

How Bluetooth® Channel Sounding will shape the future of device positioning

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Introduction

The short-range wireless connectivity landscape continues to evolve at a rapid pace.

Technologies such as Bluetooth®, Wi-Fi, and Ultra-wideband, which were once focused predominantly on sending and receiving data between devices, are becoming increasingly multi-functional. Most recently, with the introduction of Bluetooth® Channel Sounding, Bluetooth technology has added secure, fine-ranging capabilities to its suite of positioning features to enable true distance awareness. Bluetooth® Channel Sounding helps support a wide range of use cases that take advantage of highly accurate and secure device positioning, encompassing personal item tracking and digital keys to a whole host of use cases that can benefit from knowing the precise distance between two different Bluetooth® devices. With the massive ecosystem of Bluetooth devices on the market, and the potential for nearly any Bluetooth device to now be accurately located as part of a Find My network, these improvements can help enable a significant acceleration of true distance awareness for connected devices in the years to come.

The evolution of Bluetooth device positioning

The Bluetooth® suite of positioning features has evolved considerably since it was first introduced in 2010, encompassing a combination of techniques to determine presence, direction, and distance.

The first generation of positioning techniques came through the form of Bluetooth beacons. These beacons leverage Bluetooth LE's advertising capabilities to broadcast information which other devices nearby can scan to receive, making it ideal for determining when a device is in the presence of another, e.g., a smartphone to a retail beacon. In turn, the receiver devices can measure the strength of the signal received via received signal strength indicator (RSSI) and then estimate the proximity to the beacon based on the signal strength. This, in conjunction with trilateration techniques, has helped to enable several Bluetooth LE positioning use cases such as Find My item trackers, proximity marketing, indoor navigation, digital keys, and asset tracking, with accuracy typically in the meter-level range.

In 2019, Bluetooth® Direction Finding was introduced, enabling one device to determine the direction of a signal being transmitted from another Bluetooth device, enabled by angle of arrival (AoA) and angle of departure (AoD) positioning techniques. This helped increase the accuracy of location service use cases. AoA enables fixed locator anchor points with multiple antennas (or an antenna array) to help determine the location of Bluetooth LE tags which transmit their signal via a single antenna. As the signal is received, the locator is able to calculate the direction in which the signal originates from, significantly enhancing real-time location systems (RTLS) and asset tracking accuracy to the sub-meter level. AoD works in the opposite way, allowing devices such as smartphones to determine their location in relation to fixed locator anchor points with multiple antennas. The smartphone receives a signal from the anchor point and can work out the direction in which it came from, calculating the position of the device within the environment. These features can enable significant improvements for indoor navigation systems within transportation hubs, hospitals, education campuses, stadiums, and other public venues.

Bluetooth® Channel Sounding explained

The arrival of Bluetooth® Channel Sounding is the latest step in the evolution of Bluetooth LE's positioning capabilities. This introduces a new, secure, fine-ranging capability, providing centimeter-level accuracy when measuring the distance between two Bluetooth LE devices, a significant improvement over RSSI techniques. This is achieved through two major ranging techniques known as Phase-based Ranging (PBR) and Round-trip Time (RTT), explained in detail here.

Phase-based ranging (PBR)

Bluetooth® Channel Sounding leverages Phase-based Ranging (PBR) to achieve precise distance measurements between two devices. In PBR, an Initiator device sends a signal to a Reflector device, which returns the signal. This process is repeated across multiple frequencies. The distance between the devices is then calculated based on the phase difference between the transmitted and received signals over those frequencies. Figure 1 below provides a visual representation of PBR in action.

