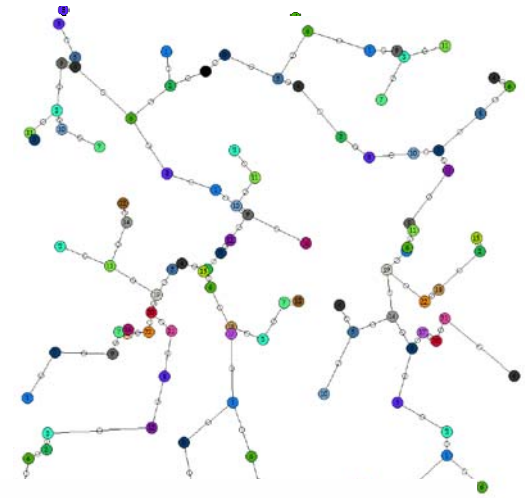
Wireless Networks

- **Adaptive Communication Protocol**
  - Normal Operation - low power, battery saving, low maintenance, closest node listening
  - Emergency Mode - high power, max. bandwidth, active any node listening

- **Network Segments Can Function Independently**
  - Entrapped or Segmented Network function

- **Multiple Edge Node Entry Points**
 - Multiple paths out to surface

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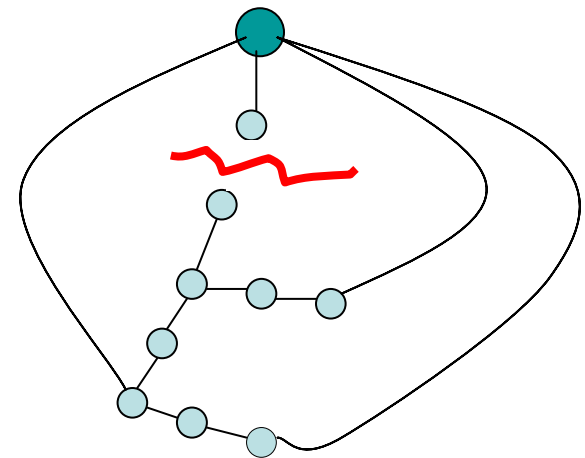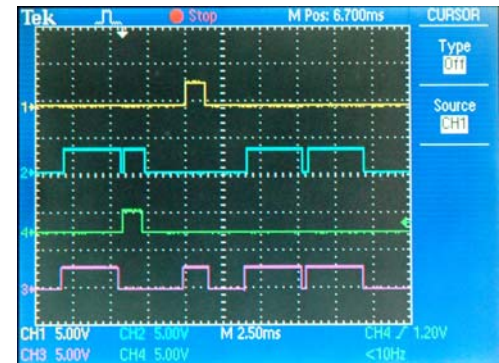
Hardware

- **Sensors Subsystem Prototype**
  - CO, CO_2 CH4 and O2 Sensing Subsystem Safety Certified Infrastructure Node
  - Human Proximity, Temperature, Light, Sound, Motion, Vibration
- **Communications Protocol**
  - Two Way Collison Free Communications
  - Intrinsically Safe High Powered Low Frequency Radio Communication
- **Wearable Mobile Node Send/Receive**
  - User can send messages with buttons
  - User can read text or graphical messages on a small screen

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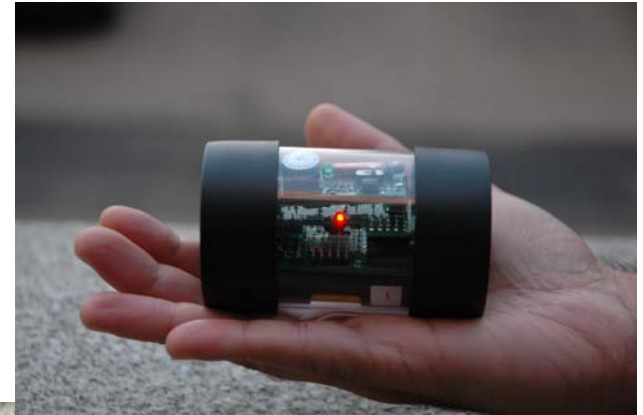
Applications

- **Location Tracking**
  - Integration of triangulated position with database and management software
- **Server Side Management Software**
  - Display Miner Positions Plotted on a Map
  - Transmit Warning Messages to mobile nodes
  - Manage and Display Sensor Data
  - Monitor Network Status
- **Web Portal**
  - Multiple Stakeholder Access
  - Owners, Operators, Inspectors, Regulators, First Responders, Search & Rescue
- **Blackbox**
  - Nodes store sensor snapshots after a emergency activation for later investigation
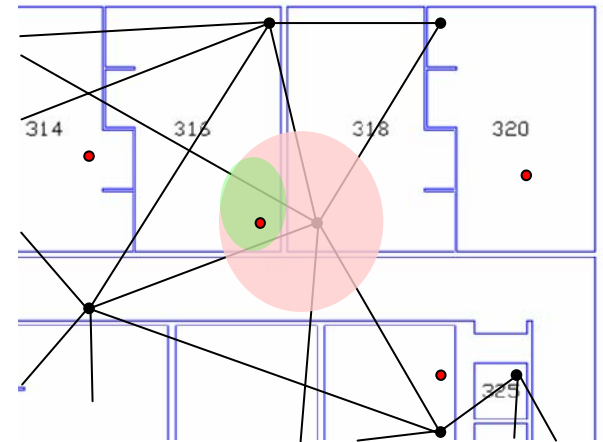
Applications

- **Safety Guidance**
  - Automatically send instructions to mobile nodes guiding people to safe zones based on infrastructure sensors
- **Automatic Hazard Detection**
  - Detect abnormal sensor readings as well as people traffic
- **Accident Analysis**
  - Advanced Blackbox functionality
  - Collect and Display Disaster Data to help isolate and analyze dangerous, or structurally unsafe regions
- **Robotic Control Wirelessly via Network**

Robots

- **Mapping**
  - Borehole wet or dry hole sonar or laser range based geometric scanner
  - Unmanned Rover with laser mapping
  - Man pack for daily mapping

- **Search & Rescue**
  - Reestablish Wireless Network
  - Location Aware
    - Sensor Network or Current/Prior mapping
  - Sensors:
  - Supplies: SCSRs, Oxygen breathers, medical, water, food
  - Interchangeable Payloads
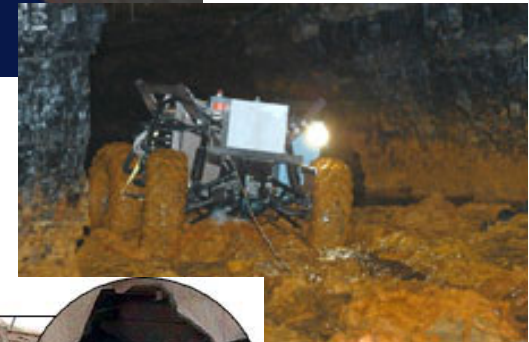
Benefits

- **Reliable Resilient Communications**
- **Real Time Condition Reports**
- **Sensor Network Initiated Instructions**
- **Documentation of Event**
- **Immediacy of Response**
- **Peace of Mind**

Results

- **Information Availability**
- **Timeliness**
- **Accuracy**
- **Professionalism**
- **Rescue Effort Coordination**
- **Productivity**

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