

**Delivering Critical Information for  
Firefighting  
Whenever and Wherever it is Needed**

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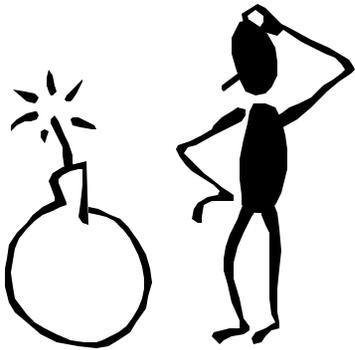
**National Institute of Standards and  
Technology**

**November 28, 2001**

# Background

Fire alarm systems in large buildings in the USA incorporate a display for the fire service:

Location of alarms, device type, sequence



*“... to enable responding personnel to identify the location of a fire quickly and accurately and to indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants ...”*

Located in fire command center or near likely point of entry by the responding fire service.

# The Concerns of the Fire Service



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# Improve Information Transfer

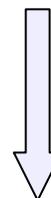
(Focus Groups)

What do you want to know?

When do you want to know it?

Where do you want to know it?

How should it be presented?



## Fire Service Needs



- **At Dispatch**

Confidence in alarm, size and growth rate of the fire



- **On Arrival**

Location of the fire, the occupants, current conditions

How to get to the fire

Staging areas, standpipes, other resource or safety issues



- **During the Incident**

Fire spread and growth, area(s) involved

Systems status, i.e., ventilation

Location of fire fighters

Controls for communications and ventilation

# How To Interpret These Responses

- **Industry Perspective**

- Consortium

- Siemens/Cerberus, Tyco/Simplex, Honeywell/Notifier, SPX/EST, NEMA, NIST

- Develop a Model of Sensors - Current Detectors, then ...

- Conduct Field Demonstrations and Testing

- **NIST Perspective**

- Reliability of the signal (is it a fire?)

- Multimode and dispersed sensors

- How big is the fire (if it is, how soon ...)

- Flashover, backdraft, limits of protective clothing

- Panel display – information wherever it is needed

- NFPA 72 Task Group

- Tactical decision aid

- Impact of ventilation, what happens?

## Premise!

- **Transducers will become common over the next decade because of demand for sensor rich buildings**
- **Improvements in understanding can be made in utilizing the tremendous amount of data that will be available**

## Detection and Alarm

- Low level sensing (early warning)
- High level sensing (fire following)
- Extract threat – heat, smoke, CO ...
- Confirmation through
  - Multiple sensors
  - Feature extraction and modeling
- Display
  - High resolution, Laptop, wireless, beeper

## Technology Components

- Neural nets for alarm notification
- Analog information allows for better decisions
- Mathematical techniques that provide data fusion from multiple sensors
- Scalable technologies that provide prioritized “data-out” service over a wide variety of communication paths
- Display schemes which conform to the new NFPA 72 Chapter 4 guidelines and are accessible over small footprint displays

# A Neural Net to Distinguish Possible from Actual

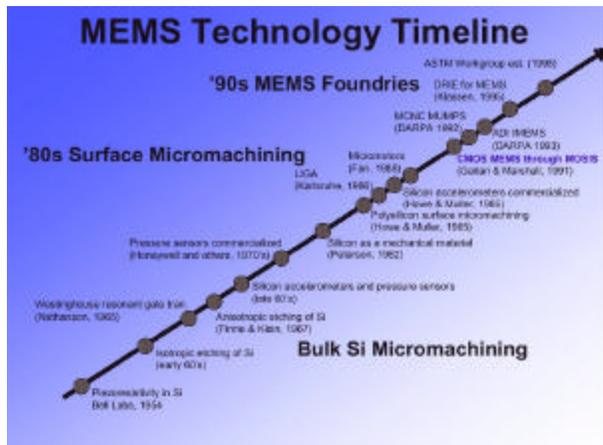
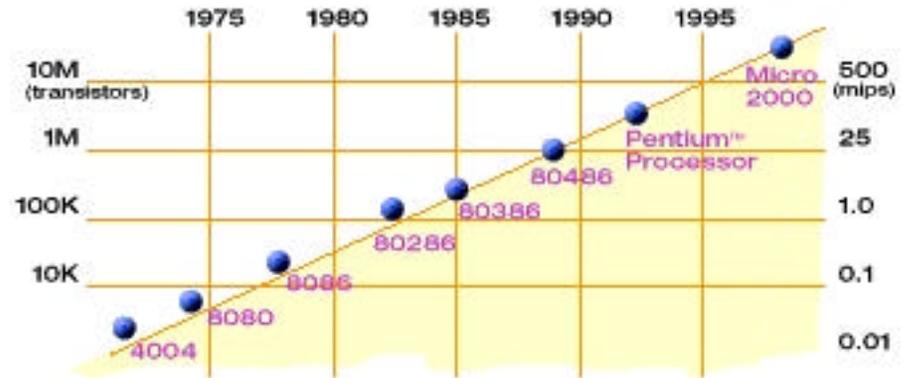


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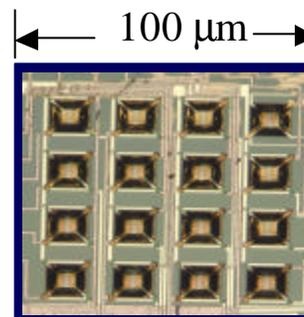
# Enabling Technology

