NFPA 72-2010
Fire Alarm Code
Mass Notification System Design Overview

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Learning Objectives

- Identify the components of a mass notification system
- Develop criteria identifying acoustically distinguishable spaces
- Understand the components of a fault-tolerant system design
- Recognize the importance of performing intelligibility testing.

Evolution of NFPA 72

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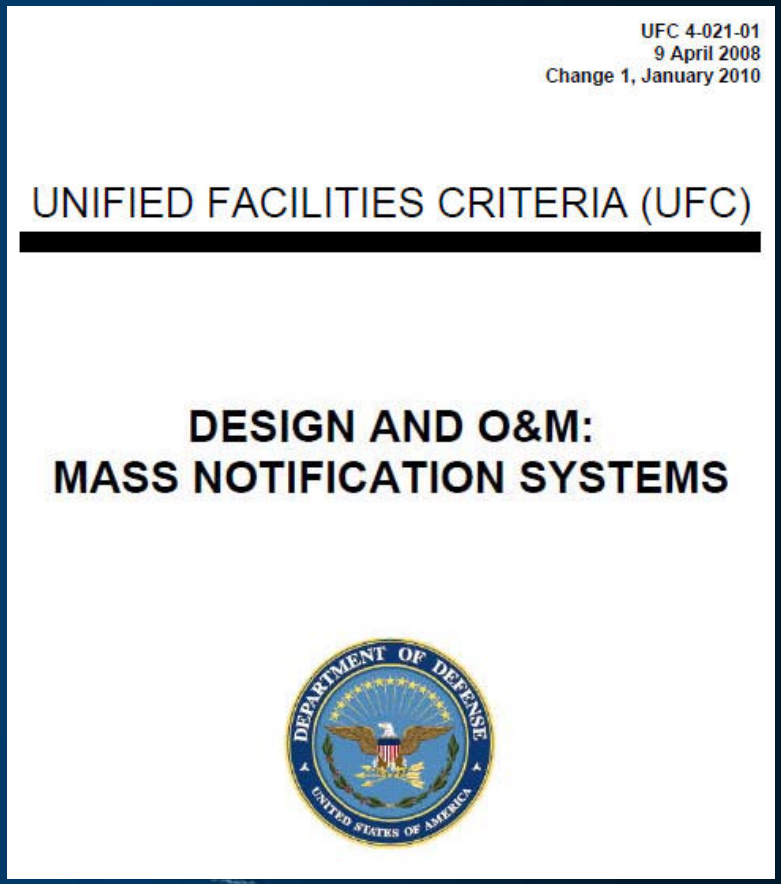
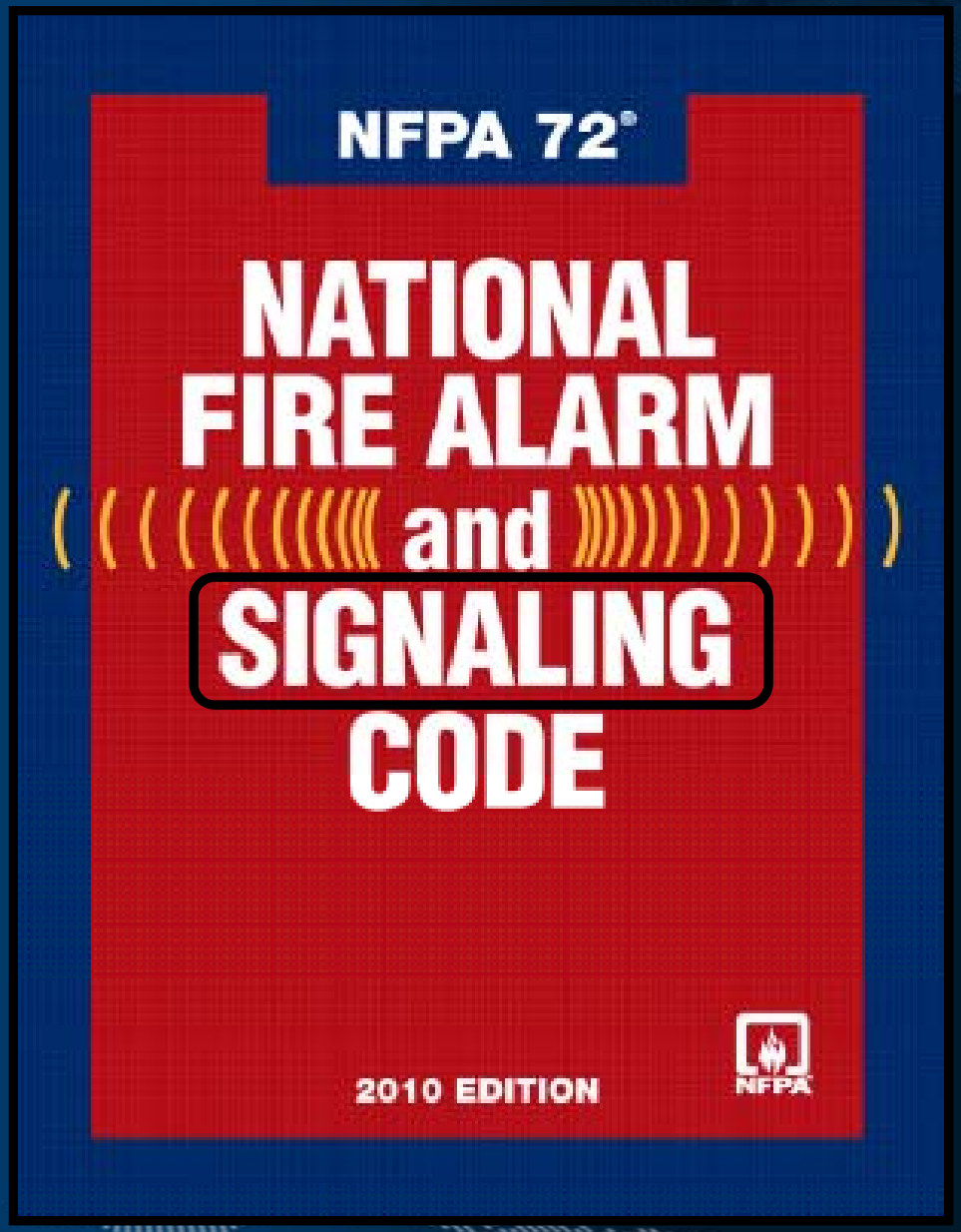
The Need for Emergency Communications Systems
Initiated by Air Force Civil Engineering petition to NFPA in 2003




