



Wireless Local Area Networks

ดร. อนันต์ ผลเพิ่ม

Anan Phonphoem, Ph.D.
anan@cpe.ku.ac.th
Intelligent Wireless Network Group (IWING Lab)
<http://iwing.cpe.ku.ac.th>
Computer Engineering Department
Kasetsart University, Bangkok, Thailand



Instructor Information

Instructor: Dr. Anan Phonphoem
ดร. อนันต์ ผลเพิ่ม
Office: Building 1, Room # 1504
Office Hours: Mon 12:30 – 14:00
or by appointment
Tel. No.: 02-942-8555 ext 1428
Email: anan@cpe.ku.ac.th
URL: <http://www.cpe.ku.ac.th/~anan/>



Course Information

Lecture:

Mon 18:00 – 21:00 Room E1102

Class URL:

<http://www.cpe.ku.ac.th/~anan/204526.htm>

Prerequisite:

Data Communications
Computer Networks



Course Objective

- Introduction to Wireless LAN
- Apply Knowledge to realistic problems
- Familiar with Wireless LAN research



Course Description

- Introduction to wireless networks
- Wireless Local Area Networks (WLANs)
- WLAN technologies, standards, and components
- IEEE 802.11 standard
 - Wireless medium access control
 - Wireless Physical layer architecture
 - WLAN system design, integration and implementation
- Multimedia WLAN and associated issues (ex. Bluetooth)



Textbook

“Wireless LANs: Implementing Interoperable Networks,”

Jim Geier, Macmillan Technical Publishing, 2000,
ISBN 1-57870-081-7



Supplements

WLAN standards and related publications



Grades Policy

- 15% IEEE 802.11 Site survey (group)
- 10% Simulation / Assignments (group)
- 15% Research report (group)
- 30% Special Topic in WLAN (Individual: report + presentation)
- 30% Final Exam (Individual)



Grading Policy

- **Your Grade** is based on the overall class performance
- The cumulative score **< 50%** = “**F**”
- An “**F**” grade will be given to any form of cheating (for all partners)
- **Attendance and Class participation:** May be considered for grade adjustment (eg. B → B+)



Assignment Policies

- Assignment must be handed in at the beginning of the class period (> 20 min. is considered late)
- Late assignment ≤ 1 week → 50% credit
> 1 week → no credit
- No credit for not ready presentation
- No credit for copying assignment (all copies), or cut and paste from website



Exam Policy

- **Make-up exam** will only be provided only for restrict circumstances (severe illness)
- You are not allowed to take the exam if > 15 min late

204526

Wireless LANs

1st semester 2002 (June – September)



Introduction to Wireless Communications

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Outline

- **Wireless World (2G, 3G, ...)**
- Basic Wireless Knowledge
 - Principles
 - Wireless Voice Communications
- Wireless Data Communications



Wireless World

- Mobile (telephony)
 - On the move
 - GSM
 - 9.6 kbps – 40 kbps
- Nomadic
 - Within a building (low mobility)
 - Wireless LAN
 - 2 Mbps – 25 Mbps
- Satellite



1G (First Generation)

- Analog
- Circuit-switched Network
- Low voice quality
- No security
- Low capacity
- AMPS
(Advanced Mobile Phone System 800-900MHz)



2G (Second Generation)

- Digital encoding
- High bit rate voice
- Limited data communications (tens Kbps)
- GSM, D-AMPS (TDMA) and CDMA
- Auxiliary services (data, fax and SMS)
- Some levels of encryption



2.5G

- Extend 2G systems (GSM)
- Packet-switched connection (GPRS)
- Higher data rate (up to hundred Kbps)



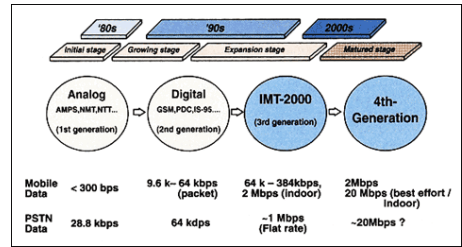
3G (Third Generation)

- Higher data rates (Mbps)
- More than voice...
 - Support bandwidth-hungry applications
 - Full-motion video
 - Video-conferencing
 - Full Internet access (IP)
- 3G & WLAN: complementary relationship
- IMT-2000
- W-CDMA

