TECH NOTE #120:: Using WLAN for Measurement Telemetry

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Abstract

This Tech Note describes why WLAN is one of the most suitable wireless network technologies for large scale measurement and telemetry applications. It will show its potential, advantages and challenges, as well as how it's already used in real life applications.

Wireless network standards

When you want to transfer data wirelessly, there are many options. WLAN is one wireless network standard but you also have, for example, Bluetooth, Zigbee, near field inductive and others. They all have pros and cons, and you need to select the most appropriate technology for your application.

WLAN is a common technology and has the advantage that a lot of different devices such as routers, laptops and smartphones can already communicate via WLAN and send a large amount of data. But sending a large amount of data requires a large amount of electrical energy, and requires a power connection or a battery.

Here, **Bluetooth** is a good alternative to WLAN as the energy consumption is low, making it a very common network for mobile phones or mobile speakers for point to point connection to different devices. But it has the disadvantage of a low range. Outdoors the range can be up to 50 m, but in buildings the range is only about 10 m. Another disadvantage is that you cannot expand your network with other devices, because in a Bluetooth network a device is not able to take data from one device and pass it to another device.

When your application requires low energy consumption and an expandable network, **Zigbee** is a good choice. Zigbee is a common technology when it comes to Smart Home low data throughput solutions.

WLAN standards

The WLAN standards are set by the IEEE (Institute of Electrical and Electronics Engineers). The IEEE is responsible for all the WLAN standard requirements, also when it comes to security and encryption (WEP, WPA, WPA2, WPA3). All WLAN standards are bundled in **IEEE 802.11** plus additional letters for the variations from this standard, for example, IEEE 802.11ac. (Generally, the letters signify the speed of the network, where ‘a’ is the lowest speed, working up to ‘n’ (for example) which is a higher speed.)

Almost all mentioned standards have a minimum range of 30 m. The main features of WLAN standards are speed and frequency. Speed tells you about the amount of data a network can transmit. This is calculated in Mbps (megabits per second). Frequency tells you what radio frequency the network is carried over, typically 5 GHz (gigahertz) or 2.4 GHz.

The following table highlights the characteristics of a selection of 802.11 WLAN standards:

Name	Speed	Frequency	Reach / Range (indoor/outdoor)
802.11a	6 to 14 Mbps (max 54 Mbps)	5 GHz	35 m/120 m
802.11b	11 Mbps	2.4 GHz	38 m/140 m
802.11g	54 Mbps	2.4 GHz	38 m/140 m
802.11n	100 Mbps	2.4 and 2.5 GHz	70 m/250 m

If a router supports different network types, they are always listed. For example, when the networks 802.11ac, 801.11ad, 802.11abg are listed, it means that each of these variations is supported by this specific device.

You might also want to send or receive information securely via WLAN. Different security algorithms have been developed to protect the wireless data transfer. The most common wireless security protocols are **WEP, WPA, WPA2**.

WEP (Wired Equivalent Privacy) was established in 1999. But it was barely configurable, its security level was low, and it was abandoned in 2004. **WPA** (Wi-Fi Protected Access) came as a temporary enhancement for WEP, but it was still hard to configure, and the overall security level had only improved a little. In 2004, **WPA2** (Wi-Fi Protected Access version 2) was established. Its main improvement was the use of **AES** (Advanced Encryption Standard), a standard used by the U.S. government for encrypting information classified as top secret. The security level is excellent but not a hundred percent – as we all know, that is impossible. The configuration is easy as well.

