Fast and accurate synchronization in the 'blink' of an eye

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Credit: Vera Kratochvil/public domain

"Let's synchronize our watches." It's the classic line before a group goes out on a mission. We are all familiar with the concept of synchronized clocks - less known, but equally important, is that wireless devices need to be synchronized too.

However, instead of requiring a precision of minutes, wireless devices

have to make their clocks match within very small fractions of a second. This so-called "clock synchronization" is needed for a large range of purposes - from increasing cellphone coverage, to increasing data speed rates, to enabling precision localization in places where GPS is not available. Some of these activities require synchronization within "only" a millionth of a second, a requirement that has been achieved by a variety of methods.

One nanosecond, a billionth of a second, is how long it takes light to travel over one foot through the air. It is at this focused level that researchers have competed to develop solutions to push synchronization to a billionth of a second, or what is known as "nanosecond accuracy." Synchronizing a whole network of wireless devices to such accuracy would enable a host of new possible applications, from precise localization to energy-efficient transmission for "internet of things" sensor networks. However, it is remarkably hard to achieve such a level of synchronization, especially when the clocks in the devices are low-cost (and thus not very precise).

Today, at the 2015 IEEE International Conference on Communications, Andreas Molisch, professor of Electrical Engineering at the USC Viterbi School of Engineering, presented the paper, "Experimental Demonstration of Nanosecond-Accuracy Wireless Network Synchronization," which he co-authored with Marcelo Segura and S. Niranjayan, former post-doctoral students at USC, and Hossein Hashemi, also professor of Electrical Engineering at USC Viterbi. The researchers experimentally demonstrate the first wireless network synchronized with nanosecond accuracy.

Segura, Niranjayan, Hashemi, and Molisch have developed a prototype, consisting of four nodes that synchronize to each other with an accuracy of approximately three nanoseconds. They also introduced a scalable protocol, which they call the "Blink" algorithm, that extends the same

accuracy of the current small-size prototype (in this case, four wireless devices) to hundreds or even thousands of wireless devices.

"Previous research has addressed precision synchronization, but, in the publically available literature, nanosecond accuracy was achieved only by connecting devices via cables, and only between few wireless devices. Even though GPS is widely used and is considered very precise, it does not easily provide this level of accuracy, and cannot be used in many indoor settings," Hashemi said.

"Our group's "Blink" protocol will allow for wireless transmission over longer distances with less energy and stands to improve the overall efficiency of wireless networks," said Molisch.

With this enhanced technology, the authors believe that applications such as coordinated signal jamming of enemy military receivers; extremely precise localization; coordinated navigation, tracking, and operation of UAVs; and distributed beam forming will all become realistic possibilities.

While this work has considerable applications for the military, it also has indications for other instances in which increased precision is necessary such as communication among a group of driverless cars to share location information. Other possible applications include helping a person with limited sight navigate an indoor physical space, or providing a map for robots employed in the home or in industrial settings.

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