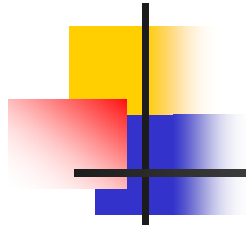


INTRODUCTION TO WIRELESS COMMUNICATION SYSTEMS





- 1.1 Evolution of mobile radio communications
- 1.2 Mobile radio system around the world
- 1.3 Examples of wireless communication systems
 - Paging system
 - Cordless telephone systems
 - Cellular telephones
 - Wireless LANs
- 1.4 Trends in cellular radio and personal communication





1.1 Evolution of Mobile Radio Communications

- Major Mobile Radio Systems
 - 1934 - Police Radio uses conventional AM mobile communication system.
 - 1935 - Edwin Armstrong demonstrated FM.
 - 1946 - First public mobile telephone service - push-to-talk.
 - 1960 - Improved Mobile Telephone Service, IMTS - full duplex.
 - 1960 - Bell Lab introduce the concept of Cellular mobile system.
 - 1968 - AT&T propose the concept of Cellular mobile system to FCC.
 - 1976 - Bell Mobile Phone service, poor service due to call blocking.
 - 1983 - Advanced Mobile Phone System (AMPS), FDMA, FM.
 - 1991 - Global System for Mobile (GSM), TDMA, GMSK.
 - 1991 - U.S. Digital Cellular (USDC) IS-54, TDMA, DQPSK.
 - 1993 - IS-95, CDMA, QPSK, BPSK.



1.2 Mobile Radio System Around the World-

Major Mobile Radio Standard in North American(1/2)

Standard	Type	Year of introduction	Multiple access	Frequency band	Modulation	Channel bandwidth
AMPS	Cellular	1983	FDMA	824-894 MHz	FM	30 kHz
NAMPS	Cellular	1992	FDMA	824-894 MHz	FM	10 kHz
USDC	Cellular	1991	TDMA	824-894 MHz	$\pi/4$ -DQPSK	30 kHz
CDPC	Cellular	1993	FH/Packet	824-894 MHz	GMSK	30 kHz
IS-95	Cellular/ PCS	1993	CDMA	824-894 kHz 1.8-2.0 GHz	QPSK/ BPSK	1.25 MHz
GSC	Paging	1970s	Simplex	Several	FSK	12.5 kHz



Major Mobile Radio Standard in North American(2/2)

Standard	Type	Year of introduction	Multiple access	Frequency band	Modulation	Channel bandwidth
POCSAG	Paging	1970s	Simplex	Several	FSK	12.5 kHz
FLEX	Paging	1993	Simplex	Several	4-FSK	15 kHz
DCS-1900 (GSM)	PCS	1994	TDMA	1.85-1.99 GHz	GMSK	200 kHz
PACS	Cordless/PCS	1994	TDMA/FDMA	1.85-1.99 GHz	$\pi/4$ -DQPSK	300 kHz
MIRS	SMR/PCS	1994	TDMA	Several	16-QAM	25 kHz
iDen	SMR/PCS	1995	TDMA	Several	16-QAM	25 kHz





Major Mobile Radio Standard in Europe

Standard	Type	Year of introduction	Multiple access	Frequency band	Modulation	Channel bandwidth
ETACS	Cellular	1985	FDMA	900 MHz	FM	25 kHz
NMT-450	Cellular	1981	FDMA	450-470 MHz	FM	25 kHz
NMT-900	Cellular	1986	FDMA	890-960 MHz	FM	12.5 kHz
GSM	Cellular/PCS	1990	TDMA	890-960 MHz	GMSK	200 kHz
C-450	Cellular	1985	FDMA	450-465 MHz	FM	20 kHz/10 kHz
ERMES	Paging	1993	FDMA	Several	4-FSK	25 kHz
CT2	Cordless	1989	FDMA	864-868 MHz	GFSK	100 kHz
DECT	Cordless	1993	TDMA	1880-1900 MHz	GFSK	1.728 kHz
DCS-1800	Cordless/PCS	1993	TDMA	1710-1880 MHz	GMSK	200 kHz





