

IEEE 802.16 and WiMAX

Explanations relating to the 802.16 standard and the WiMAX forum:

The IEEE 802.16 standard is a standard for urban wireless networks. It was developed by the IEEE and originally included the 10 - 66 GHz frequency ranges. Subsequently, the IEEE 802.16a standard, covering the 2 - 11 GHz frequency ranges, was published. In July 2004, a new standard was published combining the specifications of the two preceding documents under the reference IEEE 802.16-2004.

The standard is optimised for the internet protocol and specifies the air interface for point-to-multipoint systems. In order to be able to implement this air interface on a global scale, various options were provided making it possible to cover local needs. These options include, for example, the bandwidths of the different channels, different duplex types (FDD, TDD, semi-duplex), different modulation types, etc. Particular attention is devoted to the 2 - 11 GHz frequency ranges which permit the establishment of radio connections without "line-of-sight links". The channel access procedure that has been retained is [OFDMA](#).

The multiple alternatives that resulted from the IEEE 802.16 standard led to a fragmentation of the market and consequently an increase in costs. The WiMAX forum was founded to counteract this phenomenon. It selects different combinations of many of the options that are offered in the IEEE 802.16 standard and makes them available in the form of "profiles", accompanied by relevant test routines. The latter are intended to guarantee interoperability. In its own way, WiMAX corresponds to the WiFi association, whose aim is to promote the RLAN IEEE 802.11 standard and its different variants through interoperability tests.

At present (the end of 2004), there are 3 profiles in existence that can be distinguished by their frequency ranges. The frequency ranges chosen are mainly intended for the USA. They are the 2.6 GHz and 3.5 GHz frequency bands which require a licence and the 5.8 GHz frequency band which does not require a licence. The WiMAX forum is free to define further profiles as and when required.

ETSI is working on the same type of standard in Europe. Such a standard has already been established by a working group at the heart of TC BRAN and is called "HiperMAN". This standard is compatible with the profiles of the IEEE 802.16 standard defined by the WiMAX forum. In order to guarantee interoperability, specific documents have been exchanged between the two organisations.

As far as Switzerland is concerned, the situation in relation to frequencies is currently as follows:

3.41 - 3.6 GHz

This frequency band was allocated in the year 2000 for a fixed duration of ten years to two telecommunication services providers by means of the WLL auctions. Each licence consists of a block of 28 MHz and is technology neutral. This means that equipment which complies with the IEEE 802.16 standard can be put into service. However, one provider has surrendered his licence to OFCOM.

3.6 – 3.8 GHz

This frequency band is used as a reserve for point-to-multipoint installations in Switzerland. Again here, equipment that conforms to the IEEE 802.16 standard can be used. However, the WiMAX forum has no plans to work in this frequency range.

5.47 – 5.725 GHz

This frequency band will be available with effect from 01.02.2005 for radio LAN applications (IEEE 802.11h, Hiperlan/2, etc.), as well as for Wireless Access System (WAS) applications.

Equipment that conforms to the IEEE 802.16 standard can also form part of wireless access systems. The technical requirements for all installations in this frequency band are identical: the maximum transmitted power is 1 W EIRP, the transmit power regulations and the choice of dynamic frequencies are identical. However, the WiMAX forum has no plans to work in this frequency range.

5.725 – 5.875 GHz

This frequency band is an ISM band. The army holds the majority of this band in Switzerland. In Europe, work is in progress to test the compatibility of other services in this frequency band. Negotiations can be started with the army once the results of these studies are known.

Applications in relation to IEEE 802.16/HiperMAN

All IP services that are offered with CATV or ADSL could be possible applications. These services are primarily planned for regions not served by cable or for which services cannot be offered by cable. Depending on the system configuration, distances of 30 to 40 km are achievable, though with a reduced transfer rate (several Mbit/s). The maximum transfer rate is only possible over shorter distances. It is dependent on the bandwidth of the channel used and can reach 75 Mbit/s for a channel with a bandwidth of 20 MHz. It is not possible to have the maximum distance and maximum transfer rate simultaneously. Given that it is not absolutely essential to have a line-of-sight link, these systems can also be used in urban environments. Here, they will be in competition with the DSL and cable modem alternatives.

IEEE 802.16 deals primarily with point-to-multipoint links which offer the possibility of mobility in a given sector. Extensions making it possible to move between two sectors or between base stations are being studied (IEEE 802.16e). This corresponds to roaming applications (you are mobile, but fixed when it comes to data transmission) or mobile applications (you are also mobile in the case of data transmission).

Unfortunately in this case we are faced with a dilemma. The 3.41 – 3.8 GHz frequency bands have been allocated on an international basis to fixed radio services. Conventions exist between countries making it possible to co-ordinate the transmission equipment in these frequency bands. However, it is clear that the transmission equipment for roaming or mobile applications cannot be co-ordinated at the international level for each user. Given the fact that these transmission installations can interfere with other installations in neighbouring countries, mobile and roaming applications are not allowed. Some time is still needed before agreement can be reached on this subject at an international level.

On the other hand, roaming or mobile applications are possible in the 5.47 – 5.725 GHz frequency bands, which are assigned to RLAN and WAS. An inconvenient feature of these bands is the low allowed transmitting power and the absence of any requirement for a licence: interference can therefore be expected because of the fact that everybody can use these frequencies freely. Another inconvenience with mobile applications is the fact that it is no longer possible to work with two [polarisations](#) (horizontal and vertical).

Developments

From now until 2006, Intel plans to manufacture integrated circuits compatible with WiMAX which can, for example, be installed in laptop computers. This will make it possible to connect to the internet in areas served by WiMAX. This will overcome the problem of short connection distances inherent with current hotspots (WLAN). This method is aimed at roaming or mobile applications which are currently not permitted, however, in bands that are subject to a licence. There are also the following developments:

- Pressure is increasing on the regulatory authorities to find solutions for roaming and mobile applications in frequency bands that are subject to a licence .
- Frequency bands not subject to a licence will be used for roaming and mobile applications, but it should be pointed out that no significant difference can be established between RLAN and WiMAX.

Until WiMAX is introduced, other regulatory activities will be necessary to ensure problem-free operation of this technology.

Abbreviations:

ADSL	Asymmetric Digital Subscriber Line
EIRP	Equivalent isotropically radiated power
HIPERLAN	High Performance Local Area Network
HIPERMAN	High Performance Metropolitan Area Network
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ISM	Industrial, Scientific and Medical
RLAN	Radio Local Area Network
MAN	Metropolitan Area Network
OFDM	Orthogonal Frequency Division Multiplexing
WAS	Wireless Access System
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access

Glossary:

OFDMA: Instead of a carrier, OFDMA modulation uses many orthogonal sub-carriers. Each of these sub-carriers is modulated with part of the data. Due to the fact that each sub-carrier only transmits a small amount of data, this results in low symbol rates. The demodulation of the latter is less sensitive to propagation by multiple paths (reflections and attenuation) resulting from radio links without direct visibility.

Polarisation: In order to double the number of channels in the case of radio links with direct visibility, it is possible to use orthogonal polarisations of the high frequency signal - horizontal and vertical. In the case of mobile or roaming use, this method of transmission can no longer be used, because there is a change of polarisation on reflection.