Good essay on ultra wide band

Sociology, Communication

Isn’t it a marvel of technology that allows two computers to communicate without wires? At the dawn of the computer era people, for the first time connecting two computers, gave birth to the new phenomenon of computer network that has revolutionized the ways of data exchange between computers. This revolution led to the emergence of many computer networks, that literally entangled offices and homes enthusiasts with wires. There always have been only two primary interfaces to connect your peripherals — IEEE 802. 11 and Bluetooth. IEEE 802. 11 is a wireless LAN standard, i. e., uses a family of relevant network protocols (e. g. TCP/IP), with all the ensuing consequences. Bluetooth 4. 0 cannot boast high data rate as it is just under 1 Mbps, while USB 2. 0 is up to 480 Mbit/s.

The reasons that modern wireless technologies have such a small throughput are: first of all, the small width of the used frequency band. Secondly, its application is not too effective. And although the efficiency of usage of the frequency range depends entirely on the experience of the developers and designers, maximum achievable throughput cannot be infinitely large.

The prospect of applying of broadband technologies that connect PC with peripheral devices has been discussed for many years. In February 2004, on the IDF developer forum, Intel has released details of a new technology and introduced the first chipset designed to work in standard UWB communications (Ultra-WideBand, IEEE 802. 15. 3 a).

The definition of the term " UWB — Ultra Wideband — was first introduced by DARPA agency of the Ministry of defense of the USA in 1990 and was amended by the Federal Communications Commission (FCC) in 2000.

Ultrawide bandwidth (UWB) signals are commonly defined as signals that have a large relative bandwidth (bandwidth divided by the carrier frequency) or a large absolute bandwidth. (Win et al, 198).

These frequencies are used by military and civil radars so it took four years to create the first prototype of this technology. After debating, the developers managed to convince the state authorities that broadband wireless network in this range of short distances does not affect the operation of the radars. (Copps et al. 54).

The use of a wide bandwidth allows UWB to achieve high communication wire-speed up to 480 Mbit/s. However, at very small distances — up to 3 m. At distances up to 10 m technology allows only 110 MB/s. However, the main problem of this technology lies here: the throughput drops sharply with increasing distance, much faster than the wireless network of 802. 11 b/g standard, whose bandwidth is up to 54 Mbps at distances up to 100 m. This is due to the fact that the dispersion of electromagnetic radiation in the air leads to a significant distortion of the wideband signal compared to narrowband. Distortion builds up with distance and, eventually, leads to the fact that the signal at the receiver input has nothing to do with what was emitted by the transmitter.

The advantages of UWB technology

Multiple channels

UWB can simultaneously support hundreds of channels (unlike the three in the 802. 11 b standard and ten in 802. 11 a). This can be compared with driving on a multilane highway which is much easier and better than the single-track road.

Simultaneous networks

The UWB technology can function as a personal area network (Personal Area Network, PAN), local area network and wide area network (Wide Area Network, WAN) at the same time. This is equivalent to the convergence of technologies such as Bluetooth, 802. 11 and 3G networks into a single network with one device. Today this issue is very serious and is very relevant now and will be relevant in the future.

Lower cost and complexity

The device that use high-frequency range, require real radio receiving system, and therefore they are more complex in design and features, their price is higher, and they consume significantly more power. In addition, they are less reliable than UWB devices that operate at levels below the noise level of traditional radio systems, low-power, low-equipment parameters and they only need a few external components.

Global compatibility

Variations in the assignment of radio frequency spectrum in different countries hinder global compatibility for devices that use the radiofrequency spectrum. Without such restrictions, UWB technology provides the preconditions for the existence of a future global compatibility.

Great protection

In addition to the specific nature of the UWB signal and its equipment, devices use UWB signal power almost at the noise level. This ensures protection from transmitting of information signals. UWB is almost impossible to hack, especially on some distance from the functioning device.

This fact makes the UWB communication, perhaps the most secure wireless communication system from the point of view of protection against unauthorized access to information.

Cheap and accurate positioning

The UWB technology offers a cost-effective solution for positioning system with high accuracy when the resolution is less than centimeter. This gives great potential for a variety of location-based applications, as well as short-distance human-machine interfaces.