Major Mobile Radio Standard in Japan

Standard	Type	Year of introduction	Multiple access	Frequency band	Modulation	Channel bandwidth
JTACS	Cellular	1988	FDMA	860-925 MHz	FM	25 kHz
PDC	Cellular	1993	TDMA	810-1501 MHz	$\pi/4$ -DQPSK	25 kHz
NTT	Cellular	1979	FDMA	400/800 MHz	FM	25 kHz
NTACS	Cellular	1993	FDMA	843-925 MHz	FM	12.5 kHz
NTT	Paging	1979	FDMA	280 MHz	FM	12.5 kHz
NEC	Paging	1979	FDMA	Several	FM	10 kHz
PHS	Cordless/PCS	1993	TDMA	1895-1907 MHz	$\pi/4$ -DQPSK	300 kHz

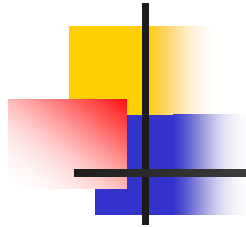




1.3 Example of Wireless Communication Systems

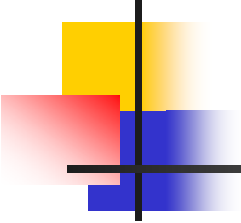
- Examples
 - Cordless phone
 - Hand-held walkie-talkies
 - Pagers
 - Cellular telephone
 - Wireless LAN



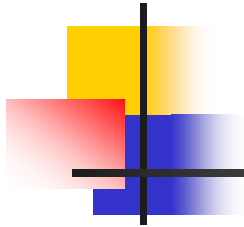


- Mobile
 - Historically - any radio terminal that could be moves during operation
 - More recently - a radio terminal that is attached to a high speed mobile platform
- Portable - hand-held and used at walking speed
- Subscriber - mobile or portable user
- Subscriber unit - each user's communication devices.

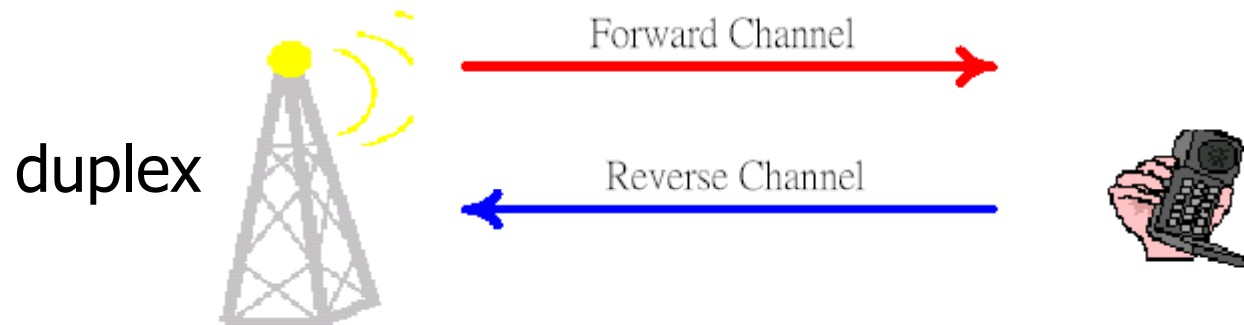
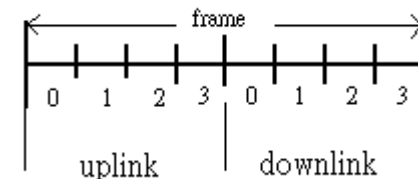


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- Classification of mobile radio transmission system
 - Simplex: communication in only one direction
 - Half-duplex: same radio channel for both transmission and reception (push-to-talk, release-to-listen)
 - Full-duplex: simultaneous radio transmission and reception (FDD, TDD)



