Electronic Escape Trails for Firefighters
Routes would be traced among RFID tags equipped with sensors showing temperatures.

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A proposed wireless-communication and data-processing system would exploit recent advances in radio-frequency identification devices (RFIDs) and software to establish information lifelines between firefighters in a burning building and a fire chief at a control station near but outside the building. The system would enable identification of trails that firefighters and others could follow to escape from the building, including identification of new trails should previously established trails become blocked.

The system would include a transceiver unit and a computer at the control station, portable transceiver units carried by the firefighters in the building, and RFID tags that the firefighters would place at multiple locations as they move into and through the building (see figure). Each RFID tag, having a size of the order of a few centimeters, would include at least standard RFID circuitry and possibly sensors for measuring such other relevant environmental parameters as temperature, levels of light and sound, concentration of oxygen, concentrations of hazardous chemicals in smoke, and/or levels of nuclear radiation. The RFID tags would be activated and interrogated by the firefighters’ and control-station transceivers. Preferably, RFID tags would be config-
ured to communicate with each other and with the firefighters’ units and the control station in an ordered sequence, with built-in redundancy.

In a typical scenario, as firefighters moved through a building, they would scatter many RFID tags into smoke-obscured areas by use of a compressed-air gun. Alternatively or in addition, they would mark escape trails by dropping RFID tags at such points of interest as mantraps, hot spots, and trail waypoints. The RFID tags could be of different types, operating at different frequencies to identify their functions, and possibly responding by emitting audible beeps when activated by signals transmitted by transceiver units carried by nearby firefighters.

It would be necessary to distribute the RFID tags densely enough to ensure reliable communication. A typical RFID of a type now commercially available is a passive device that operates at a carrier frequency of about 433 MHz, and can communicate with another such RFID, using one of several standard serial digital-data-communication protocols, over a distance of as much as about 7 m. In the proposed system, supplementary units could be dispersed along with the RFID tags to increase signal power sufficiently to ensure communication with firefighter’s transceiver units and/or with the control station, which would otherwise be out of range.

In a typical application of a basic version of the system, inexpensive RFID tags having limited range would be dispersed densely enough to enable a firefighter to go from one waypoint to another. The tags could include temperature sensors to alert firefighters to dangerously hot waypoints. If more than one tag were dropped within communication range, a tag indicating a safe temperature could become an alternate waypoint for a route out of the building.

In a more advanced version of the system, the RFID tags could communicate with each other via local daisy chains, relaying data on hot spots to the fire chief at the control station. The dispersed RFID tags could also constitute elements of an indirect positioning system. If the system were designed to measure signal-propagation delays among the various tags and firefighters’ transceivers, then the relative positions of the tags and the firefighters could be computed from these delays. The software for computing the relative positions could be integrated into a more comprehensive computer program that would correlate the positions with a three-dimensional map or graphical display of the building. In that case, locations of firefighters, hot spots, and mantraps, could all be presented on a single building display that would assist the fire chief in planning safe escape routes.

This work was done by Charles Jorgensen and John Schipper of Ames Research Center and Bradley Betts of Computer Science Corp.

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