(Cheap and pervasive sensing and computing)

## Moore's Law

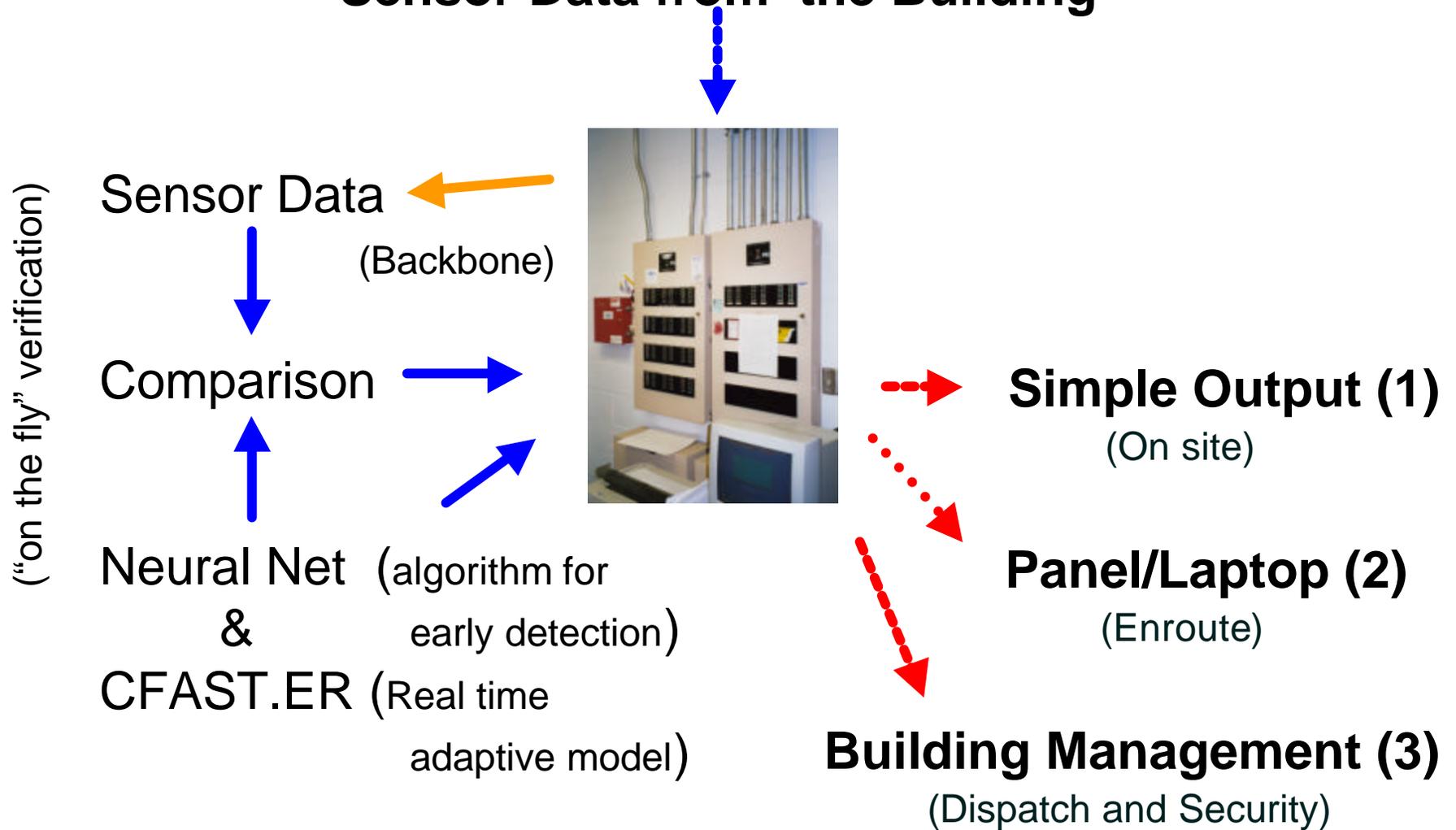


## MEMS (and other) transducers

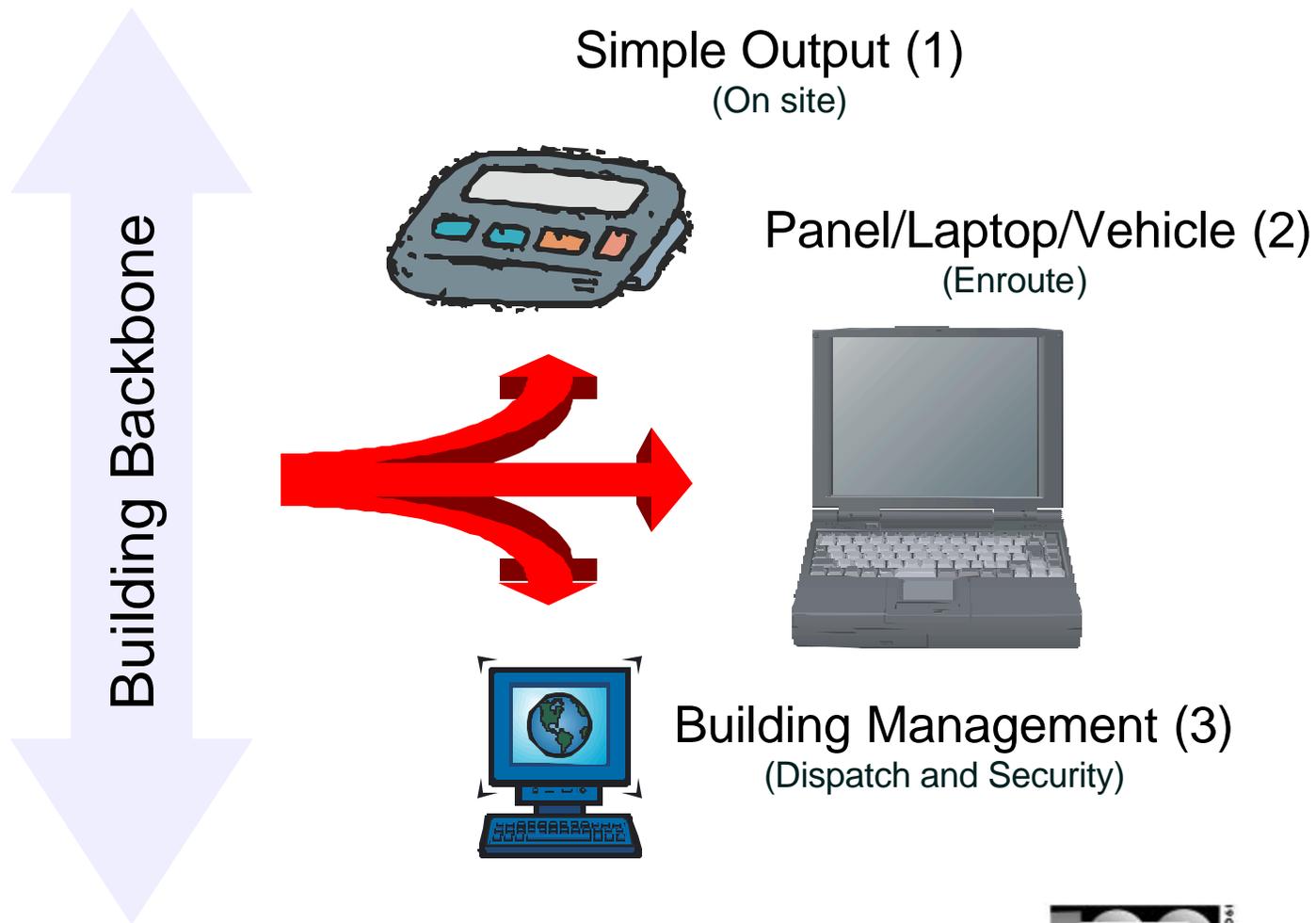


## Microchemical Arrays

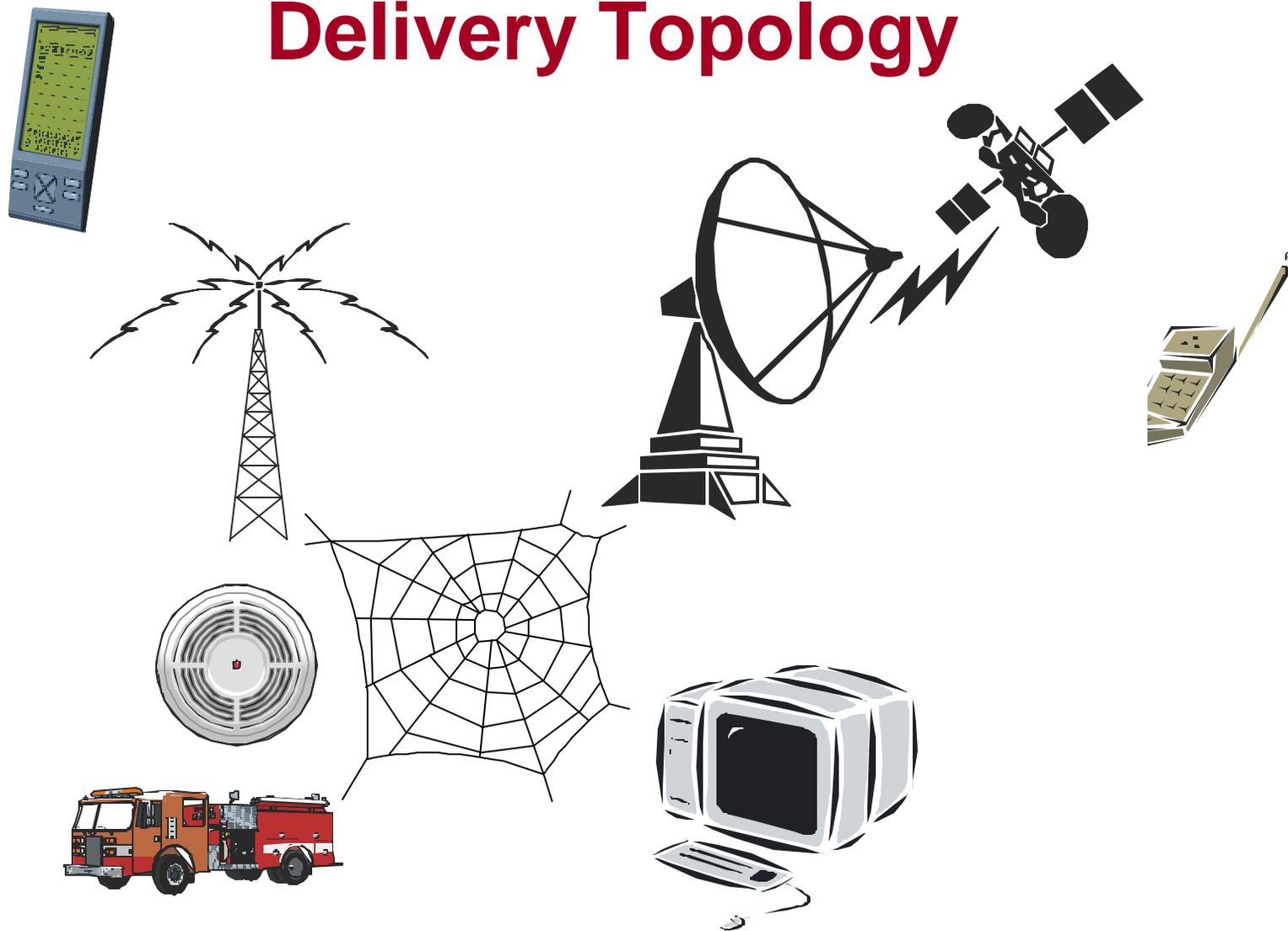
## Sensor Data from the Building



# Pathways of Deployment



# Delivery Topology



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# Delivery of Information – Examples

Layer

- **Building Management**  
Building security, fire station, ...



