



2. Communications Industrial IoT

Wired vs Wireless Technologies
RF Frequency Comparisons, WAN vs LAN

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Wired Technologies

- ▣ A wired setup uses physical cables to transfer data between different devices and computer systems
- ▣ A wired network is a common type of wired configuration
 - ▣ Most wired networks use Ethernet cables to transfer data between connected PCs
 - ▣ In a small wired network, a single router may be used to connect all the computers
 - ▣ Larger networks often involve multiple routers or switches that connect to each other
 - ▣ One of these devices typically connects to a cable modem

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Wireless Technologies

- ❑ Wireless technology refers to technology that allows us to communicate without using cables or wires
- ❑ Wireless technology includes RF (Radio Frequency) and IR (InfraRed) waves
- ❑ Two main types of wireless technology:
 - ❑ Local Wi-Fi networks
 - ❑ Cellular networks (mobile phone networks)
 - ❑ This technology allows electronic devices to communicate over long distances

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Wired vs Wireless Technologies

Categories	Wired	Wireless
General	<ol style="list-style-type: none"> 1. Proximity to the router is required 2. Increased security 3. Greater control 	<ol style="list-style-type: none"> 1. More freedom (within range) 2. Flexibility 3. Security risks
Installation	<ol style="list-style-type: none"> 1. Every device must be hard-wired 2. A time-consuming process 3. Easy to configure 	<ol style="list-style-type: none"> 1. Quick installation 2. More layout options 3. Two configuration options
Cost	<ol style="list-style-type: none"> 1. Less expensive 2. Requires more hardware 3. Nominal software costs 	<ol style="list-style-type: none"> 1. Pricier investment 2. Requires fewer accessories 3. Doesn't require special software
Reliability	<ol style="list-style-type: none"> 1. Consistently reliable 2. Decades of use 3. Failed cables might present issues 	<ol style="list-style-type: none"> 1. Improved reliability over older models 2. Multi-functionality could mean less reliability 3. Interference could cause issues
Performance	<ol style="list-style-type: none"> 1. Superior performance 2. Sufficient for multiple uses 3. Hubs could limit speeds 	<ol style="list-style-type: none"> 1. Less bandwidth 2. Multiple devices decrease speed 3. Accessories could improve speed
Security	<ol style="list-style-type: none"> 1. Doesn't support firewalls 2. Devices can use firewall protection 3. Cannot hack wirelessly 	<ol style="list-style-type: none"> 1. Built-in firewall capability 2. Can be intercepted wirelessly 3. Encryption protection is available

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Radio Frequencies

Feature	Sub-1GHz	2.4 GHz	5 GHz
Range	Sub 1 GHz is better Long Range mode can give up to 10km Range	Not as good as 1 GHz Better than 5 GHz	Not as good as the rest
Antenna Size	Higher size	Lower Size than 1GHz	Lower than the rest
Throughput	Lower throughput	higher-throughput data communication compared to sub-GHz systems	The highest throughput
Compatibility	Many Proprietary standards	Many existing standards	??
Interference	Less devices → Less external radio interference	More devices → More Interference	Less devices → Less interference
Reflection	Less susceptible to reflection	More susceptible to reflection than Sub – 1GHz	??
Penetration	Better penetrate through structures along the propagation path	Not as good with obstruction as sub-1GHz Better from 5 GHz	Not as good as the rest

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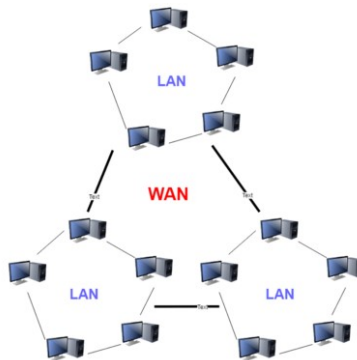
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WAN vs LAN

- ▶ **LAN** (Local Area Network), is a network that covers a small geographical area such as homes, offices, and groups of buildings
- ▶ **WAN** (Wide Area Network), is a network that covers larger geographical areas that can span the globe



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WAN vs LAN (continued)

Advantages of using LAN

- ▣ Cheaper than WANs to both implement and maintain
- ▣ Has high fault tolerance, scalability, security as well as fast and reliable speeds
- ▣ Has higher bandwidth than Wide Area Networks
- ▣ Able to transmit data at much faster speeds
- ▣ More secure than Wide Area Networks
 - ▣ Due to how WANs transmit the data and how far the data would need to travel
- ▣ More control over the network
 - ▣ Owned and maintained by a single organization/entity
- ▣ Mainly use Ethernet technology
- ▣ Use Layer 1 devices (HUB's and repeaters) and layer 2 devices (switches and bridge devices)

Advantages of using WAN

- ▣ Covers a wider area of networks
- ▣ Can be more secure using VPN technology
- ▣ Use layer 3 devices (multi-layer switches and routers)



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WiFi

Standard: Based on 802.11n

- ▣ most common usage in homes today

Frequencies:

- ▣ 2.4GHz frequency band
- ▣ 5GHz frequency band

Range: Approximately 50m

Data Rates:

- ▣ 600 Mbps maximum
- ▣ 150-200Mbps is more typical, depending on channel frequency used and number of antennas (latest 802.11-ac standard should offer 500Mbps to 1Gbps)

- ▣ WiFi offers serious throughput in the range of hundreds of megabit per second, which is fine for file transfers, but may be too power-consuming for many IoT applications



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Ethernet (IEEE Standard 802.3)

- ▣ It defines the number of conductors that are required for a connection, the performance thresholds that can be expected, and provides the framework for data transmission
- ▣ A standard Ethernet network can transmit data at a rate up to 10 Megabits per second (10 Mbps)
- ▣ Strikes a good balance between
 - ▣ Speed
 - ▣ Cost
 - ▣ ease of installation
- ▣ Has wide acceptance in the computer marketplace
- ▣ Can support virtually all popular network protocols

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GSM (Global System for Mobile Communications)

- ▣ **Characteristics:**
 - ▣ A digital mobile network that is widely used by mobile phone users in Europe and other parts of the world
 - ▣ Digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot
 - ▣ Operates at either the 900 MHz or 1,800 MHz frequency band
- ▣ **Has four separate parts**
 - ▣ the mobile device itself
 - ▣ the base station subsystem (BSS)
 - ▣ the network switching subsystem (NSS)
 - ▣ the operation and support subsystem (OSS)
- ▣ **Problems:**
 - ▣ Electronic interference
 - ▣ Because GSM uses a pulse-transmission technology, it is known to interfere with electronics like hearing aids
 - ▣ Bandwidth lag
 - ▣ When using GSM technologies, multiple users access the same bandwidth, sometimes resulting in considerable latency as more users join the network
 - ▣ Limited rate of data transfer
 - ▣ GSM offers a somewhat limited data transfer rate
 - ▣ Repeaters
 - ▣ GSM technologies require carriers to install repeaters to increase coverage.

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