Mine Emergency Communication: Options, Issues & Status

West Virginia Coal Forum
Charleston, West Virginia

Randall Harris
W. Va. Office of Miners’ Health Safety and Training
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randall.j.harris@verizon.net
Bowl of Many Cooks

Since February of 2006 hundreds for people and dozen of companies have dedicated themselves to providing better safety options for miners.

The electronics and communications giants left the field once they realized the enormity of the challenge and the diminutive nature of the coal industry. It's the small businesses that remained.

Seldom have such varied disciplines been focused on a single problem without the attraction of massive funding. Few resources have been provided those that persevered except the desire to provide a solution.

We all owe a resounding thanks to those that have given of themselves and their time to allow our industry to reach this point and all our encouragement to them as they push on toward all our goal…

Everybody gets to go home!
Communication Reality

WV SB 247 and the Miner Act did not revoke the laws of physics

WV §56-4 drafted with all the laws in mind
Wireless – miner not connected by wire

Two-way communications to each miner in at least two separate airways

Tracking each miner in relation to known points prior and in escapeways after

Operators submit Communication/Tracking Plan by July 31, 2007

- Understand needs and thought through risks
- Survive accident or be quickly repairable
- Communication center operator min. red-hat
Talking Where Cell Phones Won't Go

Practical options are limited by physics and existing uses.
Through The Earth (TTE)

200Hz-4000Hz

**Current Reality**
- Commercial One-Way w/Text
- Off-Axis Reception Problematic
- Large Antenna Loops
- Non-Permissible Power Levels
- Emergency Shelter Option

**Greatest Potential**
- No In-Mine Backbone
Medium Frequency (MF)

300 kHz - 3 MHz

Greatest Potential
Use Existing Metal as Backbone
Interoperability

Current Reality
Prototype Demonstrated
Unknown Safety
Wi-Fi Mesh Nodes

2.4 GHz

Current Reality
- Prototypes Demonstrated
- Limited Node-to-Node Range
- Line-of-Sight Only
- Handsets not Commercial
- Requires Redundancy & Hardening

Greatest Potential
- Wide Bandwidth Flexibility
- Interoperability
Leaky Feeder (VHF)

150-170 MHz Distributed Antenna System

**Greatest Potential**
Available and Upgradeable
Interoperability

**Current Reality**
Multiple Installations
Commercial Handsets
Limited Beyond Sight of Feeder
Limited Data Capability
Requires Redundancy & Hardening
Leaky Feeder (UHF)
400-500 MHz Distributed Antenna System

Current Reality
- Multiple Installations
- Commercial Handsets
- Some Beyond Sight of Feeder
- Moderate Data Capability
- Requires Redundancy & Hardening

Greatest Potential
- Available and Upgradeable
- Interoperability
Leaky Feeder Enhancements

Distributed Antenna System

- Greatest Potential
- Mine Wide Coverage
- Multiple Pathways

Current Reality
- Limited Installation Experience
- Some Needed Devices in Prototype

RADIATING CABLE EXTENSION

2ND LEAKY FEEDER RUN

SPECIALTY ANTENNA
Future Technologies = Survivability

Current Reality
Standard Telecom Practice
Site Specific Best Solution
Interoperability Limited
Device Development Required
Adoptable to Current Technology

Greatest Potential
Multiple Pathways
System Integration
Signal Takes Whatever Survives
Tracking Where GPS Won't Go

Know the Location
- Proximity signal strength
- Acknowledgement

Communicate the Location
- Dedicated backbone
- Shared backbone

Show Information
- Map display
- Data analysis
- Threshold alarms

Current Reality
- Zone Systems
- RFID Active Tag Systems
- Ethernet Backbone and Leaky Feeder Backbone
- Signal Triangulation Near
After the evaluation of the documentation submitted and with the recommendation of our technical reviewers the Office of Miner’s Health Safety and Training verifies that ________ has demonstrated functionality such as would allow W.Va. underground mining permit holders to meet all or part of their requirements for emergency communications and tracking outlined in the West Virginia Emergency Rule Governing Protective Clothing And Equipment, §56-4-8 and will be included in the listing of reviewed devices.
Active Applications

- **Varis Communications**
  - 150-170MHz Leaky Feeder
  - Kenwood Radios
  - Digital – 56kbps

- **Hughes Supply**
  - 150-170MHz Leaky Feeder
  - 400-500Mhz Leaky Feeder
  - Kenwood Radios
  - Digital – 56kbps

- **Marco North-America**
  - 900MHz RFID Tracking
  - Leaky Feeder or Ethernet

- **Hannah Engineering**
  - 2.4GHz 802.11 Nodes
  - VoIP Phones and WiFi Tags
  - Digital – 11mbps

