Intelligent Building Response

By William Davis, Ph.D.

In the event of a building emergency, fire, police and other emergency personnel who arrive at the event are faced with the need to quickly appraise the situation. The task of sizing up the emergency and determining the best way of dealing with it typically requires both an inspection of the building perimeter and entering the building to obtain information from the fire alarm panel and other equipment panels. These activities can require a considerable amount of time, particularly if the building is large.

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Why should first responders need to do a size-up at the scene in order to find out what is happening inside? Real-time information regarding building systems should be available while they are enroute to the scene. Why can't a dispatcher understand the emergency inside the building from the start of an incident, even before the apparatus is dispatched? A modern building fire system has fire sensors in every room that report alarms to a fire panel when the smoke level or temperature reaches a set threshold. These same sensor signals could be processed by a computer to identify growth and progress of a fire and identify hazardous conditions throughout the building. That information could be made available to the incident commander before he/she arrives on scene.

Modern buildings are capable of supplying substantially more information to the fire service than just the simple detection of a possible fire. In 1984, Nelson recognized the importance of tying all the building sensors to a smart fire panel.[1] Many large buildings have building automation systems (BAS) that manage the environment, fire and security, elevators, etc. In addition to the fire system, these other building systems could provide useful information for the emergency responders. For example, the HVAC system could provide its system status to verify that smoke is not being transported through the building and that the areas that are pressurized to control smoke flow are pressurized. The lighting system, if it uses motion sensors, could identify rooms with lights on where occupants could be located. The elevator system could report elevator location and occupancy, as well as presence of smoke, water and/or high temperatures that could render the elevator dangerous to use by emergency responders. And the access control system could identify forced entry as well as provide video feeds from cameras. Yet, for the most part, all this information is bottled up in the building even while it could provide tremendous situational awareness to those outside the building, telling them where a fire is, where smoke is, where occupants are, which devices are operating, which lights are on or which doors are open.

In the building industry, there is ongoing work to address building controls' interoperability between different manufacturers, including the work on the BACnet[2] standard at the National Institute of Standards and Technology (NIST) and, more recently, work to provide building information to those outside the building. Lacking now is a standard method of moving real-time information out of the build-

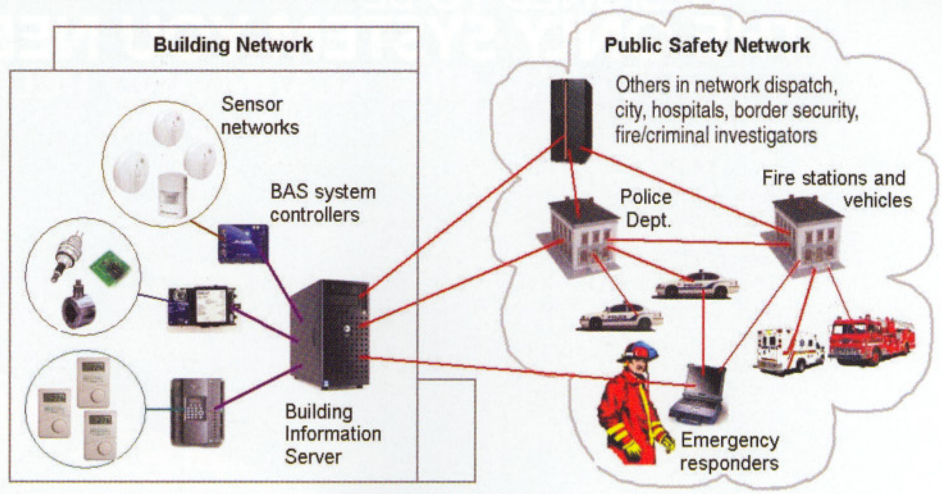

Figure 1. Schematic of System Architecture.

ing and into the hands of emergency responders.

Due to the large quantity of data that they could be made available from building systems, it is important to define what types of data are most useful to emergency responders at what time, and how to represent, transport and present these data. These data need to be integrated to provide a clearly defined picture of the building incident. Emergency responders would then have the power to see what is happening in order to respond to an incident quickly and safely.

Critical building information needs to be sent to and displayed on a wide variety of devices, from high-resolution screens at dispatch centers to wireless devices for notebook computers in fire apparatus/police cars and handheld devices. In order to assure interoperability of the information (or data) transmissions, requirements for the data and presentation formats must be defined as well.

A comprehensive approach to providing building tactical information to building incident responders, applicable at all jurisdictional levels and across functional disciplines, would further improve the effectiveness of emergency response providers and incident management organizations across a full spectrum of potential building incidents and hazard scenarios. Such an approach would aid in coordination and cooperation between public and private entities in a variety of domestic incident management activities. Figure 1 shows a data path from building sensors to subsystem controllers to building information server and then to a public safety network, where it is accessible by public safety officers.

