

# Wireless Local Area Networks (LANs)

# Materials

- Textbook
  - None
- References
  - reading materials are assigned when necessary

# Evaluation

- Exam. (Middle 30% + Final 40%) 70%
- Paper presentation 10%
- Quiz 20%
- Simulation (option) (5%)
- 上課講話打擾上課或睡覺按次數累計扣總分

# Syllabus

- Introduction to Mobile Computing
- IEEE 802.11
- Routing in Mobile Ad Hoc Networks
- Mobile IP
- Wireless Mesh Networks (Presentation)
- Sensor Networks (Option)

# 課程網頁進入方法

- 步驟一:在網頁上輸入 <http://140.136.149.173> ([jwlin1.csie.fju.edu.tw](http://jwlin1.csie.fju.edu.tw))，並點選Teaching Activities



# 課程網頁進入方法

- 步驟二:點選紅色方塊之連結，就可以進入到課程網頁

課程名稱	選別	開課系所	課程大綱	網頁
高等通訊系統	選修	資工系研究所	大綱	<a href="#">連結</a>
無線區域網路概論	選修	資工系三	大綱	<a href="#">連結1</a> <a href="#">連結2</a>
網路概論	選修	資工系三	大綱	<a href="#">連結</a>

# Lecture 1

## Introduction to Mobile Computing

# What is Mobile Computing ?

According to a dictionary:

- **Mobile:**
  - Able to move freely
- **Computing:**
  - The activity of using a computer
- **Wireless network:**
  - Communications



# Wireless Comes of Age

- Guglielmo Marconi invented the wireless telegraph in 1896
  - Communication by encoding alphanumeric characters in analog signal
- Communications satellites launched in 1960s
- Advances in wireless technology
  - Radio, television, mobile telephone, communication satellites

# Broadband Wireless Technology

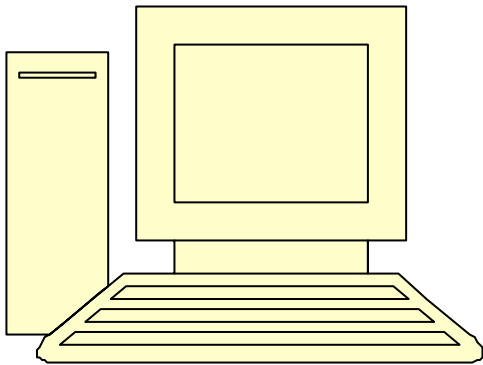
- Higher data rates obtainable with broadband wireless technology
  - Graphics, video, audio
- Shares same advantages of all wireless services: convenience and reduced cost
  - Service can be deployed faster than fixed service
  - No cost of cable plant
  - Service is mobile, deployed almost anywhere

# Limitations and Difficulties of Wireless Technologies

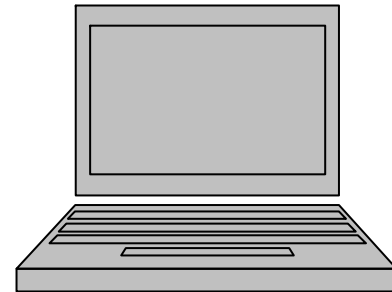
- Wireless is convenient and less expensive
- Limitations and political and technical difficulties inhibit wireless technologies
- Lack of an industry-wide standard
- Device limitations
  - E.g., small LCD on a mobile telephone can only displaying a few lines of text
  - E.g., browsers of most mobile wireless devices use wireless markup language (WML) instead of HTML

# Mobile Computing

Desktop



Laptop



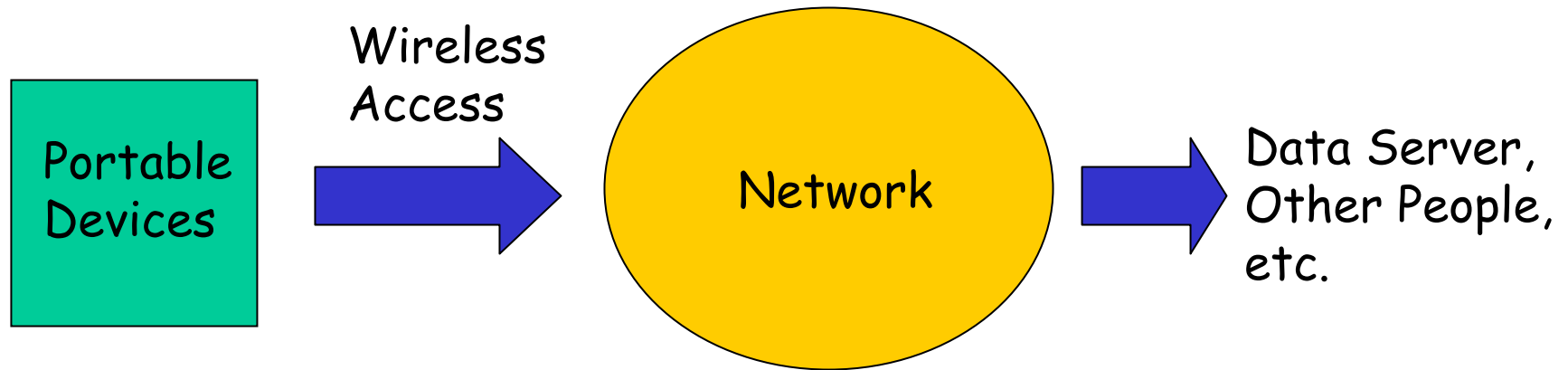
Mobile Computing?

# Computer Applications

- Information Processing
  - word processing, spreadsheet, database, etc.
- Networking
  - email, web browsing, ICQ, etc.

# Mobile Computing

- Able to communicate (or to access information)  
*anytime*, and *anywhere*



# Portable Devices

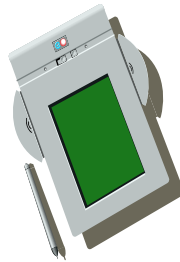
## PDA

- simple graphical displays
- character recognition
- simplified WWW



## Mobile phones

- voice, data
- simple text displays



## Laptop

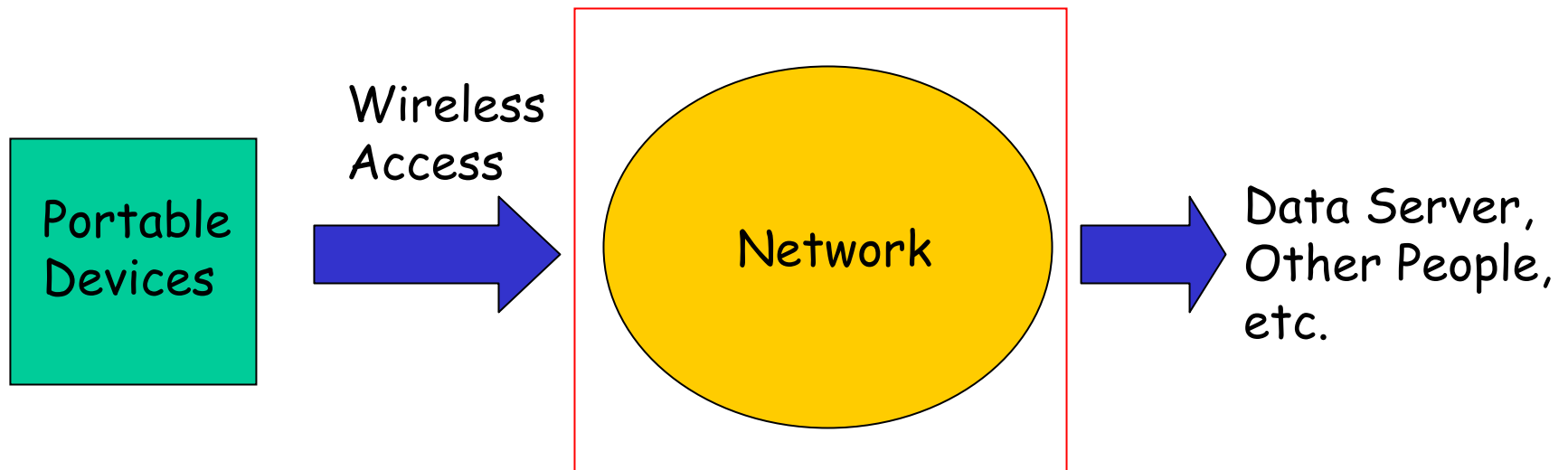
- fully functional
- standard applications

