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

Design goals for wireless LANs

- global, seamless operation
- low power for battery use
- no special permissions or licenses needed to use the LAN
- robust transmission technology
- simplified spontaneous cooperation at meetings
- easy to use for everyone, simple management
- protection of investment in wired networks
- security (no one should be able to read my data), privacy (no one should be able to collect user profiles), safety (low radiation)
- transparency concerning applications and higher layer protocols, but also location awareness if necessary

Comparison: infrared vs. radio transmission

Infrared

- uses IR diodes, diffuse light, multiple reflections (walls, furniture etc.)

Advantages

- simple, cheap, available in many mobile devices
- no licenses needed
- simple shielding possible

Disadvantages

- interference by sunlight, heat sources etc.
- many things shield or absorb IR light
- low bandwidth

Example

- IrDA (Infrared Data Association) interface available everywhere

Radio

- typically using the license free ISM band at 2.4 GHz

Advantages

- experience from wireless WAN and mobile phones can be used
- coverage of larger areas possible (radio can penetrate walls, furniture etc.)

Disadvantages

- very limited license free frequency bands
- shielding more difficult, interference with other electrical devices

Example

- WaveLAN, HIPERLAN, Bluetooth

History of Wireless Networks

Progress of transmission:

- fire and smoke used by Indians ==> messenger on horseback ==> telephone line ==> networks

Traditional networks (LAN, MAN, WAN) have provided great convenience:

- in office, hotel room, or home.
- But you cannot utilize the service unless you are physically connected to a LAN or a telephone line.

ALOHANET by Univ. of Hawaii:

- 7 campuses over 4 islands; star-like structure centered at the Oahu island.

In 80's, amateur radio hobbyists built TNC (terminal node controller) to interface "hams" radio equipment and their computers.

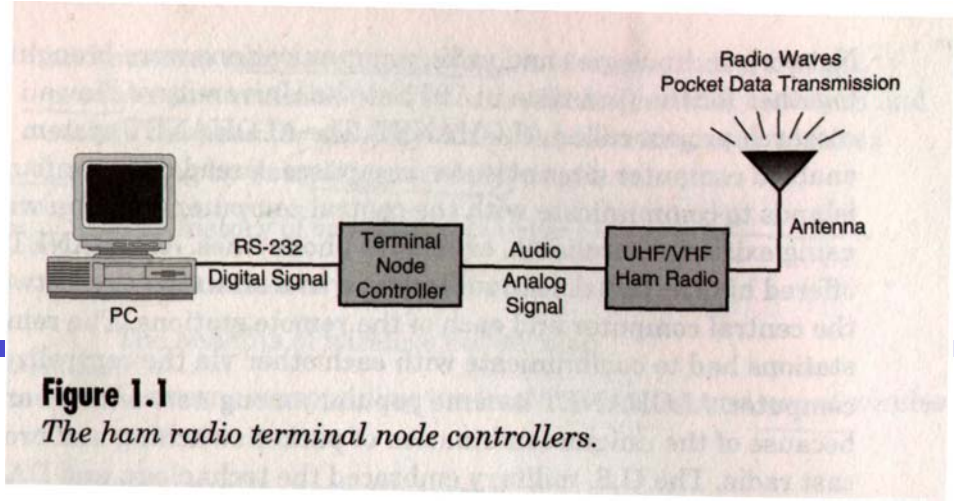

Figure 1.1
The ham radio terminal node controllers.

