Interoperable Dynamic Tactical Information for Public Safety Officials

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Abstract

Currently, fire department notification of a building fire comes from either a building fire alarm system monitoring service or a 911 call. The emergency responders know very little about the situation until they arrive on the scene. Information for their initial response begins with the pre-emergency building survey, if available, and is supplemented upon arrival by the visual "size up" of the situation. Many fire departments are replacing paper pre-emergency building surveys with electronic information that can be accessed from mobile computing equipment in the apparatus. Unfortunately, there are currently no standards for the content of building emergency information or its display format. Without these standards, interoperability of equipment to share electronic information between all first responders to large-scale emergencies will be a problem.

The purpose of this study is to develop standards for building emergency information to improve situational awareness. Practical methods to supply and use the information are also investigated. The standards effort will cover six areas: information content, representation, storage, access, transport, and presentation. This effort enables improvement in the safety and efficiency of emergency responders. It provides the foundation for a future emergency decision support system that takes advantage of modern developments in building fire and other hazard predictions.

Introduction

Response to a building emergency typically commences with notification from a central alarm or security system monitoring service or 911center. The first responder is provided with the type and location of the incident. A map of the running routes and hydrant locations is used by the responding apparatus. The extent of the building information on the route map depends on the type and use of the building. For commercial buildings or apartment houses, the route map may include an outline of the building and the location of the standpipe/sprinkler connection and door/garage entrances. For newer buildings, the location of the fire alarm annunciator panel and fire control room is sometimes available. "First due" firefighters responding to the alarm prepare mentally for the typical fire expected in the class of structure identified.

Additional information about the structure may be available in binders or file boxes carried in the responding apparatus. An example is shown in figure 1. These pre-emergency surveys may contain interior floor plans, stairwell risers, the location of utility shutoffs, known hazards, etc. Its detail will depend on the person who conducted the survey.

Figure 1 Pre-emergency plans stored in the cab
of an engine. Wilson, NC Fire/Rescue Services

With the development of small, rugged portable computers and compact electronic storage media, fire departments are moving toward using electronic pre-emergency surveys (e-plans) for buildings that can be accessed from mobile computer terminals in the apparatus. Advances in telecommunications have opened up the possibility of supplying first responders with access to municipal databases and real-time information from sensors and alarm systems in buildings prior to arrival. The potential amount of information that can be available to first responders is staggering.

In the future, first responders will make use of data from many sources in responding to emergencies. For enhanced reliability, critical information for use in the initial emergency response will be carried with the responders. Other information may be transmitted. The transmitted information may come from both secure and public municipal databases and also from inside building systems. Using the pre-emergency survey diagrams as a platform, incident commanders may have displays of relevant building and surrounding area information from the databases (static data) and real-time building sensor and alarm information (dynamic data) to use as decision aids. Electronically transmitted information about conditions in the building can be used as input to predictive models that can forecast the development of hazards. Output from predictive models can improve the situational awareness of the incident commander to the development of potential hazards well beyond the capabilities that exist today.

Working with the on-site NIST Fire Department, a demonstration of all of the potential advances in fire emergency information transfer was conducted using a structure fire experiment in the NIST Large Fire Facility. In the demonstration, information from

sensors and detectors installed in the structure, and images from the fire floor were directed to both the central monitoring station and the responding vehicles. Even before the arrival of the apparatus, the dynamic data stream from the fire floor provided the firefighters with a timeline of temperature, smoke concentrations, and fire size for the space. Firefighters knew before entering the building the fire conditions they would be confronted with and were prepared for them.

NIST Research for First Responder Information Systems

To help assure interoperability of present and future first responder information systems, NIST is developing a set of minimum information standards for e-plans. This research is being funded in part by the National Institute of Justice (NIJ). The information set published in NFPA 1620[1], Recommended Practice for Pre-Incident Planning, is an appropriate guide for pre-emergency planning but contains far more detail than an incident commander can use in the critical early response to an incident. NIST is working with first responders to answer the question of what information a first responder can use, how to obtain it from municipal and building systems, how to transmit this information, and what display formats should be used for this information.

