

## Wireless communication

**Wireless communication**, or sometimes simply **wireless**, is the transfer of information or power between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio waves. With radio waves distances can be short, such as a few meters for Bluetooth or as far as millions of kilometers for deep-space radio communications. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Other examples of applications of radio *wireless technology* include GPS units, garage door openers, wireless computer mice, keyboards and headsets, headphones, radio receivers, satellite television, broadcast television and cordless telephones.

Somewhat less common methods of achieving wireless communications include the use of other electromagnetic wireless technologies, such as light, magnetic, or electric fields or the use of sound. The term *wireless* has been used twice in communications history, with slightly different meaning. It was initially used from about 1890 for the first radio transmitting and receiving technology, as in *wireless telegraphy*, until the new word *radio* replaced it around 1920. The term was revived in the 1980s and 1990s mainly to distinguish digital devices that communicate without wires, such as the examples listed in the previous paragraph, from those that require wires or cables. This became its primary usage in the 2000s, due to the advent of technologies such as LTE, LTE-Advanced, Wi-Fi and Bluetooth.

Wireless operations permit services, such as long-range communications, that are impossible or impractical to implement with the use of wires. The term is commonly used in the telecommunications industry to refer to telecommunications systems (e.g. radio transmitters and receivers, remote controls, etc.) which use some form of energy (e.g. radio waves, acoustic energy,) to transfer information without the use of wires.<sup>[1]</sup> Information is transferred in this manner over both short and long distances.

### 2G (or 2-G)

**2G (or 2-G)** is short for second-generation cellular technology. Second-generation 2G cellular networks were commercially launched on the GSM standard in Finland by Radiolinja(now part of Elisa Oyj) in 1991. Three primary benefits of 2G networks over their predecessors were that phone conversations were digitally encrypted; 2G systems were significantly more efficient on the spectrum enabling far greater wireless penetration levels; and 2G introduced data services for mobile, starting with SMS text messages. 2G technologies enabled the various networks to provide the services such as text messages, picture messages, and MMS (multimedia messages). All text

messages sent over 2G are digitally encrypted, allowing the transfer of data in such a way that only the intended receiver can receive and read it.

After 2G was launched, the previous mobile wireless network systems were retroactively dubbed 1G. While radio signals on 1G networks are analog, radio signals on 2G networks are digital. Both systems use digital signaling to connect the radio towers (which listen to the devices) to the rest of the mobile system.

With General Packet Radio Service (GPRS), 2G offers a theoretical maximum transfer speed of 50 kbit/s (40 kbit/s in practice). With EDGE (Enhanced Data Rates for GSM Evolution), there is a theoretical maximum transfer speed of 1 Mbit/s (500 kbit/s in practice).

The most common 2G technology was the time division multiple access (TDMA)-based GSM, originally from Europe but used in most of the world outside North America. Over 60 GSM operators were also using CDMA2000 in the 450 MHz frequency band (CDMA450) by 2010.

### **3G**

**3G**, short for third generation, is the third generation of wireless mobile telecommunications technology. It is the upgrade for 2G and 2.5G GPRS networks, for faster internet speed. This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV.

3G telecommunication networks support services that provide an information transfer rate of at least 0.2 Mbit/s. Later 3G releases, often denoted 3.5G and 3.75G, also provide mobile broadband access of several Mbit/s to smartphones and mobile modems in laptop computers. This ensures it can be applied to wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV technologies.

A new generation of cellular standards has appeared approximately every tenth year since 1G systems were introduced in 1979 and the early to mid-1980s. Each generation is characterized by new frequency bands, higher data rates and non-backward-compatible transmission technology. The first 3G networks were introduced in 1998 and fourth generation 4G networks in 2008.

### **4G**

**4G** is the fourth generation of broadband cellular network technology, succeeding 3G. A 4G system must provide capabilities defined by ITU in IMT Advanced. Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, and 3D television.

The first-release Long Term Evolution (LTE) standard (a possible 4G system that hasn't been implemented yet) has been commercially deployed in Oslo, Norway, and Stockholm, Sweden since 2009. It has, however, been debated whether first-release versions should be considered 4G, as discussed in the technical understanding section below.

### Technical understandings

In March 2008, the International Telecommunications Union-Radio communications sector (ITU-R) was specified a set of requirements for 4G standards, named the International Mobile Telecommunications Advanced (IMT-Advanced) specification, setting peak speed requirements for 4G service at 100 megabits per second (Mbit/s)(=12.5 megabytes per second) for high mobility communication (such as from trains and cars) and 1 gigabit per second (Gbit/s) for low mobility communication (such as pedestrians and stationary users).<sup>[1]</sup>

Since the first-release versions of Mobile WiMAX and LTE support much less than 1 Gbit/s peak bit rate, they are not fully IMT-Advanced compliant, but are often branded 4G by service providers. According to operators, a generation of the network refers to the deployment of a new non-backward-compatible technology. On December 6, 2010, ITU-R recognized that these two technologies, as well as other beyond-3G technologies that do not fulfill the IMT-Advanced requirements, could nevertheless be considered "4G", provided they represent forerunners to IMT-Advanced compliant versions and "a substantial level of improvement in performance and capabilities with respect to the initial third generation systems now deployed".<sup>[2]</sup>

Mobile WiMAX Release 2 (also known as *WirelessMAN-Advanced* or *IEEE 802.16m'*) and LTE Advanced (LTE-A) are IMT-Advanced compliant backwards compatible versions of the above two systems, standardized during the spring 2011, and promising speeds in the order of 1 Gbit/s. Services were expected in 2013.

As opposed to earlier generations, a 4G system does not support traditional circuit-switched telephony service, but all-Internet Protocol (IP) based communication such as IP telephony. As seen below, the spread spectrum radio technology used in 3G systems is abandoned in all 4G candidate systems and replaced by OFDMA multi-carrier transmission and other frequency-domain equalization (FDE) schemes, making it possible to transfer very high bit rates despite extensive multi-path radio propagation (echoes). The peak bit rate is further improved by smart antenna arrays for multiple-input multiple-output (MIMO) communications.

