2018 CFAA NCR Technical Seminar

Wireless Fire Alarm Systems
(or – What your electrician isn’t telling you)

Paul Latreille, CET
Senior Fire Protection System Specialist
AGENDA

- Going Back In Time
- Jumping to the future
- Glossary
- Codes and Standards
- Applications
- Why we DO and Why we DON’T Want Wireless Fire Alarm Systems
- Design Considerations
- Questions
When Old becomes New

- Wifi invented in 1991 by NCR Corp and AT&T for wireless cash registers
- Mesh networks were first created in 1981 by the US military and widely commercially available by 1990
- First multiplex fire alarm network – 1979
- First fire alarm graphics management computer on the network – 1983
- First redundant fire alarm network - 1986
- First wireless smoke detector and control panel – 1988 – in Europe
Going Back In Time

- Some of the first fire alarm systems:
Going Back In Time

• Some of the first fire alarm systems:
Going Back In Time

• Some of the first fire alarm systems:
Going Back In Time

- Some of the first fire alarm systems:
CFAA NCR 2018 Technical Seminar

Present Time
Jumping to the future

• Wireless
Jumping to the future

- Current Ethernet and Fire Alarm:
Jumping to the Future

- Currently Available Technology gets some horsepower

- Fire alarm processor speed up until about 5 years ago was equivalent to a Pentium 1 processor speed

- Current technology is making use of Pentium 2 technology so we can do a lot more now 😊

- Ethernet/Cloud based technology being utilized

- Apps!

- User Friendly (fire departments don’t use panels anymore)

- Wireless and hybrid systems
Glossary

• **Booster** – a device used to boost weak wireless signals. Can be an actual detection device or a separate booster

• **Gateway** (translator) – a wireless portal that is wired to an addressable loop that allows wireless devices to connect to it
Glossary

• Dongle – a device used to connect a peripheral (e.g., a computer peripheral) to a wireless fire alarm network.

• Frequency Hopping Spread Spectrum (FHSS) – the repeated switching of frequencies during radio transmission to reduce interference and avoid interception. It is useful to counter eavesdropping, or to obstruct jamming of telecommunications. It minimizes the effects of unintentional interference.
Glossary

- MESH network – all devices connect to other devices (nodes) on networks that are nearby. Nodes send data to devices within range from node to node until it gets to the final destination.

  - Makes use of routing protocol (i.e. a set of rules) implanted in nodes and determines best path to send the data. Think of it as a redundant fire alarm network without wires with better performance.
Glossary

- Self healing
- Self Discovering
- Self Configuring
- Automatic protocol assignment
Glossary

- Often though of as a “parent-child” relationship – always two parents to each child
Glossary

- Hub and Spoke
3.64 SHORT-RANGE RADIO FREQUENCY DEVICE - Any device that communicates with control / receiving equipment by low-power radio signals.

NOTE: These devices are commonly referred to as wireless devices and may be subject to the requirements of Industry Canada Radio Standards Specifications.

3.65 SHORT-RANGE RADIO FREQUENCY DEVICE LINK - A low-power radio signal that provides a data channel between short-range radio frequency devices.

NOTE: Short-range radio frequency device links are commonly referred to as wireless device links and may be subject to the requirements of Industry Canada Radio Standards Specification.
Glossary

- **Bidirectional communication** – a communications protocol that allows data to be transmitted in both directions from transmitter to receiver and back but not usually at the same time.

- **EN54-25** - European standard for fire alarm systems and components using radio links.

- **NFPA 72** – National Fire Alarm and Signaling Code.

- **902-928 MHz** - frequency dedicated in North America for wireless fire alarm systems.
Codes and Standards - Wireless

CANADA
- ULC-S524-18 (public comment)
- ULC-S527-11

US
- NFPA 72

EU Union and BRITAIN
- EN-54-25
Codes and Standards Wireless

CHINA

- Who knows?

- I know I can get this wireless fire alarm on [www.Alibaba.com](http://www.Alibaba.com) for $547 USD
What does ULC-S524 say?

4.7 SHORT-RANGE RADIO FREQUENCY EQUIPMENT (WIRELESS)

4.7.1 Short-range radio frequency (wireless) devices shall comply with the Standards listed in Clause 4.1.3.

4.7.2 Short-range radio frequency devices shall be installed in accordance with the applicable requirements of this Standard.