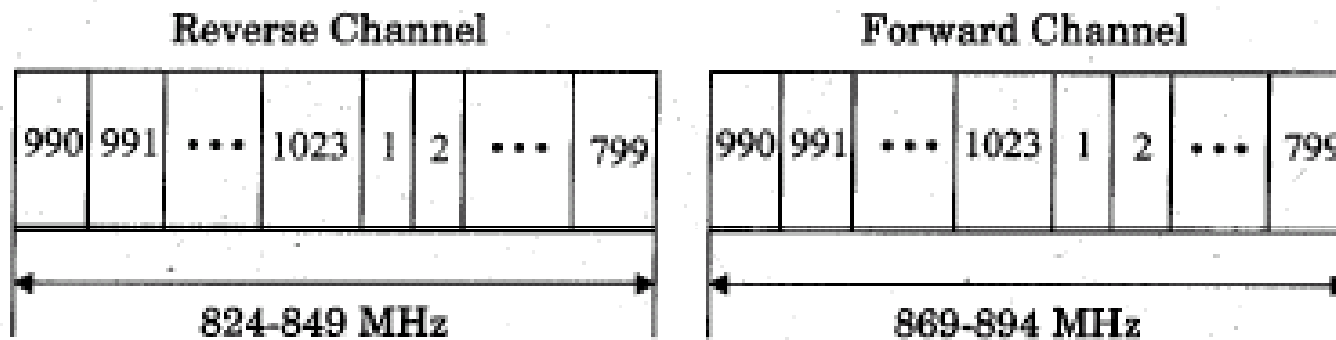
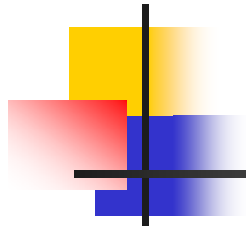


- Frequency division duplexing uses two radio channel.
(analog/digital)
 - Forward channel: base station to mobile user
 - Reverse channel: mobile user to base station
- Time division duplexing shares a single radio channel in time. (only for digital)



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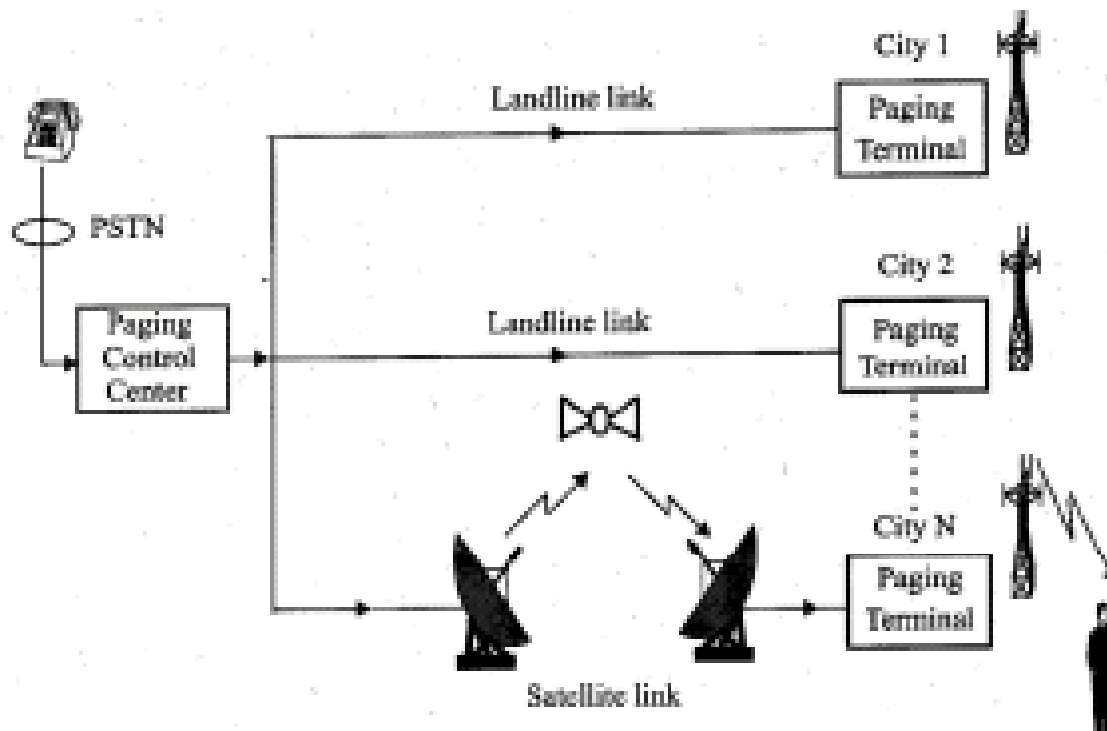