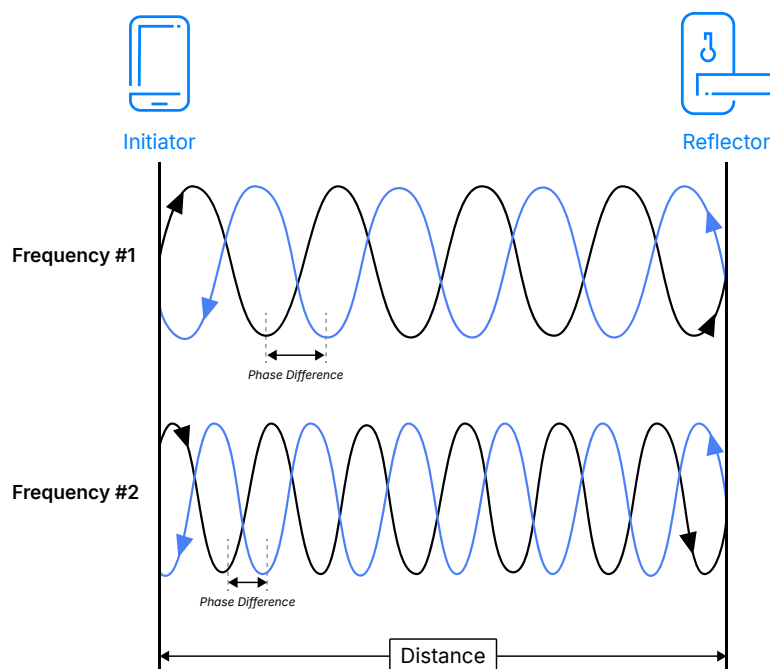


Figure 1: Phase-based Ranging (PBR) Source: Bluetooth SIG

Round-trip time (RTT)

Bluetooth® Channel Sounding also incorporates a secondary ranging method called roundtrip Time (RTT) as a counter measure against sophisticated man-in-the-middle (MITM) relay attacks. In RTT, an initiator device sends cryptographically scrambled packets to a reflector device, which returns the packets. The distance between the devices is then calculated based on the time it took for the packets to travel back and forth. RTT acts as a secure distance-bounding technique, providing an independent distance measurement to crosscheck the PBR measurement, significantly reducing the risk of MITM attacks. By combining PBR and RTT, Bluetooth® Channel Sounding enables secure and accurate distance measurements between devices. Figure 2 below provides a visual representation of RTT in action.

Combining fine-ranging techniques with direction and presence capabilities has helped round out a complete suite of Bluetooth positioning features. Figure 3 below summarizes the major positioning capabilities of Bluetooth LE to date.

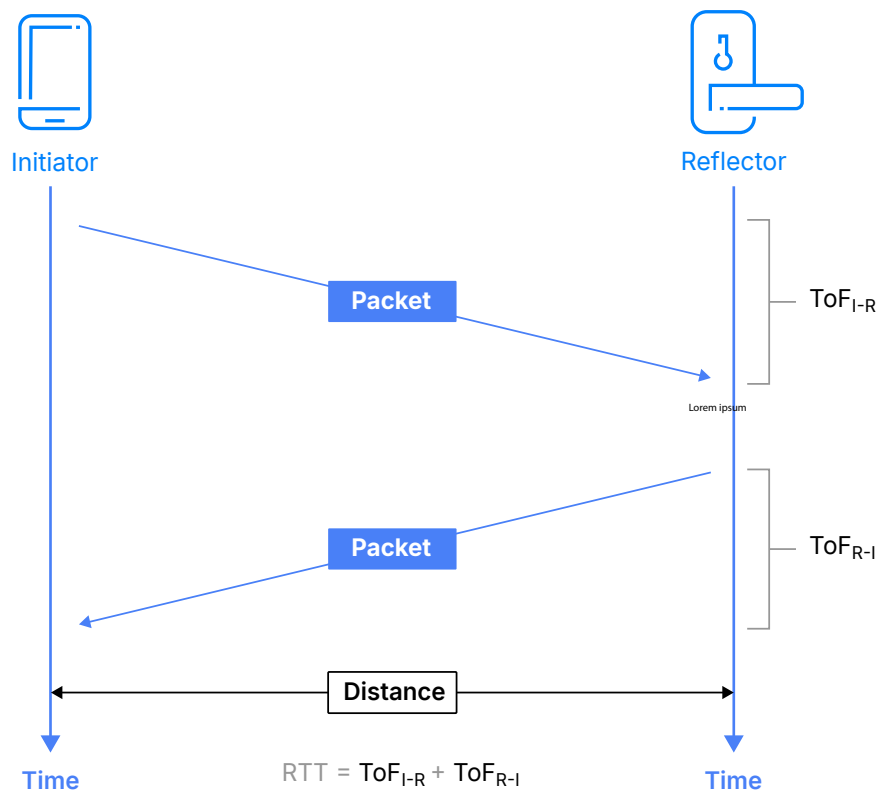


Figure 2 Round-trip time (RTT) Source: Bluetooth SIG

The complete suite of Bluetooth positioning features

With the addition of Bluetooth® Channel Sounding, the suite of Bluetooth technology positioning features now includes multiple techniques for measuring distance between two devices, along with proven methods for detecting presence and understanding direction.