4.7.3 Short-range radio frequency devices shall be installed in accordance with the manufacturer’s published installation instructions including, but not limited to:

A  Distance from device to receiver/transceiver;
B  Quantity of devices per receiver/transceiver;
C  Compatible with other short-range radio frequency devices communicating on the same short-range radio frequency device link; and
D  Primary and secondary power supplies (see Appendix A (Informative) Explanatory Materials, Clause A4.7.3-D)
Codes and Standards Wireless

ULC-S524 Continued

4.7.4 Each short-range radio frequency device shall be securely mounted.

   NOTE: Battery operated short-range radio frequency devices are not required to be mounted to a utility box.

4.7.5 AC-powered short-range radio frequency devices shall be mechanically supported independent of wiring in accordance with CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installation.

4.7.6 A fire alarm system incorporating short-range radio frequency devices shall operate in accordance with Table 2, Response Times for Control Units and Transponders, for fire alarm system response times.

4.7.7 The removal of a short-range radio frequency device from the system or its installed location shall cause a specific trouble signal that indicates its removal and individually identifies the affected device. See Appendix A (Informative) Explanatory Materials, Clause A4.7.7.
As wireless devices may be easily removed or relocated, which could impact the effectiveness of the device, the indication of the removal of the device from where it was installed is important so the building owner is aware of system changes. To ensure wireless devices can be confirmed as being installed in the correct location, it is important that accurate as-built drawings and any approved changes to the system are documented.

ULC-S527

Section 10 - Performance Tests – 10.31 Short Range Radio Frequency Device Tests
Codes and Standards Wireless

• So why aren’t we using more of these systems in Canada?
Because of this:

<table>
<thead>
<tr>
<th>OUTPUT</th>
<th>FIRST INPUT OPERATION (s)</th>
<th>SUBSEQUENT INPUT OPERATION (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audible Signal Devices and Visible Signal Devices within the same manually initiated fire alarm zone</td>
<td>5</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Audible Signal Devices and Visible Signal Devices&lt;sup&gt;1&lt;/sup&gt;</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Interconnection to Signal Transmitting Unit</td>
<td>10</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Releasing Device Service Start of Sequence</td>
<td>10</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Annunciation</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Central Alarm and Control Facility</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Ancillary Circuit</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Trouble Signal&lt;sup&gt;2&lt;/sup&gt;</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Water flow Devices&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

**US:** 200 seconds  
**EU:** 300 seconds

<sup>1</sup> Refer to Clause 12.3.3.

**NOTE 1:** For the purposes of testing for response time, the determination of input operation shall be the operation of a contact device or the operation of the means to indicate a latched-in alarm condition of a smoke detector (e.g. operation of local LED).

**NOTE 2:** Outputs shall operate within the specified time under worst case loading conditions.

**NOTE 3:** Manually operated control activations for paging and alarm selection shall have indication to confirm output operation in a maximum of 5 s. There shall be a means of providing sensory indication to the operator within 2 s that the function has been requested.
Codes and Standards Wireless

- Essentially no existing system in Europe or the US can meet the Canadian standard of 90 s for TROUBLE reporting.

- Time for the Canadian standard to change? US and European history is well established (20 years of use)

- Real world approach – trouble conditions on wired FACPs come in quickly and are just as quickly ignored. 200, 300, 400 seconds - what’s the difference

- Water flow switches can legally take 300 seconds to report to the FACP
### Codes and Standards Wireless