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

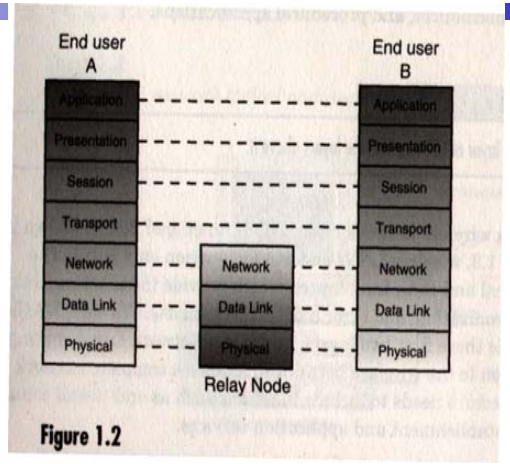

Figure 1.2

OSI reference model: Fig. 1.2

wireless LAN/MAN/WAN layers: Fig. 1.3

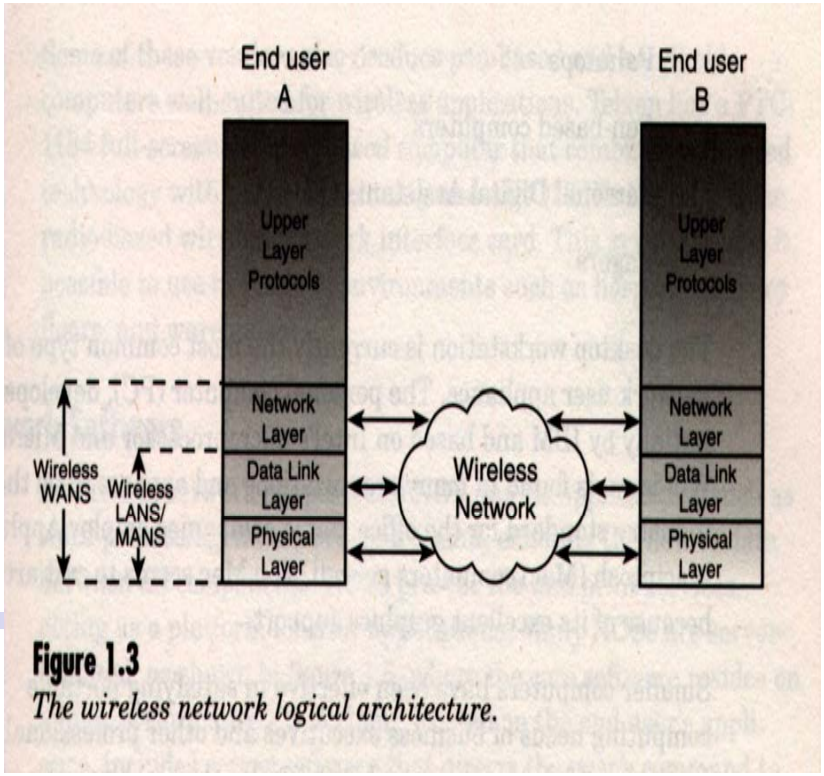

Figure 1.3
The wireless network logical architecture.

Wireless Network Interface Card

Functionality:

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

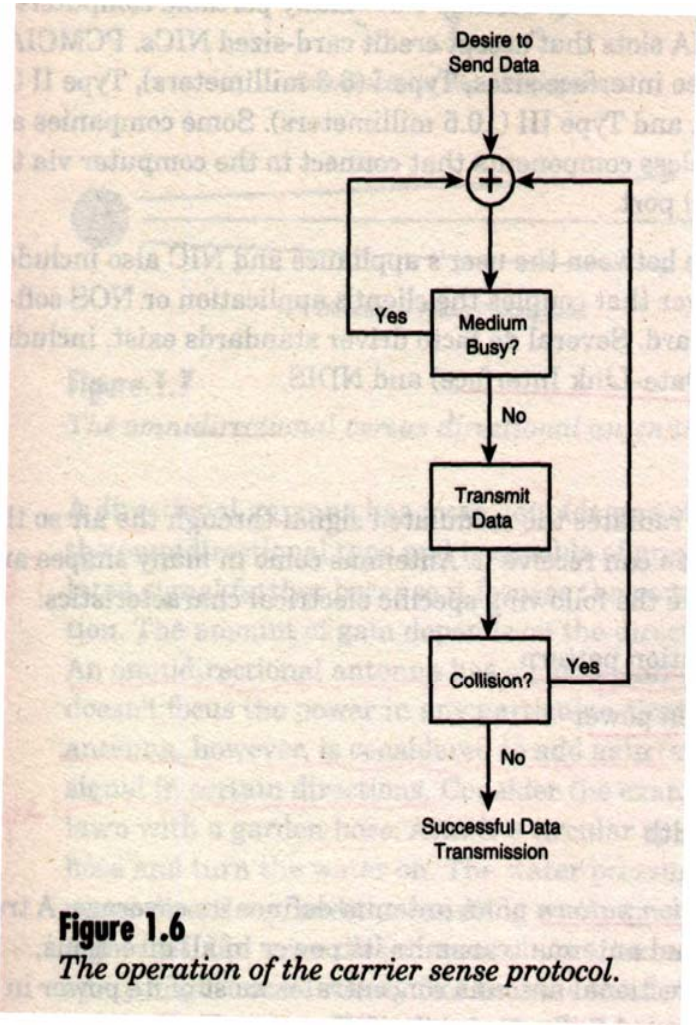

Figure 1.6
The operation of the carrier sense protocol.

