Workshop on Smart Buildings and Fire Safety

Proceedings

Workshop Date: Wednesday 7 March 2014
Workshop Location: Orlando, Florida

Prepared by:

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Fire Protection Research Foundation

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EXECUTIVE SUMMARY

These are the proceedings of a workshop held on 7 March 2014 in Orlando, Florida to address “smart buildings and fire safety.” The goal of this workshop was to establish and clarify a needs assessment for how systems in smart buildings can be used for fire safety.

To address this goal, this workshop provides a baseline understanding of smart buildings, followed by the identification of the current/proposed methods and approaches for gathering, processing, and utilizing data. This includes identifying the needs of key participants in the built environment as they relate to the virtues and opportunities of cyber physical systems, and providing recommendations on how best to enable a path forward to realize these opportunities.

Keywords: smart, buildings, fire, fire safety, cyber physical systems, data
ACKNOWLEDGEMENTS

The workshop has been made possible through support from the:

The Fire Protection Research Foundation

With additional support from the National Institute of Standards and Technology (NIST) through their funded project to “Develop a Research Roadmap for Smart Fire Fighting”

This workshop summary report has been prepared by Casey Grant, Research Director for the Fire Protection Research Foundation. The information contained herein is based on the input of numerous professionals and subject-matter-experts. While considerable effort has been taken to accurately document this input, the final interpretation of the information contained herein resides with the report author.

Photographs included in this report were taken at the workshop by Mike Hazell, NFPA

About the Fire Protection Research Foundation
The Fire Protection Research Foundation plans, manages, and communicates research on a broad range of fire safety issues in collaboration with scientists and laboratories around the world. The Foundation is an affiliate of NFPA.

About the National Fire Protection Association (NFPA)
NFPA is a worldwide leader in fire, electrical, building, and life safety. The mission of the international nonprofit organization founded in 1896 is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education. NFPA develops more than 300 codes and standards to minimize the possibility and effects of fire and other hazards. All NFPA codes and standards can be viewed at no cost at www.nfpa.org/freeaccess.
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Figure 1: Breakout Group Discussions
The technology of today’s world is advancing at an amazing rate. The enormous amount of available data in our ever increasing sensor rich environment is changing our way of life. We are on the cusp of a new technological era rich with a plethora of new data collection abilities and analysis tools. This environment of “big data” and the prevalence of “cyber-physical systems” is steadily increasing in importance in today’s world.

How does this relate to the fire safety community, and “SMART” buildings? Exciting new possibilities for addressing unwanted fires are being realized, based on: (1) available data gathered from an increasingly sensor rich environment, (2) the comprehensive ability to analyze and process this data, and (3) new ways of delivering and using this data. The SMART buildings of tomorrow and their sensor rich environments offer great fire safety potential to building owners, occupants, emergency responders, and all other participants in our built environment.

The goal of this workshop is to establish and clarify a needs assessment for how systems in SMART buildings can be used for fire safety. This will be accomplished by clarifying a baseline understanding of SMART buildings, followed by the identification of the current/proposed methods and approaches for gathering, processing, and utilizing data. This includes identifying the needs of key participants in the built environment as they relate to the virtues and opportunities of cyber physical systems, and providing recommendations on how best to enable a path forward to realize these opportunities.

This workshop is related to another on-going research project to “Develop a Research Roadmap for Smart Fire Fighting,” which intends to establish the scientific and technical basis for achieving the vision for Smart Fire Fighting in the United States through the development of a research roadmap. Specifically, this roadmap will identify and address high-priority measurement science research challenges, technical barriers, and related research and development gaps that hinder widespread application of Smart Firefighting technologies and systems by the U.S. Fire Service. The results of this workshop are intended to support this one-year research effort.

The vision for Smart fire fighting includes “Smart buildings” and is based on creating, storing, exchanging, analyzing, and integrating information from a wide range of databases and sensor networks, including:

- Building Systems – All monitoring, data and control systems integral to buildings, including but not limited to electrical, security, environmental, safety, inventory, and property protection systems.
- Infrastructure and Community Data Systems – All data systems not included in the three aforementioned topic areas and intended to include data from public utilities, weather,
vehicular traffic (e.g., passenger vehicle telematics, rail traffic, etc.), and computer aided dispatch.

- Fire Fighting PPE & Equipment – All equipment and gear on-board and directly attached to an individual when operational.
- Fire Fighting Apparatus & Equipment – All fire fighting apparatus and equipment used by emergency responders and their supporting infrastructure not in physical contact with the individual when operational, including vehicles and robotic delivery systems.

