October 2023

DYNAMIC LOCATION DETERMINATION THROUGH SHORT RANGE NEIGHBOR DISCOVERY

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ABSTRACT

Techniques are presented herein that support a close-proximity, ultrasound-based discovery and data exchange capability that provides a non-intrusive method for exchanging data (such as, for example, location information) between devices that share the same airspace. Using ultrasonic sound, information may be shared between any device capable of transmitting and/or receiving ultrasonic sound waves and elements of a network or building infrastructure allowing for the exchange of very specific and dynamic location data. One immediate use case for such technology is in the handling of emergency service (e.g., 911) calls where time and accuracy are critical. The presented techniques may find use in any number of other environments or scenarios including, for example, security and safety, an Internet of things (IoT) setting, a retail establishment, capacity planning, contact tracing, etc.

DETAILED DESCRIPTION

One of the most consequential challenges that a large organization faces concerns the handling of an emergency service call (such as a call to the emergency telephone number 9-1-1, or 911). When such an emergency call is placed, there needs to be a mechanism in place to provide information regarding where the call came from along with a call back number (in case the call is disconnected). It is also beneficial to notify internal organization resources of the emergency call so that they can assist first responders to more rapidly provide support.

There are a number of complex and static solutions on the market that provide such a mechanism. However, those solutions were designed to handle legacy calls and cannot handle certain situations like Wi-Fi or virtual private network (VPN)-connected clients.

Additionally, those solutions rely heavily on network design and static configurations that associate a location to an Internet Protocol (IP) address pool. Over time, such static mappings can become stale and end up providing incorrect data when an emergency call is placed.

With the rapid expansion of remote workers, VPN users, and soft clients, the above-described problem has become top of mind for large organizations. A new and innovative solution is needed that supports flexible workspaces, mobile and remote workers, and modern soft clients no matter how or where they are connected to a network.

Such a solution may leverage the ubiquitous nature of the modern wireless device. Everyone carries a smartphone with them wherever they go. As a result, in an office environment at any given time there will be one or more mobile phones or tablets within arm's reach and those mobile phones and tablets contain, among other things, advanced methods for determining a precise location. Leveraging that location data in a network environment would be extremely beneficial and help to streamline complex processes like emergency services.

Typically, for a device to communicate with another device both of the devices need to share the same network. This could be problematic when trying to obtain location data from a mobile device, which might not be on the same network as the device that is placing an emergency call, or which might have security controls in place that prevent network communication.

Techniques are presented herein that support a significant enhancement to existing neighbor discovery protocols (such as the Link Layer Discovery Protocol (LLDP), the multicast DNS (mDNS) protocol, etc.) and which use ultrasonic sound to share location data from a mobile device with neighboring clients and an upstream network. Under an alternative approach, aspects of the presented techniques could be implemented as their own standalone protocol.

The presented techniques' use of ultrasonic sound offers a number of benefits. First, the techniques are inherently secure since ultrasonic sound will not penetrate through walls and thus has a very limited range. Second, a mobile device doesn't need to be on the same network as a neighboring device, it only needs to share the same airspace. Third, if there are multiple devices with an enabled capability (these could, for example, be dedicated information technology (IT)-deployed devices sharing the same location) location accuracy may be increased by averaging the developed location data. And fourth, the techniques provide dynamic and real-time location information without the need for any centralized resources.

Additionally, an upstream device may retain any learned location information for future use. For example, if a new client (that does not have a working ultrasonic sound-based neighbor discovery facility) connects to a network then a previously learned location can still be available for use in case of an emergency.

As seen in Figure 1, below, by simply adding a neighbor discovery and announcement protocol (such as LLDP, mDNS, etc.) to a soft client, that client will then have the ability to discover its current static location from its upstream network device (such as a wireless access point, a switch, etc.).

