Wi-Fi technology with fibre-optic-like performance for Industry 4.0

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ALBA Synchrotron. Credit: Sergio Ruiz

Despite significant advances in wireless technology, the manufacturing industry continues to turn to wired forms of communication such as Ethernet or fiber optics for its most critical tasks. A new study by Cristina Cano and the full professor Xavier Vilajosana, researchers from the Wireless Networks (WiNe) group at the Internet Interdisciplinary Institute (IN3), opens the door to the use of wireless technologies with power and reliability that are comparable to fiber optics and that could replace cabled connections. The research project, published in the journal IEEE Transactions on Wireless Communications, has created the first parameterization of a millimeter-band signal propagation model, a wireless technology capable of transmitting a huge amount of data per second, in an industrial environment. According to the researchers, this new model is the first step towards understanding how this type of signal behaves in an industrial plant and could have a significant impact on the development of Industry 4.0.

Cristina Cano said: "This study is aimed at making communication less expensive and more flexible by incorporating mobile devices into the manufacturing process, something that could be very useful in moving towards Industry 4.0, since it allows, for example, connecting freely movable robotic arms to the production process or establishing communications for data reporting, and controlling or stopping the different components of the process in an emergency. But it could also allow the worker to be a part of the process."

A unique study at the ALBA synchrotron

Before implementing millimeter bands in industrial settings, it is necessary to understand how they propagate in such a distinctive environment. There are currently several propagation models of this type of high-frequency signal, but none in industrial facilities. Cano said: "A model is a representation of reality that, using equations, allows us to predict what will happen to the signal in each environment. There are several models for millimeter bands in office and urban settings, but there are hardly any in industrial settings. These sorts of facilities differ in many ways which could interfere with the behavior of the wireless signal, such as the height of the ceiling, the material of the walls and floors, or the type of machinery they contain. Our research has allowed us, for the first time, to establish the parameters for an industrial environment."

The researchers were able to measure the behavior of this type of signal at the ALBA synchrotron, an electron accelerator located in Barcelona that enables researchers from all over the world to carry out experiments using synchrotron light, chosen because its facilities have characteristics that resemble different industrial environments in large production plants, such as refrigeration facilities, server rooms or experimental halls. "It is very difficult for the scientific community to access a manufacturing plant for testing, which is why we believe that this type of model has taken so long to be parameterized. We have been able to advance in this investigation thanks to the ALBA synchrotron, which allowed us access to its facilities. These facilities are very similar to those that we might find in an industrial setting and, also, since we carried out the tests when the accelerator ring was stopped, we were able to access the interior and experiment with the signal in these bands in such a specific environment. We believe that it has been a unique opportunity," explained the researcher.

By measuring in this environment we have been able to verify that typical surfaces in industrial plants, such as reflective pipes, are very beneficial for this type of communication, since they allow the signal to travel along various paths and reception is reinforced, allowing greater coverage. "Specifically, we were able to establish a 110-meter link, the largest communication link achieved with the IEEE 802.11ad standard to date," highlighted the researcher.

Model accessible to the research community

This model is the first step toward understanding how this type of signal behaves in this environment, but protocols must be established to guarantee the reliability required for this sort of communication by the manufacturing industry in its critical processes. The researcher said: "The research in this field can be applied to replace cables in the monitoring processes of production lines where very quick and reliable decisions have to be taken."

She continued: "For this reason, we must be able to guarantee that when an emergency message is sent to stop the production process, it arrives in the required time and its reception is highly reliable. Otherwise, if the message is lost or arrives late, the consequences could be disastrous."

In order to expedite the drafting of these protocols, the new model is accessible to the entire research community. By way of conclusion, Cano said: "The parameters that we provide in the article are useful to predict how the signal will behave in an industrial environment. They can, for example, be configured in a simulator to simulate different configurations and obtain a result that reflects the real situation. In this way, it can help other researchers to design protocols that guarantee the correct functioning of the network."

More information: Cristina Cano et al. A Channel Measurement Campaign for mmWave Communication in Industrial Settings, *IEEE Transactions on Wireless Communications* (2020). DOI: 10.1109/TWC.2020.3024709

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