3

- **Panel/Laptop**  
Laptop “in vehicles”  
Building enunciator panel



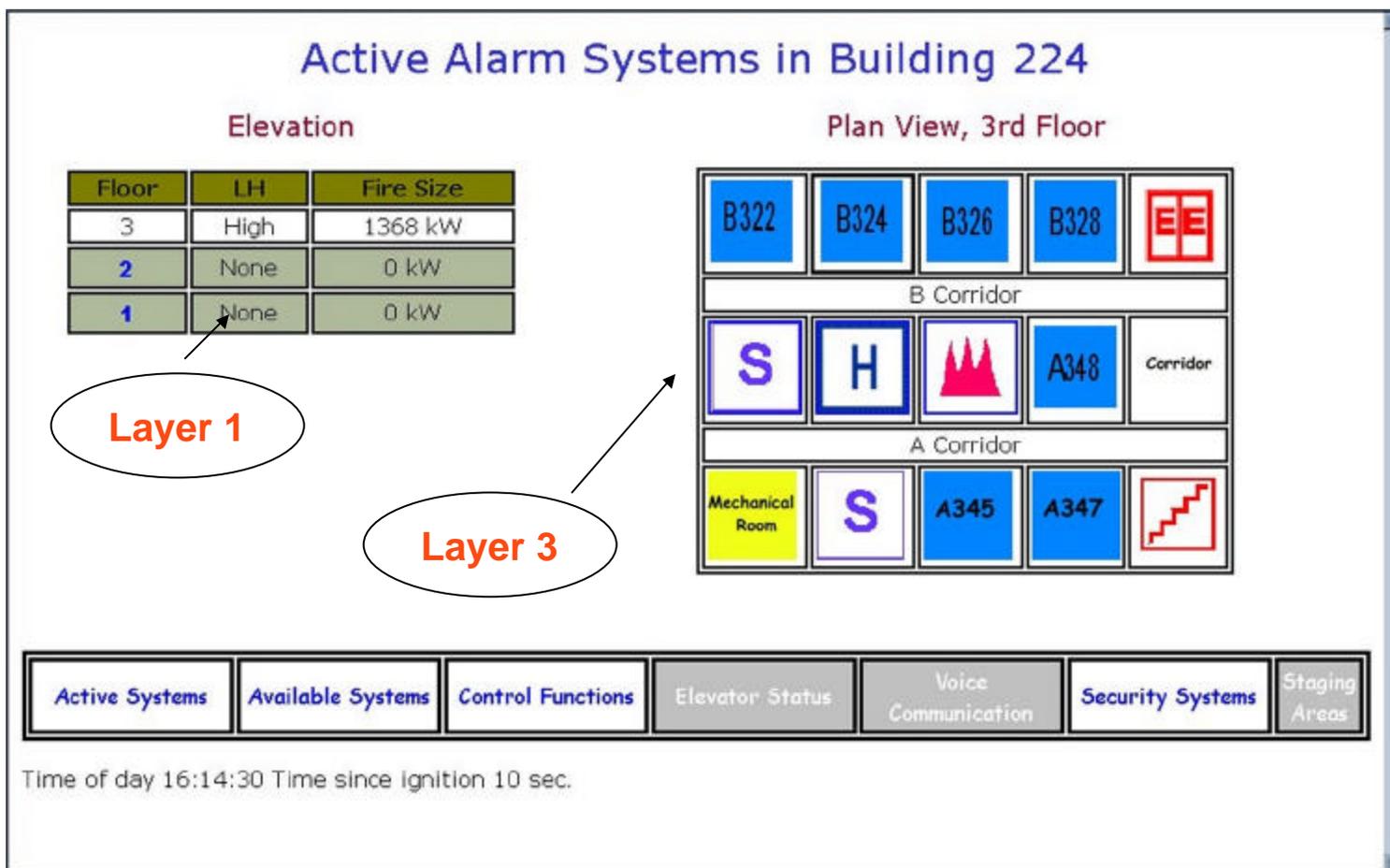
2

- **Simple Display**  
Handheld device

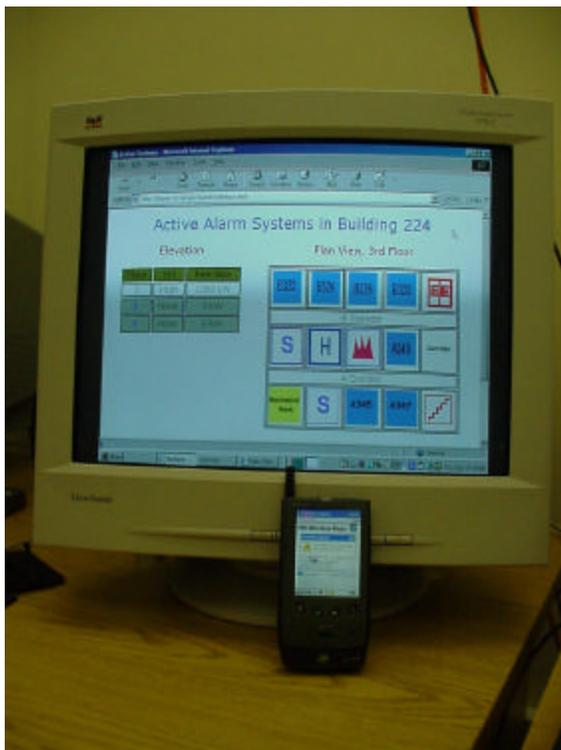


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# Implementation of Layers One and Three



