



Office of
Mine Safety and
Health Research

Alternate Communications Paths & Secondary Systems

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Recall from this morning

- **Primary communications systems are those that:**
 - Operate in the conventional radio bands
 - Use small antennas that allow the miner to have wearable devices with long battery life
 - Have sufficient throughput for general, as well as emergency, operations
- **Leaky feeder and node-based systems are examples of primary systems.**

Secondary Systems

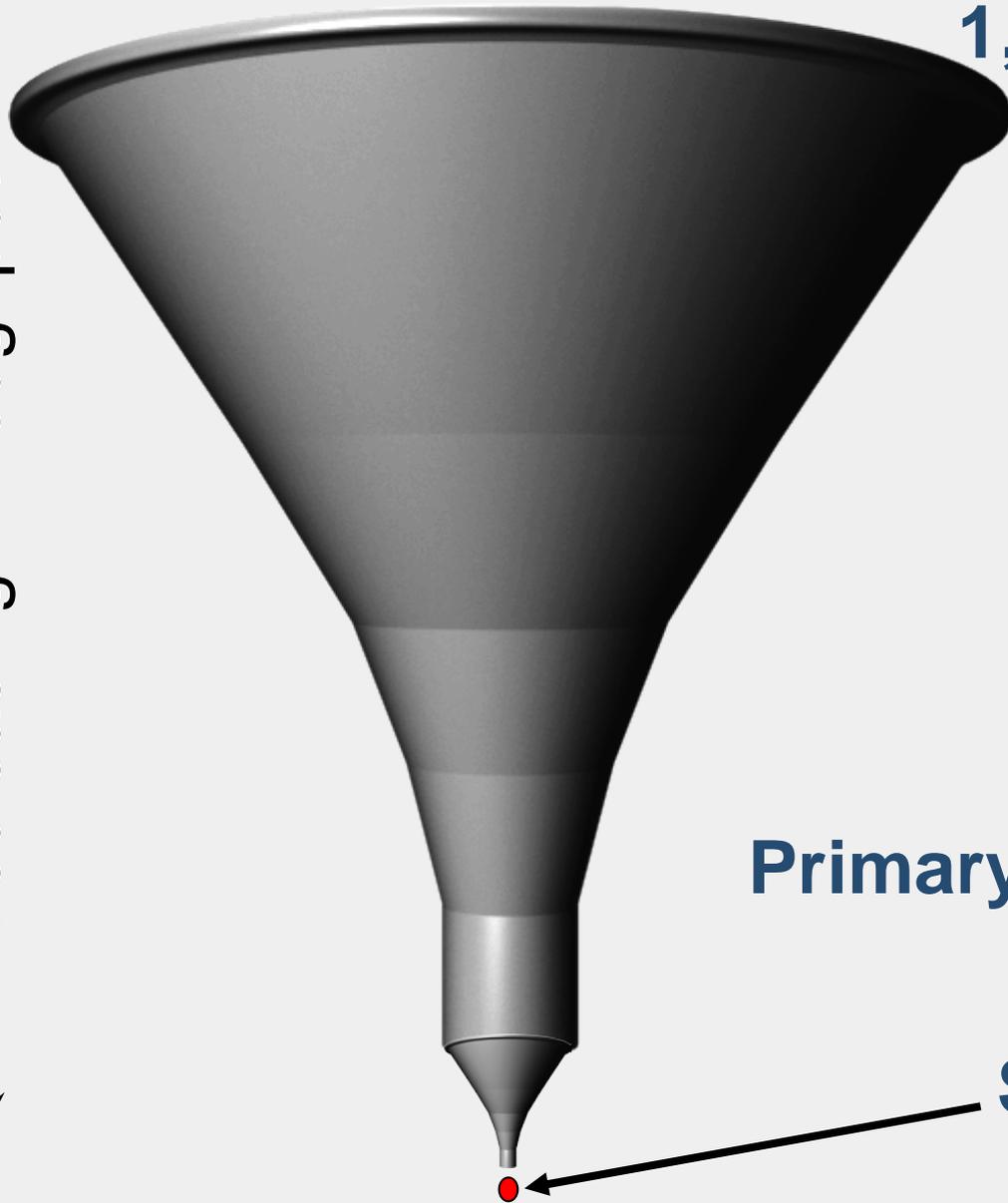
- **We define secondary systems which are the opposite of the primary systems, these are systems that:**
 - Operate in non-conventional frequency bands
 - Use large antennas that are best suited for fixed locations or portable applications
 - Do not have sufficient throughput for general operations.
- **Medium Frequency (MF) and Through-the-Earth (TTE) systems are examples**

What is throughput?

