

NIOSH/OMSHR

Office of Mine Safety and Health Research



Communications, Tracking, & Data Integration: Research Priorities

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Alpha Foundation Priorities Planning Meeting
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Underground coalmine communications and tracking (CT): MINER Act

- Disasters are going to happen
- Emergency Response Plan (ERP) by June 2009
 - 2-Way wireless communications and electronic tracking systems
 - CT Systems must be *permissible*;
 - Have battery backup
 - Radio coverage in primary and secondary escape ways and within 200 feet of critical areas (not mine wide)
 - Redundant systems (no single point failure)
- Update systems to reflect advances in technology
- Intent: CT Systems must survive the disaster

Primary Communications

- Similar to conventional radio handsets
- Use small antennas
 - Small, wearable devices
 - Long battery life
- Sufficient throughput for general operations
- Require significant in-mine infrastructure
- All u/g coal mines have systems installed
- Two types:
 - Leaky feeder
 - Node-based
 - Wired node-to-node
 - Wireless node-to-node



Secondary Communications

- Use unconventional 'radios'
- Unconventional signal propagation
- Require large antenna
 - Not wearable
- Typically only one channel
 - very low throughput
- Require less infrastructure
- Two types
 - Medium Frequency (MF) systems
 - Through the Earth (TTE) systems



