



Office of
Mine Safety and
Health Research

RFID Tracking Systems

Conventional and Reverse RFID

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Outline

- **Overview of conventional RFID**
- **Overview of reverse RFID**
- **System implementation**
- **Performance and limitations**
- **Post-accident usage**
- **Comparison of conventional and reverse RFID**

Conventional RFID

Conventional RFID

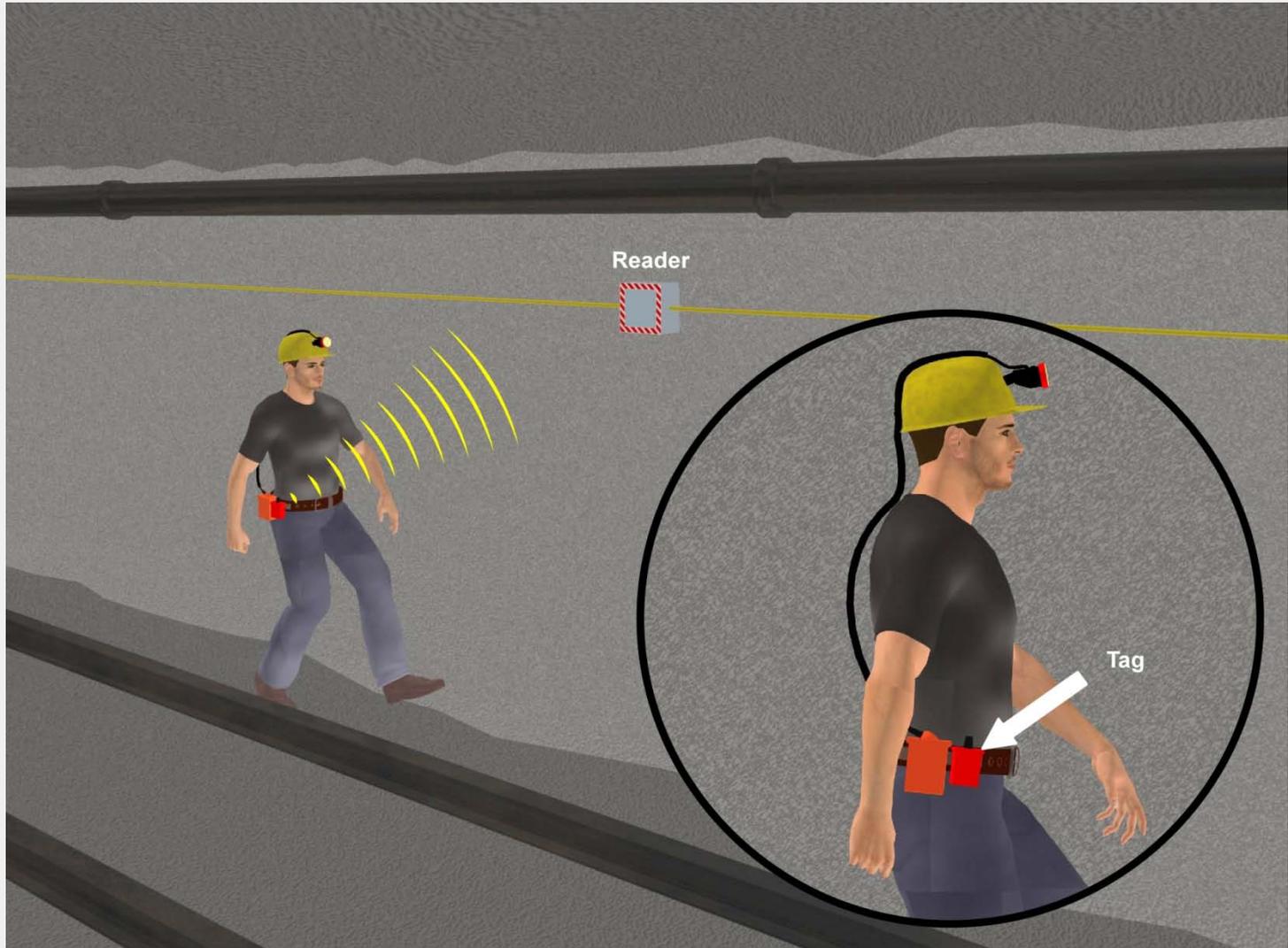
- **RFID popular in many industries**
 - Retail: theft prevention
 - Industrial/medical: asset tracking
- **RFID in mining**
 - Equipment and asset tracking
 - Zone-based tracking of personnel

