# TECHNICAL PROGRESS REPORT

## Quarterly Report

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## ABSTRACT

Work has progressed on both subsystems: the Through-the-Earth (TTE) Communications system and the In-Mine Power Line (IMPL) Communications system.

The TTE system: The system was fabricated and repackaged as an industrial product enclosed in a commercial rugged, waterproof housing suitable for installation in mines. Features were added to the system to appeal to the preferences of different mine managers. Arrangements were made with NIOSH to install the system in the Lake Lynn underground mine for evaluation and demonstration to potential users.

The IMPL system: Voice compression was successfully implemented and incorporated into the laboratory model. Compressed voice was transmitted through a power line, expanded at the receiving end, and received with high clarity.

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## RESEARCH, DEVELOPMENT, AND EXPERIMENTAL

Work has continued on both subsystems: the through-the-earth (TTE) Communications system and the In-Mine Power-Line (IMPL) communications system.

*The TTE System:* An industrial rugged prototype was manufactured and assembled into a fiberglass, waterproof enclosure of dimensions 17”X15”X6”. This required redrawing the electronic circuits schematic diagrams and making layouts for printed circuit boards (as compared with wire-wrap circuit boards used in the laboratory prototype). A subcontractor fabricated the printed circuit boards. The assembly was designed for easy manufacturing, production, testing and quality control. This required a number of mechanical structures to make assembly and access easy. A subcontractor fabricated the mechanical structures.

Transtek and NIOSH (National Institute of Occupational Safety and Health) agreed to install the system in NIOSH’s Lake Lynn underground mine for evaluation and demonstration to potential users. This will be done early in 2002. Transtek will also install in the mine its Cat-5 in-mine wireless communications system. The two systems will be linked making possible two-way wireless communication between any locations within the mine as well as between any location inside the mine and the surface.

We shall build a second industrial prototype for testing and demonstration at different mine sites. Managers at different mines have different preferences as to the method of communication. Therefore, we included in the prototype three methods. The first method includes telephone telephone handsets that will make for the end user in a deep mine the task of communication unchanged from the traditional hard-wired telephone method, except that a wireless link will replace the telephone wire. A second method built into the prototype is communication using a built-in microphone and speaker. One must press a push-button switch to initiate communication. A third method built into the prototype utilizes wireless two-way radios. A person, at the surface or inside the mine, uses a conventional two-way hand-held radio that connects via an RF signal with the TTE

system. At the other end the TTE system communicates via an RF signal with hand-held two-way radios tuned to the same frequency. This method yields a seamless link with the in-mine communication system.

*The IMPL System:* This project centered on voice compression and integration into a complex protocol for digital communication over a noisy power line. The voice was digitized and then compressed by an 12/1 ratio. The compression is necessary to enable multi-channel communication over a relatively narrow bandwidth transmission medium. Digital transmission over a noisy transmission line requires a large amount of overhead to check and correct transmission errors and, if necessary, to request retransmission. The voice information must be made to fit into this process. Digital data is transmitted in spurts to fit into the control and error correction protocol and does not interfere with the net result of the information received at the receiving end. When it comes to voice, it can make the message sound chopped or interrupted. Therefore, the received signal must be buffered and smoothened out before it is converted to an analog audio signal and applied to a speaker.

We integrated the audio voice signal (after digitization), coming from a microphone, with a power line modem to be transmitted in packets together with the complex error correction and retransmission protocol. At the receiving end the voice data was expanded, smoothened, converted into an analog signal and applied to a speaker. The received signal exhibited a high degree of clarity. There was a delay of about 30 milliseconds between the transmitted and received signal as measured on an oscilloscope. Such a delay is not noticeable by the conversing parties.

## RESULTS AND DISCUSSION

We have a TTE industrial prototype communications system ready for installation in NIOSH's Lake Lynn underground mine for evaluation and demonstration to potential users. Three different methods of communication are available (telephone handset, microphone/speaker, and two-way radio) in the system. Interesting parties can choose any, or all, the methods for installation in their mines, depending on their preference for their particular environments. The system can be linked to Transtek's in-mine wireless communication system making possible communication between persons anywhere in the mine and on the surface. An additional industrial prototype will be build for testing and demonstration in other mines.

A voice compression device was integrated with a power line modem to make possible multi-channel voice communication over a noisy power line. The system was successfully tested in a laboratory setting. The voice transmission was loud and clear. This paves the way to wireless voice communication over mine/industrial power lines.

## CONCLUSIONS

The goals set for the first year of this project to develop wireless through-the-earth voice communication, and wireless in-mine voice communication using power lines were met. The through-the-earth system is ready for commercialization. Additional work must be done to move the power line system from the laboratory to industry.

Transtek is now poised to add data communication channels to the systems in the second year of the project.