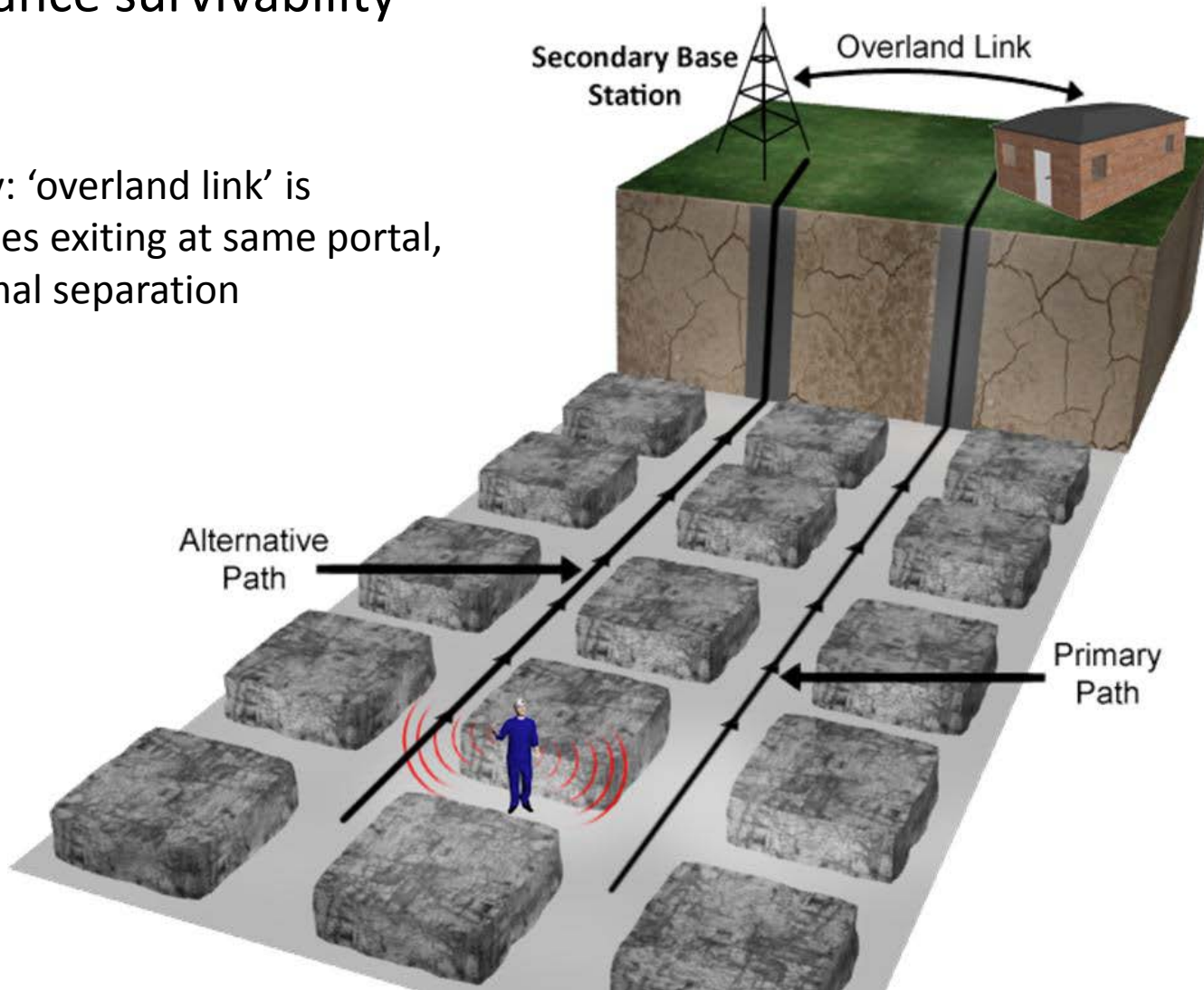
Electronic Tracking Systems

- Zone-based tracking systems:
 - RFID (Radio Frequency Identification Device) tags and RFID reader
- Node based systems:
 - Generally use radio signal strength from node (from primary communications) to estimate distance
- **Inertial tracking** (minimal infrastructure, survivable) (needs development) [NIOSH has some background]