Conventional RFID

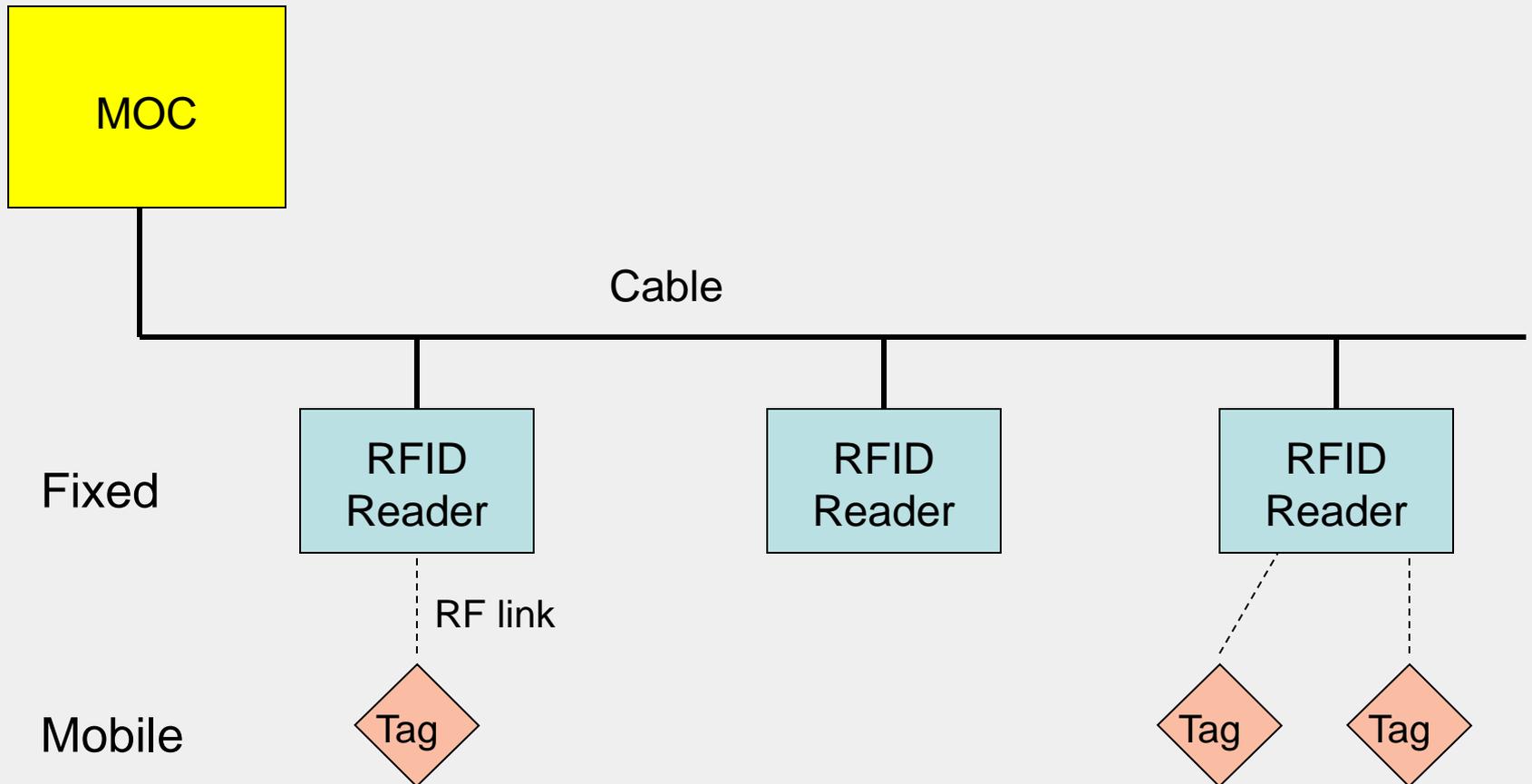
Components:

- **Tag readers mounted in the mine at known locations**
- **Tag readers connected to either**
 - their own communications backbone (wire, fiber, coax, wireless)
 - Interfaced to existing mine communications system (leaky feeder)
- **Tags worn by miners**
- **Tracking computer**

Conventional RFID

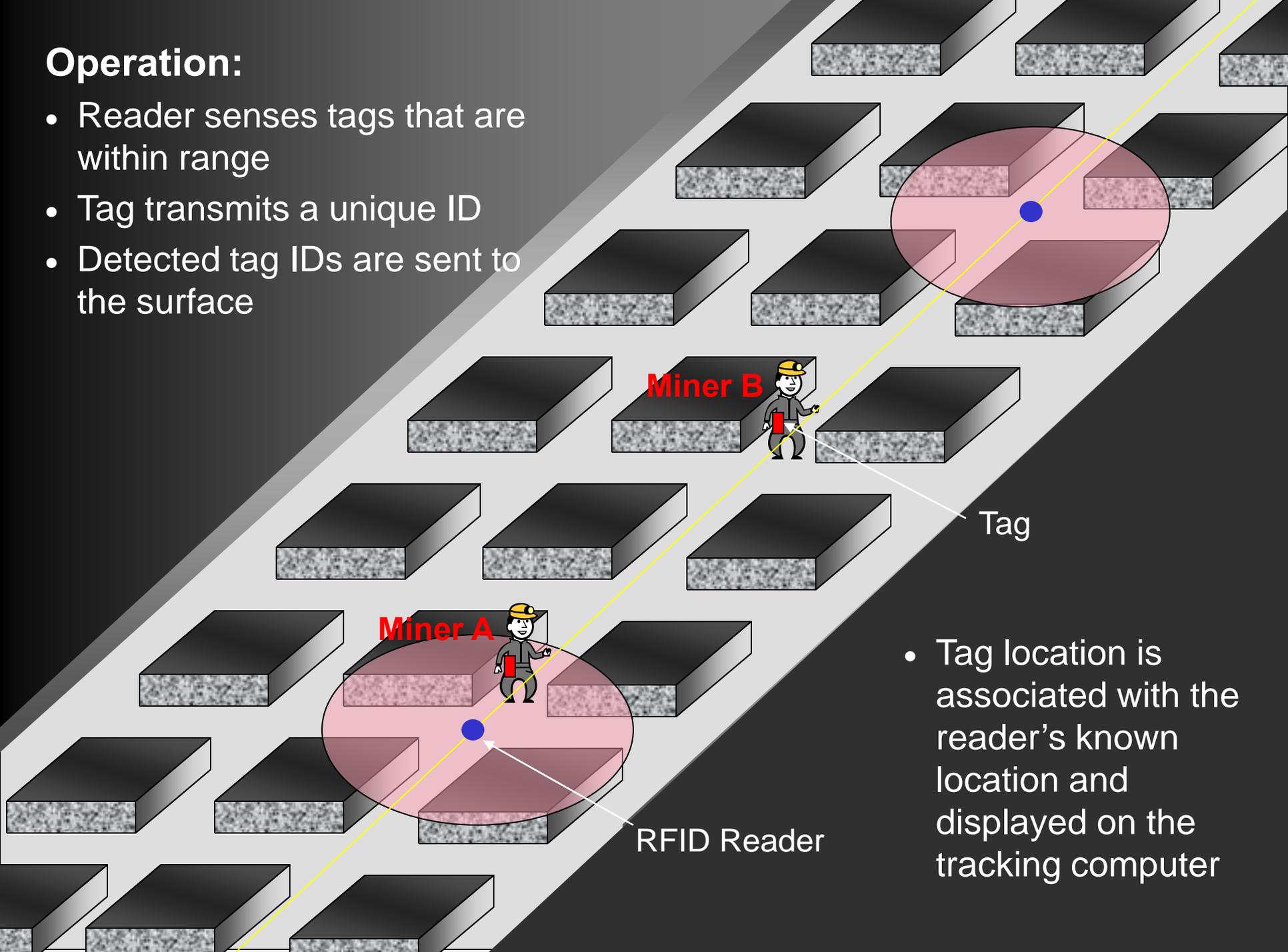


Conventional RFID



Operation:

- Reader senses tags that are within range
- Tag transmits a unique ID
- Detected tag IDs are sent to the surface



- Tag location is associated with the reader's known location and displayed on the tracking computer

