Introduction to Wireless Networks

Chapter 1: Introduction to Wireless Local Area Networks (WLANs)

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Characteristics of wireless LANs

Advantages

- very flexible within the reception area
- Ad-hoc networks without previous planning possible
- (almost) no wiring difficulties (e.g. historic buildings, firewalls)
- more robust against disasters like, e.g., earthquakes, fire - or users pulling a plug...

Disadvantages

- typically very low bandwidth compared to wired networks (1-10 Mbit/s)
- many proprietary solutions, especially for higher bit-rates, standards take their time (e.g. IEEE 802.11)
- products have to follow many national restrictions if working wireless, it takes a vary long time to establish global solutions like, e.g., IMT-2000

Figure 1. Development of the IMT systems

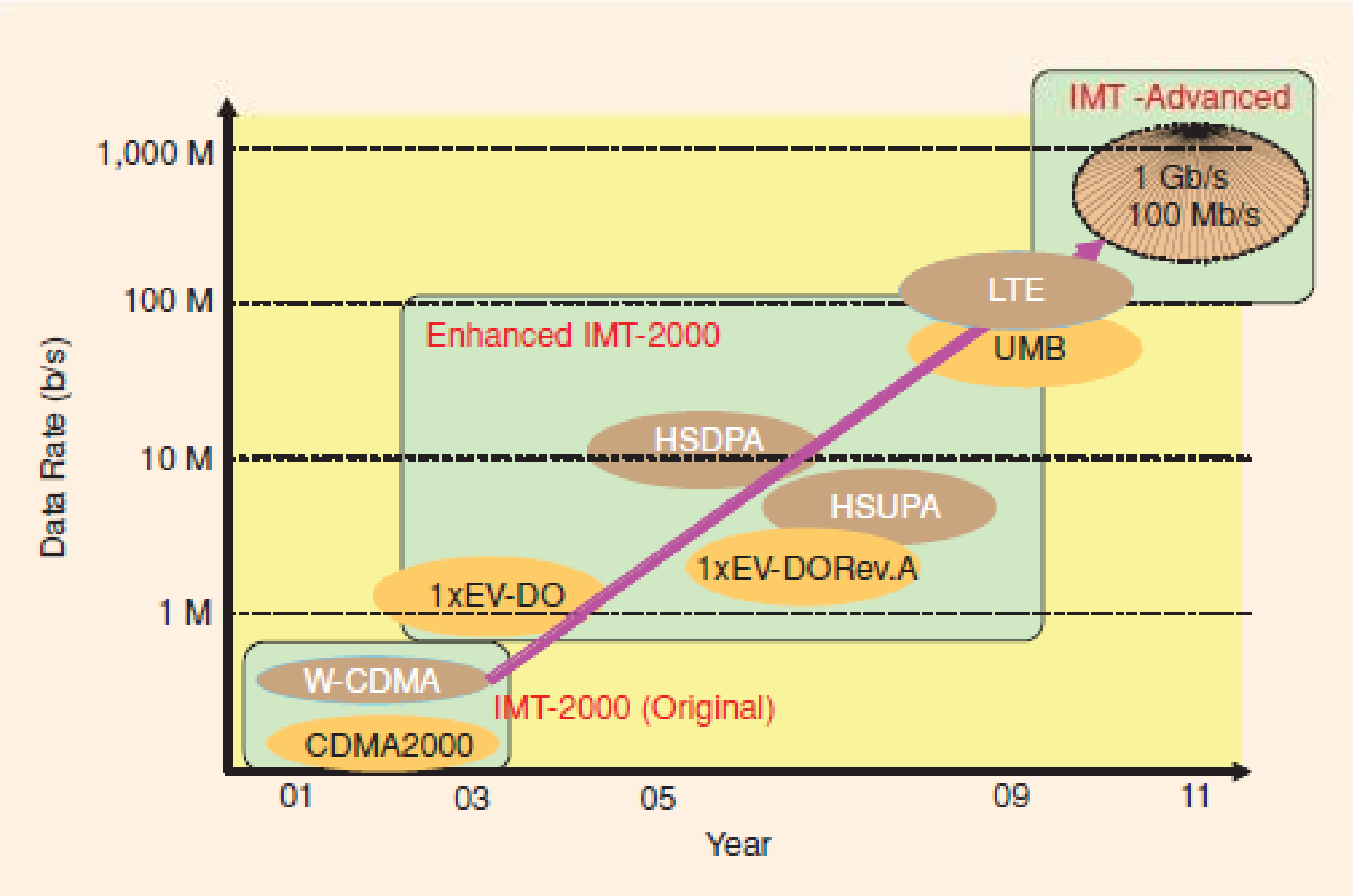

Figure 1. *Development of the IMT systems.*

Examples of basic parameters for future IMT systems

TABLE 3. Examples of basic parameters for future IMT systems.

