

Network System

Wireless Network

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Bibliography

- **Matthew Gast.** *802.11 Wireless Networks: The Definitive Guide, Second Edition (Definitive Guide)*. O'Reilly. 2005.
- **Houda Labiod, Hossam Afifi and Costantino De Santis.** *Wi-Fi, Bluetooth, Zigbee and WiMax*. Springer. 2007.

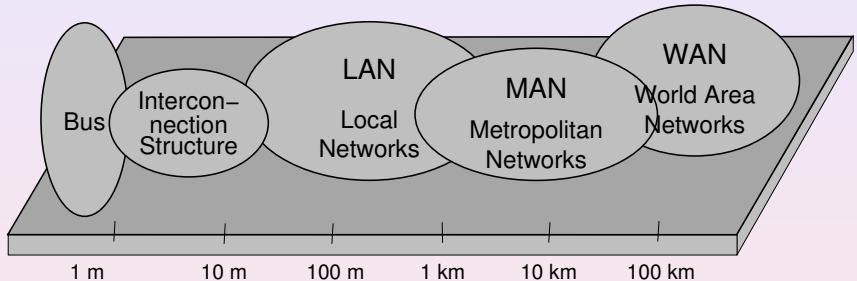
Background

- A greater mobility of the users makes traditional networks (wireline) inadequate.
- Since few years, many wireless technology standard has appeared.
- None wireless technology is perfect: it is always a balance between different factors (range, speed, etc.).
- The constant increase performance through research and tomorrow improved performance and will enable new uses.

Metrics

- Distinction according to their field of action:
 - WPAN: Wireless Personal Area Network.
 - WLAN: Wireless Local Area Network.
 - WMAN: Wireless Metropolitan Area Network.
 - WWAN: Wireless Wide Area Network.
- Interconnection between these different types of networks can also be applied through wireless network that wired.

Metrics of the different networks (1/3)



The different categories of networks based on the distances between the interconnection nodes

Metrics of the different networks (2/3)

- BUS:
 - less 1 meter,
 - they interconnect processors, memories, input-output of a computer or multi-processors.
- Interconnecting structures:
 - few meters,
 - they allow to interconnect many computers in a same room in order to have very high speed networks (cluster),
 - high bandwidth greater than many hundred of mega bytes.
- Wireless Personal Area Network (WPAN):
 - few meters,
 - they allow to interconnect personal equipment: GSM, cellular phone, organizer, etc.

Metrics of the different networks (3/3)

- Wireless Local Area Network (WLAN):
 - many hundred meters,
 - they interconnect the computers of a same firm or a same university,
 - bandwidth is from few MBytes/s to many GByte/s.
- Wireless Metropolitan Area Network (WMAN):
 - they interconnects many places in a same town,
 - they interconnects local area networks in different buildings.
- Wireless World Area Network (WWAN):
 - they interconnects place and networks in a scale of a country,
 - they could be either by earth or by satellite ways.

The distance covered by wireless network

- This is often a theoretic indication:
 - It may be decreased by the obstacles.
 - It also depends on the used frequency (for example: the frequency of the 2,4 GHz used in many wireless networks can be decreased by the water and so by human people who are made up of 70% of water).
 - It depends also of the power: more we go away, less the bandwidth is.
- The authorized power is a politics limitation and not a technical one. It changes according to the country.
- We can increase the distance covered by concentrate the signal in only one way thanks to an antenna.
- This method is especially used to link two distant point and it is called Point-To-Point link.

Wireless Personal Area Network (WPAN)

- The most famous Wireless Personal Area Network is Bluetooth.
- There is Ultra Wide Band (UWB) which allow to use large bandwidth.
- And then, there is Zigbee which allow to connect many equipment with a low cost.

Bluetooth

- Bluetooth used to be the surname for one King of Denmark (940-981).
 - This technology has been designed by the Ericsson (Sweden).
 - An appliance can communicate with 7 other slave appliances.
 - It has been created to replace the cables that links peripherals between each others.
 - This kind of connection is more dedicated to Point-To-Point link. It also allow interconnecting of PDA or mobile phone.
 - It may be possible to create 10 groups (80 appliances) in a same area.
- Bluetooth is an IEEE standard: 802.15.1
 - It allow a maximum bandwidth of 750 Kb/s in a radius within 10 meters.
 - It uses the band frequency of 2,4 GHz (the same as WiFi and the microwave oven) which do not need any license.