## Palmtop

- tiny keyboard
- simple versions of standard applications



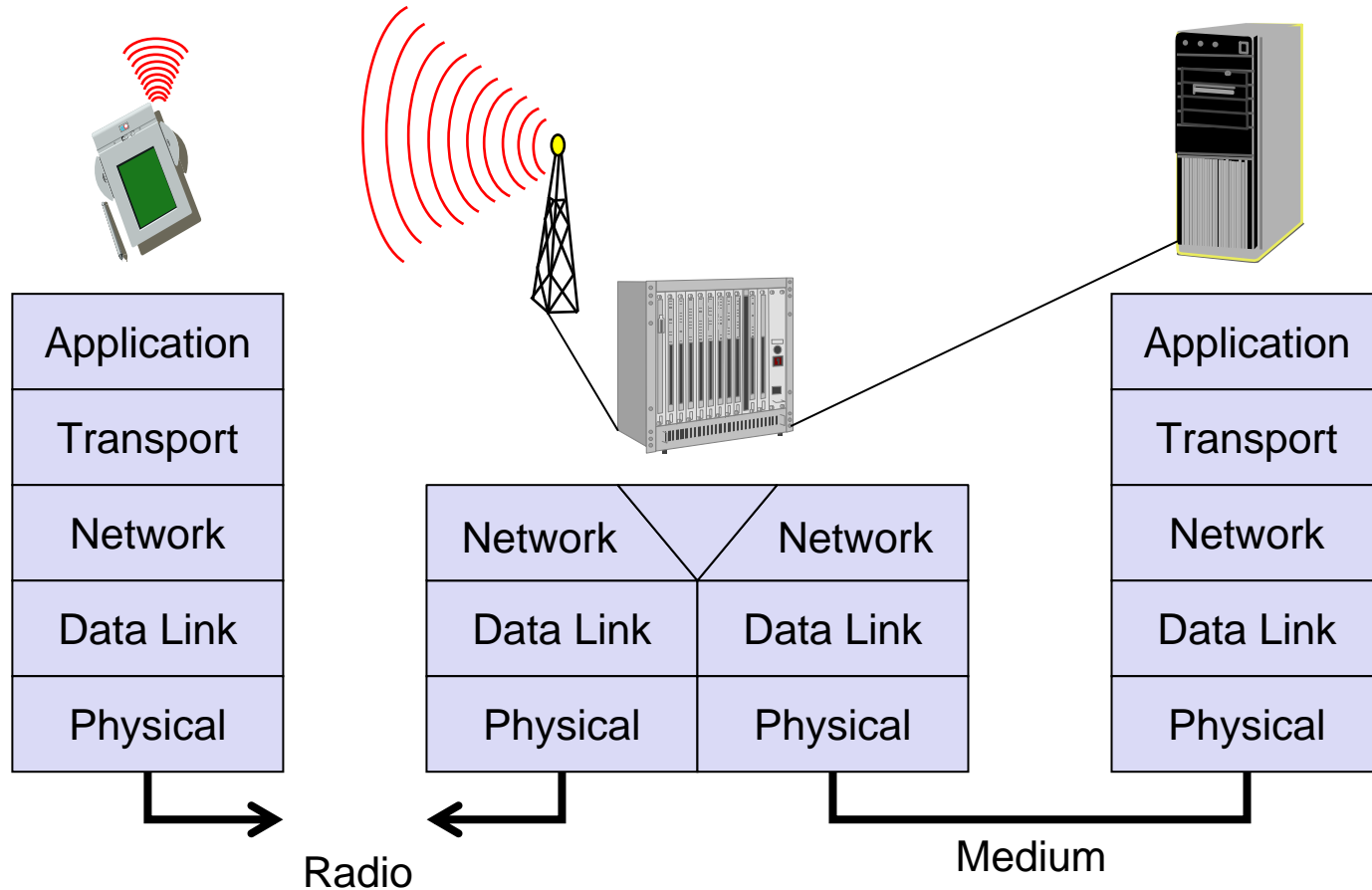
# Our Focus



- Mobile Cellular Systems
  - GSM, CDMA
- Wireless LAN



# Layered Architecture



Scope of this course:

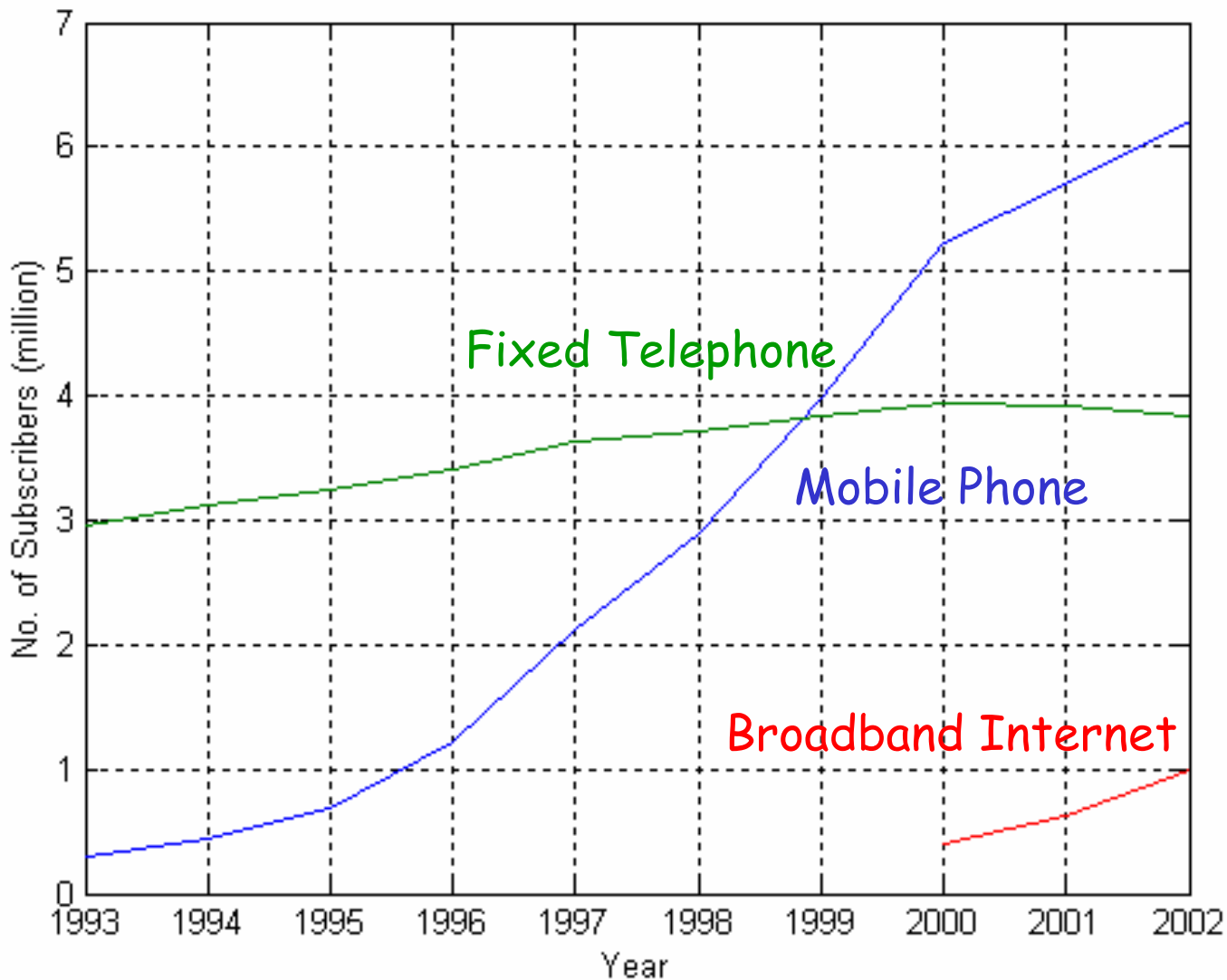
Anything above and including the data link layer.