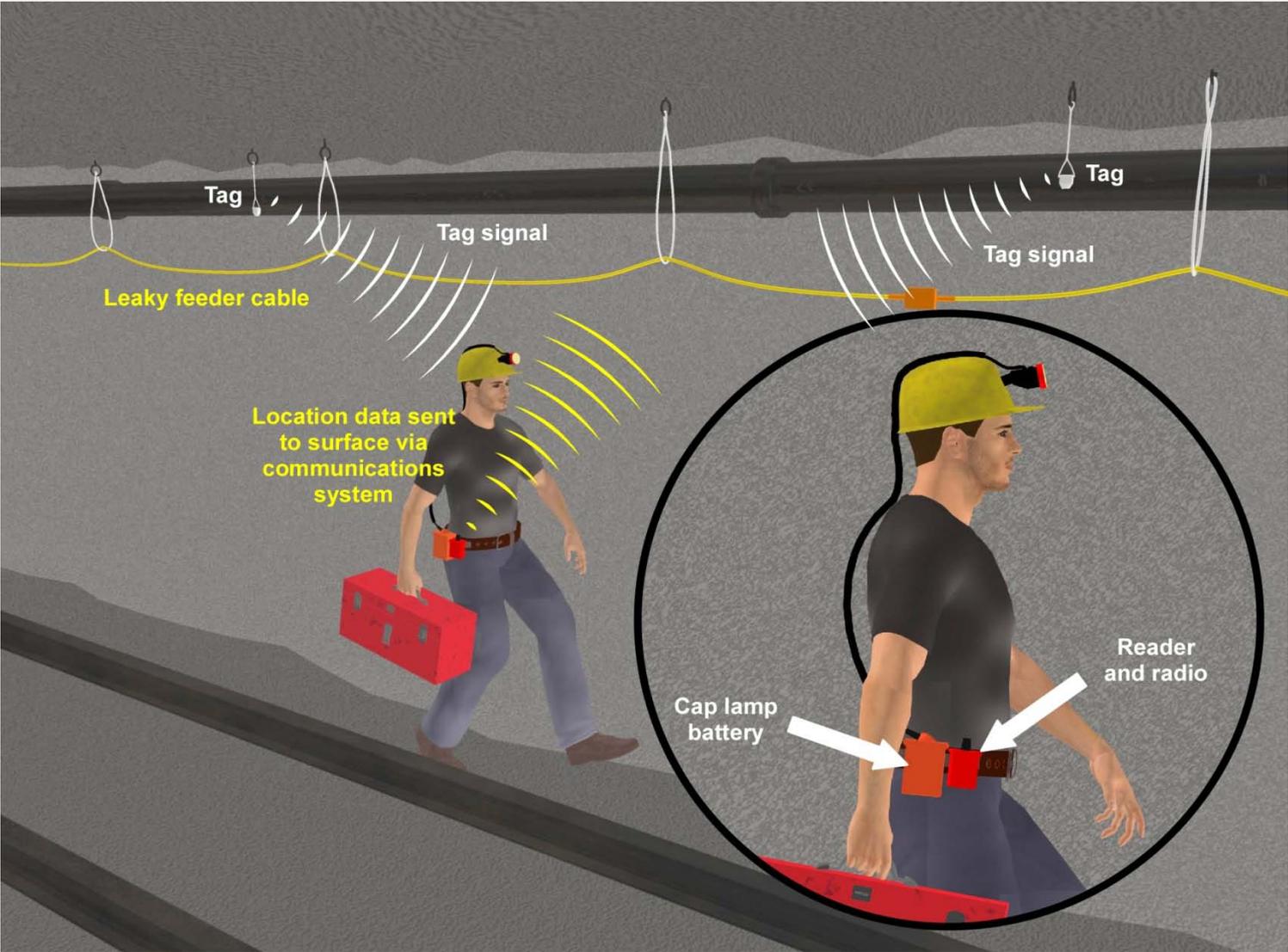
Reverse RFID