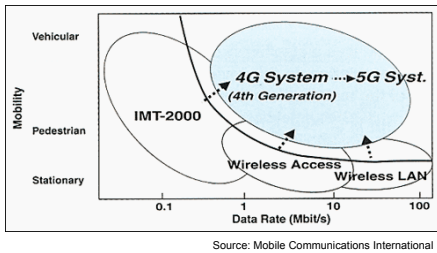
4G

- NTT DoCoMo of Japan
- Beyond IMT-2000

Evolution of the system



Wireless System Path

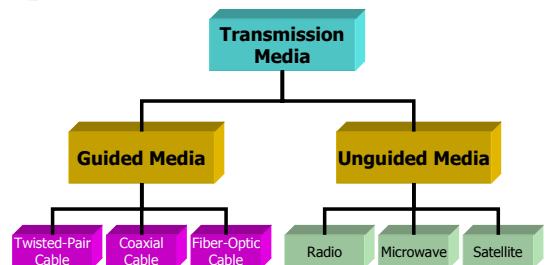


Outline

- Wireless World (2G, 3G, ...)
- **Basic Wireless Knowledge**
 - Principles
 - Wireless Voice Communications
- Wireless Data Communications

Wireless Communication Principle

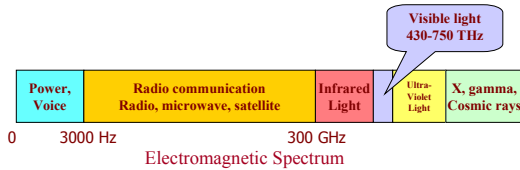
Communication Media



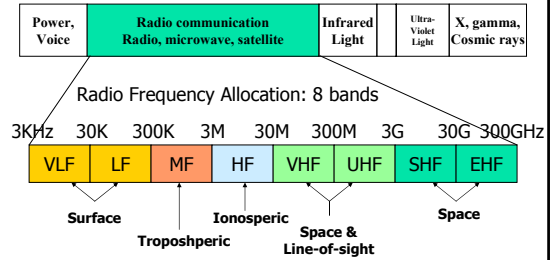


Communication Principle

- How can the information be transmitted?
Information → Signals (Electromagnetic Energy)

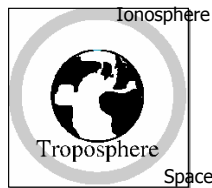


Electromagnetic Spectrum

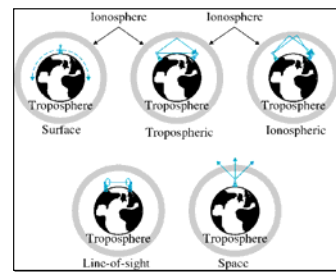


Earth atmosphere

- Troposphere**
 - 30 miles from earth
 - Air
 - Clouds, wind, weather
 - Jet plane travel
- Ionosphere**
 - Between Troposphere and space
 - Free electrically charged particles



Types of propagation



Surface Propagation: VLF & LF

- VLF (in range of 3KHz – 10KHz)**
- Low attenuation
 - Atmosphere noise (heat & electricity)
 - For long-range radio navigation
- LF (in range of 30KHz – 300 KHz)**
- For long-range radio navigation
 - Greater attenuation



Troposphere Propagation: MF

- MF (300KHz – 3MHz)**
- Distance is limited by reflected angle
 - Rely on line-of-sight antennas
 - AM radio (535 KHz – 1605 MHz)



Ionosphere Propagation: HF

HF (3 MHz – 30 MHz)

- Amateur radio (Ham radio)
- Citizen's band (CB)
- International Broadcasting



Light-of-sight Propagation: VHF & UHF

VHF (30 MHz – 300 MHz)

- VHF television
- FM radio

UHF (300 MHz – 3 GHz)

- UHF television
- Mobile telephone
- Cellular
- Microwave communication



Space Propagation: SHF & EHF

SHF (3 GHz – 30 GHz)

- Mostly light-of-sight & space
- Terrestrial & satellite microwave
- Radar communication

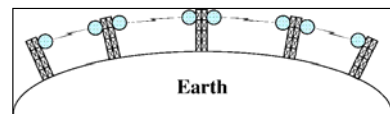
EHF (30 GHz – 300 GHz)

- Radar
- Satellite



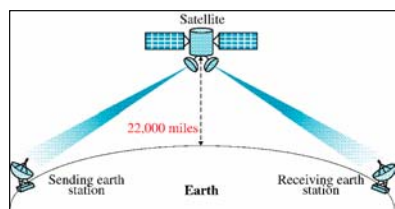
Terrestrial Microwave

- Need light-of-sight (Do not follow the earth)
- The Taller the antennas, the longer the distance
- Propagate in one direction at a time (2 frequencies for 2-way communication)