MINER Act Requires Redundancy

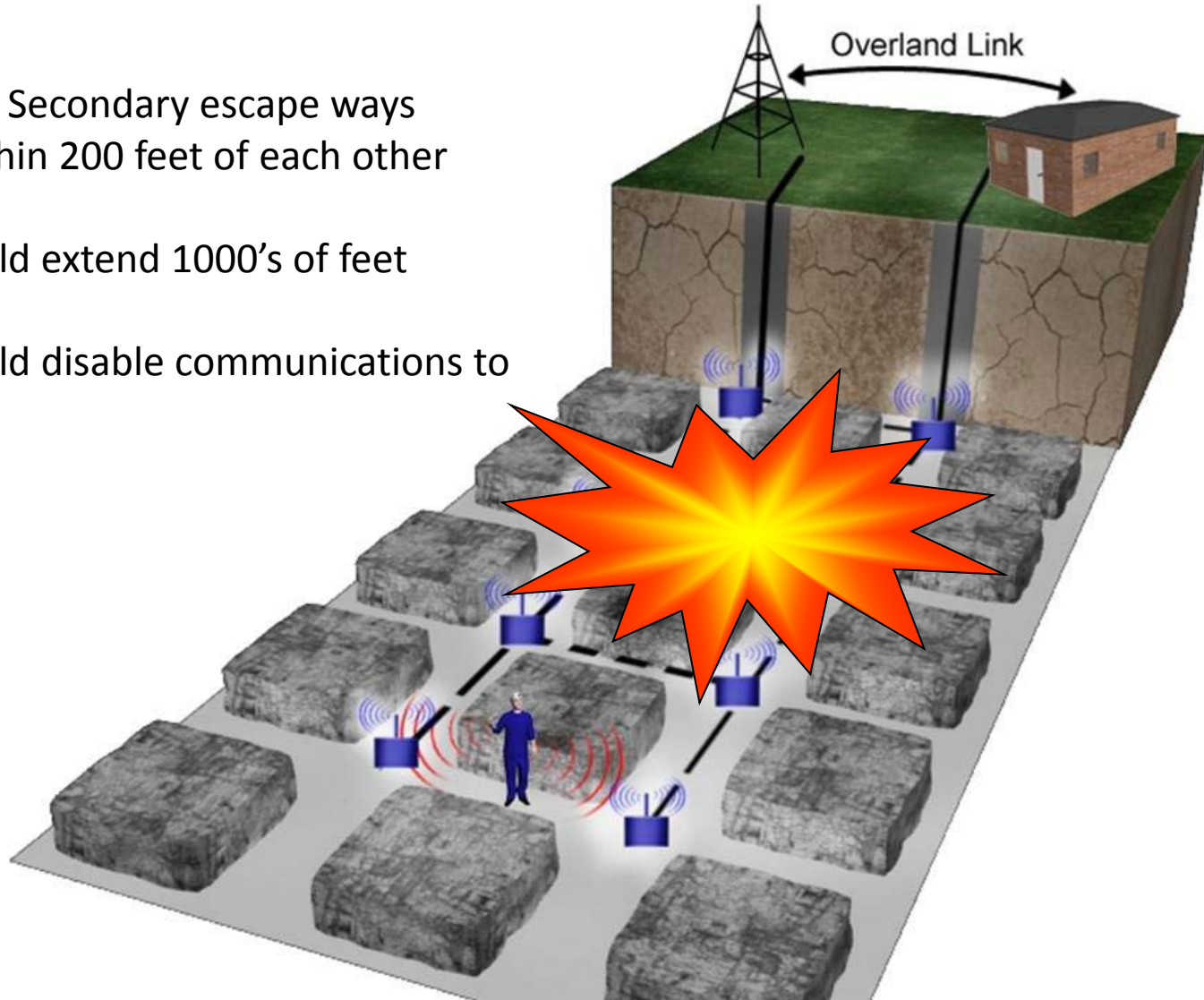
to enhance survivability

Generally: 'overland link' is both cables exiting at same portal, i.e. minimal separation



MINER Act Requires Redundancy

- Primary and Secondary escape ways typically within 200 feet of each other
- Disaster could extend 1000's of feet
- Disaster could disable communications to surface