Presence

It's nearby

Bluetooth® Advertising allows a transmitting device to share its presence to scanning devices within a general area, enabling one device to detect the presence of another device at distances of up to 100m or more.



Direction

It's that way

Bluetooth® Direction Finding enables a receiving device to determine the direction of a signal from a transmitting device. It includes two different methods for determining signal direction, angle of arrival (AoA) and angle of departure (AoD). Bluetooth Direction Finding can typically determine the direction of a signal within +/- 5 degrees.



Distance

It's that far away

Bluetooth RSSI and Channel Sounding are features that enable course-ranging and fine-ranging, respectively. Each feature enables a receiving device to estimate the distance to a transmitting device. RSSI estimates distance by measuring the power level of the received radio signal. Bluetooth RSSI can typically achieve distance estimations with meter-level accuracy. Bluetooth® Channel Sounding leverages PBP and RTT to enable a device to compute the distance to another device with centimeter-level accuracy, enabling true distance awareness. Bluetooth Channel Sounding can typically achieve distance measurements with an accuracy of +/- 50cm up to 100 meters.

Figure 3: Bluetooth positioning features (source: Bluetooth SIG)

Key benefits of Bluetooth® Channel Sounding

Given the aforementioned features of Bluetooth® Channel Sounding, there are a number of benefits that the technology brings to the table. Table 1 below discusses these in more detail.

Key Benefit	Explanation
High-accuracy distance measurement	Bluetooth® Channel Sounding leverages multi-channel, phase-based ranging (PBR) to enable highly accurate fine ranging between Bluetooth connected devices. Bluetooth® Channel Sounding offers centimeter-level accuracy over considerable distances, meeting the needs of the vast majority of applications and allowing even the simplest connected devices to take advantage of true distance awareness.
High security	The combined use of PBR and RTT in Bluetooth® Channel Sounding ensures that the vehicle and building door locks are only opened when the authorized digital key or fob is actually within a certain distance, making them much less susceptible to man-in-the-middle relay attacks
Ubiquitous adoption in tracking devices	Bluetooth LE has a ubiquitous presence in consumer platform devices such as smartphones, PCs, tablets, and wearables, creating a huge installed base of potential initiator devices. While there may need to be hardware upgrades to support Bluetooth® Channel Sounding, there are some devices on the market that can be upgraded to support this feature. And though the presence of UWB fine-ranging solutions is expected to grow in the years to come, the rollout of Bluetooth® Channel Sounding compatible hardware is expected to be much more rapid than the rollout of UWB technology.

Key Benefit	Explanation
Enormous Bluetooth device ecosystem	With nearly 8 billion Bluetooth devices expected to ship in 2029 alone, there are an enormous number of devices that can potentially incorporate Bluetooth Channel Sounding over time. While some more advanced implementations of Bluetooth® Channel Sounding with multiple antennas may be more complex, single antenna implementations can enable Bluetooth® Channel Sounding without impacting the design of existing Bluetooth LE products, taking advantage of the Bluetooth chip already on the device to create a highly scalable ecosystem of devices that can become part of a wide range of connected device solutions, such as a Find My network
Reduced cost and complexity	Implementing Bluetooth® Channel Sounding does not require the integration of an additional radio into the device, keeping the BOM cost down while adding secure ranging. For example, a Bluetooth LE Audio enabled true-wireless earbud or charging case could implement Bluetooth® Channel Sounding without the need to redesign the board to incorporate a UWB chip, reducing the cost, complexity, and time to market while enabling that device to be accurately tracked when lost. As a Bluetooth LE chip is already required by the device itself for audio purposes, the only additional cost is to leverage a Bluetooth® Channel Sounding capable chipset.
Interoperability	One of the major benefits of being part of the Bluetooth ecosystem is that all devices will also be fully interoperable. This means that a Bluetooth® Channel Sounding compliant smartphone or mobile device from one vendor will be able to track a Bluetooth® Channel Sounding device from another vendor. This will help to create a scalable ecosystem of solutions which can address multiple devices and applications
Reduced power consumption	Bluetooth® Channel Sounding takes advantage of the inherent low-power characteristics of Bluetooth LE technology. This is likely to be a key factor when deciding what technology to embed in battery-sensitive devices requiring high-secure ranging
Reliability	Bluetooth® Channel Sounding solutions that utilize multiple antennas can help mitigate the impact of multipath reflections on accuracy. This can help increase the reliability of distance awareness across a diverse range of environments.