NFPA 72®
NATIONAL
FIRE ALARM
and
SIGNALING
CODE
2010 EDITION
NFPA

The Changing Role of NFPA 72

- 72-2007: National Fire Alarm Code

- 72-2010: National Fire Alarm and Signaling Code

- The word “fire” is being removed from the code whenever possible:
  - Fundamentals of ~~Fire~~ Alarm Systems
  - Alarm signals initiated by manual ~~fire~~ alarm boxes, automatic ~~fire~~ detectors …

Emergency Communications Systems

- Give incident-specific guidance to those in danger as to the best course of action on an area-by-area basis:
  - Fire
  - Natural disasters, weather
  - Shooters
  - Terrorist events
  - Weapons of Mass Destruction
    - NBC
      - Nuclear, biological, chemical
    - BNICE
      - +Incendiary and explosive
    - CBRNE
      - All of the above

Focus of this Presentation

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- Review the design issues related to integrating a public address system with a fire alarm system to meet the requirements of NFPA 72-2010

- Design Team Integration
- Acoustics
- Audio system design
- Cabling and cabling pathways
- Acceptance testing

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MNS Design Components

- Acoustics
- Speaker selection and coverage area
- Cabling infrastructure
- Equipment selection for
    - Reliability
    - Redundancy
    - Fault-tolerance
    - Availability
    - Survivability
- Primary and backup power

Mass Notification Systems

- At this time mass notification systems are not required by any building code or by the NFPA 101 Life Safety Code

- However, MNS may be required by specific local, county, state, or federal codes, laws, regulations or statutes or organizational mandates

Design Team Integration

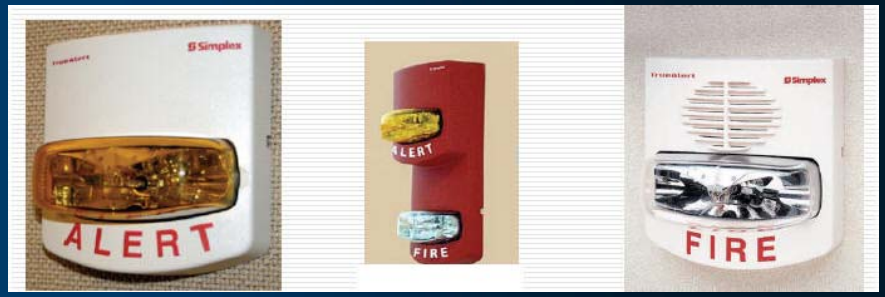
NFPA 72-2010 Mass Notification Systems

- System design by " … a professional certified or approved by the authority having jurisdiction".

- Will require an integrated team of design professionals:
  - ✓ acousticians
  - ✓ fire alarm
  - ✓ security
  - ✓ audiovisual systems
  - ✓ information technology

MNS Uses

- Fire alarm system my be used for “Ancillary Functions”
- For the first time, a mass notification system (voice announcements) may override a fire alarm system’s visual and audible devices



MNS Risk Analysis

- Consider both fire and non-fire events
- Event probability
- Event frequency
- Event consequences
- Available response time
- Available resources
- Ability to gather, analyze, and synthesize data in real-time in order to determine the best response to an incident