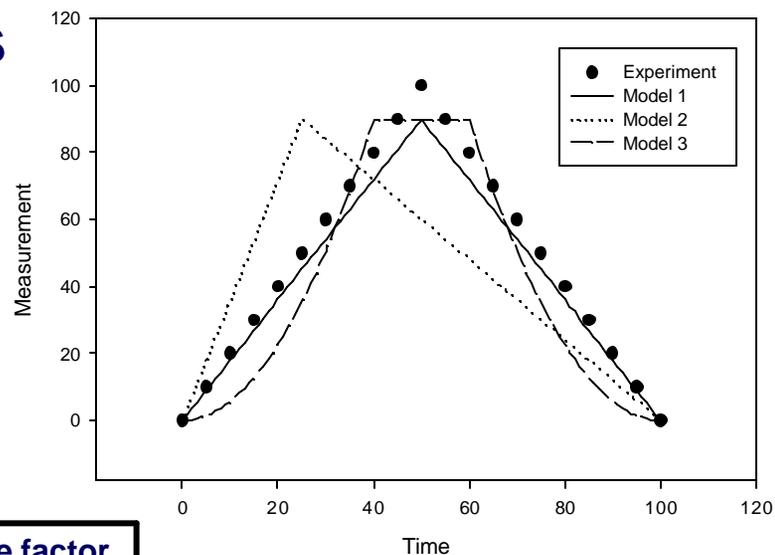
# Examples of Display Technologies



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# Reliability of the Signal

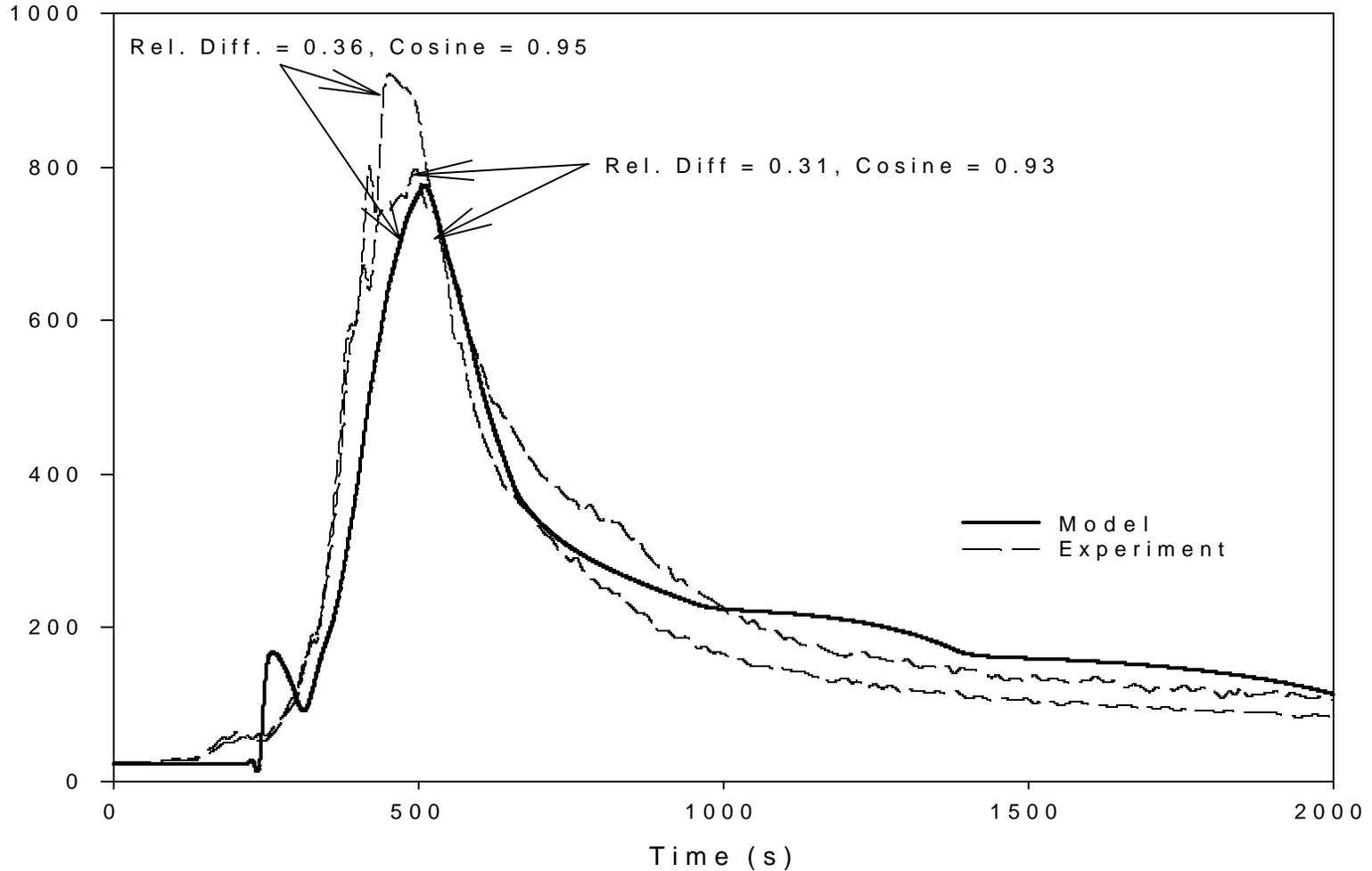
- **Method to compare curves**  
Shape matching
- **Metric for the difference**  
Deviation of curves



Geometry		Relative Difference	Shape factor (cosine)
Euclidean	1	0.1	1.0
	2	0.4	0.92
	3	0.2	0.98