Ultra Wide Band (UWB)

- It uses a large part of the bandwidth to exchange data.
- So, the signal for each frequency band is very weak and do not disturb the others signals which are on their own band.
- IEEE 802.15.3 standard: it allows a rate of many hundred Mb/s for a distance about ten meters.
- We could have 6 UWB system in a same area. Each may a have a maximum bandwidth of 50 Mb/s. They can be aggregated between each other.

Zigbee

Zigbee, a wireless network to essentially transport the order and not the data:

- It allows to design star personal area network at a low cost.
- There are two version of Zigbee:
 - IEEE 802.15.4 allow to communicate at a rate of 250 Kb/s on a distance about 10 meters to link a maximum of 255 appliances (frequency band of 2,4 GHz).
 - IEEE 802.15.4a allow to communicate at a rate of 20 Kb/s but on a distance about 75 meters for a maximum 65 000 appliances (frequency band of 900 KHz).
- It is adapted for the communication between appliances that do not need a large bandwidth.
- It has a low cost which may allow to include it in a lot of appliances.
- It has an autonomy of 2 years using only low battery.
- Objective: to make communication possible for a simple light bulb.

Wireless Fidelity (WiFi) (1/3)

- Wireless Fidelity family:
 - It allows to establish wireless network on short distance (Local Area Network).
 - WiFi network are sometimes associated to directional antenna in order to establish Point-To-Point links (for example, in order to connect some WiFi Hot Spots if we do not have WiMAX network).
 - These network are well adapted to the nomadism but not adapted to the mobile network (moving appliances). After few kilometers per hours, the don't work.

Wireless Fidelity (WiFi) (2/3)

- Different kinds of WiFi network:
 - IEEE 802.11 the first standard of the series (theoretic rate of 2 Mb/s);
 - IEEE 802.11b: theoretic rate of 11 Mb/s - within a maximum of 100 meters to few hundred meters - on the frequency band of 2,4 GHz. This standard has allowed the development of the wireless network, these last years;
 - IEEE 802.11a: theoretic rate of 54 Mb/s (but decreased with the distance more quickly than 802.11b) - within a maximum of 30 meters - on the frequency band of 5 GHz;
 - IEEE 802.11g: theoretic rate of 54 Mb/s - within a maximum of 100 meters - on the frequency band of 2,4 GHz;
 - IEEE 802.11n: theoretic rate of 540 Mb/s - within a maximum of 30 meters - use the two frequency band of 2,4 and 5 GHz. 802.11n directly includes the quality of service (standard IEEE 802.11e).

Wireless Fidelity (WiFi) (3/3)

- Extensions for WiFi:
 - IEEE 802.11e: extension for a network with signalling quality of service.
 - IEEE 802.11f: extension for the handover (changing from one cell to an other one without lost of signal).
 - IEEE 802.11i: security extension.
- Most of the time, the rate are theoretic:
 - CSMA-CA: a network mode of listen that allow many appliances to communicate in a same time ans allow a rate that is half of the theoretic rate.
 - The remoteness of the appliances according to the access point also decreases the rate.
 - The access point must keep the rate of the remoteness appliance.
 - For the 802.11n standard, it is possible to forbid the communications with the appliances that have not a minimal rate.

802.11n

- It can be used with the frequency band of 2.4 GHz or 5 GHz.
- The theoretic bandwidth may be 540 MBytes/s on a maximal distance of 125 meters.
- The standard include the MI-MO (multiple-in, multiple-out) technology which allow to parallel the wireless communications on many antenna in the same time.
- This norm has been approved March 2007 (Draft version 2.0).

Wireless Metropolitan Area Network (WMAN)

Three great family of Wireless Metropolitan Area Network:

- Worldwide Interoperability for Microwave Access (WIMAX), well adapted to the wireless metropolitan network with a high bandwidth (but with a low mobility).
- The third generation of mobile networks (3G), even if they are national network (for each mobile phone operator), allow to have in the mobile network.
- Mobile Broadband Wireless Access may allow in few year to have high bandwidth network.

Worldwide Interoperability for Microwave Access (WiMAX) (1/3)

- WiMAX is the name of a trademark intended to label appliances compatibles with the American standard IEEE 802.16 and the European norm ETSI HiperMAN.
- It allows a theoretic rate of 70 Mb/s on a maximum distance of 50 km.
- WiMAX is well adapted to interconnect at the scale of a town some local HotSpots (for example by WiFi).
- WiMAX can be used with many frequency band of with certain need a license.