# Why study this course?

- Reason 1:

Mobile computing is popular?

# Number of Subscribers in Hong Kong



Will wireless  
Internet take  
off?

# Why study this course?

- Reason 2:

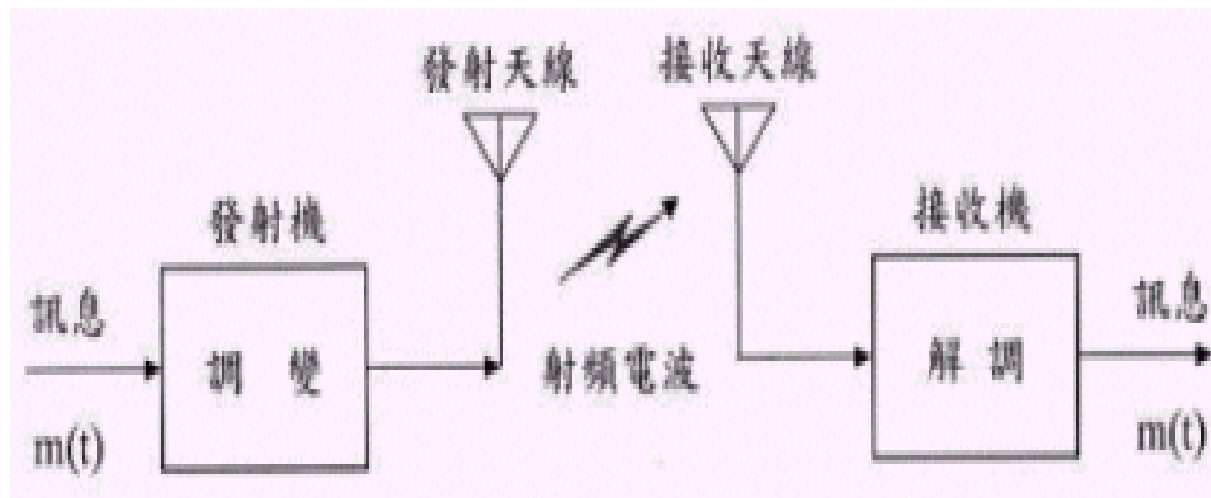
Mobile computing is interesting?

I hope all of you find it interesting after studying this course.

# Why study this course?

- You may have studied Computer Network before. **What makes wireless different?**
- In principle, TCP/IP can work on top of any physical and data link layer.
  - Can we simply transport IP packets over a wireless channel?

- **Wireless Telecommunications**
  - **Block diagram (Cont.)**



無線電通信，是由發射機將聲音或影像或訊息轉變(調變)為較高頻率的射頻(RF)交流電波，或稱電磁波，並將它輻射到空中。在接收端再由接收機來接收、解調變為原來的訊息或影像或聲音。

# Challenges in Mobile Computing

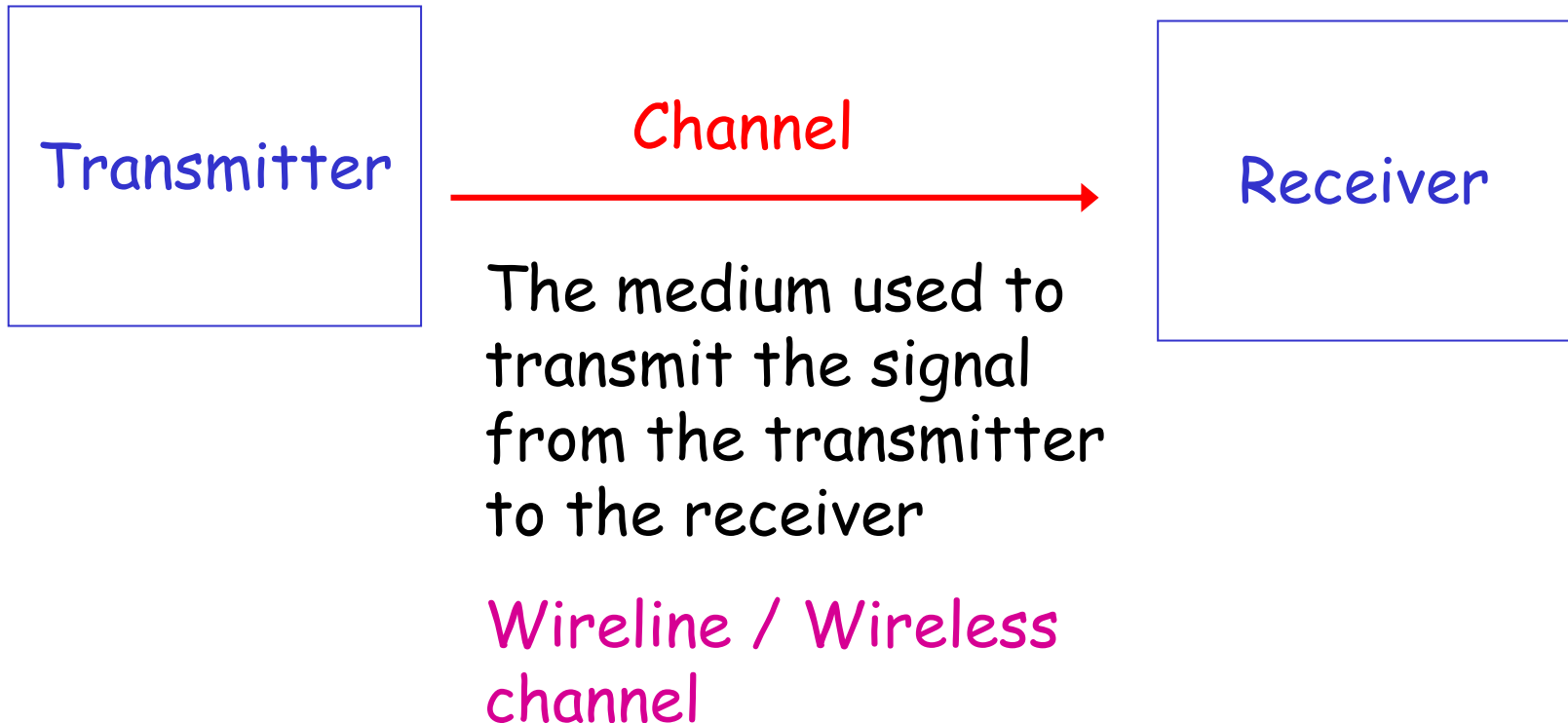
- Three major challenges:
  - Wireless Channel
  - Mobility
  - Device Limitation

