

The background of the top section features a network of blue circular icons connected by thin white lines. The icons include a gear, a padlock, a clock, a lightbulb, a television, a refrigerator, a game console, a thermometer, and a house with a Wi-Fi signal. A smartphone is held in the center, displaying a house icon and a Wi-Fi signal. The Exponent logo is in the top left, and the text 'THOUGHT LEADERSHIP' and 'PUBLISHED 2Q 2020' is in the bottom left of this section.

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THOUGHT LEADERSHIP
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Improving the Speed and Accuracy of Fire Investigations

How IoT and Connected Devices Can Help Determine Root Cause

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Fires can be difficult to investigate. Determining a fire's root cause is crucial to establishing legal liability; however, the evidence to help reconstruct the cause of a fire is often consumed by the fire itself. As a result, in many fire events, the cause is classified as "Undetermined" as opposed to Accidental, Natural, or Incendiary.¹ This problem is only becoming more difficult with the increasing prevalence of connected and Internet of Things (IoT) devices in both residential, office, and industrial settings. While electronic devices such as battery powered electronics and smart home devices are often suspect in fire investigations, many IoT devices also present an opportunity to help analyze fire spread. By understanding the digital data that is passively stored in IoT or network devices, fire investigators can gain valuable temporal and spatial information about the cause of a fire. This could help reduce the time and cost of fire investigations and increase the confidence of root cause conclusions.

An Opportunity to Modernize Data Collection

The National Fire Protection Association (NFPA) periodically releases codes and standards that outline a methodology for using the scientific method to approach fire investigations. A fundamental piece of the scientific method is the data collection phase. While data collection in NFPA 921 specifically outlines devices such as smoke detectors and security cameras, the digital data stored in IoT device logs and the network information sent between IoT devices and network infrastructure (e.g., routers) is currently underdiscussed in the fire investigation field. We believe there is an opportunity to expand the utilization of digital data to more quickly and accurately determine fire origin and cause.

Using IoT Mapping to Establish Area of Origin and Fire Spread

Data produced by an IoT device may be valuable during a fire investigation even if the data is not produced by a purpose-built electrical fault or smoke/fire detector. The last known communication with a networked device, combined with the location of the device, may aid fire investigators in piecing together where and when certain areas of a structure were consumed by fire. Investigators can access this "last known communication" state from cloud-based services that support the device (e.g., a home security camera dashboard) and use the data even if the device was destroyed in the fire. If granted authorization, investigators can access communication logs from any Internet connection, which can allow some elements of the fire investigation to take place remotely. Alternatively, investigators can recover logs from internal memory if a device is only partially destroyed. This can help determine when the device was last able to connect to the Internet.

¹ NFPA 921 2017 - Chapter 29:1.1-1.4

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The ability to map last known connection location and connection time may enable a digital mapping of the fire spread. Section 9.11.7 in NFPA 921 outlines a similar technique called “Arc Mapping”, which attempts to map fire spread pattern with the understanding that in most cases, arcing found further “downstream” in an electrical circuit occurred prior to any arcing that is found closer to the power source on the same circuit. However, arc mapping has limitations as it is difficult to perform and often inconclusive.

Digital mapping, or IoT mapping, is analogous to arc mapping and may be extremely valuable in piecing together both spatial and temporal data about the fire spread. By accessing individual device logs stored on the cloud or the log history on a connected router, IoT mapping can help investigators efficiently and cost-effectively narrowing down the fire’s start time and location. IoT mapping can also help investigators determine which devices may or may not have been involved in the fire’s cause.

Potential Limitations

IoT mapping is not without limitations. Because current IoT devices communicate with the network once every few minutes, they may only provide coarse time resolution. However, the amount of ambient internet traffic will increase over time as smart devices become more commonplace. This will increase the number of log events a fire investigator can use to pinpoint the time at which one or more devices went offline. Furthermore, issues relating to data privacy may limit ease of access to the data.

Monitoring digital data in the form of mapping or analyzing individual connected devices may not be applicable or necessary in all fire investigations. However, when applicable, this under-utilized form of analysis can be a powerful technique for determining fire origin and cause with greater speed and accuracy.

Exponent’s Expertise

Exponent’s multidisciplinary team of electrical engineers, thermal experts, polymer experts, materials scientists, metallurgists, and network experts can help both IoT device manufacturers and insurance companies use IoT mapping to help determine a fire’s root cause and help establish liability.



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