Chapter 3
A Review of Wireless Positioning From Past and Current to Emerging Technologies

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ABSTRACT

Many techniques for wireless positioning have existed for years, but with emerging technologies like 5G and ultra wideband, wireless positioning is becoming more accurate than ever. On the one hand, improved accuracy implies increased usefulness. It will open up new application areas and lead to advances in areas like internet of things (IoT), self-driving cars, and contact tracing. Furthermore, decision support systems can benefit from better positioning techniques. On the other hand, the ability to track connected devices with sub-meter precision brings some privacy and security concerns. This chapter aims to review indoor and outdoor positioning technologies and how they can be used for contact tracing. It then further discusses some of the data management, privacy, and security concerns that follow. To that end, this chapter studies the main techniques for wireless positioning, cellular-based positioning using 5G, and their use to contact tracing. Finally, the authors provide some insight into how 5G and UWB might help the area of positioning and contact tracking in the future.

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INTRODUCTION

The number of wirelessly connected devices increases by the minute, with more people having access to them while at the same time more everyday objects are being connected (Ahmed, 2020). With all of these wireless devices, more possibilities to position them arise. Cellular networking and Global Positioning Systems (GPS) are the two most common location systems in smartphones and have been around for many years (Liu, 2007). Apart from these two, the use of Bluetooth and Wireless Local Area Network (WLAN) increases by the minute. Consequently, this means that most people walk around with a device that can be used for positioning purposes but can be subjected to tracking.

As with all technology, advances are being made continuously, and newer positioning systems are emerging. For instance, 4G is being replaced by 5G to deliver improvements in all areas, such as throughput, latencies, and capacity (Koivisto, 2017). Ultra Wideband (UWB) is a proximity technology similar to Bluetooth but has much higher throughput, lower energy consumption, and more advanced positioning techniques. This makes UWB ideal for proximity tracking, e.g., contact tracing (Liu, 2007).

At the same time, as technologies get more accurate, more areas of use emerge. One new area is applications that aim to reduce the spread of COVID-19 (Ahmed, 2020). However, many have later questioned these applications' privacy and security concerns because they share user and location information. This, in turn, has opened up a discussion on the trade-offs between the usefulness of a system and the privacy and security aspects for the end-users. This is a trade-off that is important to discuss in all applications using positioning systems.

Compared to the used reference papers (i.e., Liu 2007, Koivisto 2017, and Ahmed 2020), this chapter introduces more aspects on the topic of wireless positioning, explaining the basic metrics and algorithms used. It further gives an overview of the most popular wireless positioning systems and discusses security and privacy issues that can arise when used in various tracking applications (contact tracing). This layout makes it possible to understand some parts of a wireless positioning system on an introductory level and explain how these can be applied in applications.

The remainder of this chapter is structured as follows. In Section 2, the authors summarize the fundamental techniques used in positioning systems. Section 3 summarizes the different systems used for positioning and which kinds of techniques each uses, respectively. In Section 4, the authors look at one area of use for these systems, namely COVID-19, and present what privacy and security concerns arise from different system architectures used in such applications. Section 5 discusses the reality of implementing these systems, particularly the emerging 5G and UWB, in terms of potential future use cases and how this can affect the outcome of these