# Wireless Channel

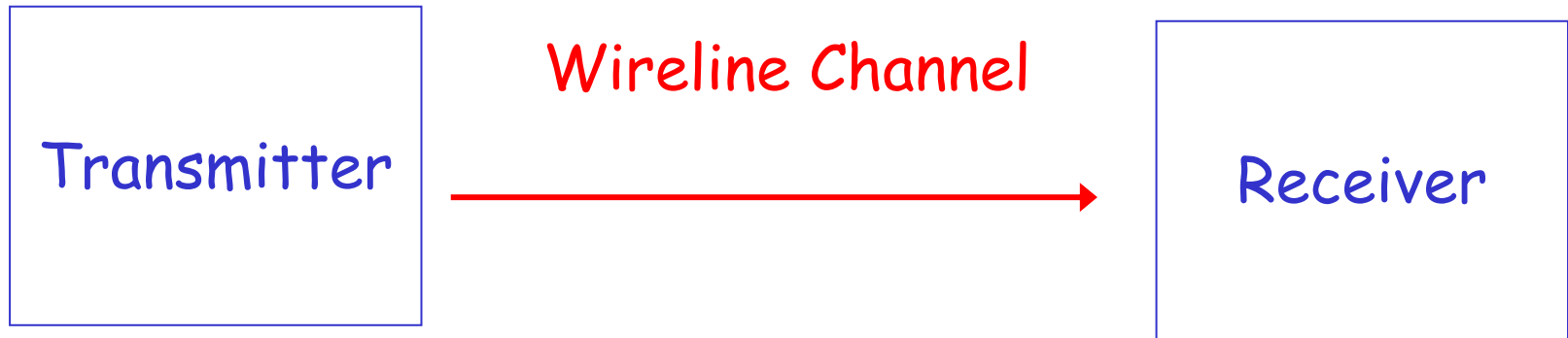
The 1<sup>st</sup> challenge



# Communication Channel



# Wireline Channel



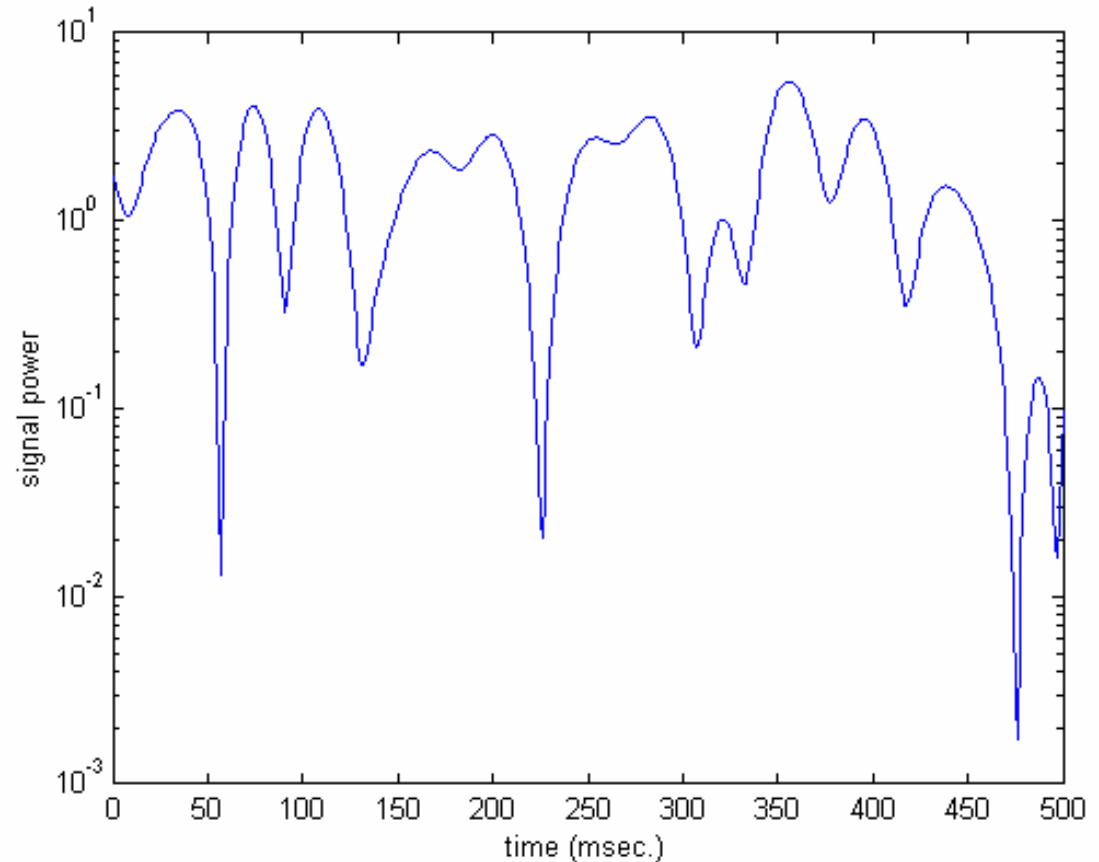
Too many noises?

Large signal attenuation?

Data speed too low?

# Fading Effect

- Typical Indoor Wireless Environment
  - Signal strength fluctuates significantly
- Wireless channel cannot be engineered.
  - You can only improve your transmission and reception technique