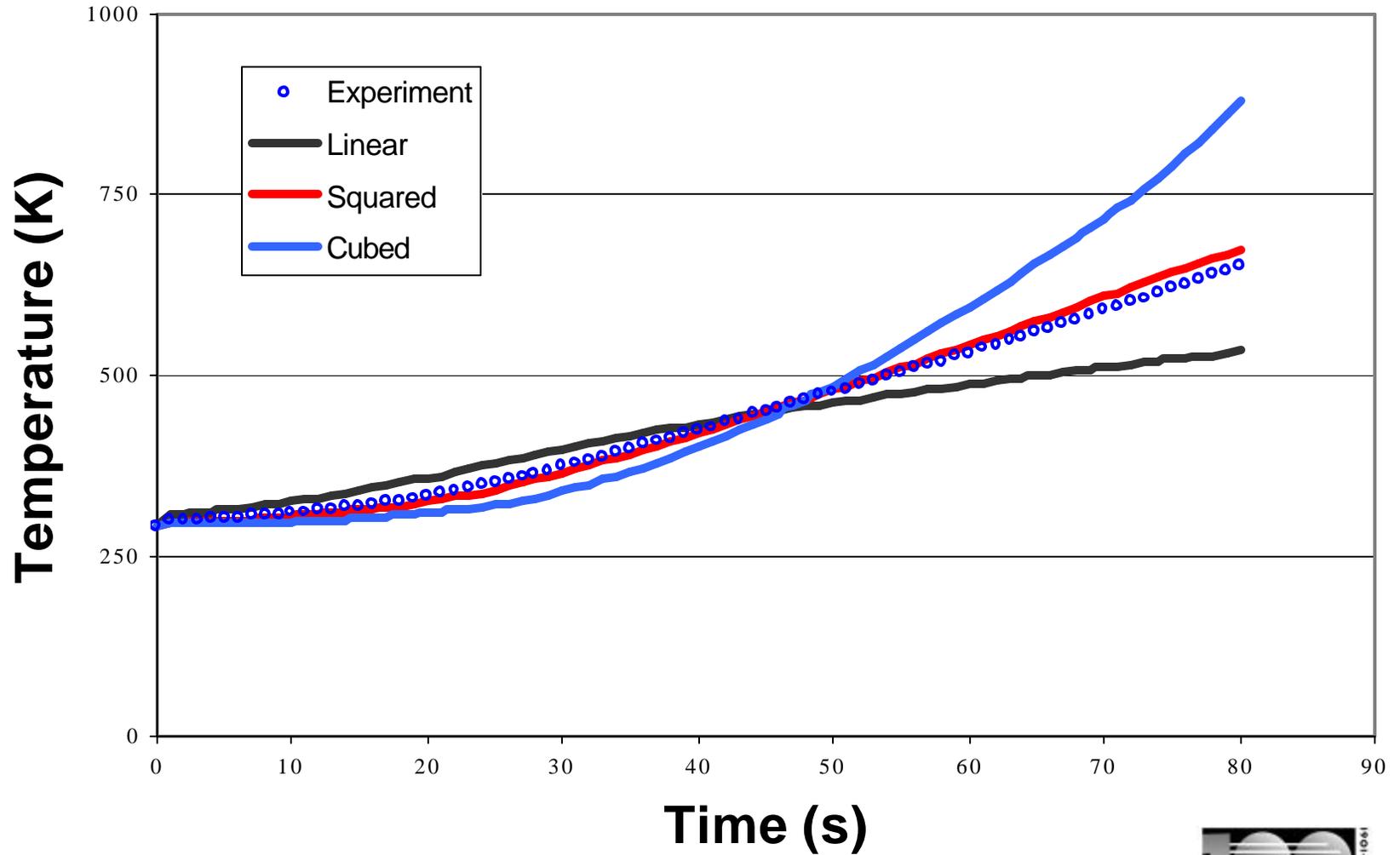
# One of our real room comparisons

Temperature Prediction for a single room



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# Using Sensor History to Predict Future Conditions



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## What does it look like now?

- This is an example of what the system might look like.

# Prototype symbology for the various components of the building system

			
<p>Smoke Detector</p>	<p>Heat Detector</p>	<p>Fire</p>	<p>Sprinkler</p>

**21 proposed at the moment - Usability issues remain**

# The Layout in Building 224

Outside	Corridor	Experiment
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# Example of Available Systems

The screenshot shows a Netscape browser window titled "Available Systems" with a timestamp of 8/24/2000 - 11:12 AM. The address bar shows the URL "file:///panel/ava/E.html". The main content area is titled "Available Systems" in green text. It features three main sections: "Special Equipment", "Building 224 Elevation", and "Building 224, 3rd Floor".

The "Special Equipment" section contains a 2x2 grid of icons: top-left is 'H', top-right is 'S', bottom-left is a blue circle with a vertical line, and bottom-right is a blue triangle pointing right.

The "Building 224, 3rd Floor" section contains a detailed grid of system status indicators. At the top is a row of five boxes: four with 'H' and one with 'S' and a red square. Below this is a section labeled "B Corridor" with a row of six boxes: 'H S', 'H S', 'H S', and three empty boxes. Below that is a section labeled "A Corridor" with a row of six boxes: 'S' with a yellow background, 'S' with a red diagonal line, 'H', 'H', 'S', and 'S' with a red diagonal line.