**Is the EN54 Standard Sufficient to ensure safety?**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Name</th>
<th>Objective</th>
<th>Procedure</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Immunity to site attenuation</td>
<td>Demonstrate that RF link not adversely affected by site attenuation</td>
<td>In accordance with manufacturer’s documentation</td>
<td>Communication is not lost between components due to site attenuation. Must be tested to attenuation having a) min. 10 dB up to f=10 MHz and b) f&gt;10MHz</td>
</tr>
<tr>
<td>2</td>
<td>Alarm signal integrity</td>
<td>Demonstrate alarm message to/from component is not loss due to collisions and/or a busy RF link</td>
<td>10 components triggered at same time to transmit/receive alarm in accordance with manufacturer’s instructions</td>
<td>First alarm to be indicated within 10 sec and last within 100 sec. No alarm to be lost</td>
</tr>
<tr>
<td>3</td>
<td>Identification of RF linked components</td>
<td>Demonstrate that components meet identification requirements</td>
<td>Verify manufacturer’s documentation that components meet ID requirements</td>
<td>Each component to have unique ID code belonging to single FA system Component not to be accepted by another FA system</td>
</tr>
<tr>
<td>4</td>
<td>Receiver performance</td>
<td>Demonstrate that receiver meets minimum performance characteristics</td>
<td>Test adjacent channel selectivity, blocking or desensitization, spurious response rejection</td>
<td>≥35 dB adjacent channel selectivity ≥40 dB spurious response rejection Various limits for blocking dependant on frequency offset</td>
</tr>
</tbody>
</table>
**Codes and Standards Wireless**

- **Is the EN54 Standard Sufficient to ensure safety?**

  **Component Tests**

<table>
<thead>
<tr>
<th></th>
<th>Test Description</th>
<th>Details</th>
</tr>
</thead>
</table>
  |9 | Verification of power source service life | Demonstrate function of power source  
  |   |     | Provide current consumption of component powered under no-load conditions  
  |   |     | Calculate service life to show power source meets minimum requirements  
  |   |     | Independent power source to be located within enclosure of component  
  |   |     | Power source to provide normal operation of component for min. 36 months  
  |10| Low power condition fault signal | Demonstrate that low power fault signal is transmitted before component loses its power  
  |   |     | Use current sink to simulate low power condition until fault is transmitted  
  |   |     | After fault transmitted, keep sink connected for additional time  
  |   |     | Connect pre-conditioned power source, trigger component alarm condition after at least 60 min to test function  
  |   |     | Component to transmit fault signal within 60 min of preconditioned power source being connected  
  |   |     | Component to sound after fault signal for min 30 min  
  |11| Polarity reversal | Demonstrate polarity reversal does not damage component  
  |   |     | Demonstrate polarity reversal cannot adversely affect component or  
  |   |     | Reverse polarity for 2 hr and measure component response  
  |   |     | Determine polarity threshold  
  |   |     | Components to function as intended  
  |   |     | Difference between before and after threshold values to be less than 6 dB  
  |12| Repeatability | Demonstrate stable transmission  
  |   |     | Determine transmission threshold six times in sequence  
  |   |     | Difference between max and min transmission thresholds to be less than 6 dB  

**CFAA NCR 2018 Technical Seminar**
## Codes and Standards Wireless

### Is the EN54 Standard Sufficient to ensure safety?

<table>
<thead>
<tr>
<th></th>
<th>Reproducibility</th>
<th>Variation of supply parameters</th>
<th>Dry heat (operational)</th>
<th>Dry heat (endurance)</th>
<th>Cold (operational)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Demonstrate transmission does not vary from component to component and establish threshold comparison data</td>
<td>Determine transmission threshold at upper and lower limits of supply parameters using bench-top power supply</td>
<td>Test heat detectors at max ambient temperature for 2 hours</td>
<td>Expose heat detectors to max ambient temperature with class C-G of EN 54-5 for 21 days</td>
<td>Expose FACP to -5°C for 16 hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Test other components at 55°C for indoor use and 70°C for outdoor use for 16 hours</td>
<td>Expose other components at 70°C for 21 days</td>
<td>Expose other components to -10°C for indoor and -25°C for outdoor for 16 hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Allow 1 hr recovery period and measure transmission threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Codes and Standards Wireless