A Layered Approach to MNS

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Person

Room/Floor/Wing

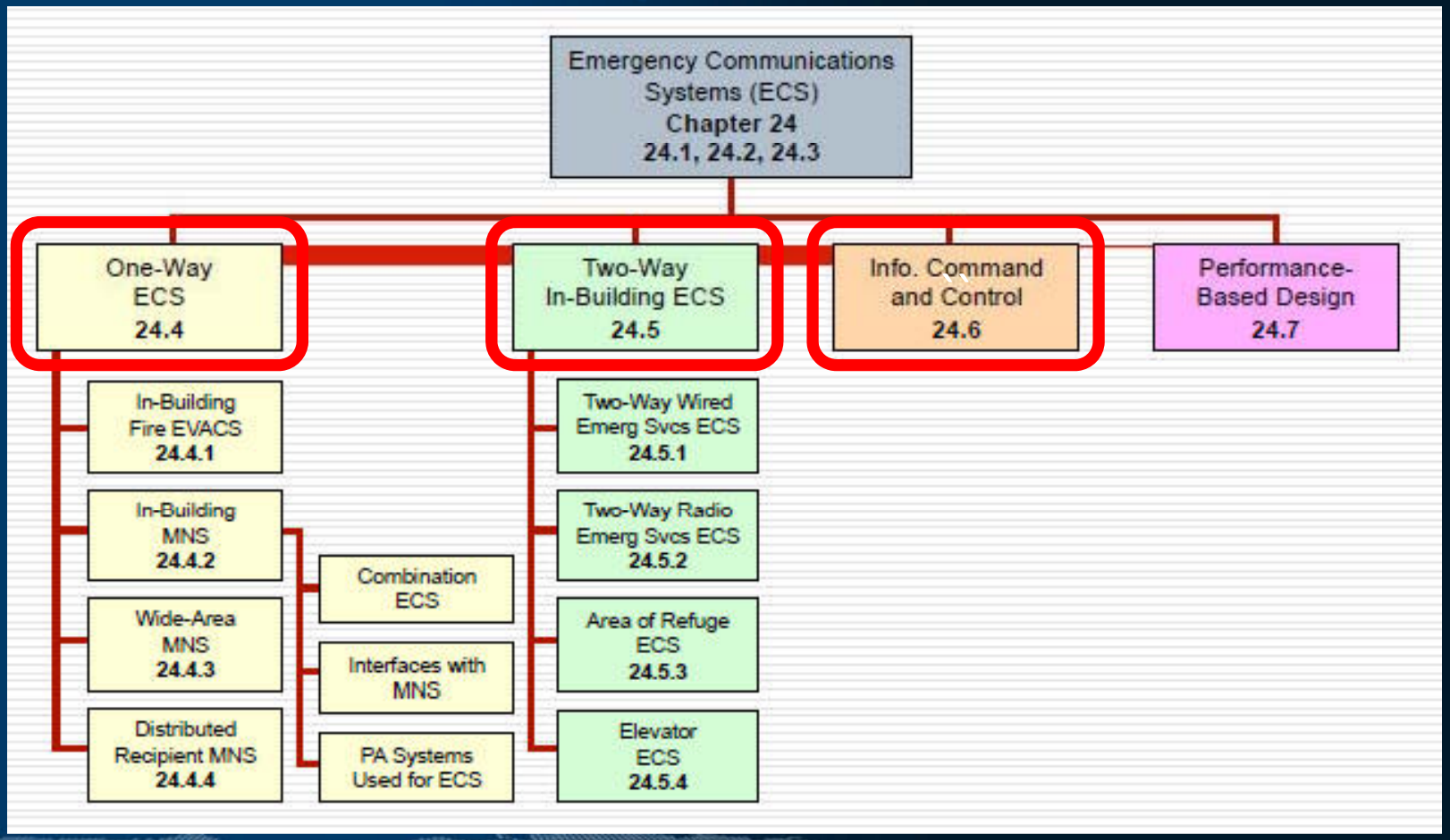
Adjacencies

Exterior
High Power
Speaker
Arrays
“Giant Voice”

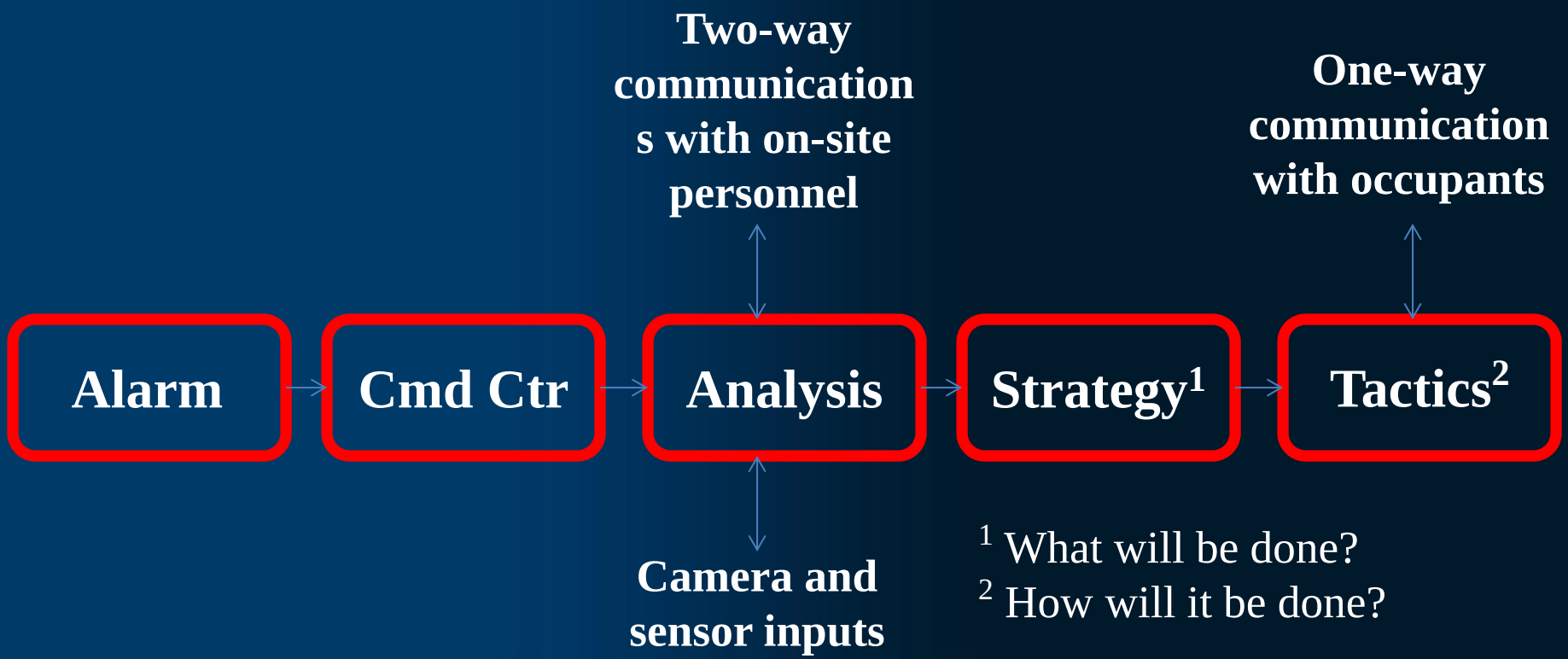
A verbal MNS is Part of Emergency Communications System Strategy

- Intelligible Voice Communications
- Visible Signals (e.g., strobes)
- Text (e.g., reader boards)
- Graphics (e.g., digital signage)
- Radio, cell phone, FAX, text messages, phone