Development of WLAN

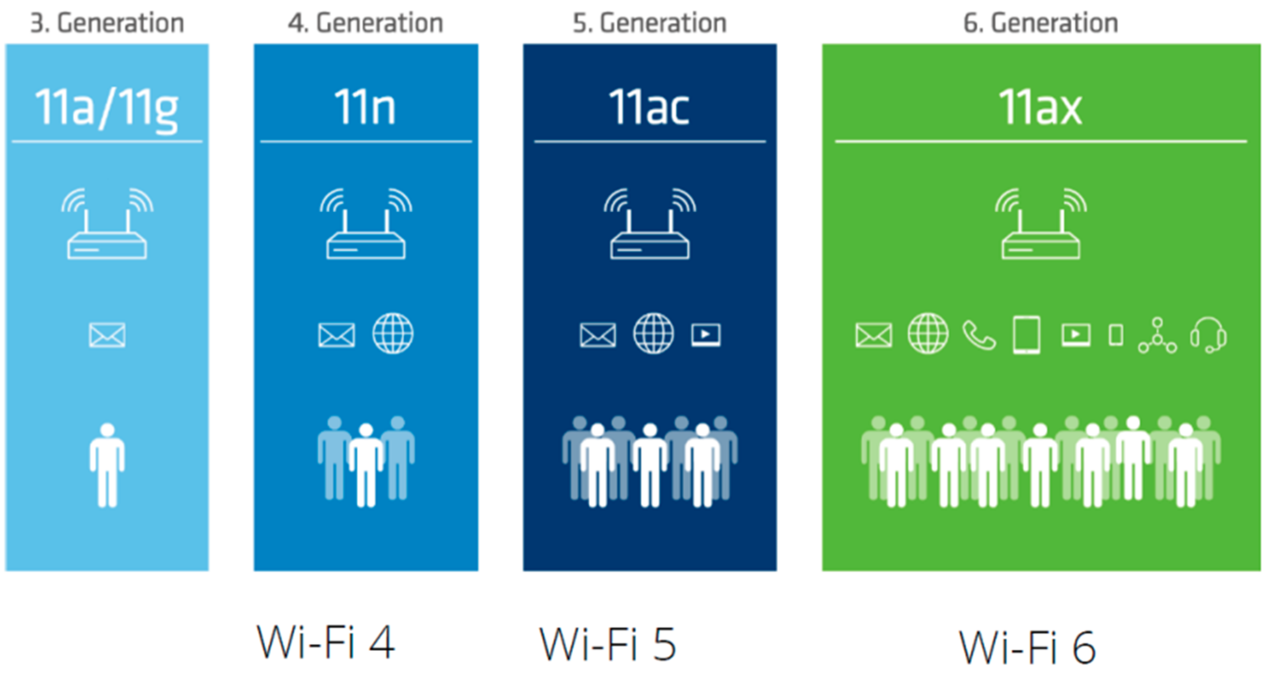
Over time and with a rising number of WLAN standards a new naming convention were established, in order to make it easier for consumers to understand. So, instead of “802.11b” it’s just now “WiFi 1”.

WiFi standards

WiFi 1	802.11b
WiFi 2	802.11a
WiFi 3	802.11g
WiFi 4	802.11n
WiFi 5	802.11ac

The development of wireless technology will not stop, **IEEE 802.11ax** or better still **WiFi 6** is already knocking on the door. nThe new generation of WLAN standards will be relevant specially for industrial applications. When it comes to IoT and Industry 4.0, WiFi 6 not only offers a very high speed (~600 Mbps in a real-world situation) with 6 GHz, but also a new carrier frequency in addition to the common frequencies 2.4 and 5 GHz.

Of course, it provides backwards compatibility. The bandwidth is split into 256 subchannels (WiFi 5 only had 64), which helps to avoid collisions when there is a high number of other networks, as there are, for example, in large companies. WiFi 6 also supports advanced encryption and authorization systems.



WLAN in measurement technology

When it comes to test and measurement applications, requirements are higher than for private or typical business applications. The network needs to be

- Fast with high data throughput
- Time synchronized, so that all devices and inputs acquire their data with the given time stamp
- Reliable and without interruptions
- Securely encrypted
- Flexible in distance between participants – from a few centimetres to kilometres

The big advantage of WLAN is obviously that you don't need a physical connection such as a cable. This is mostly noticeable when you have moving parts in your application. One of the examples below shows a measurement application on an extending crane. A WLAN connection means an easy solution for the problem that may appear when you want to cover a translational varying distance with cables. When your application includes rotating parts, a wireless connection is even more useful. For example, when you want to apply some sensors such as strain gauges or acceleration transducers on a wheel, cabled connections via a rotary joint are expensive and error prone.

And don't just think point-to-point wireless. WLAN allows for mesh networks and building up more intelligent networked areas over several floors or in large areas with buildings and towers. With access points, repeaters and routers, large networks with multiple nodes can be built – all wirelessly connected to each other.

When setting up a measurement system with a WLAN connection, you should always keep in mind that data theft, for example, might be an issue. In comparison, a cable connection is quick, easy and very safe.