### Is the EN54 Standard Sufficient to ensure safety?

<table>
<thead>
<tr>
<th></th>
<th>Damp heat, cyclic (operational)</th>
<th>Demonstrate components’ ability to function under high humidity conditions with condensation</th>
<th>Expose components to 25°C @ &gt;95% humidity and 40°C @ 93% humidity for 2 cycles</th>
<th>No fault signal during exposure</th>
<th>Difference between before and during transmission thresholds to be less than 10 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Damp heat, cyclic (operational)</td>
<td>Demonstrate components’ ability to function under high humidity conditions with condensation</td>
<td>Expose components for special/outdoor use to 25°C @ &gt;95% humidity and 55°C @ 93% humidity for 2 cycles</td>
<td>Determine transmission threshold during last ½ hr</td>
<td>Difference between before and after transmission thresholds to be less than 6 dB</td>
</tr>
<tr>
<td>19</td>
<td>Damp heat, steady state (operational)</td>
<td>Demonstrate components’ ability to function under high humidity conditions without condensation</td>
<td>Expose FACP and smoke detectors to 40°C @ 93% humidity for 4 days</td>
<td>Determine transmission threshold during last ½ hr</td>
<td>Difference between before and after transmission thresholds to be less than 10 dB</td>
</tr>
<tr>
<td>20</td>
<td>Damp heat, steady state (endurance)</td>
<td>Demonstrate components’ ability to withstand long term humidity</td>
<td>Expose components to 40°C @ 93% humidity for 21 days</td>
<td>Allow 1 hr recovery period and measure transmission threshold</td>
<td>Difference between before and after transmission thresholds to be less than 6 dB</td>
</tr>
</tbody>
</table>
### Codes and Standards Wireless

**Is the EN54 Standard Sufficient to ensure safety?**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>21</strong></td>
<td><strong>SO₂ corrosion (endurance)</strong></td>
<td>Demonstrate ability of components to withstand corrosive environment</td>
</tr>
<tr>
<td></td>
<td>Disconnect component from power supply and expose to corrosive ambient climate for 21 days</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry component for 16 hr, followed by recovery period and measure transmission threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No fault signal during exposure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference between before and after transmission thresholds to be less than 6 dB</td>
<td></td>
</tr>
<tr>
<td><strong>22</strong></td>
<td><strong>Shock (operational)</strong></td>
<td>Demonstrate components’ immunity to mechanical shocks</td>
</tr>
<tr>
<td></td>
<td>Apply mechanical shocks in accordance with EN 60068-2-27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor component during testing and for a further 2 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measure transmission threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No fault signal during shocks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference between before and after transmission thresholds to be less than 6 dB</td>
<td></td>
</tr>
<tr>
<td><strong>23</strong></td>
<td><strong>Impact (operational)</strong></td>
<td>Demonstrate components’ immunity to mechanical impacts</td>
</tr>
<tr>
<td></td>
<td>Expose component to specified mechanical impacts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor component during testing and for a further 2 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measure transmission threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No fault signal during impacts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference between before and after transmission thresholds to be less than 6 dB</td>
<td></td>
</tr>
<tr>
<td><strong>24</strong></td>
<td><strong>Vibration, sinusoidal (operational)</strong></td>
<td>Demonstrate components’ immunity to vibration</td>
</tr>
<tr>
<td></td>
<td>Test components in accordance with EN 60068-2-6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor component during testing and measure transmission threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No fault signal during impacts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference between before and after transmission thresholds to be less than 6 dB</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Test Type</td>
<td>Description</td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>25</td>
<td>Vibration, sinusoidal (endurance)</td>
<td>Demonstrate components' immunity to vibration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>EMC, immunity tests</td>
<td>Demonstrate components' immunity to electromagnetic disturbances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Applications

What are good applications for wireless fire alarm systems?
Applications

What are good applications for wireless fire alarm systems?
Applications

What are good applications for wireless fire alarm systems?
Applications

What are good applications for wireless fire alarm systems?
What are good applications for wireless fire alarm systems?
Applications

What are good applications for wireless fire alarm systems?
Applications
Applications
Applications
Applications
Applications
Applications

- Wireless Module that allows a wireless device to reside on an addressable loop of a wired circuit
- Asbestos containing areas
- Adjacent building - no wiring path
- Difficult wall to go through
Why We DO Want Wireless

• No wires or conduit to install

• Great flexibility

• Ease of installation, programming and testing

• Better survivability performance than wired networks (DCLC performance without the software sucking processing power)

• Fire departments rely upon wireless communication in an emergency (RF signals)
Why We DO Want Wireless

- As reliable as a wired fire alarm system. Maintenance take less time and is less costly

- Aren’t most fire alarm problems related to wires being damaged, cut, spliced, tampered with or grounded? No more expensive ground faults

- Significantly less disruption to occupants during installation in occupied buildings