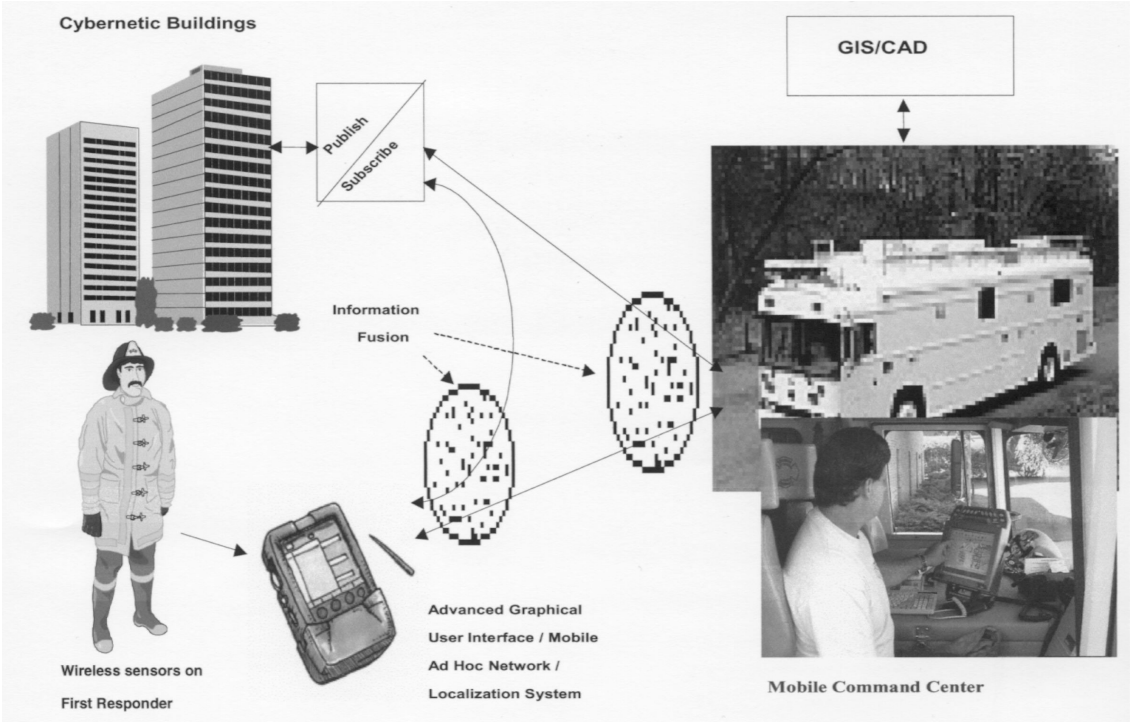

Figure 2 Building information flow to emergency responders

In general, an incident can be broken down in time to three periods. The first period is the time from dispatch until arrival at the incident; often about five minutes. The second period would be the time from arrival until the extent of the incident and method of attack

has been determined and the last period would be the mitigation of the incident. The amount of information needed during each of these periods will depend on the type of incident. The key is to look for commonalities in information across incident types and develop information groups that can be readily displayed on a computer screen. In the next section of the paper, candidate information sets will be discussed for a building fire response. Many other emergency responses, such as medical emergency, police action, hazardous material release, etc are also within the scope of this work, but the building fire response will be used as a starting point for discussion of the minimum needs and available reliable sources of the information.

A Building Fire -- The first five minutes

The "first due" responder typically has five minutes between the time of dispatch and arrival at the incident. The officer in charge must make sure that his or her team is seated and belted in the apparatus, dressed in turn-out gear, and that all the doors are closed. The officer must then check with the driver to make sure that the route to the incident is known and then uses the route map to verify that the route is correct.

At this point, the officer can start to process additional information about the incident. Due to the difficulty of reading computer screens or hard copy when the apparatus is in motion, the information display must be simple which limits the quantity of information that can be displayed. The information that may be displayed can be broken down into three categories:

- Static database information.
- Dynamic building and response information.
- Calculated decision support information.

Examples of static information would be information about the building, its contents and its surroundings that are relatively constant in time. Much of the information found in fire department pre-plans would fall into this category. Dynamic information would include sensor and system information transmitted by the building and response information from the 911 center and emergency responders. Calculated decision support information is based on real-time analysis of building and response information that is used to support the decision making of the incident commander and other public safety officials.

The static information that should be available on the apparatus for the incident commander during the first five minutes includes:

- Building occupancy (abandoned, vacant, young children, high occupancy, elderly)
- Building condition (let burn, unsafe to enter, dangerous roof, sprinklered)
- Building type (single family, commercial, gas storage, school)
- Building style (n story, auditorium, atrium, office, hospital, etc).
- Building construction (type I, II, III, IV, or V).
- Roof construction (light weight metal or wood trusses).
- Unusual hazards (above ground propane tank, gas lines, chemicals, etc)
- Location of fire hydrants on map with building outline. Nonstandard thread sizes should be noted with the hydrant.

- Location of fire department hookups for sprinkler system/standpipes.
- Other sources of water nearby.

The dynamic information available to the apparatus would include:

- Location and types of fire alarms.
- Time duration since first fire alarm.
- Fire alarm panel signals.
- Sprinklers flowing.
- Responders on scene (Police & Fire).

The calculated decision support system information would include:

- Confidence in the incident being a fire (based on number of sensors in alarm and/or calculated fire size)
- Approximate location of fire within building.
- Fire size.
- Time duration of the fire.
- Estimated water flow in gallons/minute or water - foam solution to control the fire
- Assessment of the local hydrants capability of supplying this water.
- Fire growth (fast, medium, or slow).

Other units responding to the scene should receive and share the same information even though it may take them an additional five to ten minutes to reach the incident. The fraction of this information that can be supplied will depend on the building type and age with new, large commercial buildings having the infrastructure necessary to supply most of the points on the list.

A Building Fire -- On the Scene

Once the first apparatus has arrived, the incident commander will require additional information. For house fires and other small buildings, a visual inspection from the outside and information supplied by occupants would be a first priority. For large buildings, the fire may not be visible from the outside and a visual check may not be a first step. Typically, large buildings have twenty-four hour security or lobby desk staff that may provide information on the location of the incident inside the building.