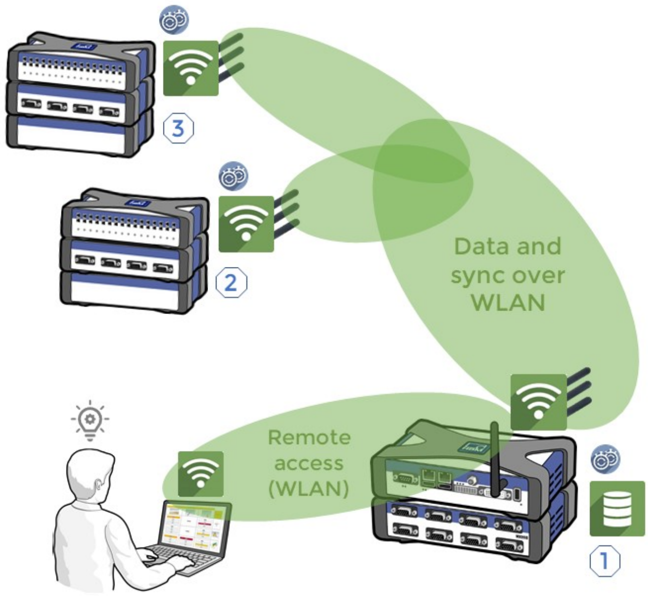
Depending on how critical your application is, you might have to make sure that the network is protected by a secure protocol such as WPA2. In complex applications, expert help is needed to set up your WLAN network, adjusting the antennas and the energy in an appropriate and reliable way, so that your network won't be disturbed by others or disturb other networks.

The overall WLAN network also needs to be time synched. There are many time sync technologies available, but the most established one in the Ethernet WLAN world is still **NTP (Network Time Protocol)**. NTP uses the User Datagram Protocol (UDP) to receive the UTC (Coordinated Universal Time) and syncs all devices in a range of 0.1 ms to 10 ms, depending on several parameters such as distance between the antennas and objects that can interfere with the signal between sender and receiver. NTP also works with varying distances or moving parts when you have the right experts on board. HBK has a strong partner here.

Examples for WLAN and measurement technology

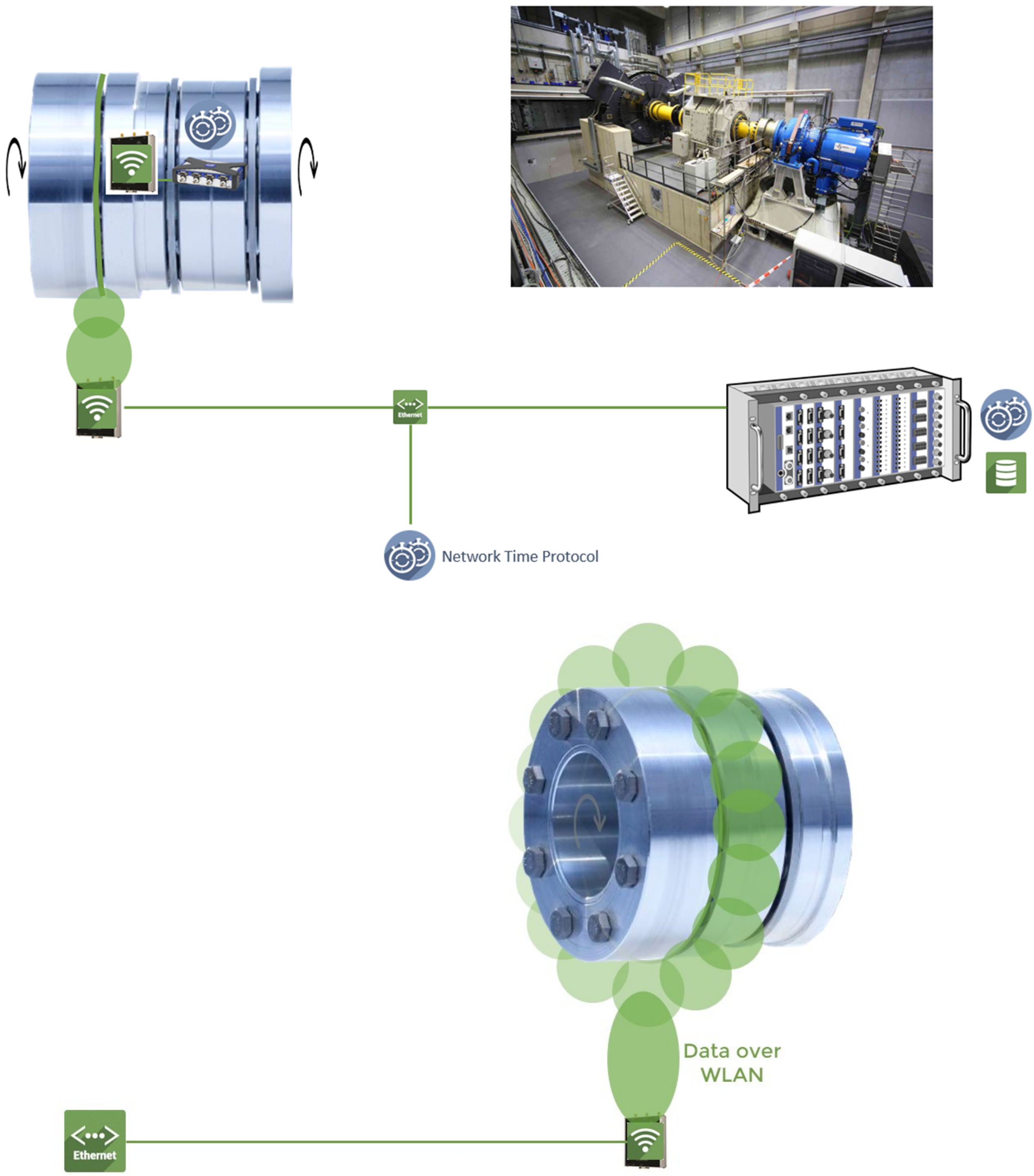
Load measurement at Tadano crane manufacturer and supplier