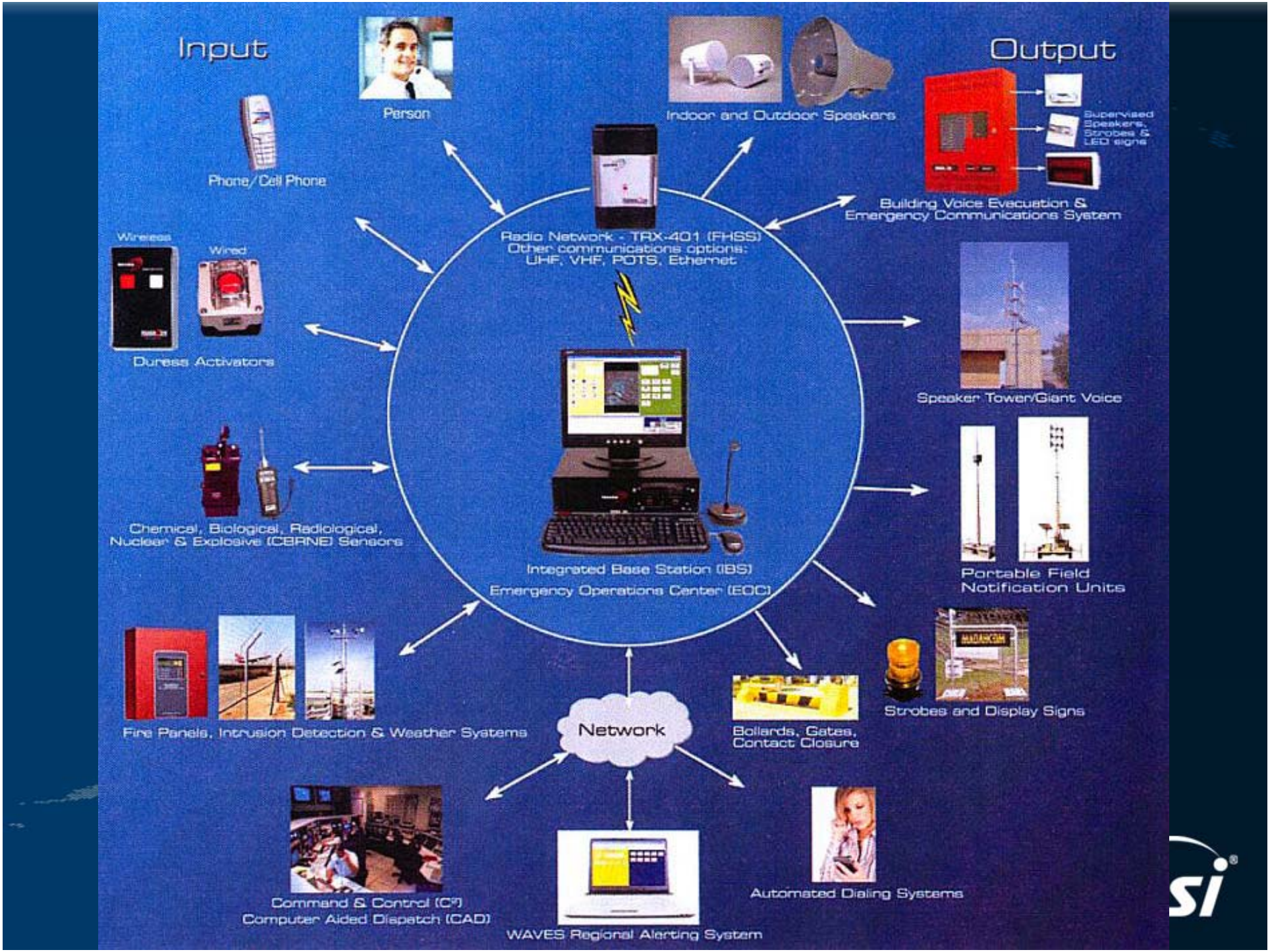
NFPA 72-2010 ECS Components



NFPA 72-2010 ECS Components



[1] What will be done?
[2] How will it be done?


Input
Person
Phone/Cell Phone
Wireless
Wired
Duress Activators
Chemical, Biological, Radiological, Nuclear & Explosive (CBRNE) Sensors
Fire Panels, Intrusion Detection & Weather Systems
Command & Control (C²)
Computer Aided Dispatch (CAD)
WAVES Regional Alerting System
Automated Dialing Systems
Network
Bollards, Gates, Contact Closure
Strobes and Display Signs
Portable Field Notification Units
Speaker Tower/Giant Voice
Output
Indoor and Outdoor Speakers
Supervised Speakers, Strobes & LED signs
Building Voice Evacuation & Emergency Communications System
Radio Network - TRX-401 (FHSS)
Other communications options:
UHF, VHF, POTS, Ethernet
Integrated Base Station (IBS)
Emergency Operations Center (EOC)

Acoustics

NFPA 72-2010 Mass Notification Systems

- Performance-based standard

- Identify Acoustically Distinguishable Spaces
  - areas (> 400 SF) requiring customized design to meet *intelligibility* requirements because of unique acoustic, environmental or use characteristics – for example:

❑ reverberation time
❑ background noise level

- *Some spaces may not need or be able to meet intelligibility requirements*

- **Emphasis on making sure announcements are effective in a given area's acoustic environment**

- ***Intelligibility*** **(per NFPA 72):** ***capable of being understood, comprehensible and clear***

Within the acoustically distinguishable spaces (ADS) where voice intelligibility is required, voice communications systems shall reproduce:

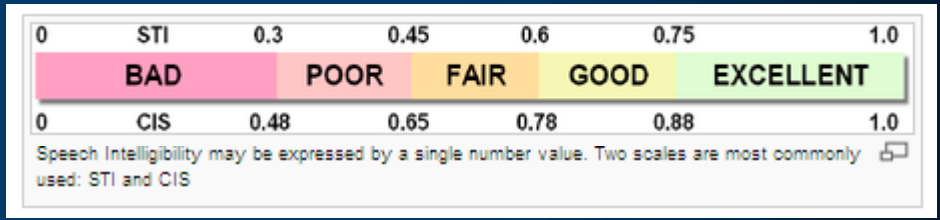
- **prerecorded**
- **synthesized**
- **or live (e.g., microphone, telephone handset, and radio) messages *with voice intelligibility***

Intelligibility Testing

- Signal-to-Noise Ratio
  - voice announcement should average 15 dB over ambient
- Frequency Range
  - 400 – 4,000 Hz (per UL)
  - Very similar to Bell Labs criteria for telephony
  - Designed to allow reliable speech and speaker recognition

Intelligibility Testing

Speech Transmission Index (STI)
Common Intelligibility Scale (CIS)



- 90% of measurements must have a
- measured STI of not less than 0.45 (0.65 CIS)
- average STI of not less than 0.50 (0.70 CIS)

(military services require higher values)

Intelligibility Testing

- Distortion
  - Average person can detect 2% distortion
  - >15% distortion considered non-intelligible
  - UL allows 20% distortion between 710 Hz and 3,550 Hz

- Assumes messages are in the listener's native language and using words that are know to the listener
- Assumes normal hearing
- Granularity of messaging
- Standardized messaging
  - Names and places
  - Transients and visitors

NFPA 72-2010 Mass Notification Systems

- Intelligibility design criteria is now in Chapters 18 and 24

- However, intelligibility testing criteria is located in Appendix D

  ► Therefore, intelligibility testing is not required.