The building information that emergency responders could use can be classified as either static information or dynamic information. "Static information" is defined as that building information that changes slowly with time. Static information would include floor plans, sensor locations and ventilation system schematics. The fire system would contain information about the location of fire sensors, sprinklers, standpipes, fire department connections and lock boxes. Of particular importance for large buildings are the location and floors served by stairways and elevators, including those stairways that provide rooftop access. The location of special hazards, such as above-ground propane tanks, would be documented. Fire departments typically have preplans of important buildings that provide the static information. The preplans historically have been stored in file boxes in paper format and located in the cab of the responding fire apparatus and are just now being made available in electronic format.

"Dynamic information" is that set of information that comes from real-time status of building system controllers and sensors, including fire alarms, security sensors, mechanical system status, elevator location, lighting system activation, occupancy sensors, etc. Dynamic information includes both direct sensor readings, as given by individual building subsystem controllers, and the output of decision support tools that analyze sensor data. An example of a fire decision support tool is one that would use the fire system sensors along with knowledge of the building geometry to estimate fire size, location, smoke spread and fire growth rate. Another example is a security support tool that estimates occupant location based on occupancy sensor and lighting system input.

Building information displayed to emergency responders must be easily understandable and supply the needed information quickly while avoiding information overload. A major step in this direction was taken in December 2005 when the National Electrical Manufacturers Association (NEMA) released the *Fire Service Annunciator and Interface Standard.*[3] This standard was designed to provide the necessary guidelines in display and function such that first responders would not be faced with the need to learn individual manufacturer display systems. It also went further in that it embraced the concept of wireless transmission of the display to remote locations and included the possibility of remotely controlling other building systems such as the elevators or HVAC system. The resulting Incident Commander Display would be useable as a fire panel in a building or could be displayed on a computer screen in a fire apparatus, in dispatch or in other appropriate locations.

One of the issues confronted in developing this standard was the choice of icons needed to provide a representation of a feature, sensor or hazard on the display. Since this display

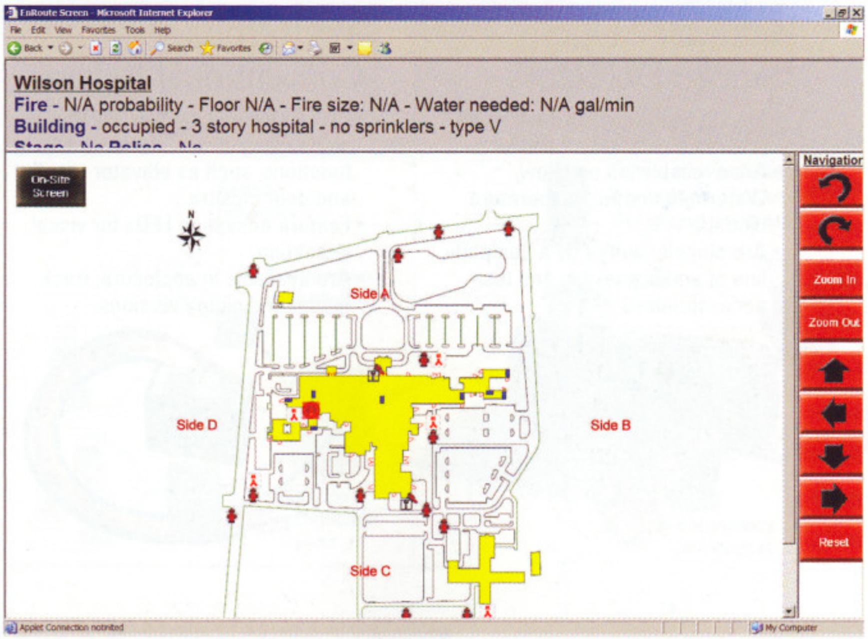

Figure 2. Enroute Screen.

standard would be used internationally, text-imbedded characters needed to be avoided. Additional icons still need to be developed and some of the current icons modified as additional features are added to the standard.

As this display expands to include building systems in addition to the fire alarm system, the ability to extract building information from building plans to populate the display becomes important. NIST researchers have been instrumental in addressing the lifecycle of building information and how it can be stored, formatted, maintained and reused over time. Beginning in the 1980s, NIST has been active in the development of information representation and exchange protocols for the building industry. This work has culminated in the Industry Foundation Classes (IFC), maintained by the International Alliance for Interoperability (IAI, www.iai-international.org). The IFC establish a common information model that enables information sharing and interoperability throughout all phases of the building lifecycle. Major building design system vendors have implemented support for IFC in their products as have developers of many downstream applications such as structural engineering, HVAC design, thermal analysis, code checking, quantity take-off, cost estimation and others.

A workshop to define information needed by emergency responders during building emergencies was conducted by NIST on May 3, 2004.[4] The participants examined information needs by first responders for fire, medical and police events. One of the participants submitted an example scenario using an incident command tactical system based on the workshop information (see appendix F of reference 4). He stressed in his example that the timeframe for absorbing any static or dynamic information is limited and provided the following example for most vehicles (see below).

Time from Dispatch	Action
1 minute	Put on personal protective gear.
2 minutes	Climb into engine, be seated and belted.
3 minutes	Use the GIS map and display to navigate and plan.
4 minutes	Monitor the proper route – best time to see building information.
5 minutes	Arrival – initial size-up.
On scene	Start SOP – assessment, deploy hoses and ladders if needed.

