SKIP THE CABLES

Wireless Industrial Communication Networks

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Wireless Industrial Communication Networks

Industry 4.0 relies on communication with all components in industrial production. One method for connecting components for the purpose of processing data, is by using wireless connections.
When you think about the vast number of sensors and actuators predicted to be used in future industrial manufacturing, wired systems soon reach their limits. Wireless methods cut out cabling and allow us to capture and distribute data on the move. With wireless systems, we can measure, manage and locate moving objects.

At first glance, the use of wireless technologies in industrial production seems to be a matter of course, the advantages overwhelming; fast, flexible and inexpensive compared to wired installations. HMS Networks' annual report on the industrial network market (Fig. 1) reveals the actual use of wireless technologies. The 2022 study includes estimated market shares (7%) and the growth rate (8%) of wireless technologies. They are "emerging, but the effects of 5G are yet to come".

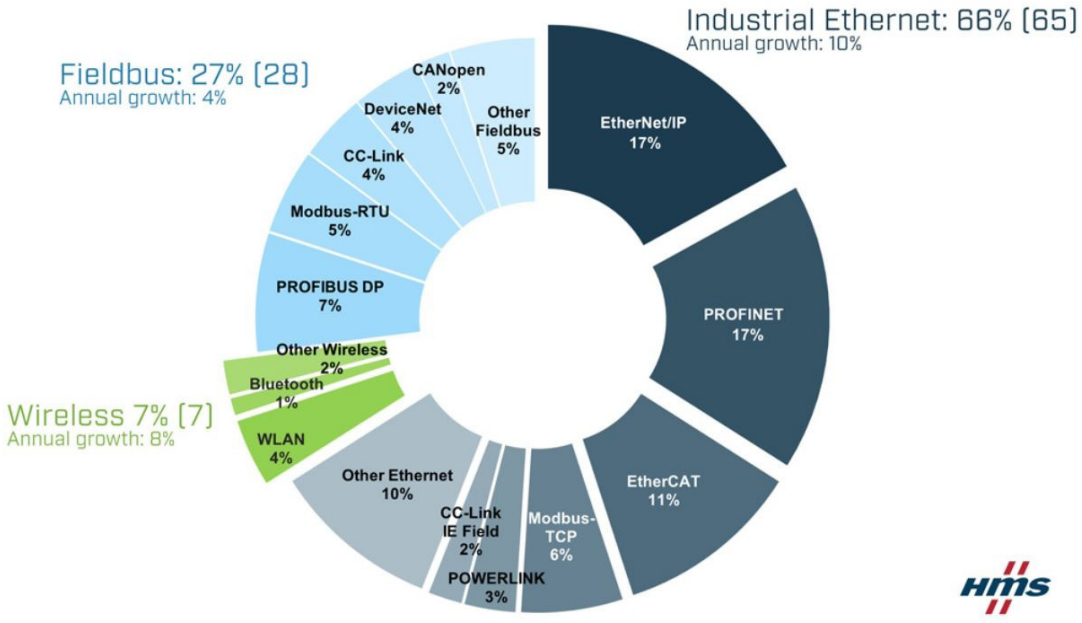

Fig. 1. Market share in 2022 according to HMS Networks – Fieldbus, Industrial Ethernet and Wireless. (Image: HMS Networks)

But it would be a fatal error to wait for the "universal 5G user": The requirements are there, and fortunately the market offers plenty of practicable wireless technologies that meet the criteria in the industrial sector. The areas of application vary, from the transmission of a sensor reading to a network hosting hundreds of participants. This results in a whole range of different wireless technologies.
Fig. 2 shows a selection of market players, the ranges and data rates of their processes.