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

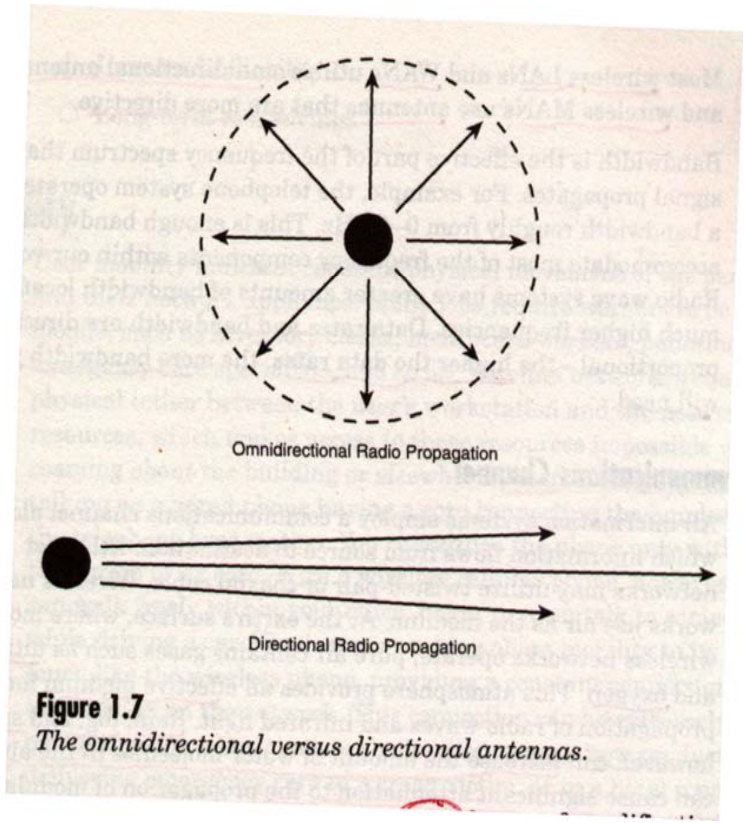

Figure 1.7
The omnidirectional versus directional antennas.

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

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

System Interoperability

- 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

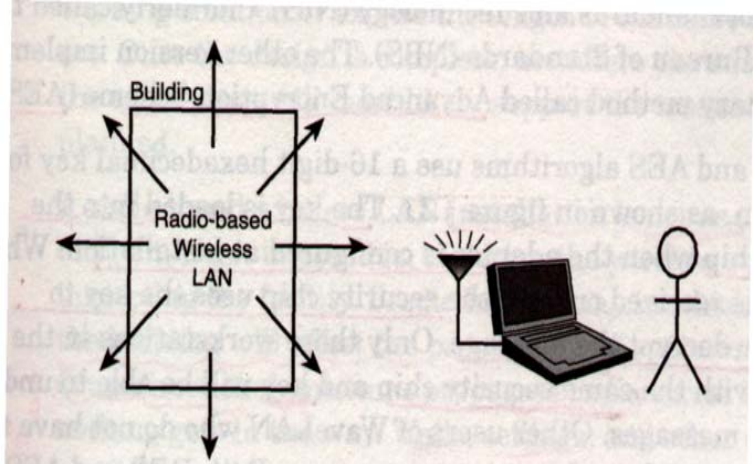

Figure 1.10
The passive reception of wireless network data.

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

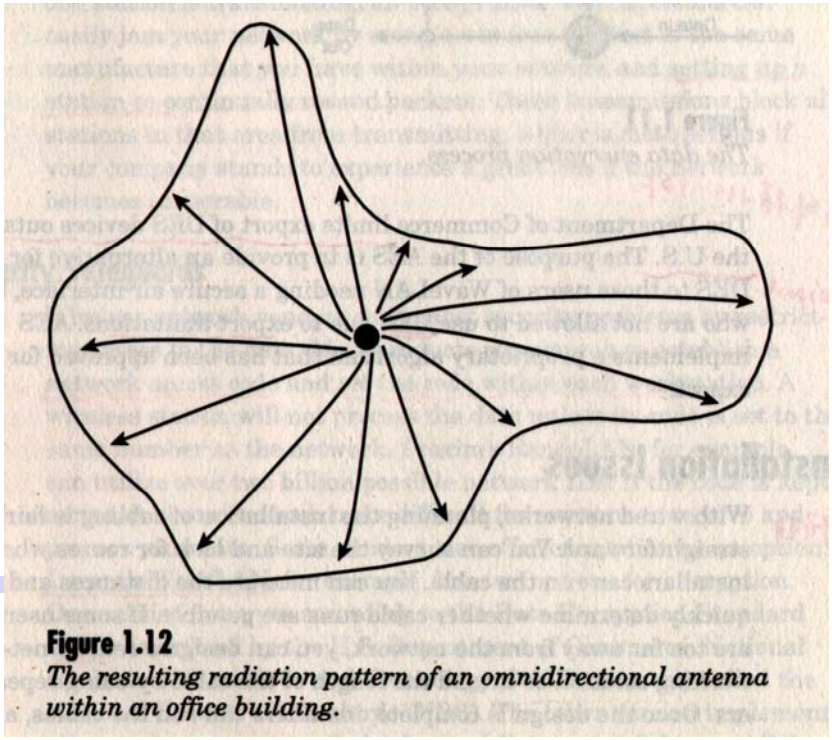

Figure 1.12
The resulting radiation pattern of an omnidirectional antenna within an office building.

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 risks into 4 classes:

- class I: wireless LAN, supermarket scanner
- class III: wireless MAN (could damage eyes if watching directly)
- class IV: laser scalpel

Homework #1

1. What's advantage and disadvantage of wireless local area networks ?
2. What's the operation of carrier sense protocol ?