- **Matrix Design Group**
  - 433 MHz Tag Tracking
  - Fiberoptic Ethernet Backbone
  - Leaky Feeder Backbone

- **Helicomm, Inc (Venture Development)**
  - 2.4GHz 802.15.4 Nodes
  - RS845 Ring of Subnet Controllers
  - Digital 250kbs
  - Text Messaging
  - 400-500Mhz RFID Tracking

- **Active Control Technology**
  - 2.4GHz 802.11 Nodes
  - VoIP Phones and WiFi Tags
  - Digital 11mbps
  - 2.4Ghz Signal Strength Tracking

- **MineComm (Pyott Boone Electronics)**
  - 150-170MHz Leaky Feeder
  - 400-500Mhz Leaky Feeder
  - Kenwood Radios
  - Digital – 56kbps

- **Mine Site Technology (CSE)**
  - 150-170MHz Leaky Feeder
  - LF Through the Earth
  - 2.4GHz 802.11 Tag Tracking

- **Mine Radio System**
  - 150-170MHz Leaky Feeder
  - Kenwood Radios
  - Digital – 56kbps

- **Becker Communications**
  - 400-500MHz Leaky Feeder
  - Kenwood Radios
  - Digital – 56kbps

- **Northern Lights**
  - 2.4GHz 802.11 Nodes
  - Fiber or CAT5 Ethernet Backbone
  - WiFi Tags and VoIP Phones
Quality of Communications

“Can you hear me now?”

Turns out not to be a trivial question

Accepted Reception Reporting Systems

<table>
<thead>
<tr>
<th>Signal Strength</th>
<th>Interference of any type</th>
<th>Overall Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-Excellent</td>
<td>5-No interference</td>
<td>5-Excellent</td>
</tr>
<tr>
<td>4-Good</td>
<td>4-Very slight</td>
<td>4-Good</td>
</tr>
<tr>
<td>3-Fair</td>
<td>3-Moderate</td>
<td>3-Fair</td>
</tr>
<tr>
<td>2-Poor</td>
<td>2-Heavy</td>
<td>2-Poor</td>
</tr>
<tr>
<td>1-Useless</td>
<td>1-Extreme</td>
<td>1-Unusable</td>
</tr>
</tbody>
</table>
Quality of Reporting

Reporting has been done in distances

Provides limited information

Adopted minimal information requirements for reporting

Miner to Miner Test Data

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Test Site</th>
<th>Comm Type</th>
<th>Distance Between Miners</th>
<th>Entry/Crosscut Conditions</th>
<th>SIO Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>TK-390</td>
<td>5-10</td>
<td>UHF</td>
<td>1000 FT</td>
<td>6FT 20FT 1 5 &amp; 7</td>
<td>LINE OF SITE IN #5 ENTRY</td>
</tr>
<tr>
<td>TK-390</td>
<td>5-10</td>
<td>UHF</td>
<td>210 FT</td>
<td>6FT 20FT 6 &amp; 7 CONCRETE BLOCK</td>
<td>LINE OF SITE IN CROSS CUT 10 THROUGH STOPPING</td>
</tr>
<tr>
<td>TK-390</td>
<td>5-10/11</td>
<td>UHF</td>
<td>70FT</td>
<td>6FT 20FT 8</td>
<td>LINE AROUND BLOCK</td>
</tr>
</tbody>
</table>

Example of tabular reporting
Ability to Relate

Still need more information to make design decisions

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**Top View**

- ICG Imperial Mine

**Relative Mine Location**

- Test performed at ICG Imperial mine on 1/18/07
- Witnessed by: John Rinchart, P.E.
- 70 ft centers on blocks
- The communications center is approx. 100 feet from mine portal
- The test was performed approx. 750 ft into the mine at crosscut 10
- The stoppings are cinder block with metal man doors

**Side Elevation**

- Name of Mine: ICG-Imperial
- Date of Testing: 1/18/07
- Certifying Engineer: John Rinchart, P.E.
Results, Status and Guidance

Go to:

wvminesafety.org

Click on:

Emergency Communications and Tracking
Time Line

August
OMHST
Markups

September –
October
Approvals

> WV Communication Plan Approvals >

July 31
Mine Submittal

August –
September
Re-writing

October +
Order-Installation

> MSHA Electrical Approvals >

OMHS&T Communications Plan Team
One inspector from each Regional office +
Member(s) of the Approval Review Team
Summary

- W. Va. functionality reviews continues
- NIOSH study group interaction continues
- MSHA electrical approval process continues
- WV Communication Plan submittal July 31
- Installation dates subject to manufacturers receiving MSHA electrical approvals

Thank You
randall.j.harris@verizon.net