Table 1: Key benefits of Bluetooth® Channel Sounding

Bluetooth® Channel Sounding use cases

While we are in the early stages of adoption for Bluetooth® Channel Sounding, the unique presence of Bluetooth technology in platform devices and connected devices alike has the potential to significantly expand the current market presence of distance awareness across consumer, enterprise, and industrial settings.

Meanwhile, the ability to provide centimeterlevel accuracy, sufficient for most fine-ranging use cases discussed below, makes Bluetooth®Channel Sounding a compelling proposition when compared to alternative fine-ranging technologies such as UWB. While UWB may offer even higher accuracy and reduced latency, there are also potential trade-offs in terms of the cost of integrating an additional radio, more limited support within mobile and platform devices, and higher overall power consumption. With nearly eight billion Bluetooth enabled devices forecasted to ship in 2029 alone, the opportunities are also significant. This following section will discuss how Bluetooth® Channel Sounding technology can address a wide range of fine-ranging applications while being easy and cost effective to deploy.

Find My solutions

Since the arrival of Bluetooth LE in 2010, one of the most notable applications for the technology from a positioning perspective has been battery-powered personal trackers. Here, dedicated tags can be attached or inserted into a variety of personal items such as wallets and purses, backpacks, bicycles, phone and tablet cases, luggage, keys, instrument cases, pets, and other valuable or sentimental items. By leveraging Bluetooth® Channel Sounding, users can now more accurately find lost items by knowing if they are heading closer or further away from their item, down to the centimeter level. This can help to improve the user experience by making it easier, more intuitive, and quicker to find these lost items.

However, arguably more exciting is that with the arrival of Bluetooth® Channel Sounding, almost any Bluetooth LE-enabled device with a compatible chipset can be tracked more accurately without the need to embed a separate tag. For example, Bluetooth LE-enabled remote controls, audio devices, connected toys, and games console controllers could all provide enhanced distance awareness without the need for additional dedicated hardware. As more and more Bluetooth platform devices integrate Find My capabilities, the rollout of Bluetooth® Channel Sounding enabled connected devices can significantly expand the scale and accuracy of Find My and Find My Device networks, enabling a huge network of Bluetooth Find My devices from which lost items can be more readily located.

Digital key solutions

RSSI based Bluetooth LE digital key solutions have existed for some time. Both Bluetooth LE-enabled fobs and phone-as-key solutions can be used to lock and unlock doors, gates and garages, bicycle locks, safes, cabinet, and drawer locks, among other devices. Bluetooth® Channel Sounding provides an additional layer of protection against man-in-the-middle relay attacks, removing a key area of concern when adopting



Bluetooth technology for digital key and access control solutions, while also providing sufficient accuracy and low enough latency for most deployment scenarios. Today, there is strong momentum for multi-protocol access control solutions, particularly in the automotive space, with the backing from the [Car Connectivity Consortium](#) (CCC) and its Digital Key Release 3.0 Specification, which combines UWB, Bluetooth LE, and NFC. Similarly, the unveiling of [Aliro](#) from the Connectivity Standards Alliance (CSA) in 2023 aims to standardize the communication protocol between access readers and user devices such as smartphones, wearables, and other devices to providing a more convenient and consistent experience for access control. Meanwhile, other organizations, such as the Intelligent Connected Car Open Alliance (ICCOA) and Intelligent Connected Car Ecosystem Alliance (ICCE) in China, are also investigating a similar approach to the CCC, combining UWB, Bluetooth LE, and NFC technology.

However, given that UWB is not yet a ubiquitous technology and the fact that it will come at additional cost and complexity, many in the industry believe that many OEMs, outside of the high-end and premium tiers of the market, will view Bluetooth® Channel Sounding as a viable, cost-effective solution for automotive, home, and building access, taking advantage of the ubiquity of Bluetooth LE technology in smartphones and other devices. Therefore, Bluetooth® Channel Sounding has the potential to help scale up digital key and phone-as-key deployments across automotive, home, enterprise, and industrial access control use cases. In addition to standalone Bluetooth® Channel Sounding digital-key solutions, Bluetooth® Channel Sounding will also likely have a complementary role to play with UWB technology, with access control solutions potentially leveraging Bluetooth® Channel Sounding to determine distance when the user is further away, and hand over to UWB for unlocking and in-cabin use cases. Here, the use of Bluetooth® Channel Sounding could further reduce the power consumption of access control solutions that utilize UWB.