Satellite Communication

- Like microwave
- Supertall antenna & repeater

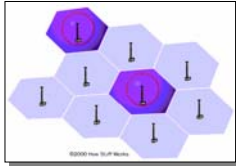


Wireless Voice Communication



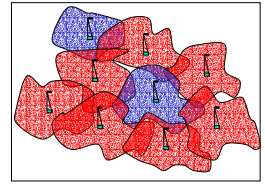
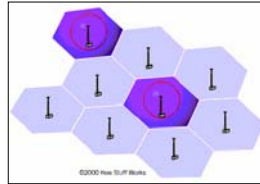
Cellular System

- Geographical Region has been divided into circular areas called “**Cells**”
- Transmission Power → Cell size
- Frequency reuse

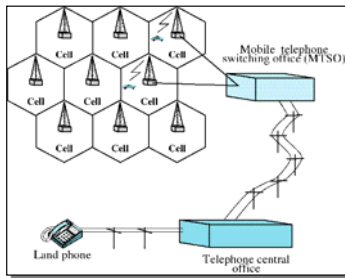


Actual Cell Layout

- Hexagonal shape → used in designing
- Irregular shape → actual cell layout



Cellular Telephone System



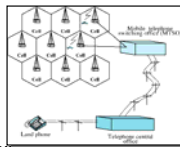
Mobile phone power up

- Listen for System Identification Code (**SID**) on **control channel** (special freq)
- Compare received SID with its own preprogrammed SID in the phone
- If SID match → in Home System
- Nothing on control channel → out of range
- Mobile phone sends registration request & SID to MTSO for location tracking database



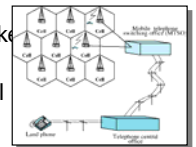
Mobile phone places a call (1)

- Key the number and send
- **Mobile phone** scans the bands & selects strong signal channel
- Send phone number to **Cell Office**
- Cell office relays phone number to **MTSO**



Mobile phone places a call (2)

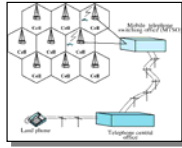
- MTSO → **Telephone Central Office**
- If **called party** available, make connection → MTSO
- MTSO assigns unused channel
- Mobile tuning to the assigned channel



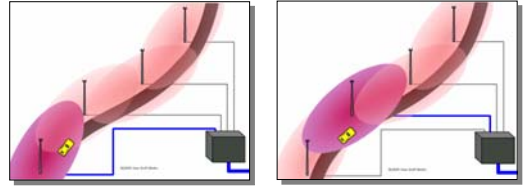


Land phone places a call

- Key the number
- Telephone central office → MTSO
- MTSO searches for mobile location (call paging)
- If found, MTSO → send ringing
- Assign a voice channel



Mobility



Hand off

- As mobile moves to the cell edge
- Current base station → get weaker signal
- New base station → get stronger signal
- Signal strength measuring → all frequencies
- Two base stations communicate through MTSO
- Mobile phone gets the new assign frequency on the control channel



Roaming

- Mobile phone receives SID that does not match with its own SID → Roaming
- Current MTSO → Home MTSO to verify



Analog System

- Advanced Mobile Phone System (AMPS)
- 824 MHz – 894 MHz
- 832 frequencies
 - 790 Voice freq & 42 Data freq (reg. , paging)
- One channel (2 freq for Tx and Rx)
 - 395 voice channels & 21 data channels
- Voice (30 KHz)
- 45MHz Tx/Rx separation → interference



Digital System

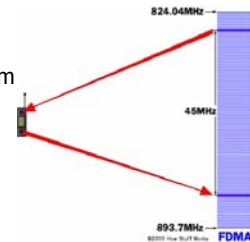
- Same radio technology as Analog
- Analog cannot be compressed
- Digital system converts voice → binary info
- Then compress the data info (3-10 times)
- Need more processing power

Cellular Access Technologies

- Frequency Division Multiple Access (FDMA)
- Time Division Multiple Access (TDMA)
- Code Division Multiple Access (CDMA)

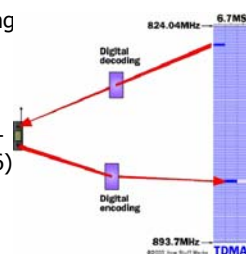
FDMA

- Mainly used in Analog System
- Voice channel → uniform BW range
- Not efficiency



TDMA

- 30 KHz wide, 7.6 ms long (3 time slots)
- 3 times capacity over Analog
- Operate in 800 MHz (IS-54) & 1900 MHz (IS-136)