- Data transfer via cable is unsuitable due to the crane jib extension during operation
- All modules are connected via WLAN and time synched via NTP
- WLAN bridges with three antennas creating several radio beams and enabling a stable connection over long and varying distances
- Power in each station is supplied by battery, good for several hours of testing
- Remote access to the data recorder from a notebook is done via cable or wirelessly during setup time and operation for live data display



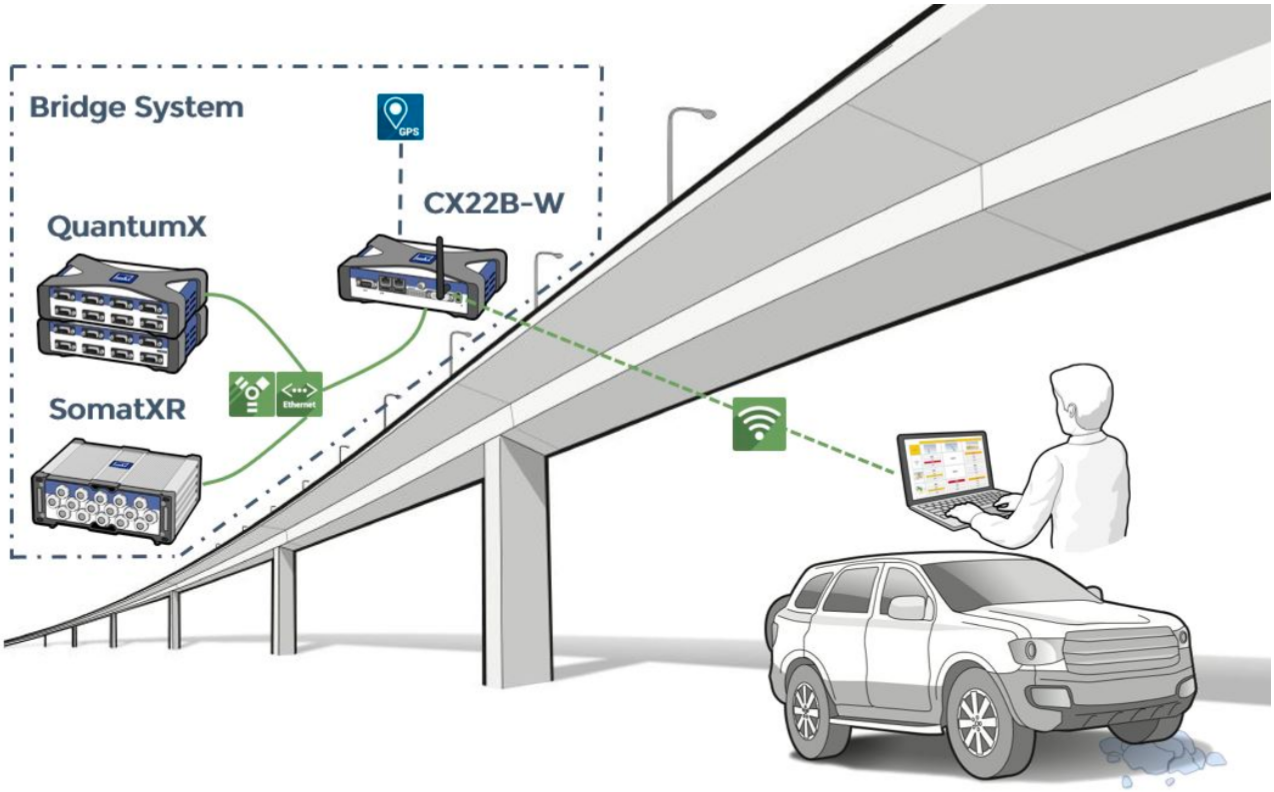
Wind turbine gondola test stand and torque measurement at RWTH Aachen