At the bottom of the main content area, there is a navigation bar with six tabs: "Active Systems", "Available Systems" (which is selected), "Elevator Status", "Voice Communication", "Building Security", and "Staging Areas". Below the tabs, the text "Current time : 11:12 AM" is displayed.

# Example of Active Systems

Active Systems - Netscape 8/23/2000 - 03:32 PM

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: file:///I:/panel/active3.html02f3.html

## Active Systems

### Special Equipment

**Camera in A 346**



### Building 224 Elevation

Floor	Fire Size
3	NA
2	NA
1	NA

### Building 224, 3rd Floor

B322	B324	B326	B328	EE
B Corridor				
A342	A344	A346	A348	Corridor
A Corridor				
Mechanical Room		A345	A347	

Active Systems
Available Systems
Elevator Status
Voice Communication
Building Security
Staging Areas

Current time : 3:32 PM

Document Done

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# Example of Active Systems (30 seconds)

Active Systems - Netscape 8/23/2000 - 04:21 PM

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: file:///panel/active3.html

## Active Systems

### Special Equipment

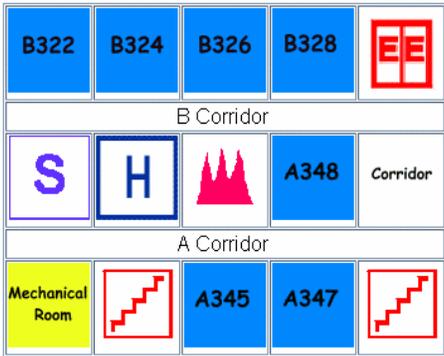
**Camera in A 346**



### Building 224 Elevation

Floor	Fire Size
3	1953
2	NA
1	NA

### Building 224, 3rd Floor



Active Systems
Available Systems
Elevator Status
Voice Communication
Building Security
Staging Areas