Other use cases

The ability for connected devices to determine their position accurately in relation to others can also enable innovative use cases that go beyond asset tracking and access control. The enhanced centimeter-level accuracy of Bluetooth® Channel Sounding has the potential to create new innovative features for Bluetooth LE enabled devices, including humaninterface devices (HID), proximity interactions and automation, and human-machine interface (HMI).

Asset tracking

Bluetooth® Channel Sounding can bring significant performance and security enhancements to indoor asset tracking applications while also enabling some reduced complexity deployments when compared with previous solutions. In enterprise environments, such as hospitals, personnel can leverage smartphones to track high-value equipment more readily, improving productivity and preventing the loss of critical assets. In retail environments, high-value equipment can be equipped with dedicated Bluetooth® Channel Sounding tags and send alerts when they are moved out of specified areas. In warehouse environments or construction sites, personnel can track Bluetooth® Channel Sounding-enabled tools without needing to install a more complex RTLS infrastructure with multiple locators. Other highvalue assets can activate alarms if they are suddenly moved outside of their predetermined location, preventing theft. These solutions can complement more scalable asset tracking implementations based on RSSI and AoA/AoD to help track hundreds to thousands of assets. In addition, Bluetooth® Channel Sounding can be combined with other techniques, such as direction finding, to enable even further accuracy and security to their assettracking platforms.



Human-interface devices (HID)

By offering centimeter-level distance measurement capabilities, a whole host of peripheral and accessory devices can now accurately determine their relative position from platform devices such as smartphones, PCs, tablets, and smart TVs. Devices such as mice, keyboards, and controllers could automatically switch between active and inactive states as they approach or are separated from the source PC. For example, when someone picks up their laptop to use it, an active wireless keyboard or mouse may turn inactive once the laptop moves from a pre-configured distance away from them. Alternatively, someone placing their game controller next to their laptop could activate it. This could help to improve the enduser experience while extending the battery life of those devices.

Proximity interactions and automation

Another potential application for Bluetooth® Channel Sounding is the ability for a platform device to detect proximity to an end user's smartphone or smartwatch and automatically lock or unlock the screen once they come within a certain threshold. For example, a user equipped with a Bluetooth® Channel Sounding-enabled smartwatch could approach their PC and have it automatically unlock and then lock again once they move a certain distance away. This could also potentially detect who is using the PC and switch between their login profiles.

Bluetooth® Channel Sounding could enable a whole host of innovative user experiences to enable proximity/geofencing-based automation. For example, holding a smartphone close to a home appliance could bring up a relevant control panel automatically rather than searching through the installed apps on the device. Much like door locks, other equipment such as lighting, audio devices, and thermostats may also be able to respond to a person's presence in different rooms. This could also be used to personalize the environment to the user's specific preferences. In hospital settings, personnel could access patient records automatically on their device as they visit them. Usage restrictions could also be set to prevent unauthorized users from interacting with assets, appliances, or equipment unless somebody with the right credentials is near the device. This same technology can also help ensure a smooth device onboarding and provisioning process based on proximity.

Human-machine interface (HMI)

Conversely, there may be use cases in which personnel safety can be enhanced by only enabling the operation of potentially dangerous equipment or machinery once the user is a safe distance away. For example, HMIs that operate robotics, machinery, appliances, and tools within commercial and industrial environments could benefit from Bluetooth® Channel Sounding's ability to more accurately determine their position compared to RSSI solutions, guaranteeing they are at the required distance from the equipment to operate it safely.

Future use cases

Given the early lifecycle of Bluetooth® Channel Sounding technology, it is too soon to predict what new types of use cases and device types may emerge over time. Some other potential future use cases may include self-optimization and configuration of devices, such as Bluetooth smart lighting, to help optimize system performance. With the ubiquitous presence of Bluetooth LE in smartphones and other platforms, ABI Research expects that many new use cases will emerge as the rollout Bluetooth® Channel Sounding accelerates in the coming years.



How Bluetooth® Channel Sounding addresses distance awareness use cases

There are several wireless technologies on the market, most notably UWB, Wi-Fi and Bluetooth LE, that can provide distance measurement capabilities. Each of these has its own unique benefits and tradeoffs in terms of accuracy, power consumption, latency, range, scalability, ease of deployment, ecosystem enablement, and cost, among many others.