Amount of information that can get through a communications link or system in a given amount of time. Often measured in:

- Bits per second (bps) for digital systems
- Number of simultaneous voice channels for analog systems

Decreasing Throughput



Fiber
1,000,000,000,000 bps

Wires
1,000,000,000bps

Primary Wireless Systems
1,000,000bps

Secondary Systems
**a few thousand to
less than 100 bps**

Secondary Systems Limitations

- **Bandwidth limitation implications**
 - Few users can be supported, usually only one at a time
 - Difficult to have a repeater arrangement to create a network for long distance solutions
- **Use of secondary systems for general operations will be limited to very small mines**
 - Size of the devices
 - Bandwidth limitations

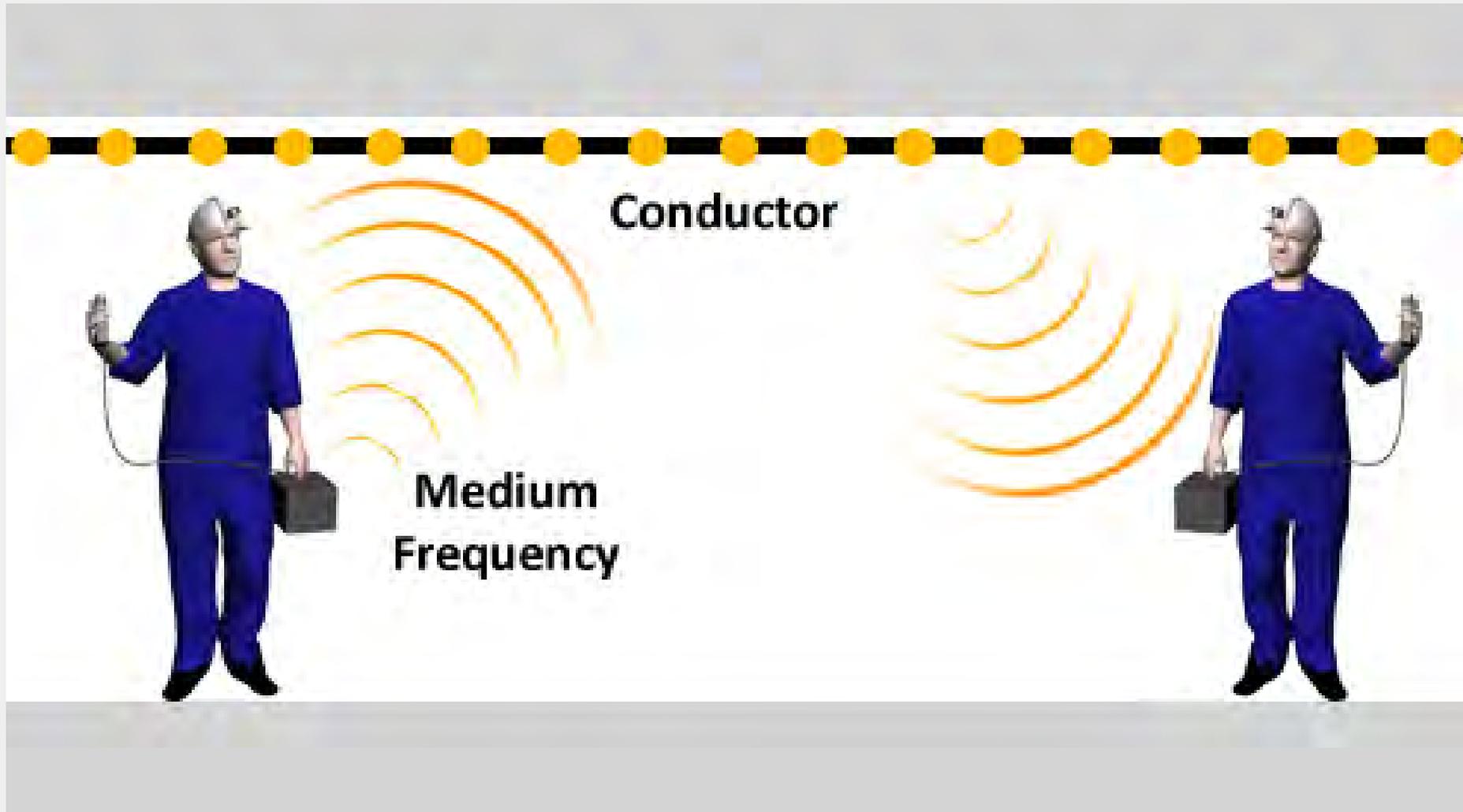
Secondary Systems Limitations (cont.)