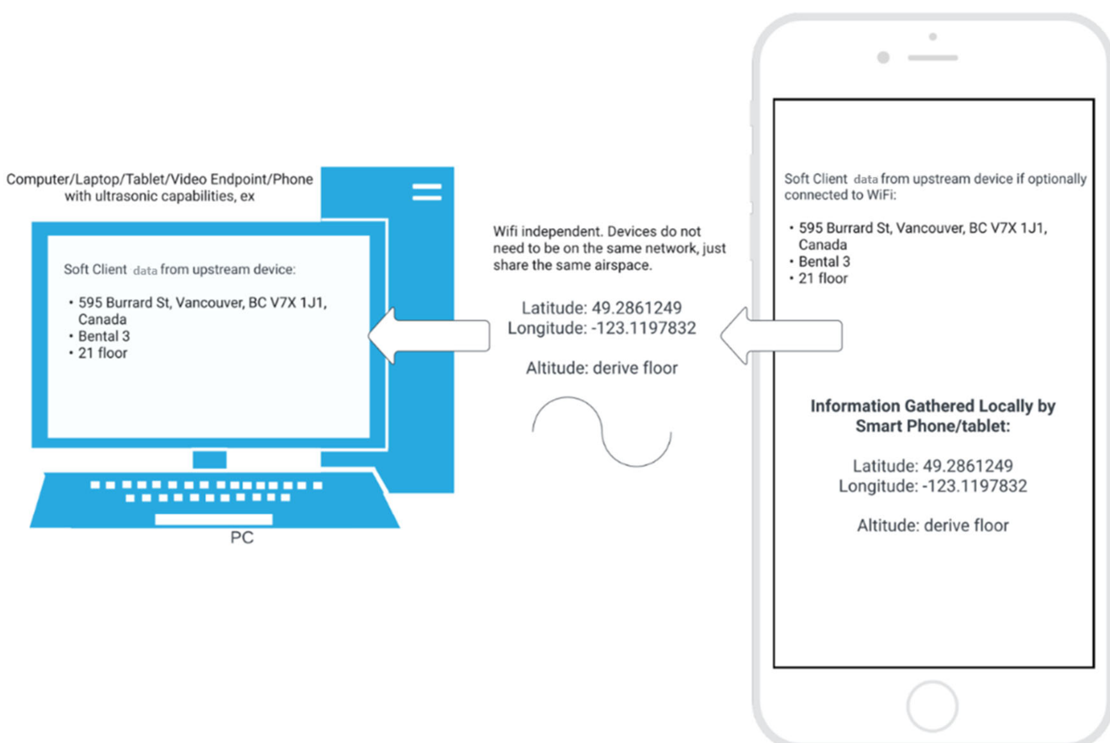

Figure 1: Exemplary Soft Client Gathering Location Data

As depicted in Figure 1, above, such location information can be further enhanced by gathering location data (such as Global Positioning System (GPS)-based coordinates, an altitude in order to estimate a building's floor, etc.) from the soft client's neighboring smart devices.

According to the presented techniques, the network infrastructure elements that may generate an ultrasonic announcement are devices that would typically exist within the user-occupied portion of the involved physical space. Such network infrastructure devices could include, but are not limited to, access points, phones, and Internet of things (IoT) devices (such as cameras, thermostats, sensors, smoke detectors, building access facilities, card swipe terminals, etc.). The above is in addition to any ultrasonic announcements that may also be generated by other neighboring clients in an environment.

Further, if multiple sources of information exist, and not all of them agree as to a current location, the presented techniques may utilize a "wisdom of crowds" approach to identify and discard outliers in order to provide the most accurate location possible. For example, if the network infrastructure and two local clients all identify the current location as "x" but a third local client indicates that the location is "y" (perhaps because that client is on a VPN, or has inaccurate or outdated GPS data), the data from the third client may be evaluated and then discarded.

Still further, under the presented techniques multiple levels of authentication or data trustworthiness may be assigned as part of an ultrasonic announcement such that, for example, an announcement from the network infrastructure is considered more trustworthy than other adjacent mobile clients, or vice versa. Such levels of trustworthiness may be assigned by a system administrator at their own discretion for use by their system.