For single-rider vehicles, which are used by most field supervisors, the best time to use displays such as the Incident Commander Display is on scene.

The above scenario provides a nice roadmap of what is needed. Today, modern fire departments have GIS capability that provides street maps and vehicle locations. These displays, when zoomed to the footprint of the building of interest, should provide two types of displays. The first (Figure 2) would be used for staging. This display would provide the location and type of incident, the location of fire hydrants and fire department connections with zones designated on the building footprint, entrances, stairwells and elevators, as well as other information useful in staging.

The second display would be the Incident Commander Display that would be based on the current NEMA standard. An example of the type of information that could be presented on the Incident Commander Display is shown in Figure 3.

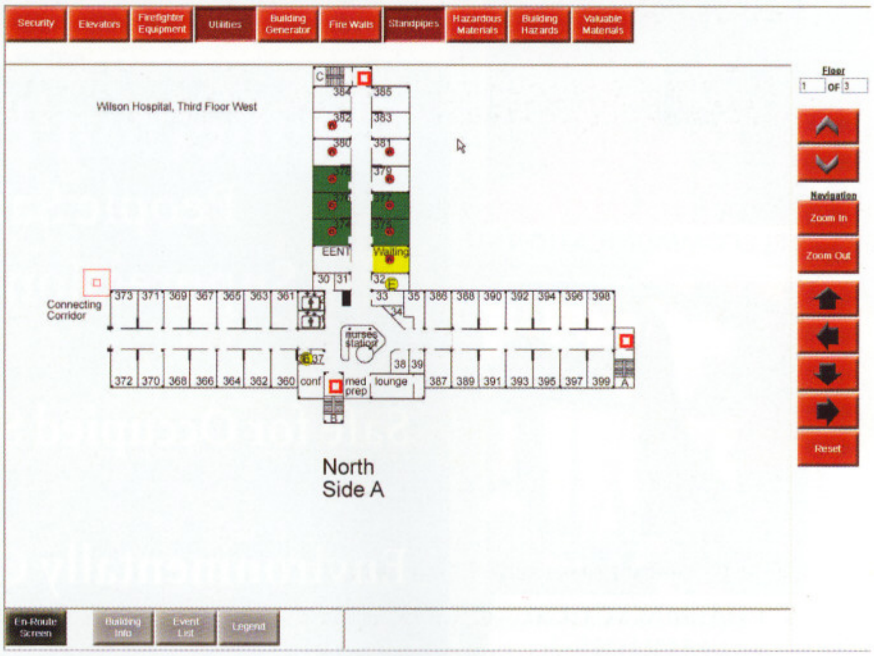

Figure 3. On Site Screen.

By using the buttons at the top of the display, the user could do manual queries such as the location of standpipes (red squares) and electrical utility closets (yellow circle with E) that would not be displayed normally to prevent cluttering the display. The green and yellow coloring in the rooms provides smoke and temperature information based on signals from the heat detectors shown as red circles in the rooms.

Future issues that were raised at the May 2004 workshop that are now being evaluated or need to be addressed in the future include:

1. First responder control of building systems via the information system interface. This might include shutting off air-handling units, unlocking doors, directing closed circuit TV cameras, turning off power and water. Participants thought this would be good, but again were concerned with command authority issues. The suggestion was made that personnel closest to an incident requiring control should have priority in making decisions to control the incident. For example, a firefighter in an elevator could override the instructions from the building security control panel, except that there were noted occasions where the reverse is true.

2. Updating "static" information in a timely manner. Somehow, there needs to be a link with the building permit process and feedback through inspections. Building use status changes frequently, and changes are not always propagated through the municipal database. The suggestion was made to somehow have building owners responsible for maintaining current building layout, use and history.

3. Managing a traffic control system to facilitate emergency access. Is it possible to automatically manage traffic flow to bypass the event?

4. Information which might not be shared. For example, classified movement of munitions or nuclear material through an area for which state and local officials may not be cleared. What classified information might be included in the information system, and to whom would it be made available?

Solutions to the issues raised by points 1 and 2 are actively being pursued at NIST. Several metropolitan areas have traffic control systems that are capable of achieving the issue raised by point 3. The question of how successful these systems are needs to be investigated. Finally, the issue raised by point 4 will be looked at in the future as standards for these systems are developed.

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References

1 Nelson, H.E., "Functional Programming/Research Planning for High Technology Federal Office Buildings," *National Institute of Standards and Technology* NBSIR 84-2828, (1984) p. 28.

2 "ANSI/ASHRAE Standard 135-2004 BACnet-A Data Communication Protocol for Building Automation and Control Networks," 2005.

3 NEMA SB 30, *Fire Service Annunciator and Interface*, National Electrical Manufacturers Association, Rosslyn, Virginia, 2005.

4 Jones, W., Holmberg, D., Davis, W., Evans, D., Bushby, S., and Reed, K., "Workshop to Define Information Needed by Emergency Responders during Building Emergencies," NISTIR 7193, January 2005.