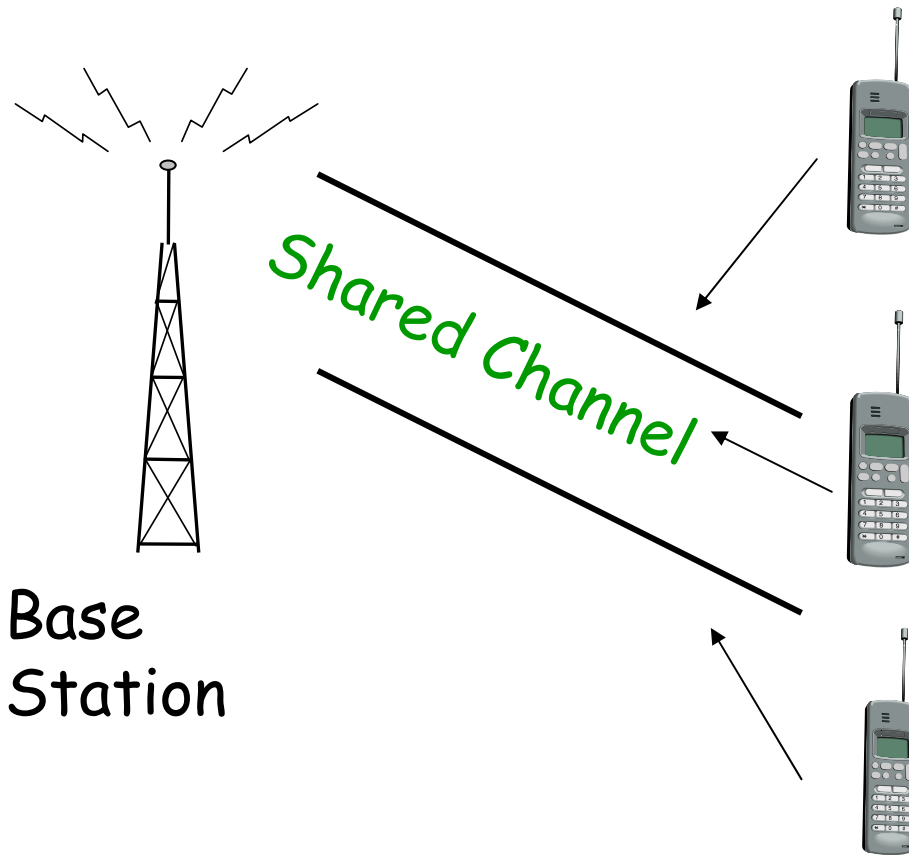
# Bit Error Rate

- Optical fiber:  $10^{-11}$  or  $10^{-12}$
- Mobile channel:
  - Good quality:  $10^{-6}$
  - Actual condition:  $10^{-2}$  or worse

# Implication

- For wireline systems, it is assumed that the channel is **error free**
- Many protocols are **designed with this assumption**
- These protocols **do not work well** in a wireless environment
  - e.g. TCP (*why?*)

# How about wireless networks?



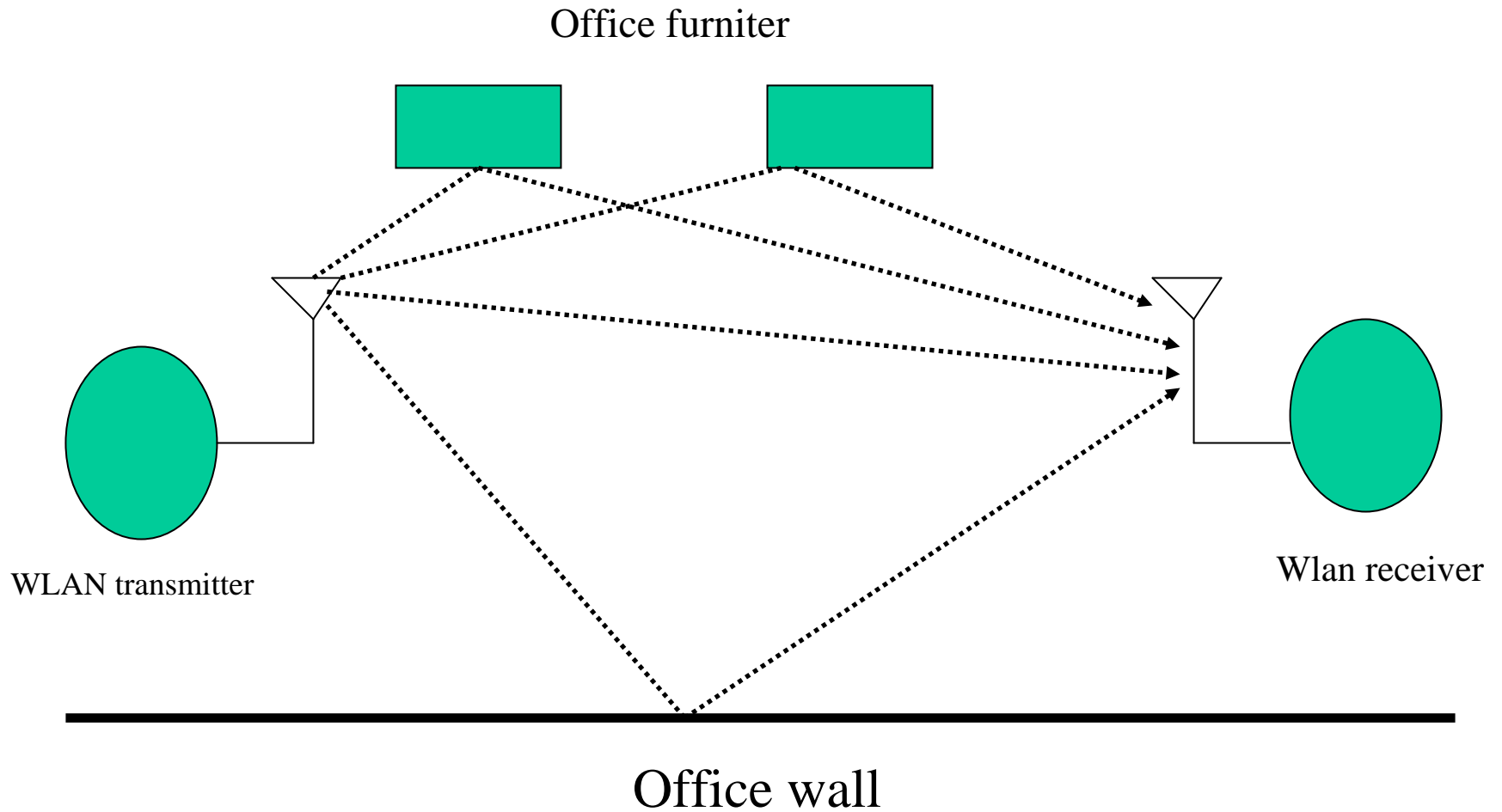
Wireless users access the network by means of a shared channel

Access capacity is inherently limited.

# Implication

- For wireline systems, we can simply **install new cables** to increase capacity.
- For wireless systems, the channel can only be **shared** by the users.
  - **Capacity does not increase.**

Fig 1.3: multipath propagation decreases the quality of the signal at the receiver





- Multipath propagation can be a significant problem, especially with indoor applications.
- As e.g., equalization and antenna diversity are methods for reducing the number of problems arising from multipath propagation.

# Interference


- Multiuser Interference
  - Radio signals of different users interfere with each other
- Self-Interference
  - Multipath effect
  - Phase-shifted images of the signal at the receiver interact and may cancel the entire signal, (i.e. destructive interference).