Figure 2: Breakout Group Discussions
2) **Workshop Overview and Agenda**

This half-day workshop was conducted on 7 April 2014 in Orlando, Florida, at the University of Central Florida. The workshop agenda is illustrated in Figure 3. The workshop was split into opening presentations, panel discussion, breakout group discussions, breakout group reports, and summary observations.

Approximately four-dozen fire protection and safety professionals attended; the list of attendees is included in “Annex A: “Workshop Participants and Attendees.” Some of the speakers used PowerPoint slides; these are included in “Annex B: “Workshop PowerPoint Slides.”

**Wednesday, 7 March 2014**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
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<tbody>
<tr>
<td>1:30 pm</td>
<td>Welcome and Introductions</td>
<td>Amanda Kimball</td>
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<tr>
<td>1:40 pm</td>
<td>Workshop Overview on SMART Buildings, Big Data, and Cyber Physical Systems.</td>
<td>Casey Grant</td>
</tr>
<tr>
<td>2:00 pm</td>
<td>Presentation: Past and Current Efforts to Coordinate Building Data (e.g., BACNet, BIM, GIS, FM, etc.)</td>
<td>Kris Overholt (NIST)</td>
</tr>
<tr>
<td>2:30 pm</td>
<td>Panel Discussion: Review of Experience, Applications and Opportunities – Building Fire Protection and Cyber Physical Systems (i.e., providing examples of building and fire system performance needs during emergency events)</td>
<td>Panelists: Dave Frable (GSA), Joe Scibetta (Building Reports), Jerry Woolridge (Reedy Creek), Curtis Donahou (Disney)</td>
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<tr>
<td>3:10 pm</td>
<td>Break</td>
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<tr>
<td>3:25 pm</td>
<td>Breakout Groups– Address SMART Building Needs Assessment</td>
<td>Workshop Attendees</td>
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<tr>
<td></td>
<td>• Identify Key Target Audiences and their Needs</td>
<td></td>
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<tr>
<td></td>
<td>• Clarify methods and protocols for: (i) Collecting Data; (ii) Processing Data; and (iii) Using Data</td>
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<tr>
<td>4:30 pm</td>
<td>Breakout Group Reports and Plenary Discussion</td>
<td>Workshop Attendees</td>
</tr>
<tr>
<td>5:15 pm</td>
<td>Workshop Wrap-up and Summary Observations</td>
<td>Casey Grant</td>
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</tbody>
</table>

Figure 3: Workshop Agenda

The panel discussion involved four panelists, and was composed of two parts. The session started with introductions by the moderator, and each Panelist provided a five to ten minute overview presentation. The presentations included:

- Describing the experience and/or applications involving data collection and CPS, and in particular how CPS is able to enhance building fire protection.
- Highlighting the value-added of potential opportunities and how CPS is enabling “Smart Building” fire protection.
- Addressing what has already occurred, what is occurring now, and what is anticipated in the future.
Following these short five to ten minute presentations by each Panelist, the floor was opened to plenary discussion. The following questions were considered for the Panel, and all attendees:

- What are the obstacles to enabling CPS to support “Smart Building” fire protection?
- What specific steps are needed for fire protection professionals to consider enabling CPS applications beyond what they are normally handling?
- Provide an example of a straight-forward CPS/fire service application that is realistically achievable and should be considered as a priority (i.e., what is the “low hanging fruit”)? An example is a recent presentation that described Otis Elevator indicating that they have been collecting sensor data on their elevators for the past 25 years, although they were unsure of what to do with the data. Two years ago, Otis established a call center that processes this data and now resolves approximately half of all maintenance issues directly from the call center. [Source; G. Sandy Diehl, “Smart Buildings: How Sensor and Information Technologies are Transforming the Built Environment”, American Architectural Foundation, presented at FPRF Conference “The Next Five Years in Fire and Electrical Safety”, 13-14/Nov/2014, Wash DC]
3) Breakout Groups

Following introductory remarks, the workshop opened with several presentations to establish a baseline understanding of Smart buildings and their associated fire protection systems. This was followed by a panel discussion, which in turn was followed by the breakout group discussions.

Attendees were assigned to one of four separate breakout groups. The breakout groups were designated as A, B, C, and D; the assignments are indicated in the attendee list in Annex A. Each breakout group worked separately on a set of questions and reported back at the plenary session at the end of the workshop. The questions considered by each of the four breakout groups are summarized in Figure 6.

Figure 5: Breakout Group Discussions
Each breakout group had a group leader who facilitated the group discussions, and also presented a summary to the plenary session. The key points from the group discussions are included in the summary observations section of these proceedings.