- **So with size, power, and throughput limitations, why are we even interested in these secondary systems?**
- **SURVIVABILITY is the answer**
 - Secondary systems can provide a robust backup solution and can potentially provide an alternate communications path out of the mine

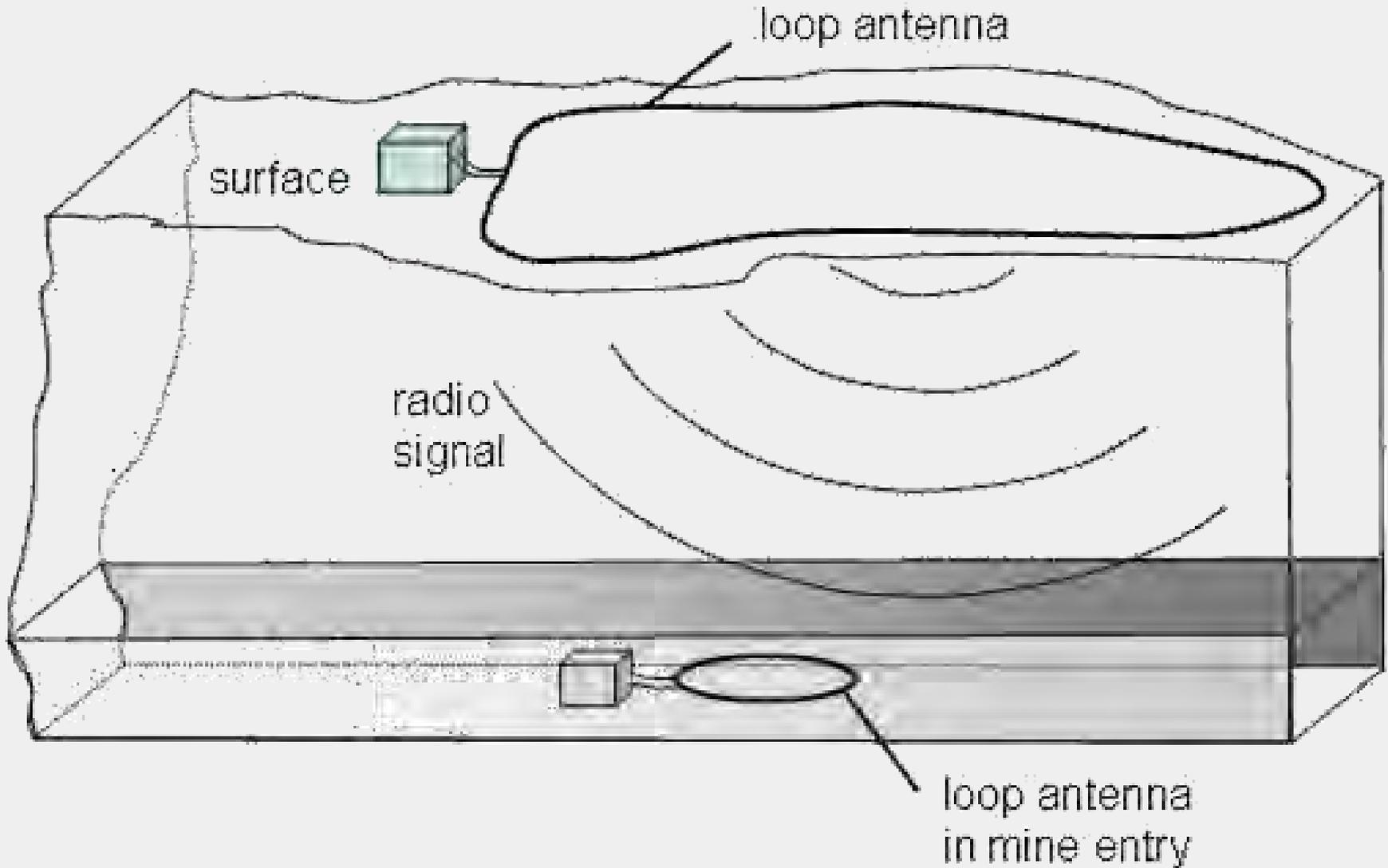
Secondary System Advantages

- **MF and TTE systems have many desirable characteristics for disaster scenarios:**
 - Very few active components and little or no network dependence
 - Simple principle of operations
 - Sustainable communications after large areas of the mine being affected by a disaster
 - Minimal number of battery locations required
 - Propagation through roof falls and debris
- **These systems can provide a ‘truly diverse’ alternate communications path to the surface**