- Flexible – wireless visuals for a new employee with hearing impairments; wireless low frequency sounders added in areas with low audibility. Worst case – only have to wire to the first repeater/booster to add a device.
Why We DO Want Wireless

- Lose a device on an addressable loop and lose all the other devices (Class B) - wireless only loses that single device

- A short circuit on an addressable loop, Class A or B, will result in all devices after the short being lost or potentially all devices. Not applicable to wireless

- Fire alarm is always the last trade on site and under a time crunch when a building has to open. Wireless is a much quicker to commission

- Easier to troubleshoot as there are no hidden wires or conduits and since every device reports individually
Why We DO Want Wireless

- Set-up is incredibly quick. Programming “wizards” with typically a three step process using a user-friendly graphical interface

- Devices are self-identifying, self-healing, self-discovering, auto-mass configuration

- Automatic communication protocols built into the devices and software

- No electrical boxes required for any device that does not require 120VAC (ie. All wireless devices except boosters and control units).
Why We DO Want Wireless

- Real time “live” display of the installed system and network

- Some current fire alarm manufacturers still don’t have a live display of the network

- Many software tools including: remote testing, app use and diagnostics of system, live link quality monitoring, device address display.

- Safe networks: mesh multipath networks, up to 18 channels to broadcast over, auto-channel switching (limits interference), multiple antennas to minimize device positioning errors
Why We DO Want Wireless

• Easy to install
Why We DO Want Wireless

- Long battery life - most US systems are listed for two years; some EU systems are listed for 5 years

- Common batteries readily available from retail battery manufacturers such as Duracell and Energizer

- Secondary battery supply good for 2 months

- A LOT LESS penetrations of fire separations

- Easy to install a new system in existing building – don’t have to use existing wiring for the new system.
Why We DO Want Wireless

- It can look good
Why We DON’T Want Wireless

• Perceived communication reliability by AHJs and Fire Department officials

• Perceived performance issues versus wired systems – slower to respond to alarm and troubles. (same standards apply for response times for wired and wireless systems)

• Lack of skilled technicians for maintenance and service as wireless systems are not widely in use in Canada

• Frequent battery changes required (average life cycle of wired fire alarm system batteries is 5 years)
Why We DON’T Want Wireless

• Not for every application

• As built accuracy – critical to these systems as devices are so easy to relocate

• More costly to purchase upfront

• Standards have not caught up to technology so every installation faces the same challenges of awareness and knowledge from owners, technicians, installers, engineers and AHJs. You are a pioneer on every project.

• Alternative solution approach required in most cases in Canada.
Why We DO Want Wireless

- OBC/NBC do not recognize wireless systems therefore most installations will require an “alternative solution” approach.

- Matching battery ratings throughout the installation (ie. In a high building, 2 hours full load, 24 hour supervisory). All devices to have this – control units, annunciators, repeaters, gateways, devices.
Design Considerations

- Consider a hybrid system
  - wireless for temporary installations
  - temporary permanent structures (schools)
  - Construction areas in an existing building
Design Considerations

- You MUST do an RF survey of your site
  - Can be done with any manufacturer’s test kit (device and transmitter/receiver)
  - Acoustical technicians do these tests all the time – industry standard
  - Signal strength to be measured throughout areas of the building where the system will be installed
Design Considerations

- Most hubs/gateways have an approximate coverage diameter of 180m and up to 5 stories.

- Most devices can be up to 30 m apart however UL/ULC/NFPA fire alarm device standards for spacing must be adhered to.

- Max of 1024 to 2048 addressable devices per system. About 50 devices per gateway.
Design Considerations

- Why do we put control equipment in the rooms (electrical rooms/service rooms) that are most likely to be the rooms where a fire will occur?
- What are we going to do with Workplace 2.0 and everyone wearing headphones at their workstations?
  - New requirements for more visuals and less audibles?
  - Use social media to transmit pertinent information
  - Make use of intranets
Design Considerations

• If we MUST use wired systems, why aren’t we using existing data networks?

  • Response times to existing data networks going down is almost instantaneous
  
  • Fire alarm response times to network issues can be many hours or even days.
  
  • We don’t use fire alarm networks for video so we won’t slow down the existing data networks.
  
  • Fire alarm network language is proprietary. Why are we re-inventing this wheel?
THANK YOU.

QUESTIONS?