Case Study

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Pennsylvania Convention Center
Mass Notification System Case Study

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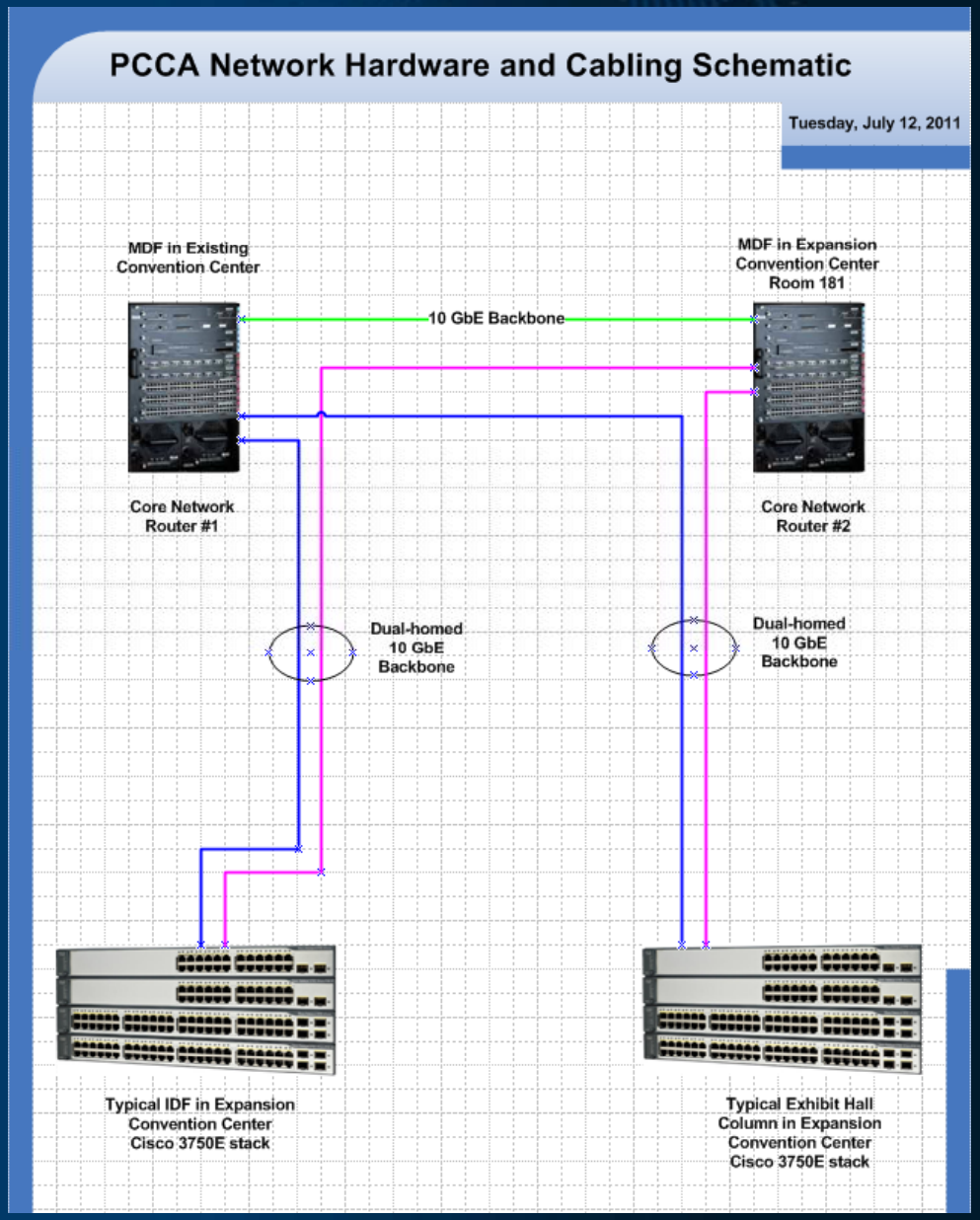
Project Description

- Overall size is approximately 935,000 G.S.F
- 358,000 GSF of meeting room, exhibit hall and ballroom space
- “Technology Design Team” began work in June 2009.