# Interference Management

- How to manage multiuser interference?
  - i.e. how to share the channel?
  - Multiple Access Problem
    - FDMA, TDMA, CDMA, etc.
  - Media Access Control
    - Aloha, CSMA, etc.
- How to manage self-interference?
  - Physical layer issue
    - Equalization, coding, diversity, etc.
  - This issue will NOT be considered in this course

# Fundamentals

## • Multiple Access



① 許多人共用同一傳輸媒介

② 每一對使用者(客戶)均享有他們專屬的通信電路，且不會感受到其它使用者的干擾。

◆ 傳輸媒介的種類

- 對線電纜
- 同軸電纜
- 光纖電纜
- 無線電介面(空中)

◆ 多工接取的優點

- 增加容量
- 降低每個客戶的分攤成本
- 容易維護及管理

# Fundamentals

- **Multiple Access (Cont.)**

- **Wireless**

- 劃頻多工連接 ( FDMA )

- Frequency Division Multiple Access

- 劃時多工連接 ( TDMA )

- Time Division Multiple Access

- 劃碼多工連接 ( CDMA )

- Code Division Multiple Access

# Fundamentals

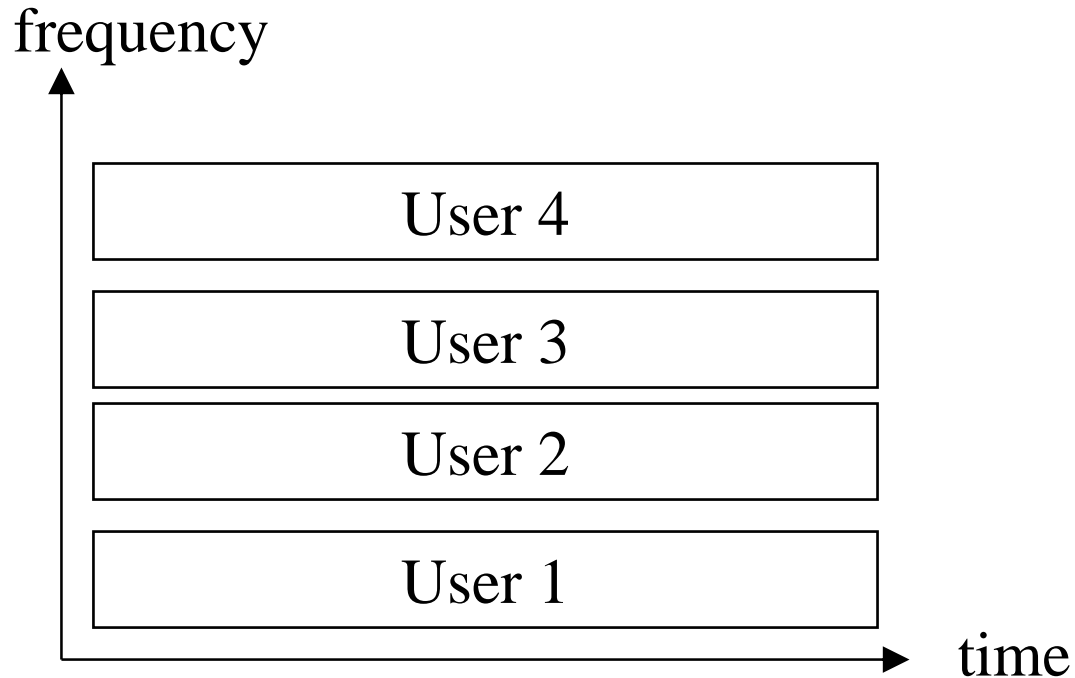
## • Multiple Access (Cont.)

### – FDMA

- ◊ 整個系統頻寬被預先劃分為若干個較小頻寬之頻道
- ◊ 各用戶(發訊站)可以同時發送,但需佔用不同頻道
- ◊ 各用戶(發訊站)間需精確的頻帶協調
- ◊ 各用戶接收機內需精確之帶通濾波器,以選擇區分所欲接收之載波頻道訊息,並拒斥其它用戶(發訊站)送出之干擾訊息
- ◊ 頻道的指配,可以採用「預先指配」(pre-assignment)或「需求指配」(demand-assignment)方式
- ◊ 在採用需求指配(或動態指配)的系統中,需有控制設備以建立與釋放兩通信點間之通信鏈路,使任一頻道均可在空閒時段再提供給其它用戶通信使用。

# Fundamentals

- **Multiple Access (Cont.)**
  - **FDMA**



# Fundamentals

## • Multiple Access (Cont.)

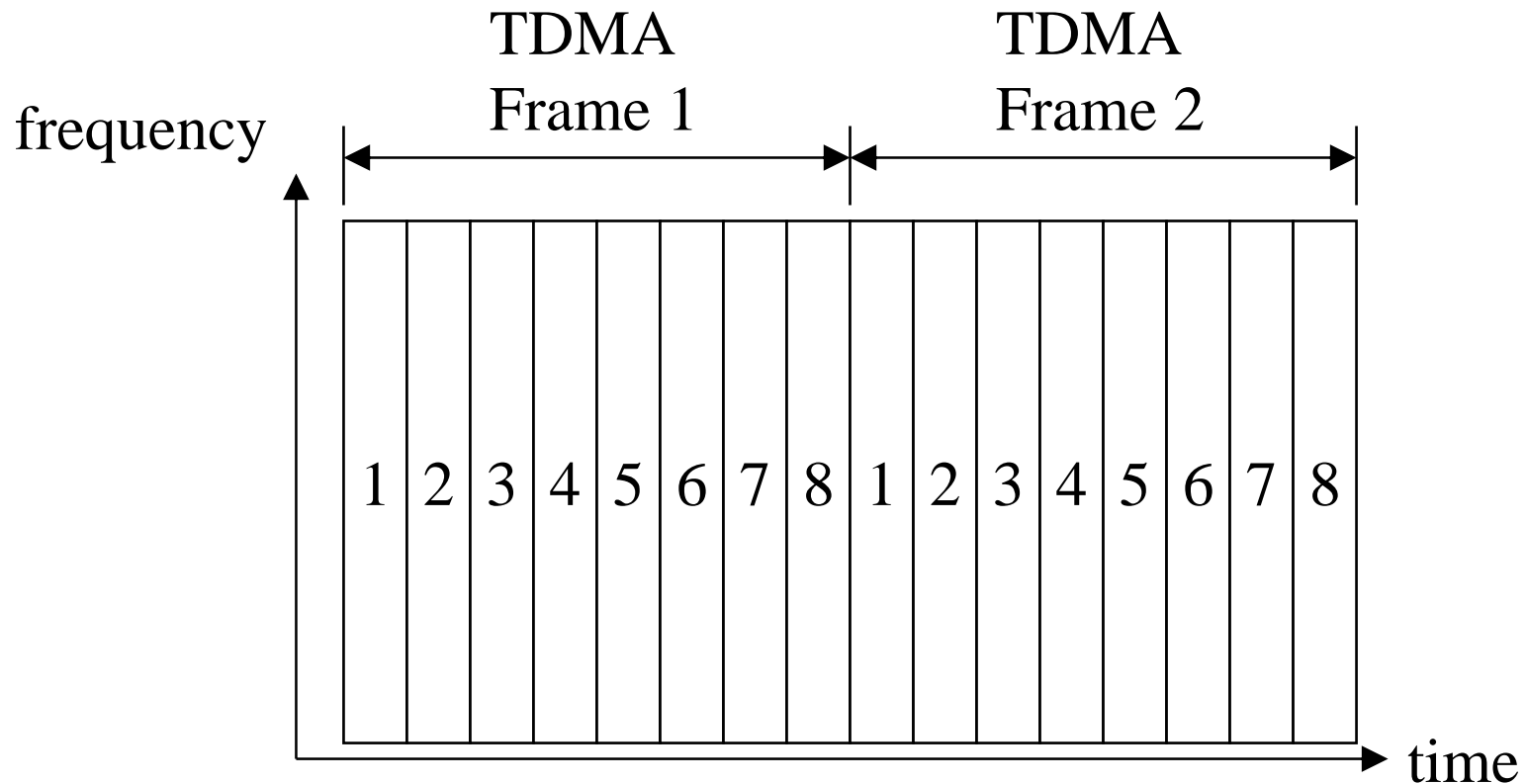
### – TDMA

- ✧ 整個頻道內之時段被依序排列成「劃時多工時框」，而每個「劃時多工時框」內則被預先劃分為若干個「時槽」
- ✧ 各用戶(發訊站)可以佔用相同頻道,但不可同時發送,只有在自己專屬的「時槽」才能發送「突波」(Burst)
- ✧ 各用戶(發訊站)間需精確的時間協調,以避免突波互相碰撞
- ✧ 各用戶收發訊機需精確之時間同步電路,以選擇區分所欲接收之「突波」,拒斥其它用戶(發訊站)送出之突波干擾
- ✧ 時槽的指配,可以採用「預先指配」(pre-assignment)或「需求指配」(demand-assignment)方式
- ✧ 在採用需求指配(或動態指配)的系統中,需有控制設備以建立與釋放兩通信點間之通信鏈路,使任一時槽均可在空閒時段再提供給其它用戶通信使用。



