Assessing Wireless Technologies to Support Underground Mine Safety Systems

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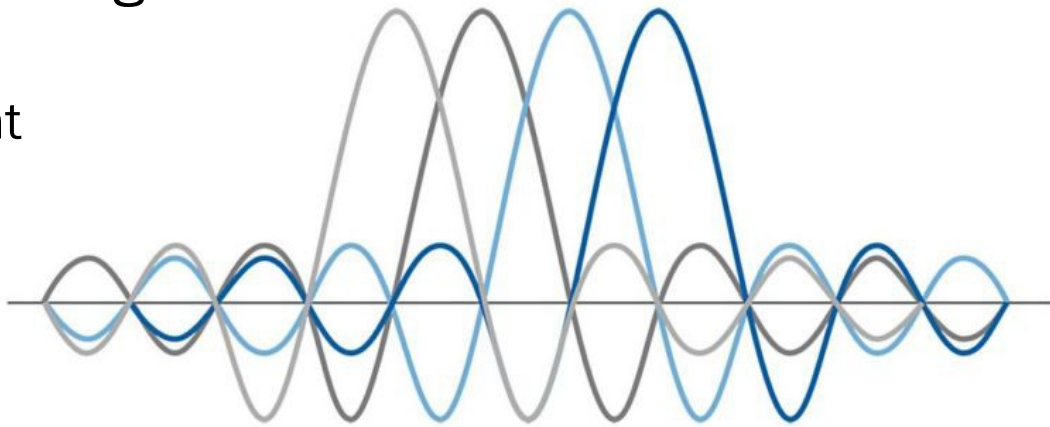
Demands for modern wireless technologies in underground mines

- Reliable and resilient
  - Real-time monitoring.
  - Reliable and robust communication at all times.
- High speed, large capacity, and low latency
  - High data rate for video surveillance, equipment monitoring, and automation systems.
  - Low latency for remote control of machinery and autonomous vehicles.
- Precision tracking
  - Autonomous vehicle movement and tracking.
  - Personnel movement and tracking.

Advanced Wireless Technologies:

1. Scalable orthogonal frequency-division multiplexing (OFDM) based air-interface.
   - Effectively address the diverse demands in different environments.
2. Multi-input and multi-output antenna (MIMO)
   - Increase both coverage and capacity.
3. Advanced channel coding
   - Support larger data blocks
   - More reliable wireless channels
4. Special reference signals:
   - Track time/frequency.
   - Track the change of wireless channels
   - Track the positions of objects.