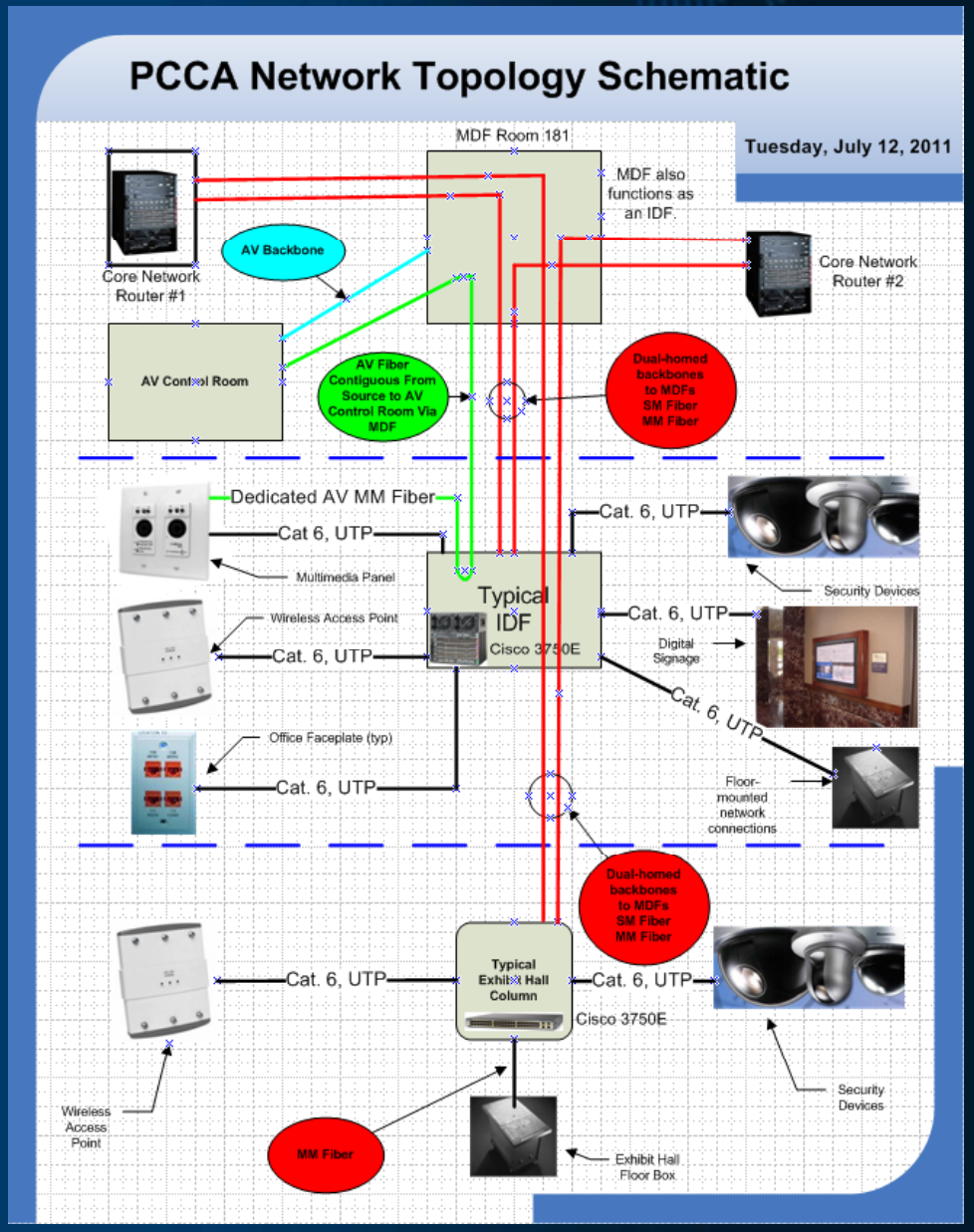
Project Objectives

- Flexible Spaces
  - Reconfigurable / Divisible spaces
  - Support current and emerging technologies
  - Interconnect via network and/or dedicated fiber cabling
- Cost Effective Upgrades/Changes
  - Design based on data network - allowed expansion and re-configuration using existing infrastructure
  - Digital Signal Processor (DSP) audio system can be modified via centralized software

Converged Network Design



Converged Network Design



Audiovisual System Objectives

- House (building-wide) Sound System
  - Interface with existing convention center systems
  - Used for general-purpose paging
  - Speakers connected in A-B-A-B … sequence
  - Emergency Voice Notification with fire alarm interface
  - System health monitoring
    - 19 KHz pilot tone monitors speakers and wiring
    - 3:00 a.m. pink noise test to monitor audio volume

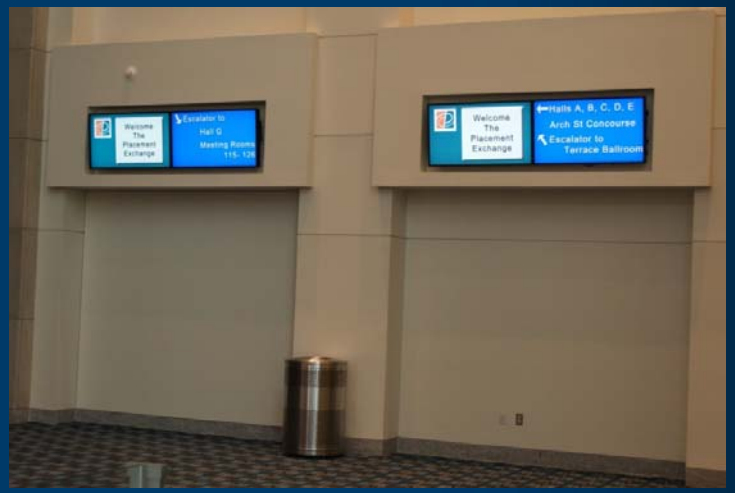
Audiovisual System Objectives

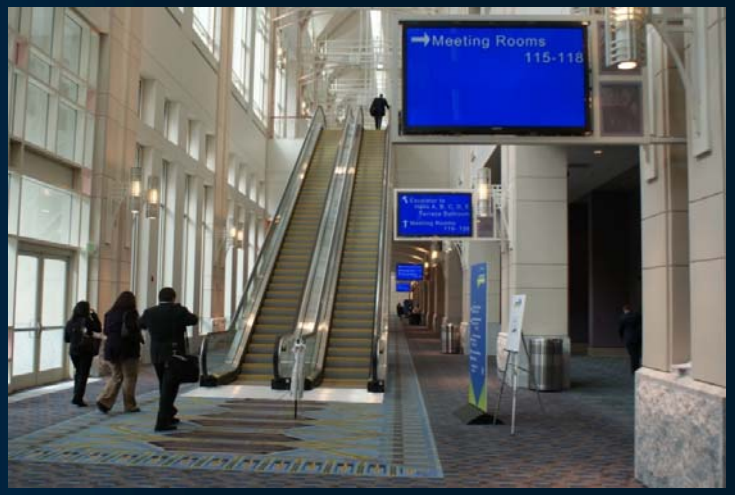
- House (building-wide) Sound System
  - Amplifiers with built-in health monitoring
  - Automatic fail-over
  - Spatial diversity
    - Existing building
    - Expansion building
  - Sound system provided with its own dedicated UPS power to support 15 minutes of operation without primary or backup power