	3G-LTE	IMT-Advanced
Target User Rate	50–100 Mb/s	100 Mb/s (high-mobility environment) 1 Gb/s (low-mobility environment)
RF Channel Bandwidth	1.4, 3, 5, 10, 15, and 20 MHz	e.g., Max. 100 MHz Support scalable bandwidth
Access Technology	Down link: OFDMA + MIMO Up-Link: SC-FDMA	T.B.D. (*)
Potential Frequency Bands	IMT-2000 band (see Table 1)	Above 3 GHz (e.g., 3.4–3.6 GHz)

*VSF-Spread OFDM presented in this article could be a candidate access technology in the downlink.

Progress of Wireless Comm. (cont.)

In 1985, FCC authorized the use of ISM bands for Industrial, Scientific, and Medical for commercial development.

- ISM bands = 902MHz and 5.85 GHz

ISM is very attractive to vendors because NO obtaining FCC license is required.

In 80's, small-size computers started to appear.

- laptop, palmtop, PDA
- Wireless LAN products populate

wireless LAN:

- IEEE 802.11 standard was finalized in July 1997.
- IEEE 802.11a, b, e, g, i, etc.

wireless WAN:

- Packet radio networks (e.g., RAM)

Personal Communication Service (PCS):

- 1.9 GHz sold $7.7 billion to TV company in 1995 by VP Al Gore.
- $15 billion in 1996.

Wireless Network Architecture

General functions of networks:

- bit pipe of data
- MAC for sharing of a common medium
- synchronization and error control
- routing

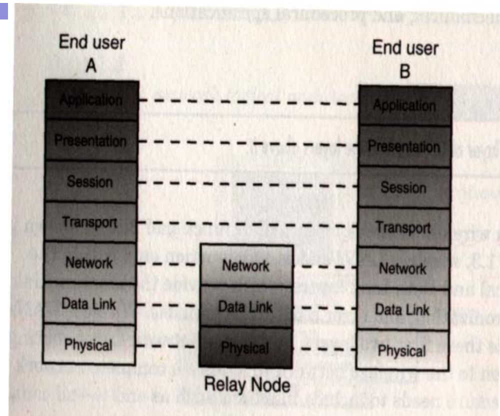

Figure 1.2

OSI reference model: Fig. 1.2

wireless LAN/MAN/WAN layers: Fig. 1.3

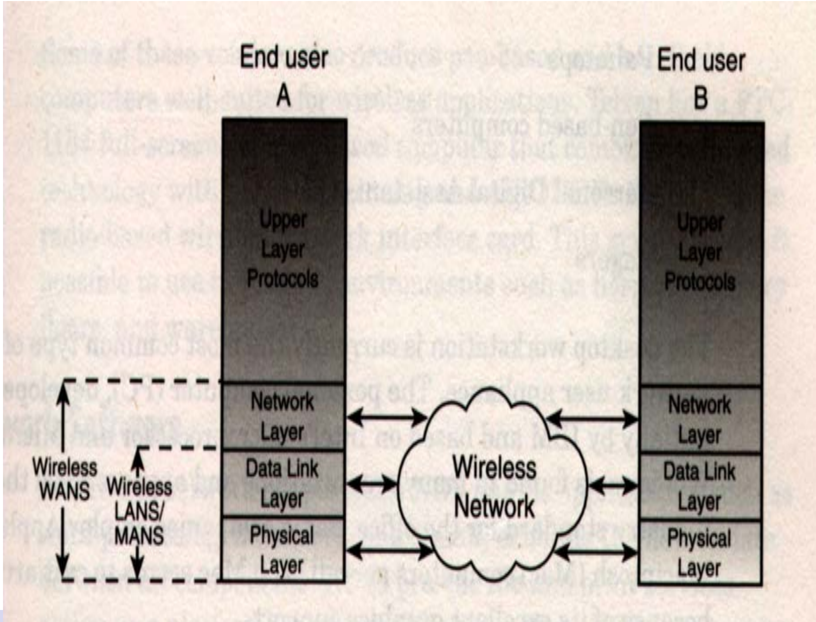

Figure 1.3
The wireless network logical architecture.