# Fundamentals

- **Multiple Access (Cont.)**
  - **TDMA**



# Fundamentals

- Multiple Access (Cont.)
  - CDMA

- ◉ 允許各用戶(發訊站)可以同時地發送,且能佔用相同頻道
- ◉ 各用戶(發訊站)發送的信號是以不同的亂碼來區分的
- ◉ 每一用戶(發訊站)均被指配一獨一無二之亂碼,欲接收某一用戶發送的信號,即需先知道該用戶之特定亂碼
- ◉ 各用戶(發訊站)間不需精確的頻帶協調,亦不需精確的時槽協調,但需
  - 精確的功率控制,以克服遠-近問題
  - 複雜的同步電路
- ◉ 使用「展頻」(Spread Spectrum)技術,故又稱「展頻劃碼多工連接」(SS-CDMA)或「展頻多工連接」(SSMA)

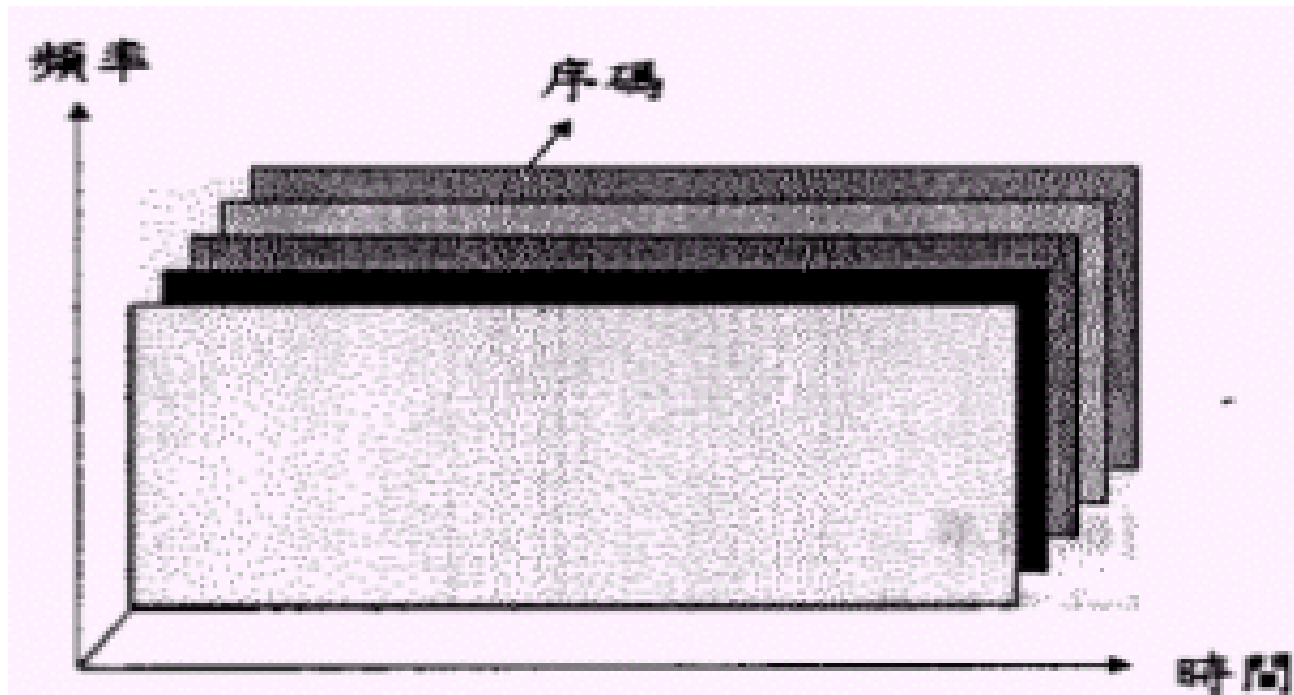
# Fundamentals

- Multiple Access (Cont.)
  - CDMA (Advantages)

- ◎ 系統容量大
- ◎ 通信品質較佳
  - 抗多路徑衰落
  - 抗干擾
  - 軟交接 (Soft Handoff)
- ◎ 安全性較高
- ◎ 細胞規劃較簡單
- ◎ 所須發射功率較低
- ◎ 基地台數目可以較少