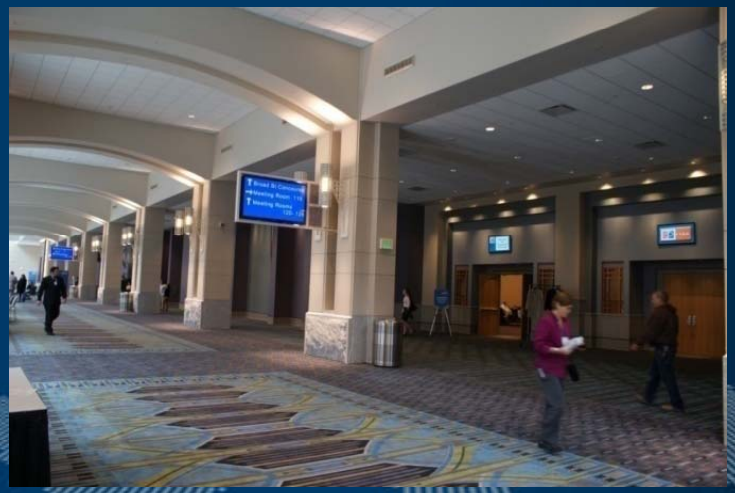
Audiovisual System Objectives

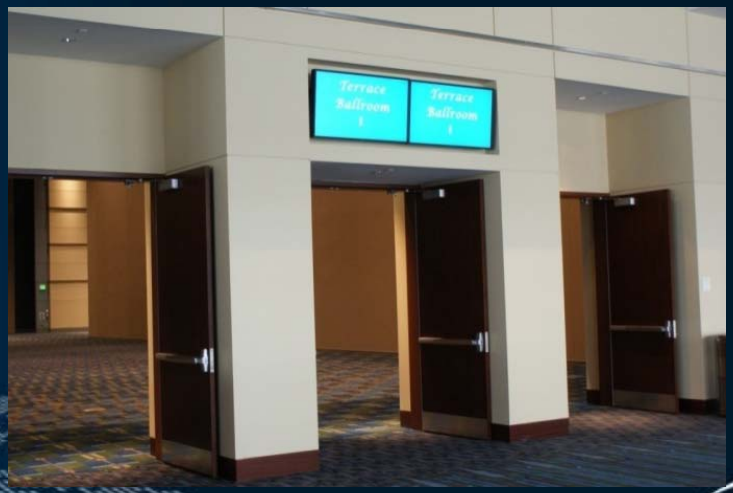
- Digital Signage
  - Expansion of existing network-based digital media system
  - Local digital media player (DMP) at each display
  - 46” – 65” flat panel displays
  - Emergency information and exiting maps
  - Way-finding and event scheduling data
  - Live event video streaming
  - Large Feature Wall in Atrium

Audiovisual System Objectives









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Audiovisual System Objectives

- House Sound System (general purpose paging)
  - Zone control via AV control system
  - Announcements from AV master control room and Fire Command Center
  - Network-based paging stations for exhibit halls

Audiovisual System Objectives

- House Sound System (general purpose paging)
  - Emergency Voice Evacuation
  - Audio and logic interface with fire alarm control
  - Dedicated audio Ethernet backbone
  - Armored fiber optic cable
  - Redundant audio network Ethernet switches

Audiovisual System Objectives

- Alarm Response Protocol

  Alarm condition transmitted to Fire Alarm Control

  no visual or audible alarms transmitted for up to 2 minutes

  Security cameras reviewed

  Staff dispatched to alarm location

  Automatic pre-recorded visual and audible alarms 2 minutes after receipt of alarm if not cancelled or overridden by voice announcements

Audiovisual System Objectives

NFPA 72 Ch 10 Requirement	Description/Excerpt	Comparable Design Feature
10.6.3 Power Supply Sources	At least two independent and reliable power supplies shall be provide, one primary and one secondary	COMPARABLE - Primary power is utility power, provided via dedicated branch circuit to the sound system equipment. Secondary power supply is standby power generators, with 15 minutes of dedicated uninterruptible power supply (UPS).
10.17.1 Monitoring Integrity of Installation Conductors and other Signaling Channels	All means of interconnecting equipment, devices, and appliances and wiring connections shall be monitored for the integrity of the interconnecting conductors or equivalent path	COMPARABLE - All speaker zones including wiring and loudspeakers will be supervised by a load impedance monitoring system integral to the sound system. This monitoring system will verify the integrity of the conductors and loudspeakers every time a signal is present.
		Use of a low level pilot tone in the upper range of the audible spectrum, e.g. 19kHz, generated internally on a continuous or scheduled interval (as required), will ensure the system integrity during periods of operational inactivity. Detection of loss of integrity will be indicated via contact closure as a trouble signal to the fire alarm system.
10.17.2 Monitoring Integrity of Emergency Voice/Alarm Communications Systems	Failure of any audio amplifier shall result in a trouble signal.	COMPARABLE/EXCEEDS – All amplifiers are designed for redundancy; that is; each audio amplifier circuit includes a primary amplifier and a secondary or backup amplifier. In the event of failure of a primary amplifier, the backup amplifier will immediately and automatically be placed in service. In addition, failure of an amplifier will be indicated via contact closure as a trouble signal to the fire alarm system.
10.17.3 Monitoring Integrity of Power Supplies	All primary and secondary power supplies shall be monitored for the presence of voltage at the point of connection to the system.	COMPARABLE – Sound system control processor will monitor power sources and loss of primary or secondary source will be indicated via contact closure as a trouble signal to the fire alarm system.

Emergency Voice Evacuation

Project success required team approach: owner, architect, technology design team, fire alarm manufacturer, and audio system manufacturer