Wireless Network Interface Card

Functionality:

- ç modulation: translate baseband signal to a suitable analog form
- ç amplification: raise signal strength
- ç synchronization: carrier sense (Fig. 1.6)
- ç error checking:

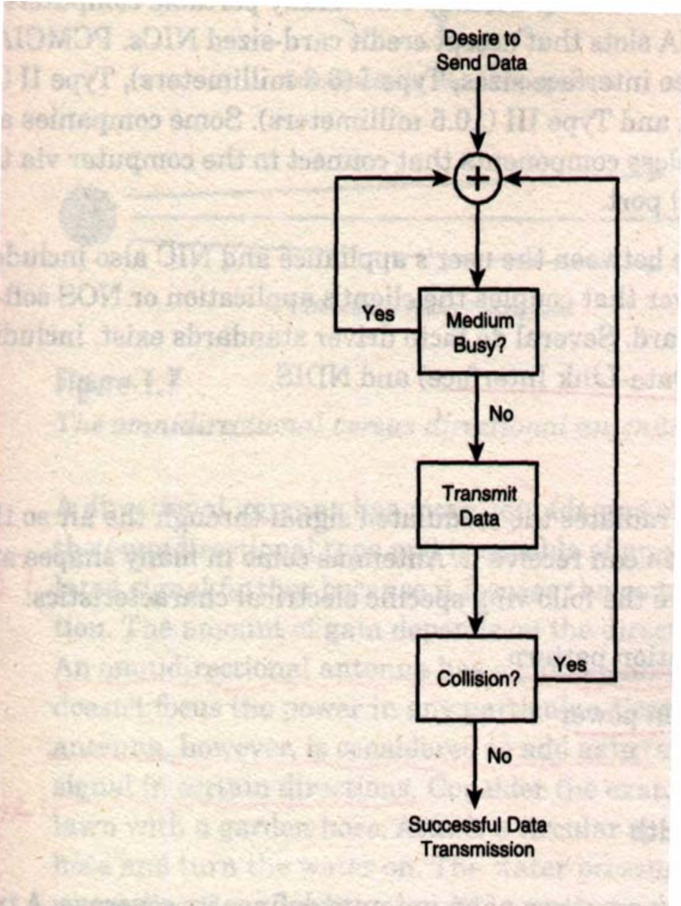

Figure 1.6
The operation of the carrier sense protocol.

Antenna Concept

propagation pattern:

- radiation power: typically less than a few watts
- gain: degree of amplification
  - omni-directional = 1
  - directional > 1 (good for longer distance)
  - example: watering your lawn
- direction: omnidirectional or directional

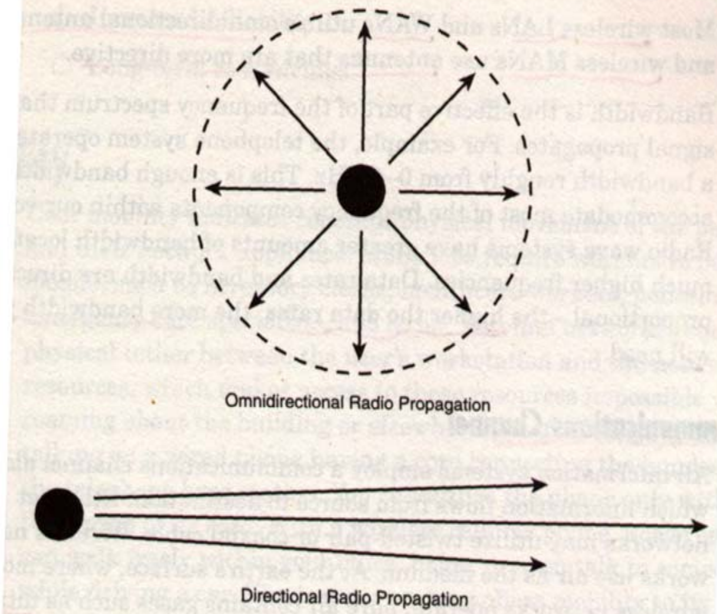

Figure 1.7
The omnidirectional versus directional antennas.

Benefits of Wireless Networks

Mobility:

- Example: talking on a cordless phone vs. cord phone.