Medium Frequency Under Emergency Operations

Last opening to the surface

UHF Radio

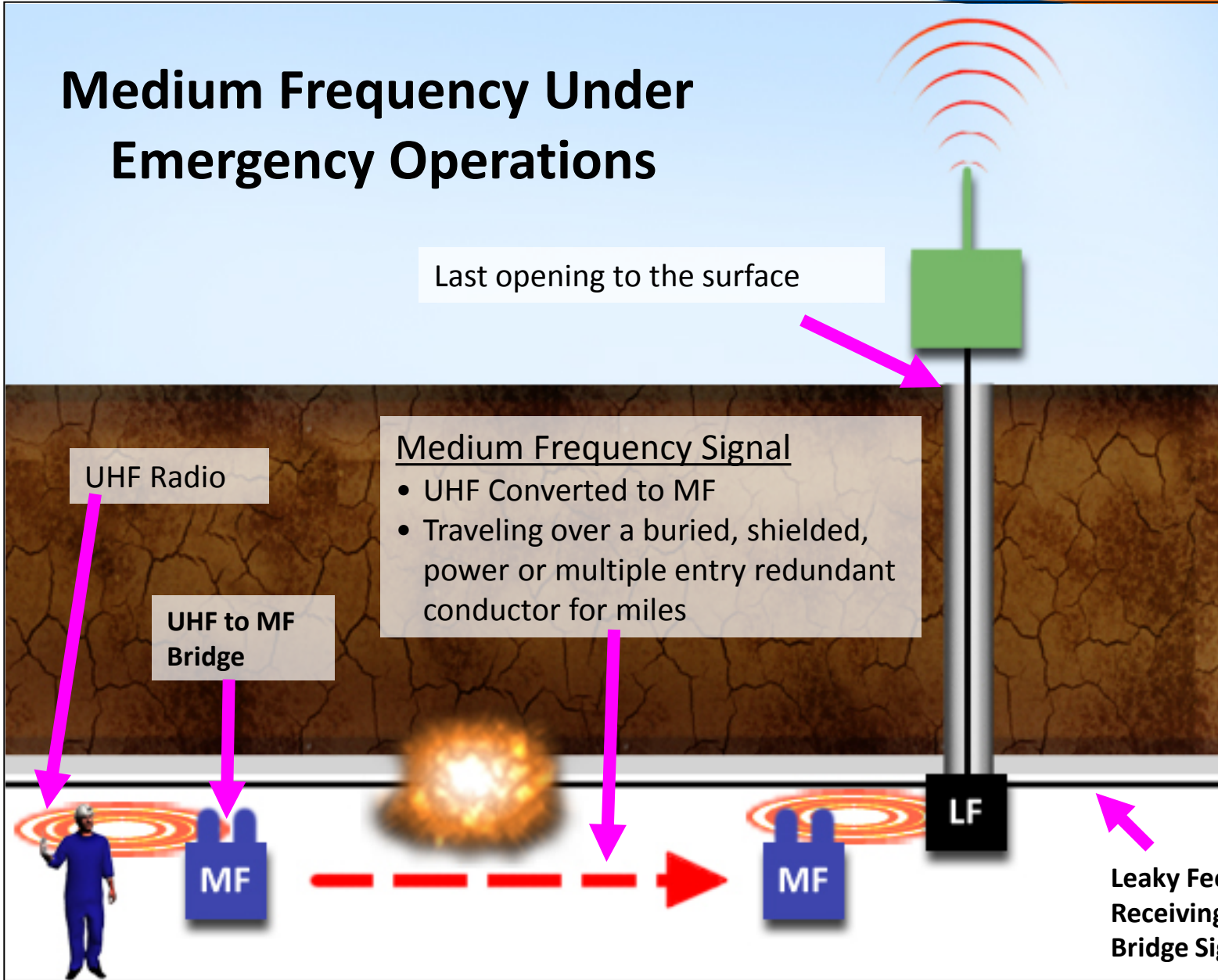
UHF to MF
Bridge

Medium Frequency Signal

- UHF Converted to MF
- Traveling over a buried, shielded, power or multiple entry redundant conductor for miles

LF

Leaky Feeder
Receiving MF
Bridge Signal



Survivable communications: from previous example

- Enhanced redundancy (hardened alternate path and with different CT technology)
- Secondary system as backup to primary
- Integrated or hybrid system (miner needs only one radio)

Where we need to be: CT Survivability

- CT Survivability:
 - How do we define it?
 - How do we measure it?
 - How do we enhance it?
 - How is it connected to performance?
 - How do we measure performance?
- Need a quantitative metric of survivability
- Need to be able to assess survivability for
 - Any mine (large, small, continuous mining, longwall mining)
 - Any installed CT technology or combination of technologies
 - Various types of disasters in various locations within the mine

Gaps in Road to CT Success

- Survivability
 - Define, develop, quantitative, measureable metric
 - Software to read/display mine-specific map [NIOSH started]
 - Configure CT technology on mine map (drag & drop)
 - Predictive CT performance modeling tools [UHF, MF, TTE !!]
 - Define, develop specific disaster scenarios (type, location, extent, forces, temperatures, debris, ...) [NIOSH has background info]
 - Ability to assess CT technology or installation configuration impact on survivability
- Primary/Secondary system integration
 - Further development/enhancement of secondary systems
 - Integration issues

Additional Gaps

- Rescue team/Mine /first responders CT & data integration
- Communications backbone capacity (BW operations vs safety)
 - Networking sensors (AMS, proximity info, battery health, miner health) to CT backbone
 - Database storage/access of data
 - Interpretation/decision from data
 - Actionable intelligence from CT data (human factors)
 - Notification/dissemination of decisions
- EMI/EMC in mine environment
 - Education/standards adoption research [NIOSH has background]
 - Lightning [NIOSH has background]
 - Blasting caps [NIOSH has background]



Discussion

- All u/g coal mines have installed 'wireless' CT systems.
- Secondary systems (MF and TTE) MSHA approved.
- Survivability is critical but not well understood
 - Further integrate primary & secondary systems
 - Mine models to quantify survivability
- Inertial tracking has great potential
- Investigate networking RF systems & backbone capacity (sensors, proximity, data, video)
- Investigate RF environment compatibility (EMI/EMC)

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