Mesh Mining

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Wireless System Connects Copper Mine

Bradley Kramer — Nov 01, 2007

Inside the gargantuan earthen bowl, dozens of dump trucks and excavators and drills lurch about, while workers perform a day's work in the world's largest open-pit copper mine. At the mine's home office, those machines are monitored for location and proper operating levels. Job assignments are sent to the miners operating the equipment. However, that equipment is more than a piece of mining machinery: It also is a wireless network node.

The Kennecott Utah Copper Corp., owned by Rio Tinto PLC, recently deployed a wireless mesh system within the Bingham Canyon Copper Mine in northwestern Utah. The system, designed by Rajent Corp., is a portable, adaptable Wi-Fi mesh network that allows the mine operators to perform telemetrics on its equipment and communicate with the workers in the pit.

Kennecott deployed Rajant's BreadCrumb system to form an interconnected network that allows loader trucks, shovels, pumps, laptops and other production equipment to communicate with each other in real-time. These systems are a mix of secure access nodes that enable data and voice communications across a meshed, self-healing network for fleet dispatch, health monitoring and other critical mining applications.

Many of the devices that require wireless communications are moving at all times throughout the wireless mining infrastructure. The mesh network is specifically designed to operate with continuously mobile nodes, assuring that IP traffic is sustained and bandwidth is maximized so that communications reach the proper destination, says Glenn Booth, vice president of marketing for Rajant, based in Malvern, Pa. Traditional mesh networks cannot adapt quickly to a roving node; the process can take a couple seconds.

"That's way too much time," Booth says, "because by the time the network settles down, that node might be someplace else."

Rajant calls the software in its nodes InstaMesh, which allows for a faster connection between units. "Mesh is not new, but the idea of multiple connections gives you resiliency so that if one node goes down, you have plenty of other paths to get back home," Booth says, referring to Rajant's philosophy of deploying as many of its radios as necessary to ensure reliable communications.

"If you picture [the mine as] a bowl, on the outside top of that bowl we have some fixed radio infrastructure, called BreadCrumbs, on small towers, pointing into the bowl," Booth says, explaining how the mesh network was deployed in the open-pit mine. "Inside the bowl, there are a few more fixed locations, such as water pumps that won't move around too much, and then all the moving equipment.

"In the whole mine, there are nearly 150 BreadCrumbs right now. About 100 are moving in some way or another."

The challenges in deploying the BreadCrumb system in an open-pit mine are not so different to those of deploying a mesh network in a municipality, where the concern is radio interference. There are no trees or buildings to obstruct radio frequencies and there are fewer other radio signals to interfere with communications.

"The challenge is having a lot of these big trucks and support vehicles that are metal and they move around, though not very fast, hauling lots of ore," Booth says. "These vehicles along with the physical shape of the pit can create obstructions and temporary changes to RF characteristics."

From Picks to Clicks

Using Wi-Fi in mining just adds to the various applications for Wi-Fi.

"Some mining and construction companies are not quite using the latest technology like you might find in the enterprise sector," Booth says. "Wi-Fi has been around for a while. So what's the big deal, right? If you go into these mines, depending on what kind of mine you go into, it's almost as if people are still using coal picks and candles.

It's that kind of variance in what kind of technology they're using."

Kennecott opted for a Wi-Fi mesh network to help keep track of workers and equipment in the mine. Dispatchers in the office are able to relay job assignments to workers and track the operational health of the machine using telemetry.

The system allows the dispatcher to send a text-based communication to the equipment operator to assign a job duty. A "handshake" system allows the worker and dispatcher to confirm that the assignment was received by the correct person.

The dispatcher also receives transmissions regarding operating levels of the machinery, whether it has enough oil or fuel and whether the machine is running properly.

"It's almost like a flight tower with an air traffic controller," Booth says. "The stakes are very high on an airplane. The stakes are also very high in a mine, at least financially."

Rio Tinto, the owner of the copper mine, makes about $100 million per month on mining spoils, Booth says. The mine depends on its equipment staying online and miners performing the proper job duties to make a profit.

Rajant has also sold some of its communications equipment to subsurface mines, where the equipment is used more for worker safety than dispatching, Booth says. However, none has deployed BreadCrumb mine-wide as Kennecott did in the Bingham Canyon Copper Mine.

The simplicity of using the BreadCrumb equipment improves the business operations of mines because there is no need to develop a network administration department to operate and maintain the system.

"When you talk about bringing in sophisticated wireless network equipment," Booth says, "it's perceived that now you need to hire a network IT person just for the mine, or a couple people because it's a large company basically, and you wouldn't have a wireless network without a point person to administer, manage and install equipment."

Additionally, the training and amount of expertise is lower because of the intelligence inside the BreadCrumb units. There is no need to reconfigure the dynamic host configuration protocol (DHCP) or other parameters of the network.

"We originally built this technology for soldiers and first responders," Booth says. "We wanted them to have a switch they could throw and immediately have a network. You shouldn't even have to know what a DHCP is."

The same philosophy works in the mine setting, where the mine ownership is looking to squeeze more productivity out of its workers and machinery, Booth says. One way the BreadCrumb network helps improve productivity is by reducing miscommunication.

"There's less human error on both sides," Booth says. "The truck drivers get clear instruction of what they're supposed to be doing and what their next assignment is. They're getting a lot more real time information about where precisely to pick up and drop off loads."

On the Battlefront

Rajant got its start in the military and first responder markets about six years ago, responding to a need that became tragically apparent after the Sept. 11, 2001, terrorist attacks when firefighters and police officers were unable to communicate.

"It was 9/11 that started our company because the guys responding to that emergency could not talk to each other and could not talk to the outside world," Booth says, pointing to the various communications systems that went offline or were overloaded.

From then on, Rajant started making rugged mesh network equipment that was portable and battery operated. The idea was to flip a switch and the InstaMesh software figures out the identity of the user, location, others in the network, how to connect to other BreadCrumb devices and other related configurations.

The system was designed without the necessity of having an IT technician on site. Whereas traditional nodes have centralized intelligence programming, the Rajant system employs distributed intelligence where every node has its own microprocessor running the mesh software.

Rajant was performing testing in the London Underground subway system to determine if its equipment could be used in tunnels when it started hearing from mining companies curious about whether the BreadCrumbs would be reliable in a mine setting.

Rajant's equipment is currently being tested by the Mine Safety and Health Administration (MSHA) to be qualified for use in all mines in the United States. The West Virginia Office of Miner's Health, Safety and Training has already approved Rajant equipment for use in all of that state's mines.

The concern about the equipment used in the mine setting is whether it is "intrinsically safe," Booth says. In the mining world, that means the equipment has to be safe to use in all environments. For instance, equipment cannot cause a spark because if the miners are near a methane gas chamber, the spark could set

off an explosion.

The main communication system used in underground mines, called Leaky Feeder, is not intrinsically safe, Booth says. Therefore, when there is an emergency inside a mine, that system has to be shut down.

Ranging Near and Far

When Rajant deploys its BreadCrumb system, it first studies the radio footprint of the environment to determine the amount of interference that the radios might encounter. The range of the BreadCrumb radios depends on how much disturbance, obstruction and interference there is in the area, but Booth says that in an open-pit mine setting a mile is about average. Wi-Fi, he reminds, is still a line-of-sight technology. Rajant makes up any discrepancies in range by flooding the network with nodes, allowing the radios to stay connected despite temporary interference like moving equipment and earth blocking the way.

The Bingham Canyon Copper Mine BreadCrumb network has been up and running for the past four months. And it continues to add new nodes to ensure that the loader trucks haul ore to the right location and excavators dig in the right spots.

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