Reverse RFID

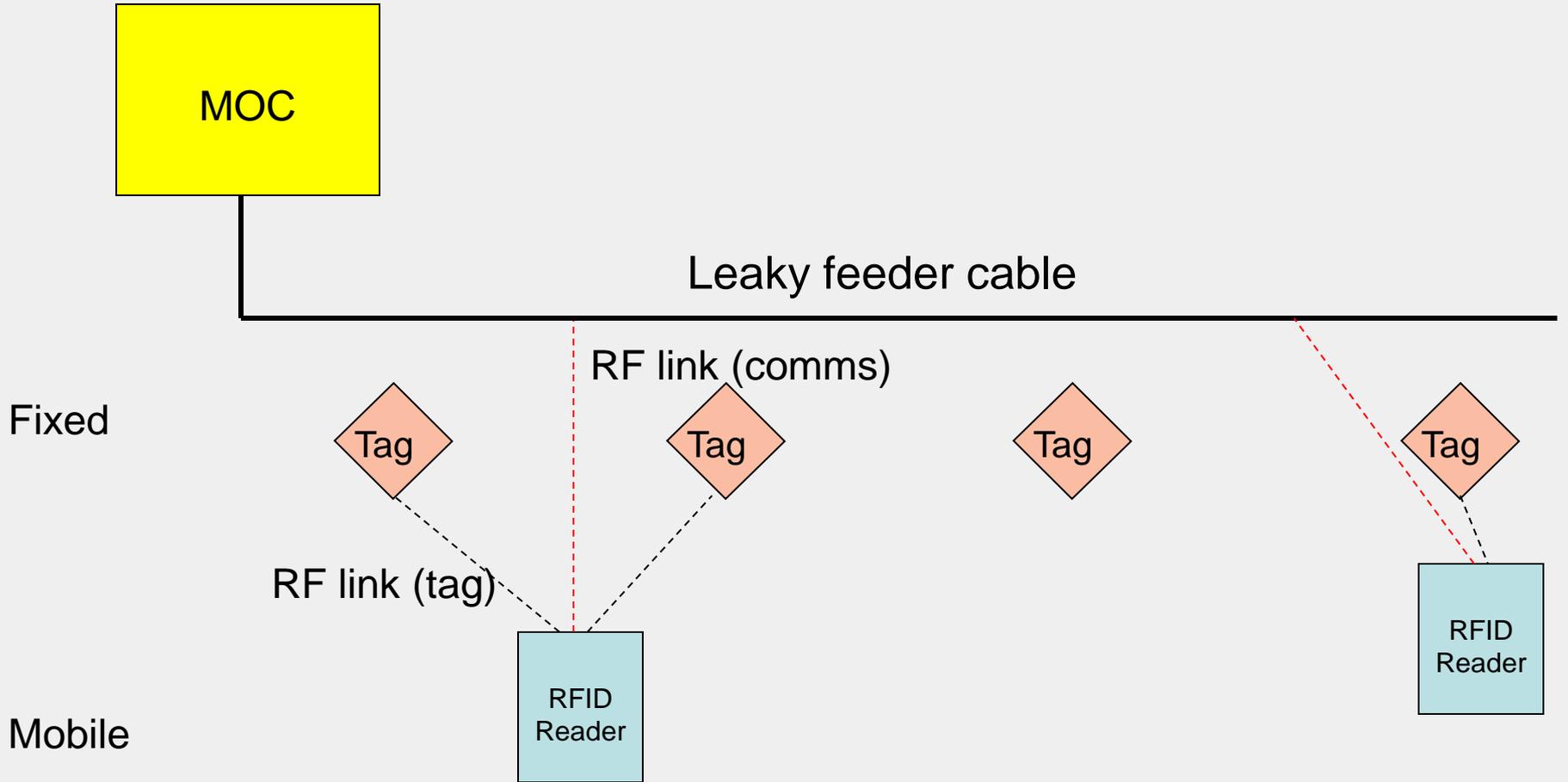
Components:

- **Tags mounted throughout the mine at known locations**
- **Tag readers worn by miners**
- **Tag reader contains a radio that transmits information to the existing mine communications system**
- **Tracking computer**

Reverse RFID



Reverse RFID



System Implementation

System Implementation

- Infrastructure -

- **Readers or tags mounted in the mine at fixed known locations (labor intensive)**
- **Associate each reader or tag with a map location**
- **Density determined by accuracy needs in a given area**
- **Communications system (dedicated or existing)**
- **Tags or readers added as mining progresses (communications must be extended too)**
- **Survivability considerations**
 - Hardening
 - Redundancy
 - AC power and battery backup

System Implementation

- Mobile device -

Conventional RFID:

- **Battery-powered tags worn by miner**
 - Integrated into cap lamp battery enclosure
 - Attached to helmet or belt

Reverse RFID:

- **Reader and radio worn on belt**
 - Integrated into cap lamp battery
 - Separate enclosure and battery
 - Must be recharged
- **Reader antenna**
 - Line-of-sight to tags requires helmet or cap lamp mounting with cable to reader

Performance and Limitations

Performance Metrics

System coverage: The areas of the mine that support tracking functionality

For both systems—Anywhere you are within range of a tag or reader AND you have communications to the surface

Range: The radio transmission range or distance a tag can be read by a reader

For both conventional and reverse RFID the tag usually limits range to less than 500 ft