1. Identify Key Target Audiences and their Needs
   1.1. Who are the key constituents and stakeholders that should be involved with SMART Buildings and fire safety?
   1.2. What are the needs of the key constituents and stakeholders?
   1.3. Who is missing at this workshop?
   1.4. Based on current trends, which professional communities, constituent groups and stakeholders will become more prominent and less prominent as building technology proliferates?

2. Clarify Methods and Protocols for Buildings and Fire Safety
   2.1. Communications (Gathering of Data)
      2.1.1. Provide case study examples of current sensor technology that would illustrate the state-of-the-art?
      2.1.2. What are the current and perceived challenges with collecting data?
      2.1.3. Identify the knowledge gaps with collecting data that require research?
      2.1.4. What is the priority to address the identified knowledge gaps?
   2.2. Computation (Processing of Data)
      2.2.1. Provide case study examples of current sensor technology that would illustrate the state-of-the-art?
      2.2.2. What are the current and perceived challenges with collecting data?
      2.2.3. Identify the knowledge gaps with collecting data that require research?
      2.2.4. What is the priority to address the identified knowledge gaps?
   2.3. Targeted Decision Making (Processing of Data)
      2.3.1. Provide case study examples of current sensor technology that would illustrate the state-of-the-art?
      2.3.2. What are the current and perceived challenges with collecting data?
      2.3.3. Identify the knowledge gaps with collecting data that require research?
      2.3.4. What is the priority to address the identified knowledge gaps?

3. Summary Observations
   3.1. Identify the top ten overall knowledge gaps that require research?
   3.2. What is the priority to address these identified knowledge gaps?
   3.3. Based on all the discussion, provide any additional case study examples of how SMART buildings relate to fire safety.
   3.4. Provide any additional summary observations not addressed elsewhere.

Figure 6: Questions for Breakout Groups
4) SUMMARY OBSERVATIONS

A review of all the key themes and pertinent points of information that were raised during the workshop were distilled into a set of summary observations. This is based on presentations and discussions that occurred throughout the Workshop, along with supplemental information where referenced in Workshop discussions.

Once identified, the top issues and key observations were separated into logical groupings. Much of this information was distilled from the output from the breakout groups. This has ultimately resulted in the following basic categories of top issues: (1) Education and Training, (2) Enhance Stakeholder Involvement, (3) Technological Barriers, (4) Non-Technical Barriers, and (5) Performance Barriers. Further, the key observations are Relevancy and Next Steps. This is illustrated in Figure 7: Summary of Top Issues and Key Observations.

<table>
<thead>
<tr>
<th>Workshop Top Issues and Key Observations:</th>
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<tbody>
<tr>
<td>• <strong>Top Issues:</strong></td>
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<tr>
<td>– Consider Education and Training: e.g., clarify trends, demonstrate virtues, etc...</td>
</tr>
<tr>
<td>– Enhance Stakeholder Involvement: e.g., IT, data analytics, etc...</td>
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<tr>
<td>– Address Technological Barriers: e.g., wireless technologies, data compression methods, hardware/software interoperability, etc...</td>
</tr>
<tr>
<td>– Address Non-Technical Barriers: e.g., privacy, liability, confidentiality, etc...</td>
</tr>
<tr>
<td>– Clarify Performance Characteristics: Availability, Durability, Maintainability, Operability, Reliability, Stability, etc...</td>
</tr>
<tr>
<td>• <strong>Key Observations:</strong></td>
</tr>
<tr>
<td>– <strong>Relevancy is important:</strong> If we don’t become involved, we will become irrelevant.</td>
</tr>
<tr>
<td>– <strong>Next Steps are needed:</strong> Consider a future Summit to address “Smart Building Technology” and invite all applicable stakeholders.</td>
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</tbody>
</table>

Figure 7: Summary of Top Issues and Key Observations.
The following were the workshop attendees, and the breakout groups to which they participated:

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Organization</th>
<th>Group</th>
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<tr>
<td>Art</td>
<td>Black</td>
<td>Carmel Fire Protection Associates</td>
<td>D</td>
</tr>
<tr>
<td>Patrick</td>
<td>Boyer</td>
<td>State Farm Insurance</td>
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<tr>
<td>Donald</td>
<td>Brighenti</td>
<td>Tyco Safety Products</td>
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<tr>
<td>Shane</td>
<td>Clary</td>
<td>Bay Alarm Company</td>
<td>C</td>
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<td>Thomas</td>
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<tr>
<td>May</td>
<td>Corn</td>
<td>UTRC</td>
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<tr>
<td>Mike</td>
<td>DeVore</td>
<td>State Farm Insurance</td>
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<tr>
<td>Curtis</td>
<td>Donahou</td>
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<tr>
<td>Tommy</td>
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<td>Forcier</td>
<td>American E &amp; I</td>
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<td>Dave</td>
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<td>GSA</td>
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<tr>
<td>Darrell</td>
<td>Franchuk</td>
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<tr>
<td>Wendy</td>
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<td>Sultan</td>
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<td>Eduardo Padilla</td>
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ANNEX B: WORKSHOP POWERPOINT SLIDES

