Sub-Nanosecond Time of Flight on Commercial Wi-Fi Cards
Technology #17746

Applications

The Inventors have developed a system that measures the time-of-flight to sub-nanosecond accuracy on commercial Wi-Fi cards. This technology has applications in device-to-device localization (i.e. enabling a pair of Wi-Fi devices to locate each other) as well as in major positioning systems including GPS, RADAR and SONAR.

Problem Addressed

Time-of-flight is the time incurred by a signal to travel from transmitter to receiver and is a highly intuitive way to measure distances using wireless signals. However, attempts at using time-of-flight for indoor localization are not accurate due to fundamental limitations in measuring time on Wi-Fi and other RF consumer technologies. Alternative methods for RF-based indoor localization do not support indoor positioning between a pair of Wi-Fi devices without third party support. The Inventors have designed a set of algorithms to overcome the above limitations and measure the time-of-flight at sub-nanosecond accuracy using off-the-shelf Wi-Fi cards. This system, called Chronos, achieves accurate device-to-device localization without any support from the infrastructure, including the location of access points.

Technology

The Inventors’ approach is based on the observation that a very wideband radio (e.g. a few GHz) can allow time-of-flight measurement at sub-nanosecond accuracy. While each Wi-Fi frequency band is only tens of Megahertz wide, there are many such bands that together span a very wide bandwidth. Their solution therefore collects measurements on multiple Wi-Fi frequency bands and stitches them together to give the illusion of a wide-band radio. Their key contribution is an algorithm that achieves this, despite the fact that Wi-Fi frequency bands are non-contiguous, and in some cases, a few Gigahertz apart.

Chronos is a software-only solution that demonstrates the performance and practicality of their design by harnessing these algorithms to enable a pair of commercial Wi-Fi devices to locate each other without any support from the infrastructure. Chronos may be applied to personal drones that follow a user around and capture videos of their everyday indoor activities. Such drones can help monitor fitness, activities and exercise of users at home, work or the gym. Chronos allows a personal drone to maintain the best possible distance relative to its user to take optimal videos at the right focus. It achieves this by using the Wi-Fi card on the drone to locate the user’s device.

Advantages

- Chronos is the first RF-based positioning system that can measure sub-nanosecond time of flight on commercial Wi-Fi cards, estimating device-to-device distance measurements without...
any infrastructure support.
- System operates on typical 2/3-antenna Wi-Fi receivers, yet delivers state-of-the-art localization accuracy.

**Categories For This Invention:**

Computer Sciences & Information Technology  
Communication & Networking

**Intellectual Property:**

Sub-decimeter radio frequency ranging  
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Sub-decimeter radio frequency ranging  
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**Inventors:**

Dina Katabi  
Swarun Kumar  
Deepak Vasisht

**Publications:**

Sub-Nanosecond Time of Flight on Commercial Wi-Fi Cards  
arXiv  
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**External Links:**

Networks@MIT  
http://groups.csail.mit.edu/netmit/wordpress/

**Image Gallery:**

![Image of a drone with a person controlling it with a string]