Performance Metrics

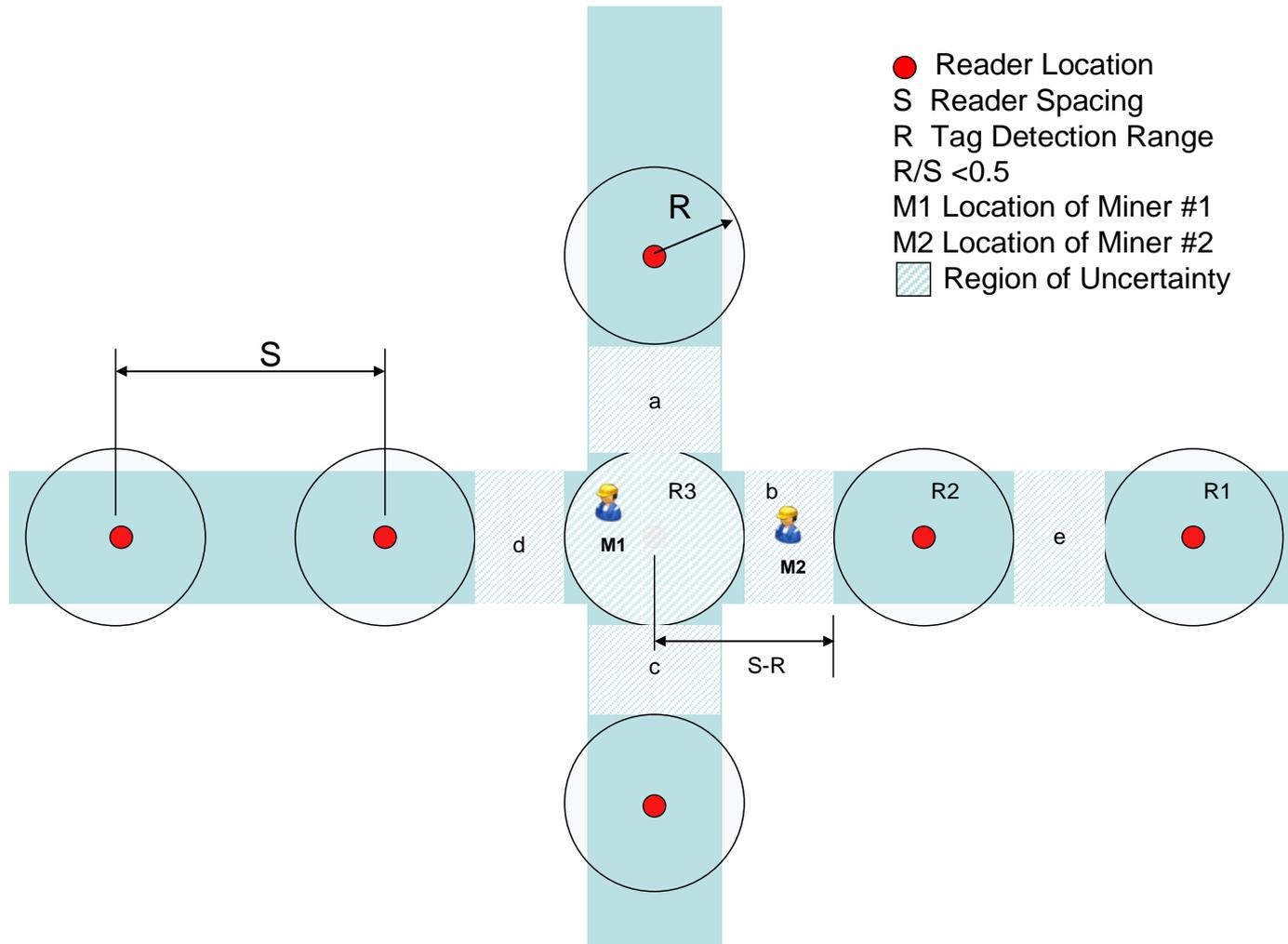
Error: The difference between reported and actual position

- Depends on
 - tracking system update rate
 - motion of miner
 - reader or tag spacing
 - Interference