The centimeter-level accuracy, ubiquitous availability of Bluetooth smartphones and platform devices, lower chipset costs, lower power consumption, reduced design complexity, and the avoidance of an additional radio could prove compelling enough to leverage standalone Bluetooth® Channel Sounding as an alternative to UWB fine-ranging across many distance measurements use cases. In some application segments, Bluetooth® Channel Sounding will compete with UWB, and in others, they will work directly together to enhance the overall positioning performance.

However, it is important to note that different use cases for secure ranging will have different requirements. While some applications may require UWB's higher level of precision, for many this will be overkill, and some OEMs may struggle to justify the additional cost and complexity of embedding UWB for the sole purpose of enabling secure ranging. For example, if we take the personal tracker use case, there may be little benefit in knowing whether an item is millimeters away versus tens of centimeters or even one meter away depending on the size of the item. Therefore, some developers may choose to develop a Bluetooth® Channel Sounding solution that provides strong enough performance, strong interoperability, and reduced cost and power consumption, while others may opt for a higher-performance solution with the tradeoff of additional cost and greater power consumption.

In phone-as-key access-control applications, knowing that the user is in sub-meter-level proximity should typically be sufficient for locking and unlocking a door. Today, there are many Bluetooth LE door locks already on the market which leverage the installed base of Bluetooth LE mobile devices for automatic unlocking on approach. Bluetooth® Channel Sounding can provide enhanced security and better user experiences over RSSI by opening only when the user is in closer proximity while avoiding the cost of an additional UWB radio. As early as 2021, companies like Broadcom have partnered with Alps Alpine Co., Ltd to develop secure distance measurement solutions for automotive applications based on Bluetooth LE.

Similarly, when tracking a limited number of high-value assets that are within a warehouse, hospital, campus, or industrial environment, distances of between one and five meters can often be sufficient in locating an item efficiently. However if the item is smaller, such as a tool, having the additional centimeter-level capabilities of Bluetooth® Channel Sounding can be beneficial. vOne of the major benefits that could accelerate the potential of Bluetooth® Channel Sounding is that Bluetooth technology is already embedded within many of these wireless devices that have the potential to be tracked. By supporting Bluetooth® Channel Sounding, this could enable many new device categories to offer tracking functionality without the need to equip them



with dedicated smart tags or to embed an additional UWB radio. In particular, low cost single antenna IoT solutions, while less accurate, can provide sufficient distance awareness to find the item without the need for developers to invest in new technologies, additional radios, or more complex product designs. This, combined with the ubiquitous presence of Bluetooth LE in mobile devices, may encourage many more end device vendors to add support for Bluetooth® Channel Sounding solutions in their devices for a variety of use cases, including item tracking, presence detection, and proximity activation, among others. While UWB penetration in smartphones is expected to grow in the coming years, only a quarter of smartphones shipped in 2023 came equipped with the technology. ABI Research expects a much swifter rollout of Bluetooth® Channel Sounding smartphones and other platform devices as compatible hardware proliferates. Furthermore, the flexibility of Bluetooth® Channel Sounding can enable it to prioritize different metrics and tailor it for specific applications that may need higher security, higher accuracy, lower latency, or lower power consumption.

Recommendations for the industry

Bluetooth® Channel Sounding brings a number of benefits to the location ecosystem thanks to its significantly improved distance measurement over previous RSSI techniques.

However, it also enters a competitive space up against technologies such as UWB which can provide unique accuracy and latency advantages, albeit with potential tradeoff on cost of integration and the wider ecosystem adoption. As a result, the Bluetooth ecosystem must do its utmost to maximize the unique advantages of Bluetooth® Channel Sounding if it is to be successful in the coming years. These will include the following:

Ensure swift adoption of compatible hardware

While several chipset vendors have been incorporating Bluetooth® Channel Sounding into their solutions for some time, the adoption rate of the technology will of course depend on having compatible hardware and devices for both platform devices as well as tags, door locks and access control readers, and other devices. The swift rollout of Bluetooth® Channel Sounding-enabled smartphones and other platform devices will help to drive the creation of new use cases and distance aware end devices.