Applied for and received variance from AHJ

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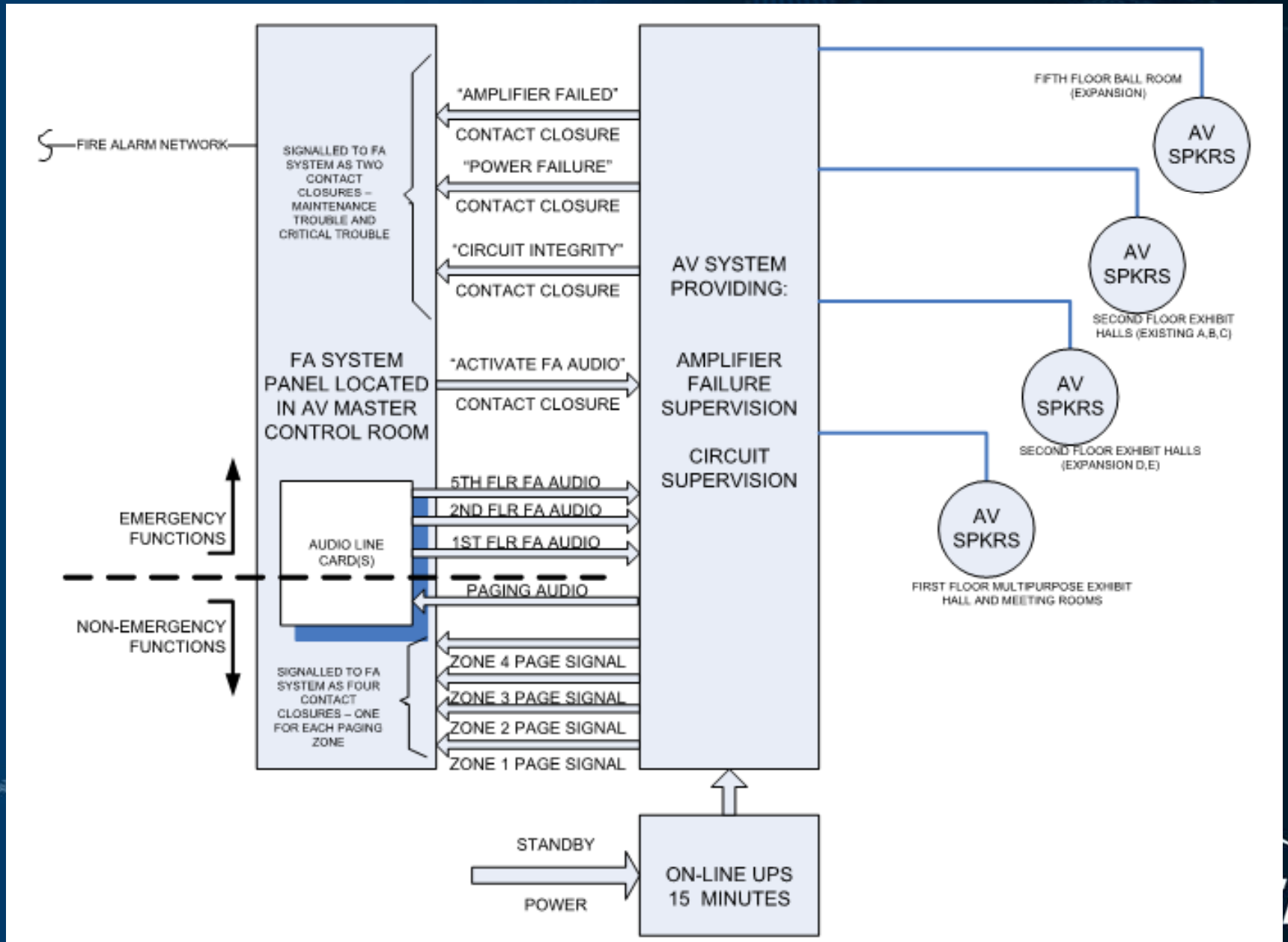
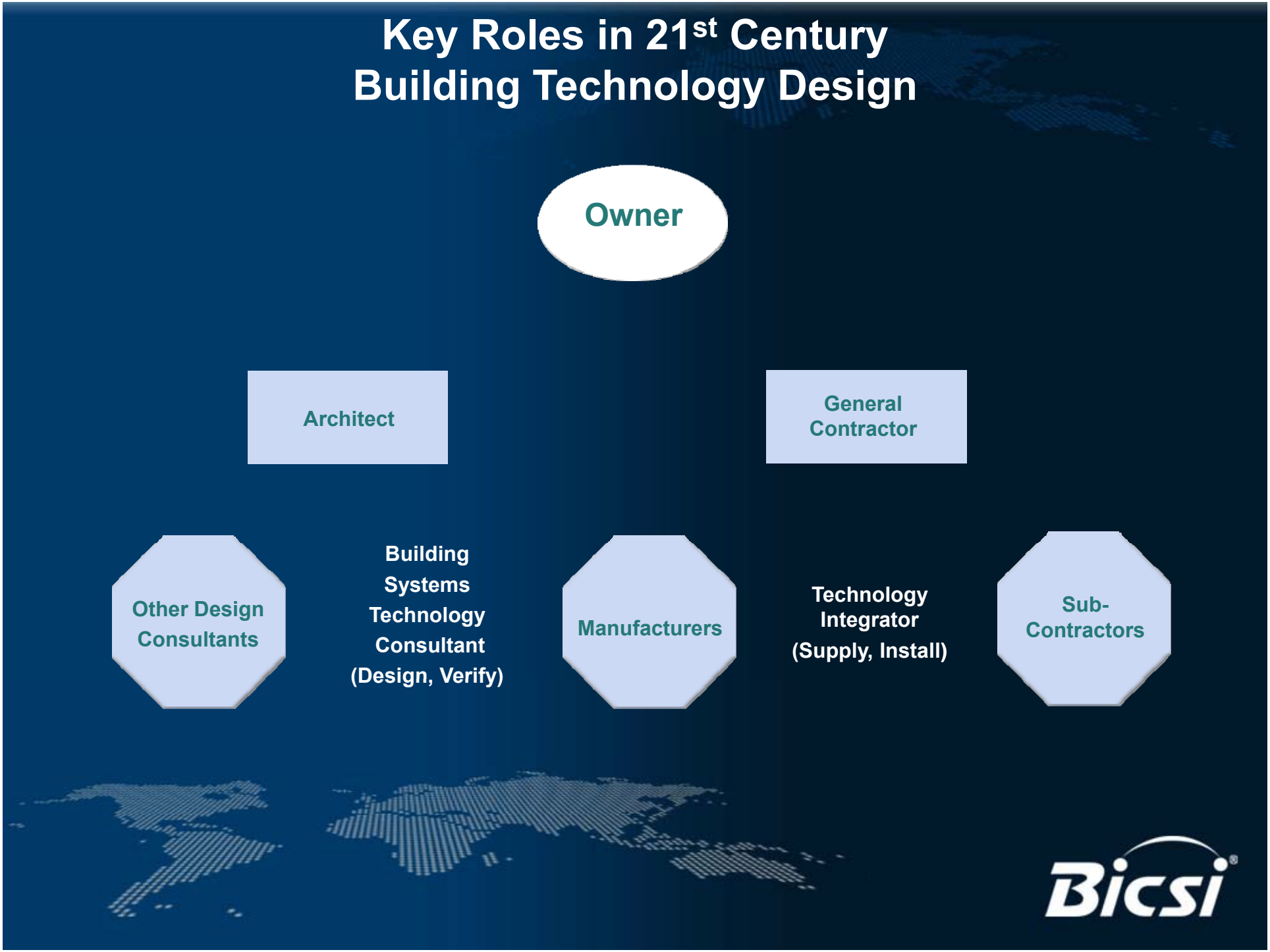
Audiovisual System Objectives



Key Roles in 21st Century Building Technology Design



QUESTIONS??

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