Medium Frequency Communications



Through the Earth (TTE) Communications

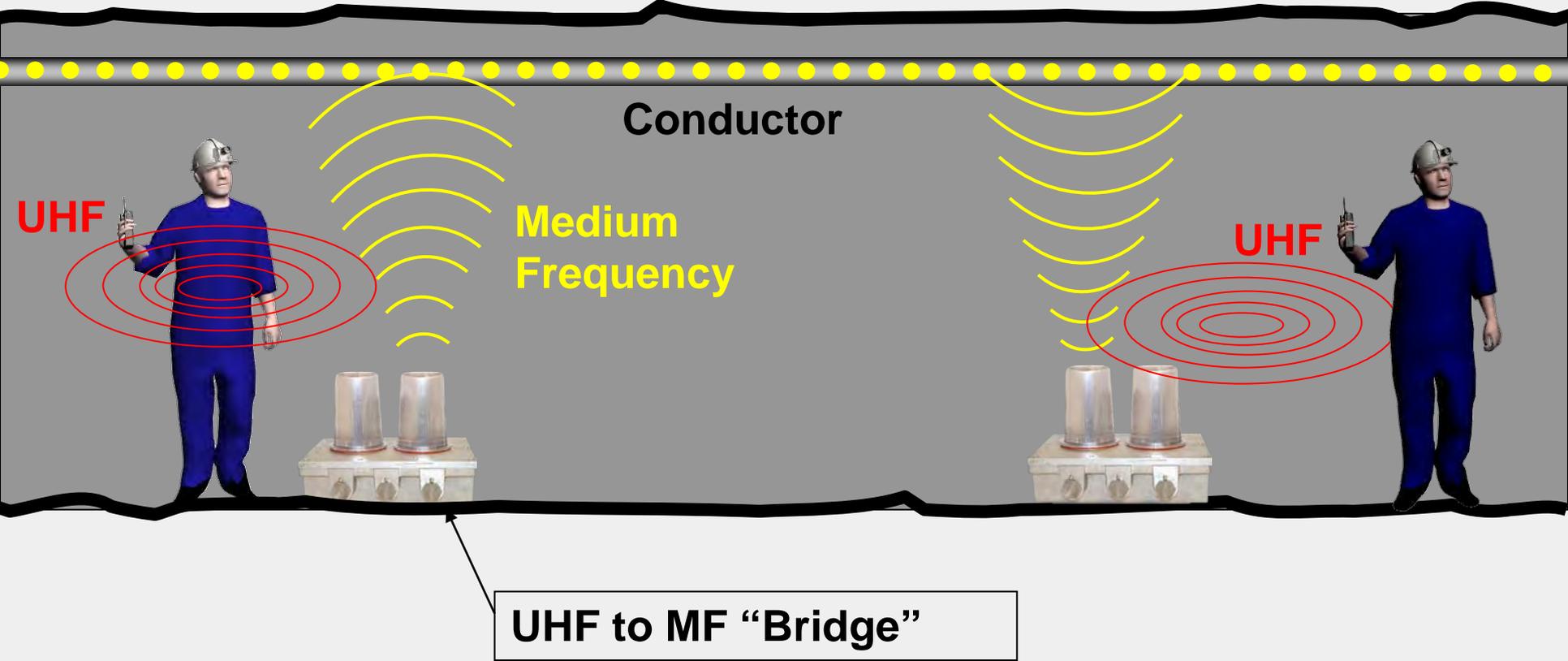


Interoperability Goal

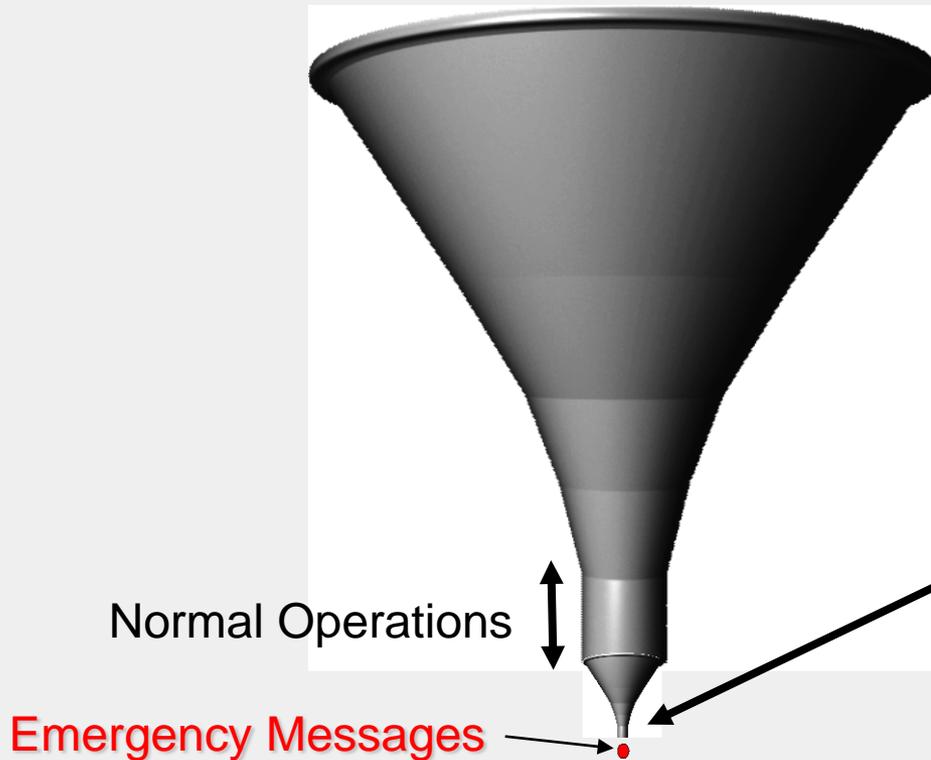
- **Interoperability goal – allow the miner to use the same device as he does with the primary communications systems, but communicate out through the secondary system**

Secondary systems will enhance the survivability of primary systems, not replace the need for them.

UHF (leaky feeder) to MF Interoperability



Interoperability Challenge



- Interoperability with digital and multi-channel communications is more complicated
- How do we ensure that only emergency traffic is directed to this secondary system?

Hybrid Systems will need to be developed to address the “bandwidth mediation” challenge.

Interoperability Challenge (cont.)

- **Challenge to the equipment manufacturing community to provide an answer over the next several years. The answer seems technically possible due to advancements in:**
 - Data compression Technologies
 - Processing Power
 - Storage Devices for Buffering

Interoperability Path Forward

- **First step is to understand what throughput the physical communications link can support.**
 - Nearly at that point for MF systems
 - Anticipated to be at the point with TTE within a year
- **Real challenge is getting vendors to work together to provide a solution that everyone can live with.**
 - Kutta Technologies is sponsoring an interoperability working group

Summary

- **Secondary systems provide a robust back-up system in the event the primary system fails**
 - Current efforts are focused on understanding and improving throughput limitations of these systems
- **Future efforts will focus on the use of secondary systems as alternate communications paths for the primary systems**
 - Integration of primary systems with secondary systems
- **Secondary systems will not replace the utility of primary systems**
- **Equipment vendors will need to work together to arrive at practical and effective solutions.**

Thank You

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