Current time : 4:20 PM

Document: Done

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## Initial fire ~ 20 kW



Click the picture to see the initial fire

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## Active Systems

### Special Equipment

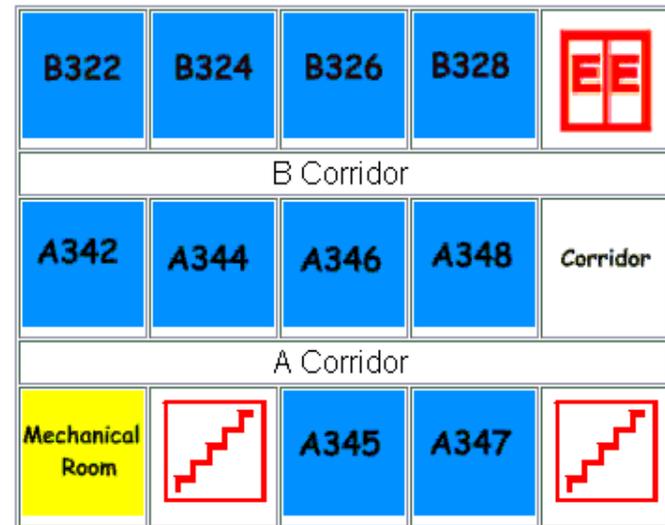
### Building 224 Elevation

### Building 224, 3rd Floor

#### Camera in A 346



Floor	Fire Size
<b>3</b>	NA
<b>2</b>	NA
<b>1</b>	NA



Active Systems	Available Systems	Elevator Status	Voice Communication	Building Security	Staging Areas
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Current time : 3:32 PM

## Full Scale Demonstrations

- **Important part of the project is “buy-in” from the fire service – does it work in the real world**  
Do through full scale demonstrations, press briefings, fire service involvement
- **First will be at NIST – February through March, 2001**  
CPSC, Toxicity, Fire Service Demo
- **Next will be in New Castle County, Delaware**  
Reverse role – EMT to provider
- **Prototype for a traveling show**

# County Municipal Office Building New Castle, Delaware



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# This is the Difficulty



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## Why is this high reliability?

- **Information gathering is redundant**
- **Information can be shared by many**  
Wired, Wireless, Standard protocols
- **Validated algorithm for high likely-hood**
- **Metric for assured signal**
- **Actual threat**  
Insult to people or structure (T, CO, ...)
- **Confirmation thru data fusion**  
From a single sensor to 10 000 sensors (NIST)

## Why is this important?

**High reliability implies all *relevant* information is available when needed**

Information gathering is redundant  
More information \* Better decisions

**Common display format**

Wider use \* safer buildings  
Information can be shared by many \* Wired, Wireless

**Metric for reliability**

Validated algorithm for high likely-hood  
“If you cannot measure it, you don’t understand it” (Lord Kelvin)

**Actual threat**

Insult to people or structure (T, CO, ...)



## 72 Task Group

**Scalable, Stylus, Icons, Inclusive, Intuitive**

### **Working groups on**

Icons (Usability, Color, Scaling )

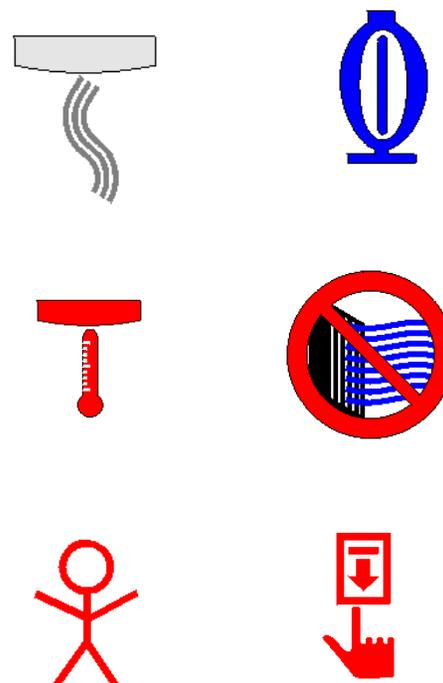
Control functions

Information and presentation

For code cycle 2002, first as an appendix to NFPA 72

# Illustrative Icons

- Drawn from Japanese standard and NFPA 170 symbols
- Must represent three states
  - Function not present
  - Function present and not active
  - Function present and active



Prototype Icons

Alarm		Stairwell (all ratings)		Occupant	
Emergency Connection		Fire Department Key Box		Sprinkler	
Exhaust Fan		Fire Pump		Smoke Vent	
Exhaust Outlet		Fire Department Connection		Shutoff (W, E, G)	
Siamese Connection		Extinguishing System (i.e. CO <sub>2</sub> and Halon)		Water Mist Sprinkler	
High Pressure Gas		Egress in Progress		Electrical Room	
Manual Pull Station		Emergency Phone		Fire Service Access Point	
Smoke Detector		Fire		Elevator Equipment Room	
Standpipe		Gas Detector		Heat Detector	

27 proposed at the moment - Usability issues remain

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## Control Functions

- Emergency voice communications
  - Zone, group, all call
- Query sensors (incl. those not in alarm)
- Manual ventilation control (stairways)
- Elevators? (status of recall only?)

# Guide for Presentation and Information

Somewhat intuitive (some training)

Consistent

Available in building, outside, in vehicles, handheld, ...

Familiar

Caution about color blindness

# Presentation and Information

- Multiple windows
- Diagrams vs. drawings
- Analog gauges with “normal range”
- Primary vs. secondary information
  - Automatic display vs. display on demand
- Place holder for fire fighter locator

## **Benefit**

- **Timely**
- **Information appropriate to person and display**
- **Information available anytime, anywhere**
- **Allows measured response, escalation of notification**

## Conclusions

- It is important to improve information delivery systems as building protection moves from passive to active
- A standard interface will drive user demand
- Standard systems allow interconnect and thus a great deal of end-user appeal
- We are progressing as per our plan, moving into full scale