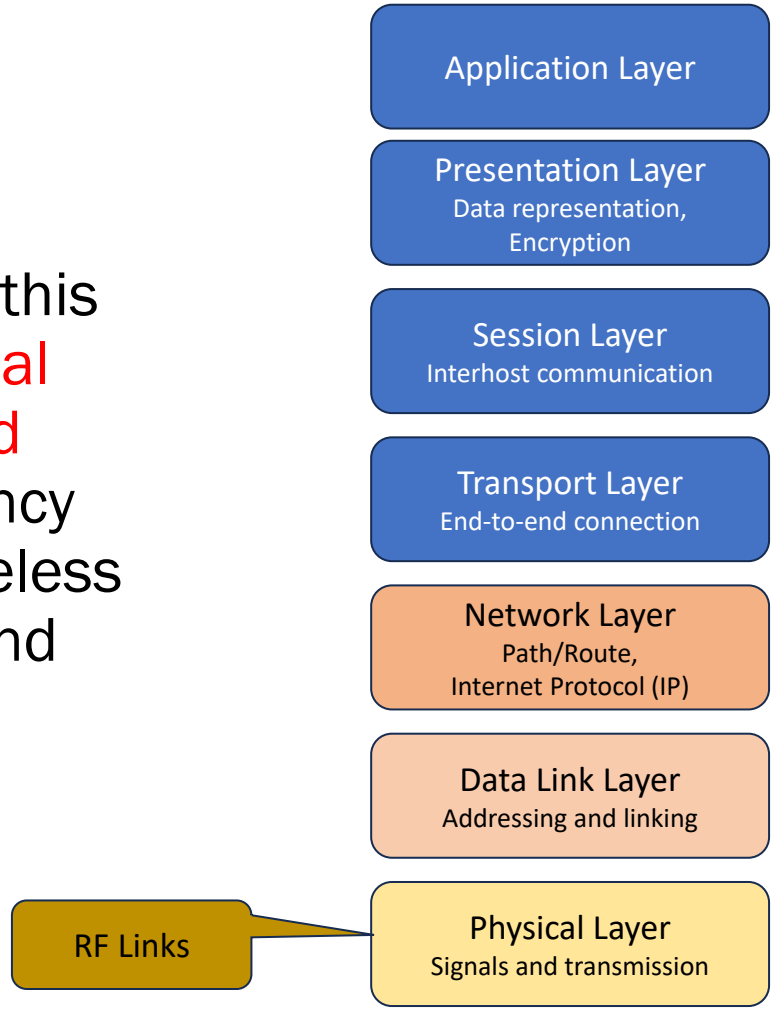
Underground communication challenges

Factors that impact wireless propagation in underground mines:

- Dimension of tunnels
- Roof/Rib materials of the tunnel
- Shapes, bends and turns of the tunnel
- Dust level, air flow, temperature, humidity
- Large obstacles, moving vehicles
- Unplanned obstructions, e.g. falls of roof

Project objective

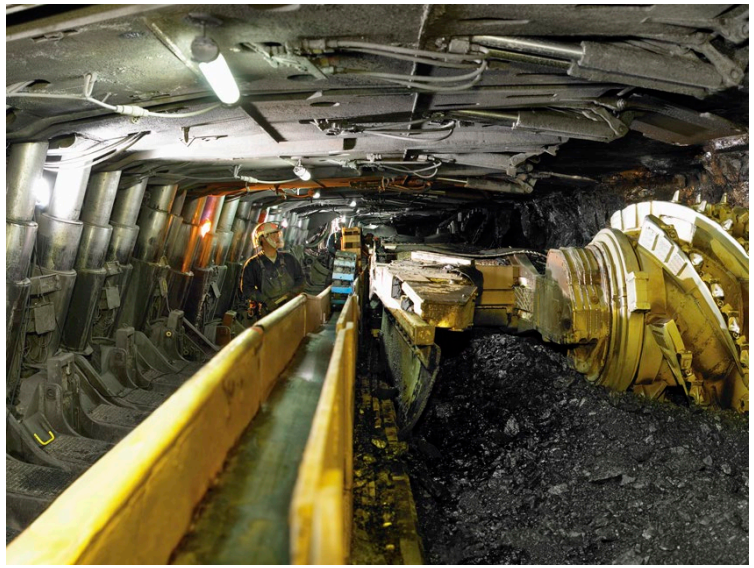
- The **primary objective** of this research is to assess critical properties, challenges, and limitations of radio frequency (RF) links of advanced wireless technologies in underground mine environments.



Project Aim #1: Assess the performance and critical properties of advanced wireless technologies

Research questions:

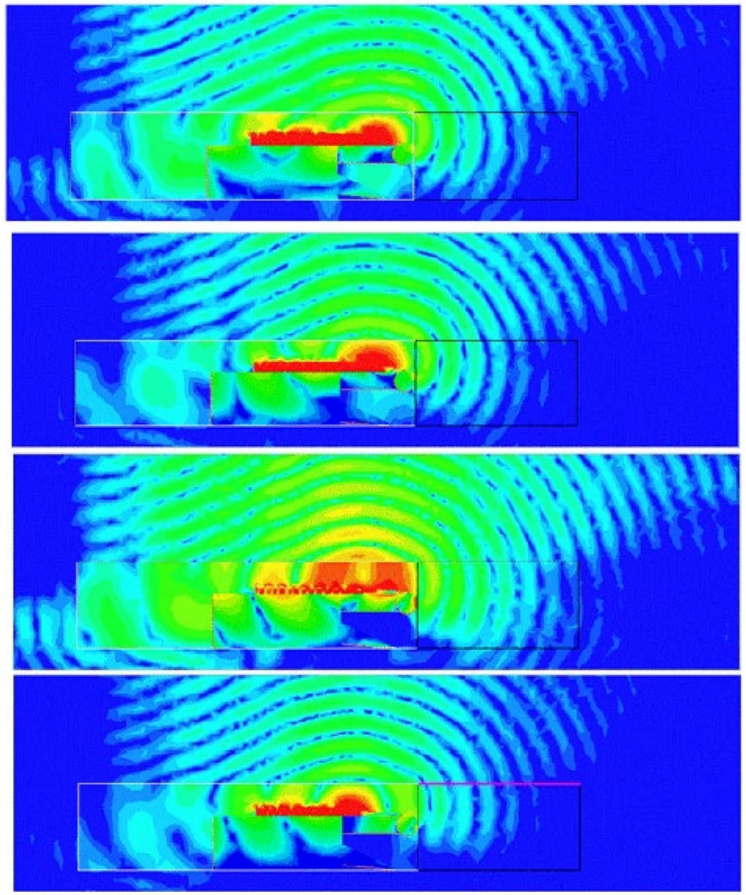
- What existing research findings address the measurement, characterization, and obstacles related to RF links in underground mine environments?
- What are the primary challenges (signal attenuation, multipath propagation, interference, etc.) of RF links in underground mines?
- How do RF links of different wireless technologies perform in underground mines in terms of throughput, reliability, and latency?
- What are the critical factors (e.g., entry dimensions, mine type, bends, turns, pillars, stationary or moving vehicles, location of antennas, frequency of operation)?



Project Aim #2: Develop RF communication channel models to facilitate the simulation of the RF links in simulation tools

Research questions:

- How to model the static physical and environmental factors in mines in simulation tool?
- How to model the dynamic factors (personnel movement, equipment movement, etc.)?
- What are the suitable techniques and tools for modeling?

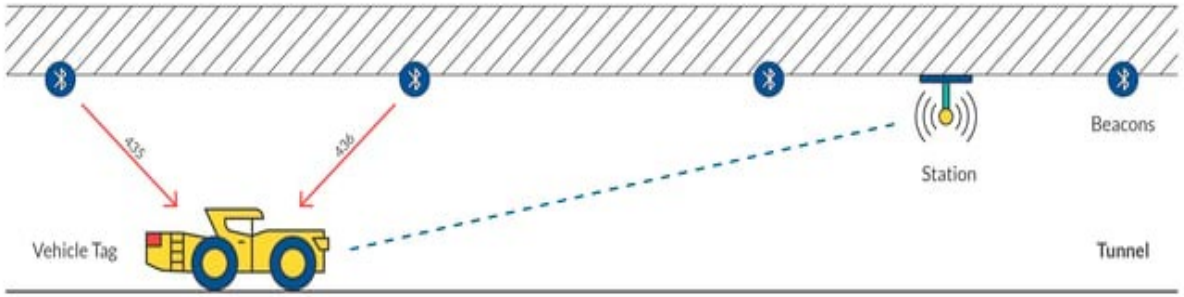


Project Aim #3: Evaluate the feasibility and constraints of using different wireless technologies for tracking and navigation in underground mines

Research questions:

- Literature research to determine the level of accuracy and reliability in location systems required to support the automation in underground mines.
- How effective are the leading wireless technologies in providing the required accuracy and reliability in a real-world underground mine environment?
- What are the specific challenges and limitations associated with deploying location-based services using different wireless technologies in underground mines?

Tracking & Navigation



From Tracking for Underground Mines - Today and Tomorrow (roobuck.com.au)

Look for Partners and Collaborators

- We actively look for partners and collaborators
  - Experimental mines
  - Operational mines
  - Test labs, etc.

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