Wireless Communications

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1 Cellular Networks

In celullar networks, the data is not transmited along a direct path, but uses an external network to relay the signal. Different technologies are already commercially deployed, such as HSCD, GPRS, EDGE or UMTS, and other still under developtment such as LTE or WIMAX (IEEE 802.16).

In theory, the range of 2G and 3G networks is unlimited, as they essentially consist of countless smaller networks that are linked together. In practice, these networks do not cover remote, sparsely populated areas. When considering the data rate, it appears that 2G is designed for speech purposes and therefore the data rate is insufficient to support image transmission. Although 3G is better suited for such puposes, the commercial costs of a privately operated network are high.

It is possible to implement the cellular concept with a self-created network in which a cellular base station such as an IP.Access nanoBTS module represents the fixed infrastructure side of the network. In combination with a 2G or 3G device attached to a UAV, a fully functional network can then be established.

2 Satellite Communication

In satellite communication, the data is not transmited along a direct path, but uses a constellation of satellites to relay the signal, such as Globalstar, Orbcomm or Iridium.

Satellite communication finds many applications in remote areas where the range of other forms of wireless communication is a limiting factor. A drawback of satellite communication is the high cost and low data rate.

3 Free Space Optical Communication

In pointing-acquisition-tracking (PAT) systems, the data is transmited along a direct path, by using a modulated light beam.

The advantage of PAT systems is the difficulty of signal interception and high data rates of up to 1 Gbps. However, drawbacks of such a line-of-sight (LOS) system are dependence on the weather condition (humidity, clouds) and limited range due to pointing inaccuracy, even with expensive hardware.

4 Wireless LAN

WLAN (IEEE 802.11) is a replacement or extension for wired LAN such as Ethernet (IEEE 802.3). The original IEEE 802.11 protocol was amended with several subprotocols when the 1–2 Mbps data rate of the original standard could be extended.

The most widely used protocols are 802.11b/g/n, of which the recently introduced 802.11n protocol has become increasingly popular due to its high data rate and reliability. Despite high data rates the range of WLAN is limited to 100 m, even with line-of-sight communication.

5 Wireless PAN

WPAN (IEEE 802.15) were created to provide the means for power-efficient wireless communication within the personal operating space (spherical region that surrounds a wireless device). Depending of the data rate, WPANs are divided into three common classes: high rate, medium rate (Bluetooth) and low rate (ZigBee)

Bluetooth (IEE 802.15.1) was designed as a short-range (often <10 m), low-power wireless connection protocol between two computers or portable devices with a data rate of up to 1Mps. Long-range Bluetooth adapters with a range of over 1000 m are commercially available, although the transmission power of these modules does not comply with European Union (EU) regulations.

ZigBee (IEE 802.15.4) allows data rates of up to 250 kbps over roughly 1.6 km in free space. An advantage of the ZigBee protocol is that a link between two endpoints can easily be extended to include multiple nodes, and that it can be implemented using low-cost hardware such as XBee (<50 per module).

6 Comparison

Communication type	Data rate [Mbps]	Bandwidth [MHz]	Range [m]	Transm. Power [dBm]	Center frequency [GHz]	Cost [€]
Cellular network						
3G HSPA+	2 [30]	12.6 [31]	∞	31	11 bands [32]	>1000
Satellite	1	36 (24×) [33]	∞	27 [16]	4–8	>70,000/an.
Wireless LAN						
802.11b/g [22]	54	22	100	20	2.4	<50
802.11n [34]	600	40	100	20	2.4/5.5	<50
Wireless PAN						
Bluetooth	3 [28]	1 [22]	1000 [28]	20 [28]	2.4 [22]	150
Zigbee	0.250 [22]	5 [35]	1600 [36]	10 [36]	2.4 [22]	80