Worldwide Interoperability for Microwave Access (WiMAX) (2/3)

- The committee IEEE 802.16 is in charge of the development of a new wireless standard for metropolitan network ("Air Interface for Fixed Broadband Wireless Access Systems"):
 - IEEE 802.16 for the frequency 10 and 66 GHz, with IEEE 802.16c which proposes many profiles (choice of options) for this standard.
 - IEEE 802.16a for the frequency between 2 and 11 GHz.
 - In theory, the rate is 70 MBytes/s within 50 km.
 - In reality, the rate is about 12 MBytes/s within 20 km or even 8 km if there is any obstacle.
 - IEEE 802.16d (802.16-2004) is a new evolution of the norm 802.16a which allow the use of fix bounds.

Worldwide Interoperability for Microwave Access (WiMAX) (3/3)

- A new extension is also planned (IEEE 802.16e)
 - It must allow the connection of mobiles about 60 km/h.
 - It is adapted to the urban mobility but not for other kind of mobility like in a train or other vehicle.
- In 2005, first appliances WiMAX certified have appeared.

Third generation of mobile network (1/3)

- The main objective is to allow the use of the network in situation of mobility (moving) whatever is the speed of the vehicle or nearly.
- Third generation of mobile network are national network but in which the size of the cells need to install new equipment in the town.
- Story of the mobile network:
 - First generation: the digital mobiles.
 - Second generation: the numeric mobiles phone like the GSM.
 - The arrival of data transport with the GPRS (sometimes called 2,5e generation)
 - Third generation of mobile network include both the voice and the data transport at high speed.

Third generation of mobile network (2/3)

- The normalization of the third generation of mobile system is arranged by the International Union of Telecommunication inside the set of norms IMT-2000.
- It exists many norms of third mobile phones:
 - UMTS is followed by the 3rd Generation Partnership Project (3GPP):
 - It allows in theory a rate 2 Mb/s even if the first deployment has been done with a rate of 384 Kb/s.
 - It exists two types of UMTS, according to the radio interface used: W-CDMA or TD-CDMA.
 - The choices which has been made by Europe and Japan in one hand and China in other hand are not compatible.

Third generation of mobile network (3/3)

- Other norms of third mobile phones:
 - Le Cdma 2000, followed by the consortium 3rd Generation Partnership Project 2(3GPP2):
 - It also allows in theory a rate 2 Mb/s.
 - It is more supported by United State (and some country from Asia).
 - It exists many evolution like 1X RTT and 3X, but it is the evolution that takes into account the mobile Internet which seems to be the best promossing: cdma2000 EV-DO (EVolution - Data Only) and EV-DV (EVolution - Data and Voice).
 - Enhanced Data rates for Global Evolutions (EDGE):
 - It is an evolution of GPRS which allows rate of 200 or 384 Kb/s according to the version.
 - It allows to a have a compatibility with GSM/GPRS in its version "EDGE Classic".
 - The version "EDGE Compact" allow to use more reduced frequency band (less than 1 MHz).

Mobile Broadband Wireless Access (1/3)

- Mobile Broadband Wireless Access is a new standard which development is in progress: IEEE 802.20.
- It should be able to develop wireless metropolitan network that may work at a speed of 250 km/h.
- The goal is to allow:
 - the deployment of wireless world network with a high bandwidth,
 - at a lower cost and available everywhere,
 - with a permanent connection,
 - and with an interoperability between the sellers for the firms and the private individual.
- MBWA uses the frequency band with a license under the frequency of 3,5 GHz.

Mobile Broadband Wireless Access (2/3)

- It allow to have a maximal bandwidth per user of 1 Mb/s in download and 300 Kb/s in upload (contrary to the other technology where all the bandwidth is shared) with share of a radius of 2,5 km in maximum.
- Some versions use a larger channel of 5 MHz which may allow a bandwith of 4 Mb/s in download and 1,2 Mb/s in upload for each user.
- MBWA is well adapted to the mobility of voice and data with some appliance focusing on data (in comparison with the third generation of mobile network which are adapted to the voice and data mobility with appliance focusing on voice).
- This standard allow a weak latency for the data. It should use well known technology of nowday (frequency jump, OFDM, adaptive antenna).

Mobile Broadband Wireless Access (3/3)

- The standard IEEE 802.20 which will be used by MBWA is not yet completely finished.
 - It has begun in March 2002.
- Ambition of the project IEEE 802.20 is to make up the gap between the wireless network with a high bandwidth but a weak mobility and the mobile network with a weak bandwidth.