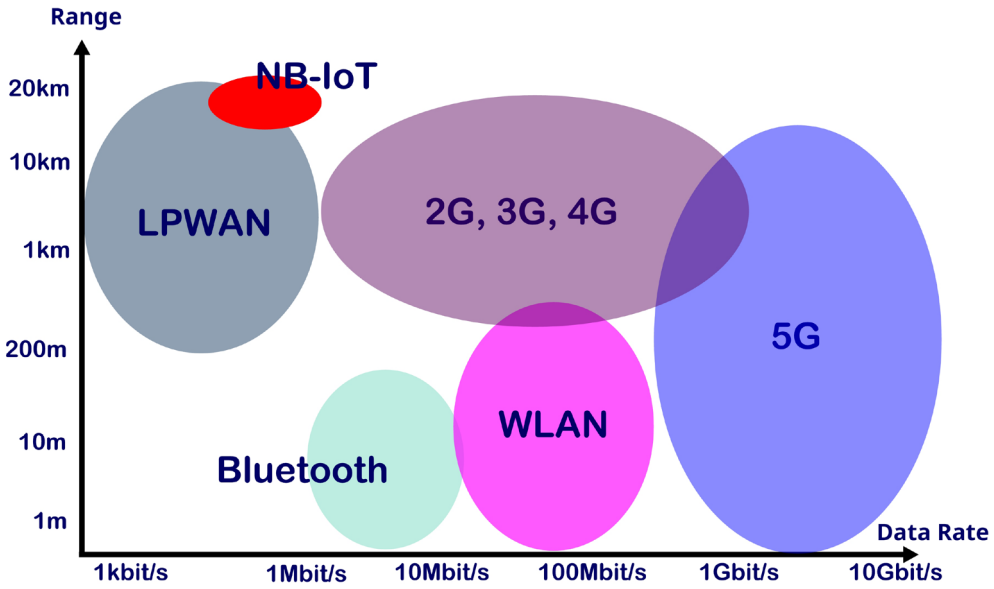

Fig. 2. Ranges and data rates of common wireless technologies. (Image: channel-e)

LOW POWER WIDE AREA NETWORKS

Low Power Wide Area Networks (LPWAN) are wireless networks designed for low energy consumption, small amounts of data and long transmission distances (several kilometres) or for use inside buildings.

LPWAN technologies can be used to create networks on a national and international scale. Typical applications include IoT tasks such as monitoring and control over longer distances and industrial communication with machines or sensors.

LPWAN standards include NB IoT (Narrow Band Internet of Things), Sigfox and LoRa (Long Range).

Sigfox is a French company founded in 2010 that operates a global low power wide area network with proprietary technology under the same name. Sigfox claims to be present in 75 countries. The technology operates in a licence-free frequency range at 868 MHz or 902 MHz. Sigfox bridges maximum distances of up to 50 kilometres. The data rate is a few hundred bits per second.

Fig. 3. The Telemecanique Transceiver uses low-power LPWAN technology and operates over the Sigfox communication network. (Image: RS)

LoRa is an open wireless standard and uses only Semtech chips in its transmitters and receivers, which is why the use of a LoRa-based network (LoRaWAN) depends on a single manufacturer. The data transmission frequencies differ by region. Europe uses the frequencies 433.05 to 434.79 MHz and 863 to 870 MHz. Australia and North America use the frequency 915 MHz, while India transmits over 865 to 867 MHz and Asia 923 MHz. The range can be up to 13 km (rural areas). The power consumption of a LoRa chip is 10 mA and 100 nA in sleep mode. Depending on the application, the battery life is between 2 and 15 years.

Fig. 4. 868-MHz-ISM-Band-Transceiver-Evaluation Module from Semtech with LoRa technology. (Image: RS)

NB-IoT- NarrowBand-IoT is a special LTE specification (LTE-Cat-NB1) and is offered by LTE network operators for IoT applications. NB-IoT specifications boost the range and signal levels of the mobile network. At the same time, the complexity of the wireless module is reduced, which means, among other things, that the maximum transmission rates in the transmission and receiving direction are limited (250 kBit/s). However, the network coverage is ten times better, which improves building penetration.

Fig. 5. Sentrius MG100 from Laird Connectivity (Image: RS)

WI-FI

Special proprietary industrial solutions are out there for the use of a WLAN network in an industrial environment, and these are marked by their higher performance, availability and robustness. They use optimised protocols, enabling more efficient channel allocation, for example, better client management. Industrial WLAN solutions available on the market according to the Wi-Fi 5 or IEEE 802.11ac standard achieve a gross data rate of between 150Mbit/s and 1.733Gbit/s.