	Channel Number	Center Frequency (MHz)
Reverse Channel	$1 \leq N \leq 799$	$0.030N + 825.0$
	$990 \leq N \leq 1023$	$0.030(N - 1023) + 825.0$
Forward Channel	$1 \leq N \leq 799$	$0.030N + 870.0$
	$990 \leq N \leq 1023$	$0.030(N - 1023) + 870.0$

(Channels 800 - 989 are unused)

1.3.1 Paging Systems

- Conventional paging system send brief messages to a subscriber.
- Modern paging system: news headline, stock quotations, faxes, etc.
- Simultaneously broadcast paging message from each base station (simulcasting).
- Large transmission power to cover wide area.

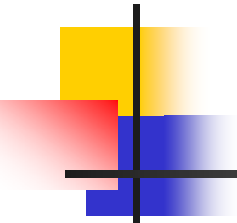


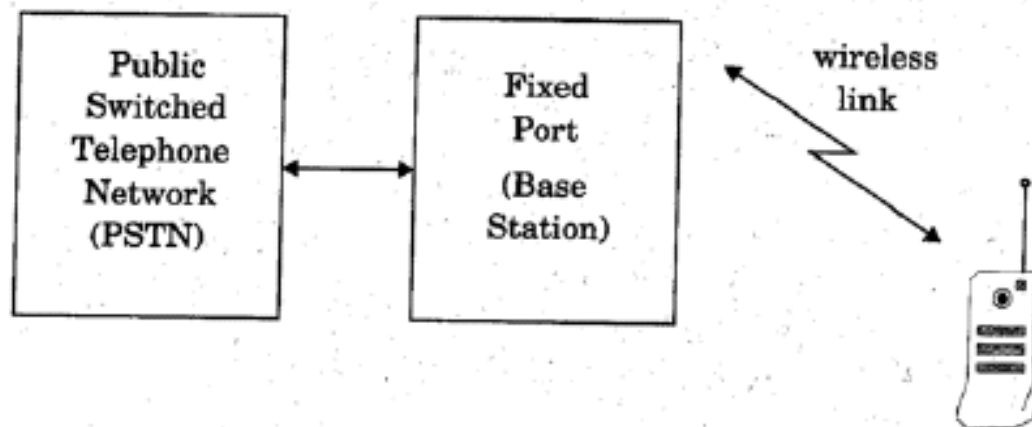


1.3.2 Cordless Telephone System

- Cordless telephone systems are full duplex communication systems.
- First generation cordless phone
 - in-home use
 - communication to dedicated base unit
 - few tens of meters



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- Second generation cordless phone
 - outdoor
 - combine with paging system
 - few hundred meters per station