- Highest precision was requested, soMX238B with 25 ppm accuracy was chosen
- WLAN data transfer over radiated mode cable (leaky cable) was the best choice
- Leaky cable is installed around the flange and works like hundreds of small antennas
- Fix installed WLAN bridge ensuring no data losses
- Complete setup in time sync (static and rotary part)



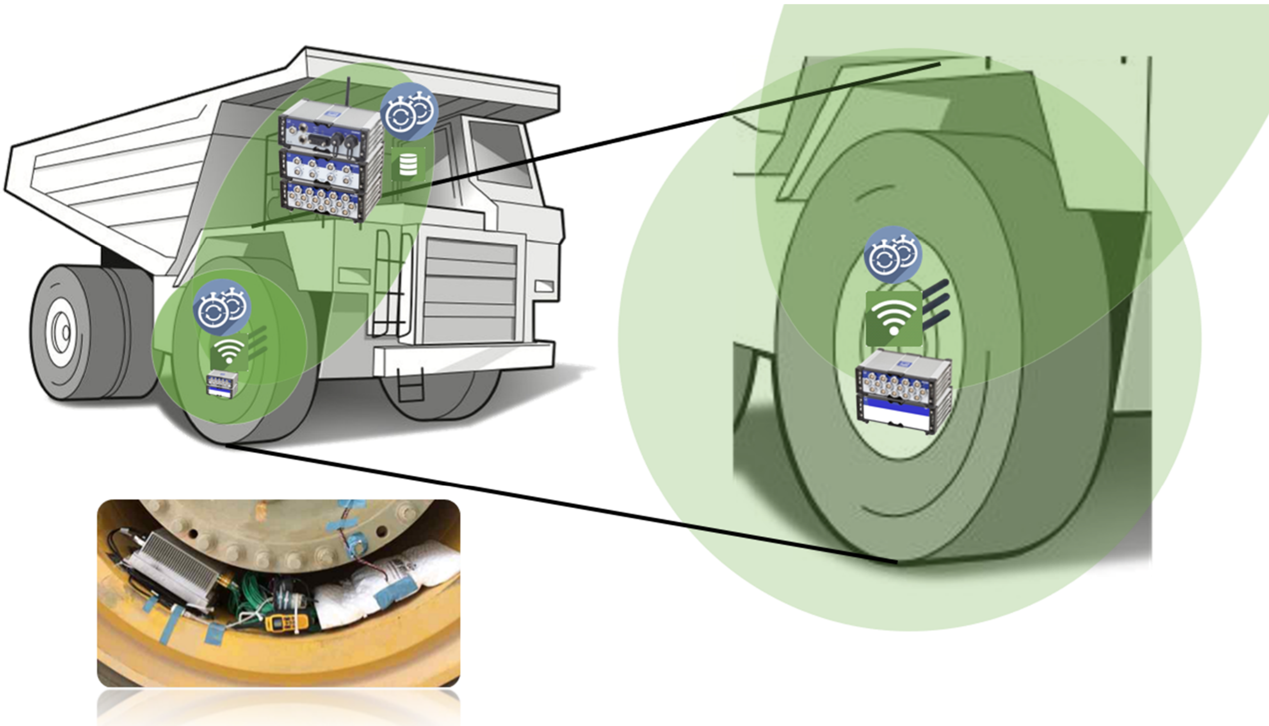
Remotely accessing monitoring station installed in South Africa

- Data transfer via cable not possible because of distance to installed recorder
- No mobile network in that area
- Monitoring station owner downloads data to notebook on a regular basis



Wheel force and acceleration measurement at GE Transportation

- Data transfer via cable not possible in rough terrain, transferring data from the rotating part to the vehicle
- Modules are connected and time synched over a WLAN and NTP
- WLAN bridges secure connection in operation
- A battery supplies power and is installed in the wheel
- Remote access via WLAN possible



There are many more applications for wireless system setups with QuantumX/SomatXR instruments. Further examples include:

- Mobile testing of super long railway vehicles transporting iron ore with a WLAN link over 1 km
- ADAS/autonomous mobile testing linking two or more vehicles to each other exchanging position data
- Ski lift cabin measurement time synched with base and mountain station measurements
- Structural health monitoring of bridges, tunnels and in mining areas
- Oil and gas pipeline monitoring

We hope this Tech Note is helpful for your decision making when it comes to your next project.

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