Figure 2, below, presents elements of a simplified workflow for an emergency call that is placed from a soft client (that is located anywhere in the world and that is housed on any device) that is possible under the presented techniques and that is reflective of the above discussion.

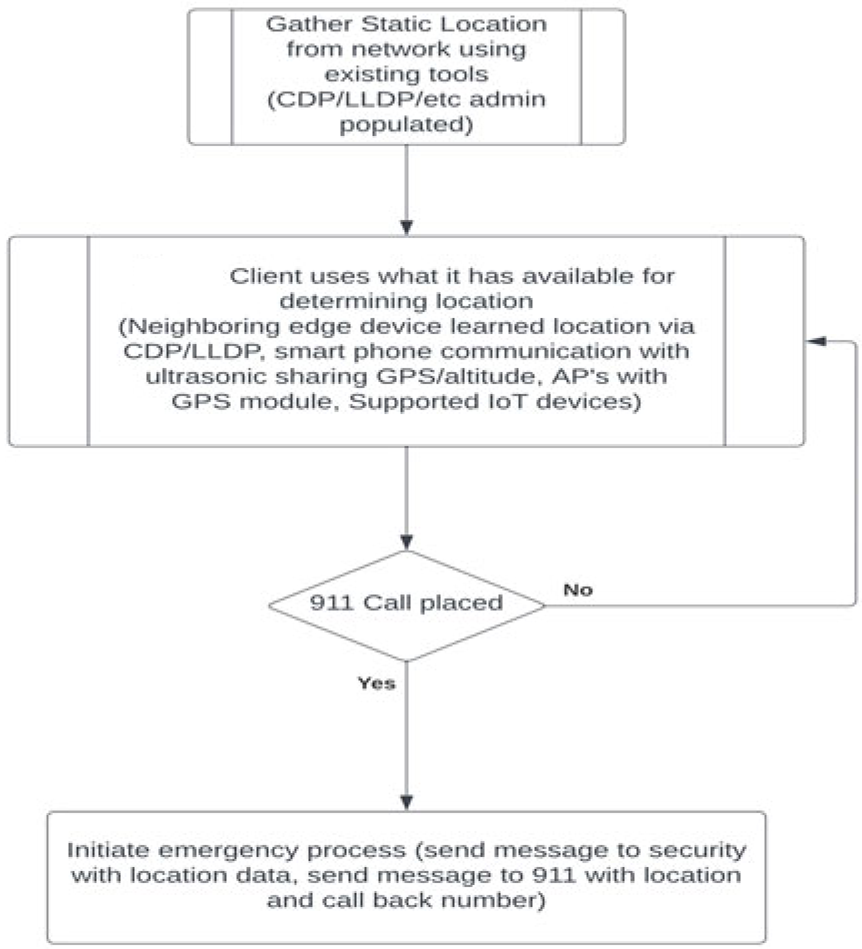

Figure 2: Illustrative Emergency Call Workflow

In the above discussion it is important to note that location data is not limited to just what a mobile device may provide. Additional information may be exchanged by elements of a supported ecosystem including, but not limited to, network monitoring and management facilities. Further, although Figure 1 and Figure 2 are discussed with reference to soft clients, it is to be understood that techniques as proposed herein may be utilized with any device capable of transmitting and/or receiving ultrasonic sound waves.

As described and illustrated in the preceding narrative, the presented techniques allow for the real-time exchange of accurate location information from and between shared-space mobile devices, IoT devices (such as access control facilities, cameras, sensors, dedicated purpose-built location entities, etc.) or, broadly any device capable of transmitting and/or receiving ultrasonic sound waves, and the network itself as shown in the illustrative workspace that is depicted in Figure 3, below.