# Fundamentals

- Multiple Access (Cont.)
  - CDMA



# Mobility

The 2<sup>nd</sup> challenge

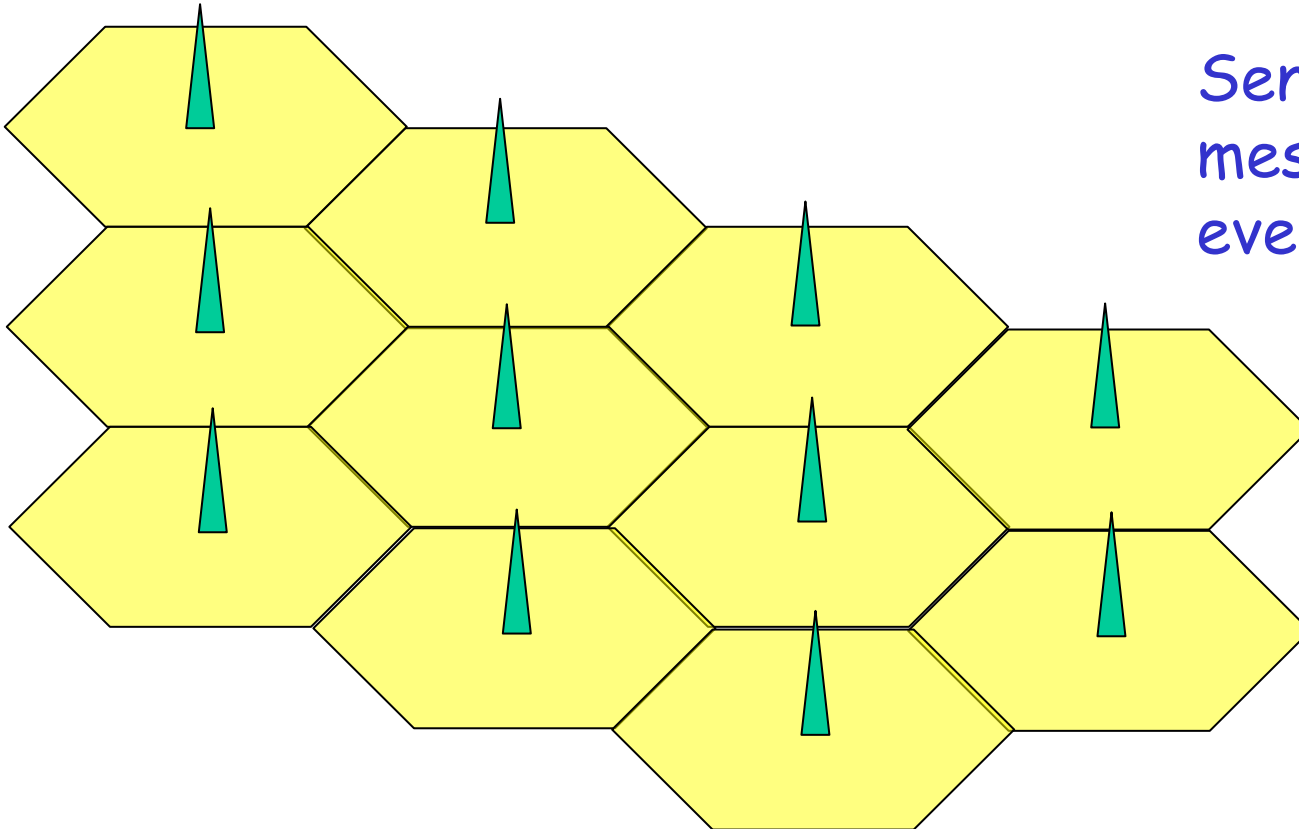
# User Mobility

- Location Management Problem
  - How does the network know **where the intended recipient of a message** is currently located?

# Cellular Scenario

Where is 97532468?

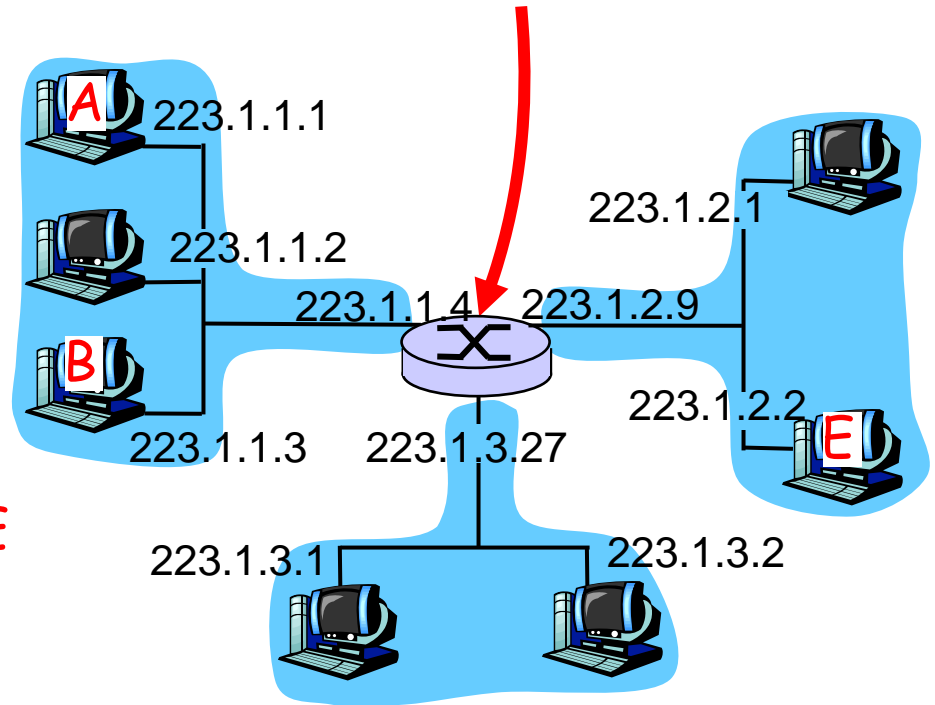
Send broadcast messages from every base station?



# Internet Scenario

## Forwarding table in router

Dest. Net	router	Nhops	interface
223.1.1	-	1	223.1.1.4
223.1.2	-	1	223.1.2.9
223.1.3	-	1	223.1.3.27



Suppose A sends a datagram to E

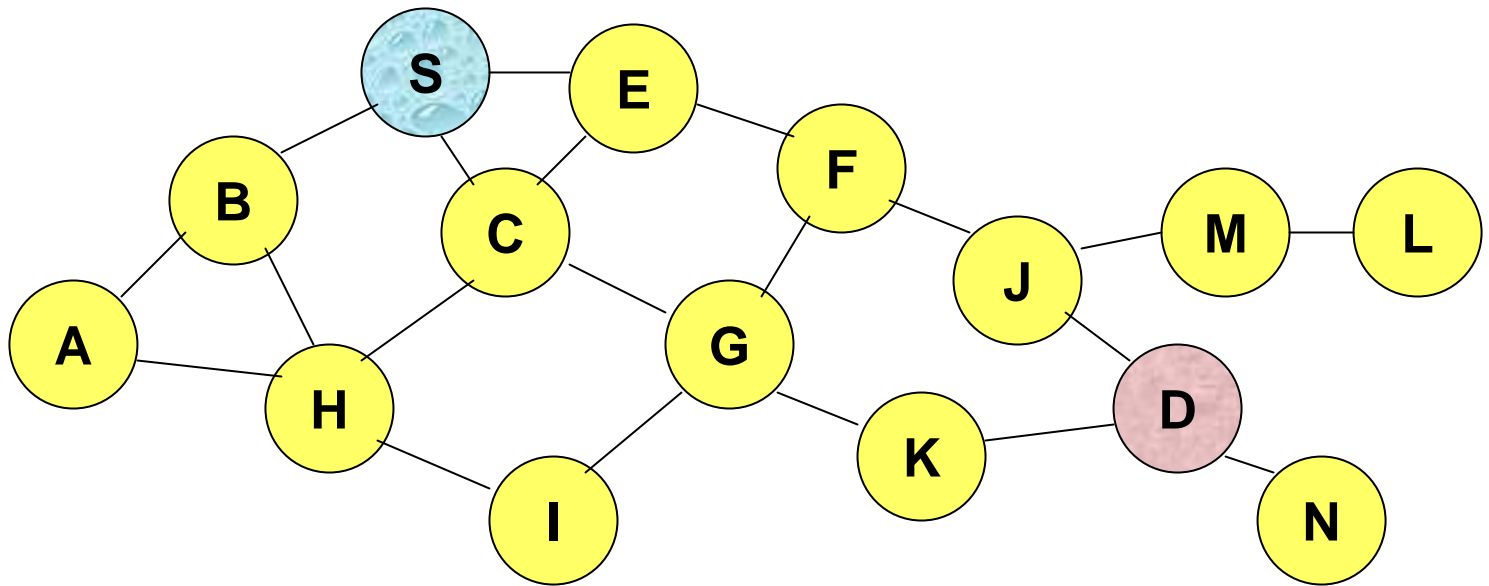
misc fields	223.1.1.1	223.1.2.2	data
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The router sends the datagram to 223.1.2.2 via interface 223.1.2.9

What happens if E moves to elsewhere?



# Ad Hoc Network Scenario



How to find a suitable path from source S to destination D?

# Device Limitation

The 3<sup>rd</sup> challenge

# Device Limitation

- Resource Poor
  - Limited memory
  - Limited computational power
  - Small display
  - Limited battery life