Figure 9: Presentation by Casey Grant (FPRF), Slide Set 1 of 4
Figure 10: Presentation by Casey Grant (FPRF), Slide Set 2 of 4
Figure 11: Presentation by Casey Grant (FPRF), Slide Set 3 of 4
Figure 12: Presentation by Casey Grant (FPRF), Slide Set 4 of 4
Challenges and Technology Plan for Smart Fire Fighting

Kristopher Overholt
Fire Fighting Technology Group
Fire Research Division

Outline
1. Where are we now?
   - Current protocols and implementations
   - Existing systems
   - Sensor and data access
2. Fire service issues
   - Tactics and strategy
   - Smart fire fighting issues
   - Knowledge management and training
3. Smart Fire Fighting at NIST
   - Sensor development
   - Technology characterization
   - Current efforts and technology plan

Where are we now?
1. Where are we now?
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The Internet of Things

Vertical Markets / Silos in CPS

Smart Grid
Smart Healthcare
Smart Transportation
Smart Manufacturing
Smart Fire Fighting

Cyber Physical Systems

Existing Systems

Firefighting
- Radio communications
- Accountability
- NIST standards
- Thermal imaging (Sensors)
- SCBA cylinder pressure
- Firefighter clothing
- Health monitoring

Building
- Fire suppression
- Building energy
- Activity sensing
- BIM

Preparation
- Contingency plan
- Building planning
- Resource management
- Risking transportation
- Research hospital

We have lots of different systems, but are they interoperable? How can we make them work better together?

Figure 13: Presentation by Kris Overholt (NIST), Slide Set 1 of 6
Device Communication Protocols

- **BACnet**: A data communication protocol for Building Automation and Control Networks.
- **LonWorks**: Automation of various automation functions within buildings such as lighting and HVAC.
- **Eigle**: Specification for a suite of high-level communication protocols used to create protocol area networks built from small, low-power digital radios.
- **Wave**: Wireless communications protocol designed for home automation, specifically for remote control applications in residential and light commercial environments.

Sensor and Data Issues

- What additional sensors do we need?
- Need a common communication protocol
  - Device do not talk to one another
  - Devices don’t talk to us
- Unstable field conditions for network
- How to distribute information to firefighters, incident commander, etc.?
- How to store data for statistical purposes?

Fire Service Issues

- Where are we now?
  - Current protocol and interconnection
  - Building systems
  - Systems and infrastructure
- Fire service issues
  - Tactical firefighting issues
  - Knowledge management and training
- Smart Firefighting at NIST
  - Sensor development
  - Technology characterizations
  - System assessment and technology plan

Vertical Markets / Silos in CPS

Overview

Smart firefighting technologies are being developed to address issues related to situational awareness and tactical decision-making on the fireground.

The technology plan for smart firefighting includes the development of sensors for:
1. Firefighters
2. Fire apparatus
3. Building systems

--- Page 22 of 28 ---

Figure 14: Presentation by Kris Overholt (NIST), Slide Set 2 of 6
Figure 15: Presentation by Kris Overholt (NIST), Slide Set 3 of 6
Figure 16: Presentation by Kris Overholt (NIST), Slide Set 4 of 6
Figure 17: Presentation by Kris Overholt (NIST), Slide Set 5 of 6
Smart Fire Fighting at NIST

- Sensor development
  - Smart firefighting
  - Smart apparatus
  - Smart buildings
- Experimental work
  - Bench scale testing
  - National Fire Research Lab
- Full scale Field experiments
- Snapshot of development progress
  - Test space for building/fire/property frameworks
  - Train and educate fire service on new technology

Call for Collaborators

- Building fire alarm systems
- Building fire suppression systems
- Firefighting tactics/operations
- Firefighting gear/tools
- Firefighter/apparatus sensors
- Firefighter education/training
- Data transmission and collection
- Data analysis and visualization
- And others...

Contact

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  www.nist.gov/fire

Figure 18: Presentation by Kris Overholt (NIST), Slide Set 6 of 6
Figure 19: Presentation by Curtis Donahou (Disney), Slide Set 1 of 2
Figure 20: Presentation by Curtis Donahou (Disney), Slide Set 2 of 2