Figure 3: Illustrative Workspace

As depicted in Figure 3, above, under the presented techniques the different devices that may reside in each of the rooms of a typical workspace may be leveraged to dynamically develop accurate real-time location information.

Central to such a capability is the introduction of an entirely new concept for neighbor discovery that builds off of existing facilities and adds the ability to leverage ultrasonic sound as a transport mechanism for neighbor information exchange between devices and the network infrastructure. In short, the presented techniques take traditional network protocols that have been used for over 30 years and enhance them with modern technology to support the current demands of a dynamic workforce. Such enhancements address the real problems that many customers are struggling to solve and enable solutions to those problems through the use of readily-available existing tools, the leveraging of capabilities across multiple devices, and the consolidation of information where it is needed.

As described and illustrated above, the presented techniques are extremely useful for use cases such as emergency service (e.g., 911) calls where very specific criteria (including the capture of a call back number, accurate information on the specific location of an emergency, etc.) must be met in order to provide adequate support to first responders. Within such an emergency service call context, mobility and new network trends have increased the challenge of deriving specific location data. Although there are many solutions on the market today that attempt to address that challenge, they all leverage static location data. In contrast, using location data from neighboring network infrastructure elements and/or neighboring mobile devices allows the presented techniques to support a dynamic and ever-changing environment while still providing location accuracy.

However, while the preceding discussion did focus on the use of the presented techniques in an emergency services context, it is critically important to note that those techniques may find use in any number of other environments or scenarios including, for example, security and safety, an IoT setting, a retail establishment, capacity planning, contact tracing, etc. The techniques essentially create dynamic broadcast domains where real-time location data may be shared from any source and leveraged by any number of applications.

It is also important to note that while the presented techniques enable a static network endpoint to retrieve location information from a mobile device using ultrasonic sound, such a capability does not necessarily require pairing and may encompass, for example, a beacon that broadcasts location data through ultrasonic sound.

Further, under the presented techniques, dynamic location data may be provided by devices other than traditional mobile phones or tablets. Such a device would need to have the capability to broadcast ultrasonic sound (thus necessitating a speaker or similar mechanism in the device) and a method for someone to define the device’s location. For example, an access point could hold an address and a floor number that could be shared with devices in the common airspace. Such a capability could also be built into endpoint software or hardware implementations, such as those that are used within a vendor’s online collaboration facilities, thus providing a significant competitive advantage to the vendor.

Still further, aspects of the presented techniques may address various of the challenges that exist within an environment comprising physically connected telephones.

For example, if a customer has a mixed environment (consisting of telephones and switches from different vendors) then the current management solution becomes quite complex, requiring significant effort and static configurations (which are not easily modified or updated as the environment evolves). In such an environment, many customers have gone a different route and instead of mapping a piece of hardware to a location, they map an IP address pool to a location. This works well but lacks granularity. Some large customers are also moving towards modern fabric-based environments (such as the Border Gateway Protocol (BGP), Ethernet VPN (EVPN), a Virtual Extensible LAN (VXLAN), or software-defined access) where it is possible to stretch subnets throughout an organization, making the allocation of an IP address pool to a location even less effective and potentially rendering it entirely ineffective. As a result, there is a greater need for the dynamic sharing of real-time location information, to go beyond what can be done with traditional methods that are built around static information, and aspects of the presented techniques may help to address that need.

In summary, techniques have been presented herein that support a close-proximity, ultrasound-based discovery and data exchange capability that provides a non-intrusive method for exchanging data (such as, for example, location information) between devices that share the same airspace. Using ultrasonic sound, information may be shared between any device capable of transmitting and/or receiving ultrasonic sound waves and elements of a network or building infrastructure allowing for the exchange of very specific and dynamic location data. One immediate use case for such technology is in the handling of emergency service (e.g., 911) calls where time and accuracy are critical. The presented techniques may find use in any number of other environments or scenarios including, for example, security and safety, an IoT setting, a retail establishment, capacity planning, contact tracing, etc.