Does not require compliance with the conditions of direct visibility

Disadvantages

There are a few of them, but they are significant.

First of all, having a wide bandwidth (currently the range of about 3-10 GHz) and high power, signals can have a hindering effect on existing and prospective systems. (Álvarez et al. 1).

Secondly, for the same reason, the system can interfer the signals of other UWB devices.

Finally, the reception of UWB signals is quite complicated due to the very short duration of the signal. To detect the signal (i. e. reception) correlator or matched filter (the first option is preferred) can be used. Without going into details, we should note that the synchronization of reception is a big challenge, which, among other things, requires very accurate and stable oscillator frequencies. Reliable reception requires the increasing power of the transmitted signal and, thus, complicates the whole process.

In addition, this standard implies the use of non-licensed radio spectrum, in which various home appliances, such as a automatic garage locks and car alarms operate. So, protection against interference should be provided for wide dissemination of the standard. One more disadvantage is limitation of transmitter power in the range of UWB that is valid only in the U. S. This is why, the current communication systems that are working on the basis of this standard have a range that is not exceeding 10 meters. As for transferring small amounts of data between household devices, the all trumps are owned by ZigBee Protocol IEEE 802. 15. 4.

Prospects

Manufacturers of equipment associated with this technology hoped this technology would succeed since devices operate in an unlicensed part of the spectrum. But unfortunately, in 2008 the decision of the European Commission set very small limits of power levels and extremely hard mask when using ultra-wide signals because of the possibility of interference to existing technologies. This made UWB technology economically unviable. Some experts believe that this decision was lobbied by mobile network operators to protect the business, others say there is insufficient research on the use of UWB technology.

However, ETSI (the European Institute for standardization in the field of telecommunications) and CEPT (European conference of postal administrations and communication services) continues working in this direction. Now experts on the standardization are conducting studies on harmonization of spectrum across Europe for some applications in the framework of this technology, and then proceed to field trials to determine

safe levels of power and ways of protection from interference. (Di Benedetto, 18)

In August 2012, the CEPT 45 report was published, where the most important application of UWB technology was tracking of objects and determination of their location. It is reported that there are no alternatives to UWB.

What are the applications of UWB technology and in what ranges does CEPT offer?

The UWB device will help to carry out analysis of construction materials. These applications include the discovery of locations and determining the depth of installation of electrical wiring, metal and pipes of all types, detection of water content and salt in the structure of buildings, inspection of quality of materials and work performed.

UWB is indispensable to distinguish objects (e. g., fingers) when working with stationary saws for secure work.

The UWB devices are involved in determining the location of objects and tracking them on Assembly lines, in warehouses, for the protection of labor in hazardous conditions and personal control at public events. There is also a system of long-range locating assets and employees in large industrial facilities. (CEPT, 23).

On airplanes, UWB signals can be used to control the location of the crew and position of controls, and also to provide communication and entertainment for passengers. It is expected that UWB will become part of the future of instrumentation in the cockpit and individual means of communication of pilots and stewards.

On the railroad UWB can be used for tracking the movement of trains, both on the surface and under ground.

It is hoped that next time the will receive a comprehensive document with a full set of recommendations based on in-depth research and testing, and would not oppose the application of technology using ultra-wideband signals.

At the moment, prospects and sphere of application of this technology are very vague, as the market is filled with a lot of standards and technologies that can provide greater throughput and greater range of communication, but there are still important areas of daily life, in which there are no alternatives to the UWB standard. Development of UWB technology is ongoing, but not with such pace as it was expected. In the end, we can only follow the development or abandonment of the technology in a highly competitive and rapidly developing data transfer market.

References

Álvaro Álvarez, Lorena de Celis, Esther López (2009). Ultra-Wideband: Past, Present and Future, White Paper, 1

Copps, Martin (2002). Federal Communications Commission, Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems, 54

Di Benedetto, Maria-Gabriella (2006). UWB communication systems: a comprehensive overview, 18

European Commission (2013). CEPT Report 45, 23

Win, Moe Z., Dardari, Davide (2009). History and Applications of UWB Proceedings of the IEEE | Vol. 97, No. 2, February, 198