Installation in Difficult-to-Wire Areas:

- rivers, freeways, old building
- Hazard materials (such as asbestos particles) when drilling.
- Right-of-way restrictions in some city to dig ground.

Reduced Installation Time:

- It may take months to receive right-of-way approvals.

Increased Reliability:

- cable vs. cable-less

Long-term savings: never need re-cabling

Wireless Network Concerns

Interference Issues

Power Management

- ç Electricity in battery is a limited resource.
- ç modes control:

System Interoperability

- ç e.g., IEEE 802.11 standard

Security Concerns

Security Threats:

- Radio waves can easily penetrate walls.
- One can passively retrieve your radio signal without being noticed (Fig. 1.10).
- Electronic sabotage: someone maliciously jam your wireless network

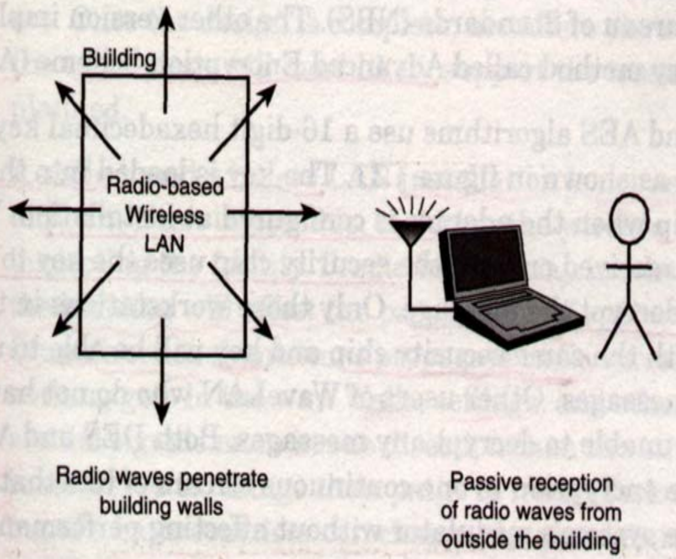

Figure 1.10
The passive reception of wireless network data.

Installation Issues

Wireless coverage as a contour: Fig. 1.12

Intra-system interference:

- e.g., between 802.11 access points

Inter-system interference:

- e.g., from external Bluetooth, which is also on 2.4 GHz

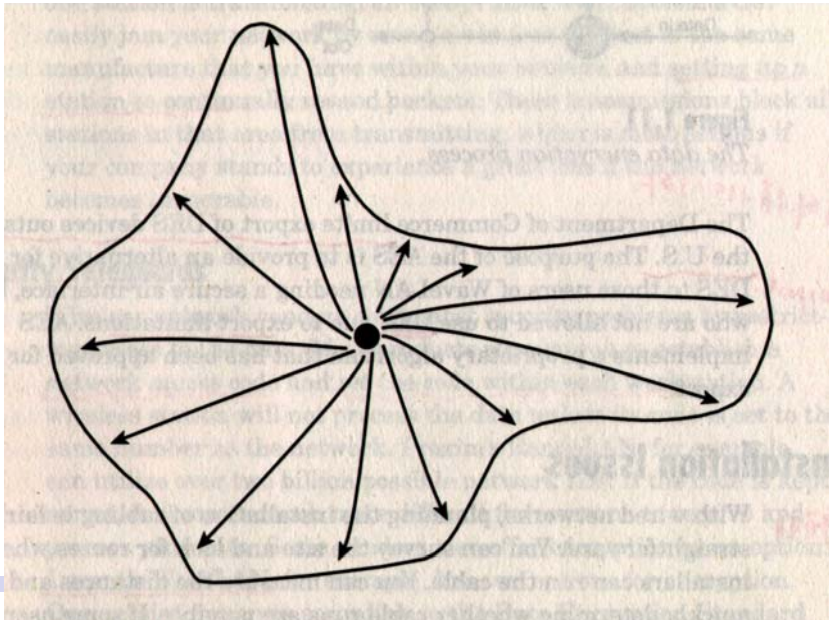

Figure 1.12
The resulting radiation pattern of an omnidirectional antenna within an office building.

Health Risks

So far, no conclusive answer yet!!

- Radio is safer than cellular phones!!
- Wireless network is even safer as it operates at 50~100 milliwatts, compared to 600mw~3w of cellular phones.

US Detp. of Food and Drug classifies ris