With IEEE 802.11ax-compliant Wi-Fi 6, there is a standard that should further increase the performance of today's WLAN communication technology. Wi-Fi 6E takes things up a level, transmitting over the 6 GHz band. Wi-Fi 6 achieves data rates of several GBit/s, it also has a greater transmission range. Another feature is the energy-saving function Target Wakeup Time (TWT).

WLAN is also suitable for localisation, commonly using field strength and angle-based localisation methods.

Currently pending, the IEEE 802.11be standard (Wi-Fi 7) is expected to enable a maximum data rate (peak data rate) of up to 30GBit/s. This standard, also known as Extremely High Throughput (EHT), is designed to use the 6GHz band and support Time Sensitive Networking (TSN) with a latency of less than 5ms and reliability of up to 99.99%. (In other words, 0.01% of the sent data bundles are not transmitted correctly).

BLUETOOTH

Bluetooth is a short-range technology operating in the ISM band (Industrial, Scientific and Medical Band) between 2.402GHz and 2.480GHz and can be used in any country in the world without further certification. The wireless system uses the frequency-hopping method, which selects one of up to 79 wireless channels for each data bundle, so that interference is minimal. Bluetooth is a practical solution suitable in industrial applications for bridging ranges of up to around 200m.

Fig. 6. The Silicon Labs Direction Finding Antenna Array used in SiLabs' Bluetooth Direction Finding solution. (Image: Press image Silicon Labs)

Fig. 7. The EFR32BG22 module is used in the Silicon Labs Bluetooth Direction Finding solution. (Image: Press image Silicon Labs)

Some of the almost 'built-in' functions of Bluetooth technology prove to be particularly useful for industrial use.

- As of Bluetooth version 5.1, we can enjoy 'location services' (see RS article), used for navigation and positioning applications at an accuracy of a few centimetres (Fig. 6 and Fig. 7).
- Another function is the PAN profile (Personal Area Network), which enables transparent Ethernet transmission. This technology is also suitable for protocols such as Modbus TCP, Profinet RT and Profisafe. It is a classic Bluetooth profile from Bluetooth standard 2.1.

- Bluetooth Low Energy comes with the Generic Attribute Profile (GATT). A GATT server provides data in a structure that a GATT client can query.
  For example, a GATT server may be used as a sensor to record measurements and store the results in a certain structure (including the way in which this measurement is to be handled). The GATT client, such as a smartphone app, can then come along, connect to the sensor and retrieve a specific measurement from its data structure. This method also works vice versa, e.g. to operate an actuator.
- Bluetooth Mesh is a technology in which each device acts as a relay station for all other devices, increasing their wireless range.

5G

You could be forgiven for calling the 5G wireless standard the 'Holy Grail' of Industry 4.0. It is, after all, the ultimate in terms of performance.
5G is the successor to the 4G or Long-Term-Evolution (LTE) Advanced standard. In industrial applications, the 5G standard offers three key advantages compared to its predecessors:

- A higher bandwidth of up to 20GBit/s in the downlink and 10GBit/s in the uplink (eMBB, enhanced Mobile Broadband)
- Higher device density of up to 1,000,000 devices per square kilometre (mMTC, massive Machine Type Communication)
- Lower latency of up to 1ms combined with Ultra-Reliable Low Latency Communication (URLLC)

It should be noted that not all performance characteristics of 5G can be met the same time or, at least, certain prerequisites must be met. Nevertheless, there is plenty of potential for industry in the implementation and improvement of Industry 4.0 solutions. 5G acts as an enabler technology, allowing the implementation of already known possibilities while unlocking brand new potential. 5G can help us locate objects by means of triangulation, for example, and can even be used in covered areas.

While local ranges are provided for company-owned campus networks in Germany, the framework conditions differ greatly internationally. Some countries do not offer regulation of 5G networks or do not allow for company-owned campus networks. For global companies, this makes it difficult to transfer 5G-based production automation concepts developed in Germany to international production facilities.