Accuracy: The error limits of a system

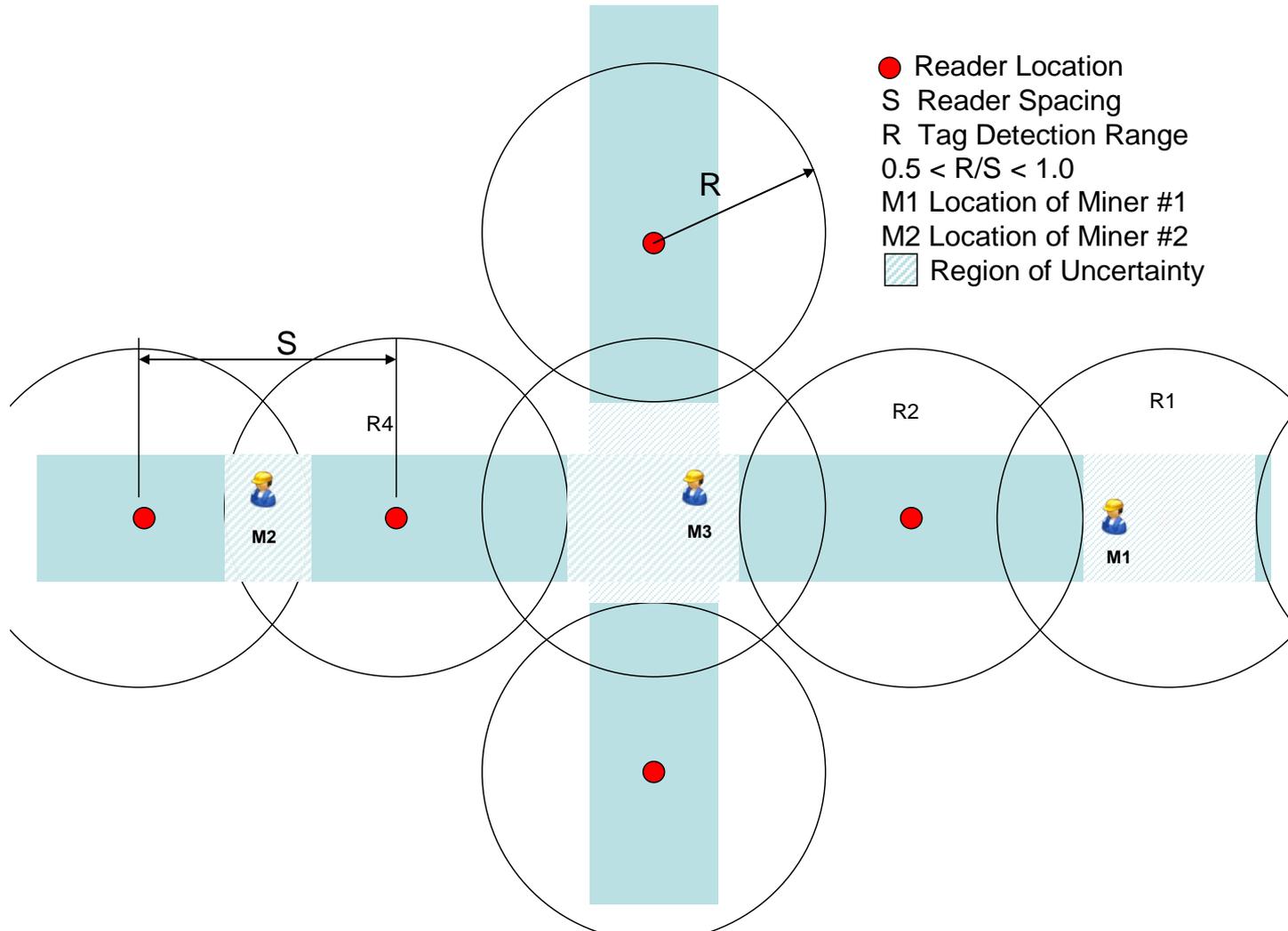
- Some level of uncertainty
- Usually given as an average value

Accuracy Discussion



RFID with no zone overlap

Accuracy Discussion



RFID with zone overlap

Post-Accident Functionality

Post-Accident

- **Both systems—Location information calculated at the MOC tracking computer**
- **Rescue team must consult the tracking computer (tracking information not available underground)**
- **If communications or tracking are down:**
 - Last known position of each miner stored and displayed on tracking computer
 - No rescue beacon functionality yet (possible with both systems)
- **When communications are restored**
 - Tracking system will update (if miner within range of comms)
 - Rescuers must obtain updated info from surface

Comparison

Comparison of Technologies

Tracking Infrastructure

Conventional RFID

- Readers installed in mine
- Increase in accuracy requires higher reader density
- Readers are more expensive
- Communications link required between readers and to surface
- AC power required (backup batteries needed)
- More difficult to add another reader
- In use now

Reverse RFID

- Tags installed in mine
- Increase in accuracy requires higher tag density
- Tags are inexpensive
- Stand-alone

- Low power
- Long battery life

- Easy to add another tag

- In development stage

Comparison of Technologies

Mobile Device

Conventional RFID

- Small tag worn by miner
- Less complex
- Less power required

Reverse RFID

- Reader worn by miner
- More complex
- More power required
(connect to cap lamp battery)
- Requires radio link to existing comms