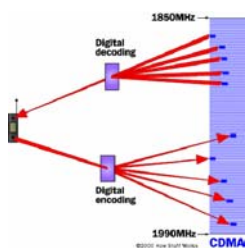


GSM

- Global System for Mobile communications
- TDMA
- Use encryption → security
- 900 MHz & 1800 MHz (Asia-Europe)
- 1900 MHz (US. – not compat. with above)
- International support → by changing Subscriber Identification Module (SIM) card

CDMA

- Spread spectrum
- Data → spread out
- Each call → unique sequence code
- Need accurate time stamp
- 800 MHz and 1900 MHz
- 8-10 times over Analog



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- Wireless World (2G, 3G, ...)
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- **Wireless Data Communications**

Examples of Wireless Network Application



- Retail organization and Warehouses
 - Ordering, pricing, inventory, shipping
- Healthcare
 - Ensure the effective patient care record
- Field Service (Construction, Real Estate, Police, Disaster)
 - Mobile office (documentation access)

Examples of Wireless Network Application



- Hospitality
 - Reservation, check-in, status report
- Utilities / Vending
 - Automatic meter reading / maintenance / Stock

Wireless Network Applications



- Mobility needs
- Physical media is not feasible
- Eliminate paperwork
- Decrease errors
- Reduce process cost
- Improve efficiency

Wireless Network Benefits



- Mobility application support
- Lower network infrastructure cost

Mobility application characteristics



- Physically move while using an appliance
- Need real-time data access
 - Centralized database
- Applications that needs mobility
 - Immediately aware of data change
 - Immediately data availability
- Examples
 - Handheld devices in department store
 - Data acquisition in racing car

Reduce network infrastructure cost



- Release the tether
- Examples
 - **Installation**
 - **Reliability**
 - Decrease downtime
 - Mostly by cabling system
 - Imperfect splicing (unpredictable errors)
 - **Long term saving**
 - Reorganizing / renovation

Wireless Network Installation



- Installation in impossible to wire areas
 - Historical site
 - Digging the restriction area (road)
- Installation in difficult-to-wire areas
 - Rivers, freeway, obstacle building
- Health concern in the installation process
 - Asbestos working areas
- Installation time
 - Wiring period (cabling, digging, trenching)

Wireless Network Concerns



- Radio signal interference
- Power management
- System interoperability
- Network security
- Connection problems
- Installation issues
- Health risks

Radio signal interference



- Sources
 - Atmospheric noise
 - Nearby wireless devices
- Effects
 - Delay
 - Blocking
 - Bit errors
 - Limit the coverage area

Interference Types



- Inward interference
 - Interfered by others
 - Harmonics, microwave oven
- Outward interference
 - Causing interference to others
 - Adjacent WLAN

Interference reducing Techniques



- Limit operating power (< 1 watt)
- Spread spectrum Techniques
 - interference with signal-to-interference < 10dB
- Frequency management
- Propagation test (site survey)

Power Management



- Tetherless to the electrical power outlet
- Battery (Weight & Operating time)
- Power management
 - Doze mode
radio off → periodically wakeup to check waiting msg.
 - Sleep mode
radio standby mode → wakeup to send, cannot receive



System interoperability

- Standard
 - protocols and electrical characteristics
- Current wireless standards
 - IEEE 802.11
 - HiperLAN
 - Bluetooth



Network Security

- Information protection
 - Loss
 - Corruption
 - Improper use
 - Interception (same NICs)
- Data flow in bit level
- Access restriction (access code)
- Data encryption (e.g., DES, AES algorithm)



Connection Problems

- Connection loss
 - Client / Server applications (TCP/IP)



Wireless Network Concerns

- Radio signal interference
- Power management
- System interoperability
- Network security
- Connection problems
- **Installation issues**
- Health risks



Health risks

- No conclusive answer
- Safer than cellular phone
 - 50 – 100 mW for WLAN
 - 600mW – 3 W for cellular phone
- Laser for public use



Wireless Network functionality

- Data transmission path
- Medium Access Control techniques
- Synchronization and error control
- Routing mechanism (source → destination)
- Appliance connectivity

Wireless Network Architecture



- Physical Architecture
 - Appliances (computer, PDA, printer)
 - Network software (Win2000 server)
 - Wireless Network Interface (NIC, modem)
 - Software driver (NDIS-Microsoft, ODI-Novell)
 - Antenna (Omnidirection, Direction)
 - Communication channel (air, atmosphere, light)
- Logical Architecture
 - Network protocol (OSI)

Wireless (Data) Applications



- Mobility needs (Inventory)
- Physical media is not feasible (Factory)
- Eliminate paperwork (Car Rental)
- Decrease errors (Health care)
- Reduce process cost (Automatic Reading)
- Improve efficiency (Mobile Office)