Electronic data that would be useful at this time would include a building floor plan and a plot plan of the area. The floor plan would include layers/overlays that would allow the incident commander to locate:

- Key Box.
- Doors, windows and stairwell risers.
- Fire alarm panel and remote annunciator panels.
- Utility shutoff.
- Location and types of hazardous materials.

Figure 3. Marion Ohio Fire Department Response

- Location of HVAC system controls.
- Location of building smoke control system.
- Contact number for building engineer.
- Location of areas of refuge.
- Identification of evacuation quality elevators, floors served, and location of elevator overrides and machine room.
- Identification of areas protected by sprinklers or other devices.
- Potential building hazards that may require decontamination.

Dynamic and calculated information that would be useful and could be a series of overlays on the floor plan include:

- Location of fire detectors in alarm.
- Location and size of fire/fires.
- Time duration of the fire/fires.
- Location and condition of smoke.
- Presence of smoke in elevator shafts or stairwells.
- Identification of activation of sprinklers or other devices.
- Location of elevators used during incident.
- Location of people in need of rescue (911 calls or visual sightings).
- Warnings of structural collapse based on material type, fire location, fire size and time duration.

The plot plan would be resizable and contain the following information:

- Building location with street designations.
- Location of fire fighting obstacles such as street widths, overhead clearance and elevations.
- Location of underground pipelines and other utilities.
- Name and phone numbers of building owners and managers.

- Name and phone numbers of utility contact people.
- Indicated runoff or water table problems.
- Helicopter landing areas.

Dynamic and calculated information that could be displayed on an overlay of the plot plan would include:

- Location of responding units (fire, police, and EMS).
- Location of units responding but not yet on scene.
- Hospital availability.
- Helicopter availability.
- Hazmat response.
- Location of police line necessary to isolate the incident.
- Location of evacuation or triage areas.
- Suggested hazard perimeter

Additional data that may be needed concerning the incident may include a long list of contact numbers for public safety or relief agencies.

This list of information represents a first cut for electronic information available at an incident. While additions and subtractions to this list are expected, a next step is to decide how to order the information by electronic screens and standardize the symbols used on the displays. An excellent starting point is NFPA 170[2], Standard for Fire Safety Symbols, and NFPA 72 annex[3], National Fire Alarm Code. A subset of these symbols should represent a starting point for the e-plan standard. There are several companies developing GIS based software that is being used for preplanning by fire and other public officials and the good ideas in their products should be incorporated in the standard. The use of colors on displays needs to be explored as an aid in recognition of information.

Issues to resolve

A major issue to resolve is how to interface first responder equipment with the sensing and alarm systems already installed in buildings. Even alarm systems that have been operational for many years may possess some information transfer capability. Retro-fitting of existing systems may have to be addressed. The typical fire alarm systems stores and processes a great amount of information collected from fire detectors, but may only transmit a minimal amount of the information out of the building to a central monitoring station. Typically only an indicator that a trouble or fire condition exists in the building is received by the monitoring service.

Some systems are available today that provide building schematics with sensor alarms on the fire panel but none of this information is available at the fire station or on the apparatus. In this study NIST will examine available strategies for collecting and transmitting building information to first responders. One method, a building publish-subscribe system, is being explored. This system would collect information from BACNET[4] compliant building controllers and use the Internet to send the information to

first responders. There are a number of issues to be resolved such as providing for security and encryption of the transmitted information and analyzing the information for presentation in a form that would be useful for first responders.

NIST has been developing decision support systems (DSS) that would make use of building sensor or controller information, analyze it, and present it in a useable format for first responders. One such system, the Sensor-Driven Fire Model (SDFM) [5], was demonstrated to members of the fire service in 2003 operating in real-time and analyzing the development of a computer generated fire in a forty-five-room zone in one of the NIST buildings. Simulated thermal sensors were used to supply the data to the SDFM that returned smoke layer temperatures, fire size and smoke spread throughout the zone. The results were displayed in real-time on a two-dimensional building diagram using colors to represent building threats within the zone. The continued development of these types of models is required in order to make optimum use of building information.

The major issues to be faced include:

- Work with the Fire Alarm Industry to roadmap practical means to get alarm information to first responders from new and existing building systems
- Standardize building communication systems for controllers and sensors
- Develop methods for access and security of building information

Technology Development

Much of the technology development concerns decision support systems that can be used to provide meaningful input for the incident commander and other public safety officials. The areas that need to be addressed include:

- Develop decision support systems to analyze controller and sensor information and present it in a standard format
- Develop reliable on-scene tracking method for first responders
- Develop reliable condition assessment methods
- Develop rapid means to forecast conditions and assess response effectiveness
- Develop training aids for systems

Opportunity

We invite all parties that have a stake in moving information from building systems that help to define conditions in buildings and anticipate developing hazards to work with us to improve first responder operations. We welcome ideas from industry, the fire service, and building operators that would help us move ahead as quickly as practical. The safety and effectiveness of all first responders to emergencies depends on reliable information. We should make as much information available as can be used by those who serve and protect the community.

References

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