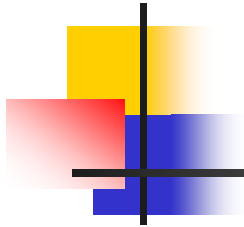




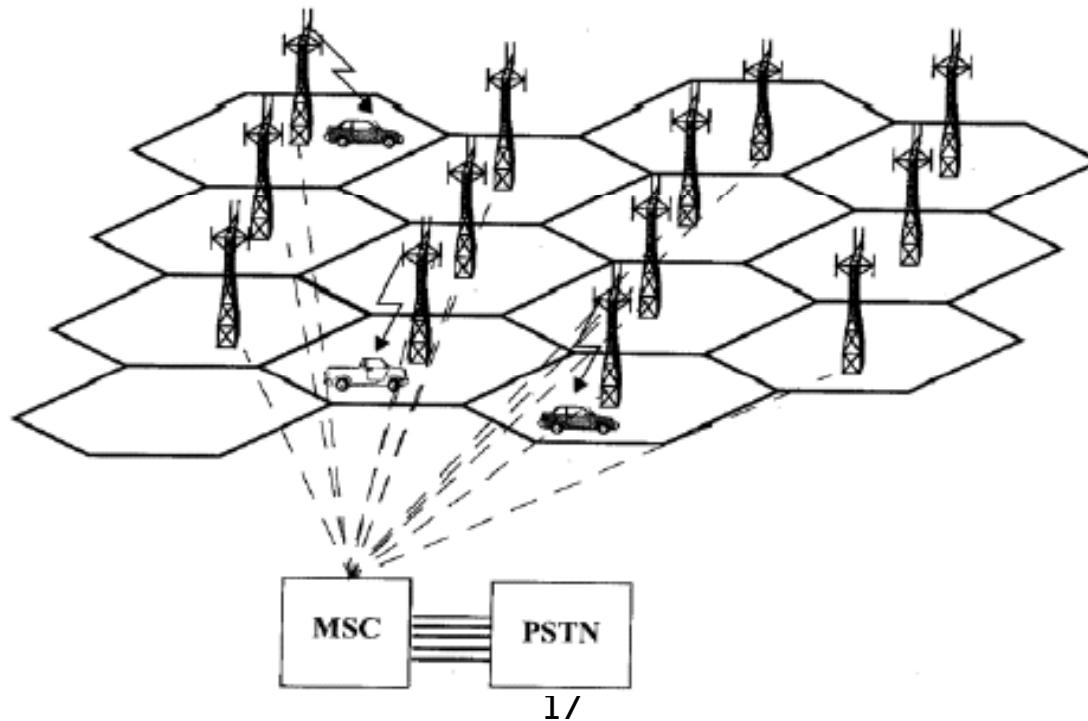
1.3.3 Cellular Telephone Systems

- Provide connection to the PSTN for any user location within the radio range of the system.
- Characteristic
 - Large number of users
 - Large Geographic area
 - Limited frequency spectrum
 - Reuse of the radio frequency by the concept of “cell”.



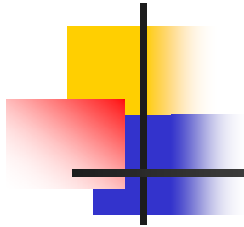


- Basic cellular system: mobile stations, base stations, and mobile switching center.



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- Communication between the base station and mobiles is defined by the standard common air interface (CAI).
 - forward voice channel (FVC): voice transmission from base station to mobile
 - reverse voice channel (RVC): voice transmission from mobile to base station
 - forward control channels (FCC): initiating mobile call from base station to mobile
 - reverse control channel (RCC): initiating mobile call from mobile to base station