Create optimized solutions for different use cases and form factors

In addition to compatible smartphones, chipset vendors should offer optimized solutions that can help to target different applications for Bluetooth® Channel Sounding. Some vendors have already released single-antenna solutions targeting high-value asset tracking applications and are now developing dual-antenna solutions for more size-constrained devices such as key fobs. Bluetooth Channel Sounding solutions that enable in the highest accuracy and security are also likely to emerge over time. Product manufacturers should prioritize their initiatives based on these different performance metrics. Thanks to the flexibility of Bluetooth® Channel Sounding, chipset vendors can differentiate on accuracy, latency, security, cost, and other metrics, setting them apart from the competition.

Work with industry consortia

The Bluetooth ecosystem should also work closely with vertical and region-specific organizations and incentives such as the Car Connectivity Consortium, the Intelligent Connected Car Open Alliance (ICCOA), the Intelligent Connected Car Ecosystem Alliance (ICCE), and the CSA's Alio to promote Bluetooth® Channel Sounding as another viable technology for access control and keyless entry applications, as well as complementing UWB technology. This will help to cement trust and show the viability of the technology in supporting some of the more stringent, security-driven applications.

Focus on the differentiators

Historically, there has been an obsession in the location ecosystem around which technology can provide the highest level of accuracy. However, in recent years, there has finally been a realization that for technology to be successful it also needs to be cost effective, easy to deploy and manage, interoperable, and scalable. Bluetooth® Channel Sounding is compelling precisely because it can be readily embedded in devices without major hardware upgrades or design complexity. Combine that with its ability to communicate

with a huge installed base of Bluetooth LE devices, strong interoperability, low-cost, and low-power consumption, and Bluetooth Channel Sounding becomes an ideal solution for solving a wide range of locationing challenges. Instead of focusing on the more stringent performance applications, those promoting Bluetooth® Channel Sounding should highlight the sufficient centimeterlevel performance and high security which can effectively address the widest number of applications. The emphasis should be on a huge upgrade versus RSSI solutions which will be readily embedded rather than competing with UWB levels of accuracy, which requires an additional radio.

Educate the industry on the benefits of bluetooth® channel sounding

Given the relative novelty of Bluetooth® Channel Sounding, much work needs to be done to educate end users on the benefits of the technology and effectively communicate the KPIs of Bluetooth® Channel Sounding across different device types. Demonstrations, trials, case studies, and highlighting the availability of real-world products and their actual performance and benefits will be beneficial in incentivizing further adoption in the years to come.

Enable new use cases and experiences

The industry should also look towards new use cases that can be enabled by Bluetooth® Channel Sounding beyond access control and personal tracking. While these will remain significant opportunities, they have the potential to be dwarfed by a whole range of device categories that can embed ranging capabilities for the first time. These can also help to enable new user experiences, new ways of interacting with the world around us, and enhanced personalization and automation across many different environments.

Take advantage of the ubiquitous bluetooth ecosystem

With the rollout of Bluetooth® Channel Sounding compatible hardware expected over time, there will be billions of devices on the market that can embed high-accuracy distance measurement capabilities without the need for product redesigns or embedding an additional radio for the single purpose of distance measurement capabilities. This has the potential to create an extremely scalable ecosystem where Bluetooth devices can share their relative distance to others and enormously extend the presence of Find My networks available today. This, in turn, can lead to compelling new use cases and user experiences where the only additional cost will be upgrading to Bluetooth® Channel Sounding compatible hardware. Meanwhile, with many use cases already using Bluetooth LE-based RSSI coarse ranging, this can provide a remarkable upgrade to performance without investing significantly in a major hardware redesign.



Investigate ways to work with other technologies

Vendors should also look at ways in which Bluetooth® Channel Sounding can also work together with additional technologies – whether Bluetooth RSSI, Bluetooth Direction Finding, Wi-Fi, or UWB – to enable even more unique location solutions that can maximize performance while reducing power consumption and deployment complexity. For example, there are many devices on the market today that combine UWB and Bluetooth LE technology, and in many applications Bluetooth® Channel Sounding may provide further enhancements in the future. With UWB typically requiring adoption of Bluetooth LE alongside it, this can also bring potential benefits to the Bluetooth ecosystem. Ultimately, Bluetooth® Channel Sounding is well positioned to provide a broader rollout of secure, distance-measurement solutions. By embedding this feature into the Bluetooth® Core Specification, it has the potential to scale rapidly and significantly enhance the availability of accurate, low-power, secure, fine-ranging across a wide range of device types. This in turn will enable the creation of innovative location-based experiences such as accurate Find My solutions, secure access control, and other innovative device-to-device interactions in the years to come.

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