

# Time-of-flight positioning using the existing wireless local area network infrastructure

Ivan Casacuberta  
Independent Researcher  
Barcelona, Spain  
ivan.casacuberta@gmail.com

Alejandro Ramirez  
Wireless Communications  
Siemens Corporate Technology  
Munich, Germany  
alejandro.ramirez@siemens.com

## ABSTRACT

The ubiquity of IEEE 802.11 WLAN as well as the advancements in location based services and applications make locating a device more important than ever.

Extending an existing WLAN infrastructure with localization capabilities would lead to lower investment costs. For implementations based on commercial off the shelf (COTS) hardware, most research concentrates on using the received signal strength indicator (RSSI). The RSSI is inherently nondeterministic in dynamic environments. This relatively poor characteristic limits its use in real world scenarios.

To solve this problem, we have developed a new measurement method and refined two measurement methods which use the time-of-flight (ToF) of a wireless signal to calculate the position of any device using only COTS hardware. We show the details of the implementation of each of these methods on a commercial device as well as its performance under challenging conditions.

Our first and new method reads the clock of the WLAN chipset. The second method uses the “time synchronization function” (TSF), through which some WLAN devices add timestamps to received frames. The third method employs a higher resolution timestamp based on the CPU-clock. This timestamp is triggered directly by the hardware interrupt that is generated when sending or receiving a frame. Therefore it can be added to the software on any device.

The test environment was a business complex characterized by metallic walls, doors and ceilings. Each wireless frame exchange generated three timestamps, one for each method, making the measurements directly comparable. The results show close-to-real-time functionality with an average error of 1.6m and maximum error of 4.2m.

We highlight that our system can be deployed through a simple firmware upgrade, bringing an instant added value to any existing infrastructure. We make comparisons with representative work from the state of the art to show the benefits of our system.

**KEYWORDS:** WLAN, COTS, Positioning, RTT, ToF