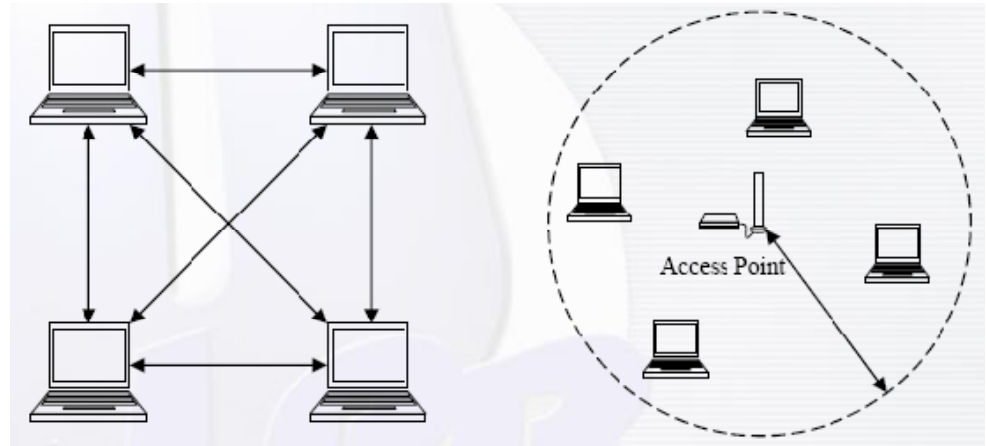




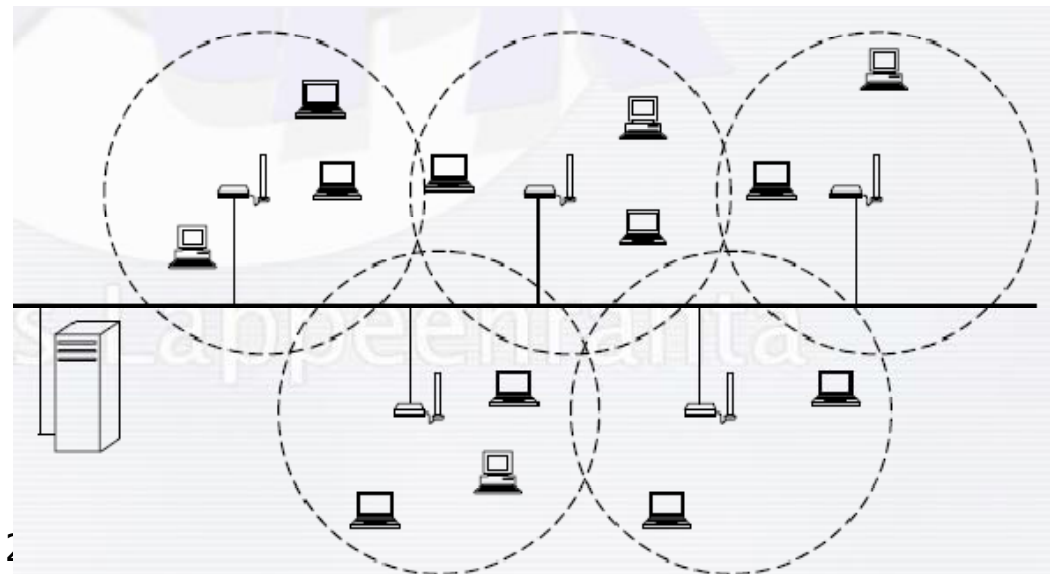
1.3.4 Wireless Local Area Networks (WLANs)

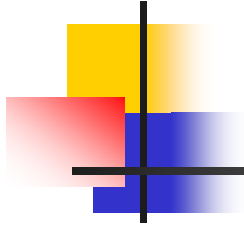
- Suitable for local short-distance networking.
- Compatible with existing LANs.
- WLANs use unlicensed radio frequency.
- WLAN is already affordable and popular
 - Used widely in airports, railway stations, hotels, business parks and office buildings
 - Integrating to laptops and PDA devices.

- Basic Service Set (BSS, Ad hoc, peer to peer)



- Extended Service Set (ESS, Infrastructure network)





	802.11b	802.11a	802.11g
Maximum Data Rate	11 Mbps	54 Mbps	54 Mbps
Frequency Band	2.4 GHz	5 GHz	2.4 GHz
Channel	3	12	3
Typical Range	Up to 300 ft.	Up to 180 ft	Up to 300 ft
802.11b Compatible	Yes	No	Yes

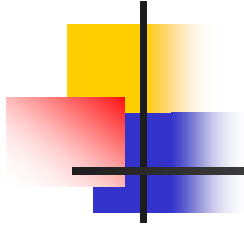




1.4 Trends in Cellular Radio and Personal Communication

- Since 1989, there has been enormous activity throughout the world to develop personal systems that combined the network intelligence of today's PSTN with digital signal processing and RF technology. The concept is called Personal Communication Services (PCS).
- Indoor wireless networking products are rapidly emerging and promise to become a major part of the telecommunications infrastructure. An international standard body, IEEE 802.11, is developing standards for wireless access between computers inside buildings.





- The technical group TG 8/1 is considering how worldwide wireless network should evolve and how worldwide frequency coordination might be implemented to allow subscriber units to work anywhere in the world.
- Worldwide standard also required low earth orbit (LEO) satellite communication systems.

