TEE 843 – Sistem Telekomunikasi

Sistem Komunikasi Nirkabel

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Jurusan Teknik Elektro FT-Unimal
Lhokseumawe, 2015

Wireless Communications

- Introduction
- Cordless Telephones
- PMR (Professional/Private Mobile Radio)
- Radio Paging
- Microwave Relay Systems
- Satellite Communications
- Bluetooth
- WLAN
- Cellular Communications

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Komunikasi Nirkabel
(Wireless Communication)

- **Sistem komunikasi nirkabel** atau **nirkawat *(wireless communication)*** adalah sistem komunikasi yang media transmisinya berupa non-fisik (**tanpa kabel/kawat**).
- Transmisinya menggunakan **gelombang elektromagnetik**.
- Terminologi **komunikasi nirkabel (*wireless*)** adalah pengganti terminologi **komunikasi radio**.
- ***Mobile communication*** adalah sistem komunikasi yg bersifat nirkabel dan memungkinkan pengguna *(user)* dpt **berkomunikasi sambil bergerak**.

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Komunikasi Nirkabel (2)

- Secara umum ***mobile*** diidentikkan dgn ***wireless***, sehingga istilah ***mobile communication*** sering dipertukarkan dgn ***wireless communication***.
- Meskipun sebenarnya ada ***fixed wireless communication*** dan ***mobile wireless communication***.
- Oleh karena sistem komunikasi bergerak yg paling dominan adalah sistem komunikasi seluler, maka ***mobile communication*** sering juga diidentikkan dengan ***cellular communication***.
- Padahal sebenarnya sistem komunikasi bergerak tdk hanya berupa sistem komunikasi seluler.

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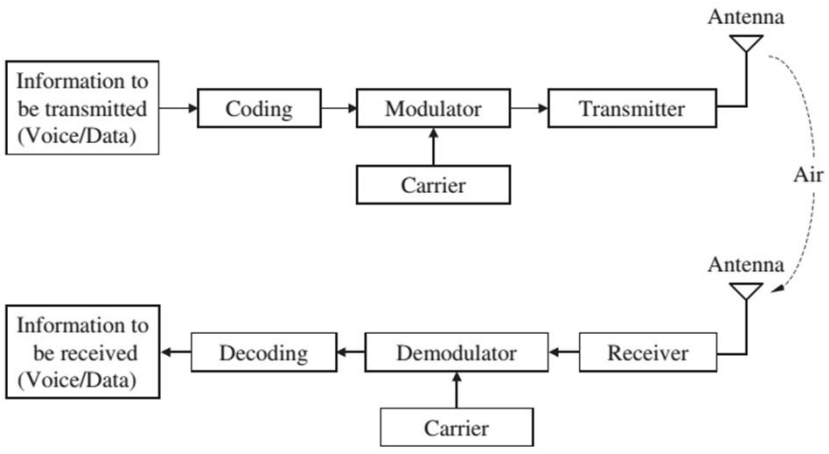
Klasifikasi Komunikasi Nirkabel

Wireless Communication	**Fixed Wireless**	**Non Cellular**	**contoh :** point to point communication, infra red communication, LMDS, Microwave communication
		Cellular	**contoh :** PHS, CT2, PACS, DCS1800, DECT
	Mobile Wireless	**Non Cellular**	**contoh :** paging system (ERMES, NTT, NEC) , dispatching system, PAMR (*Public Access Mobile Radio*) dsb
		Cellular	**contoh :** GSM, CDMA/IS-95, AMPS, UMTS, PHS, DCS1800, NMT450, TACS, C-450, dsb

Sistem Komunikasi Nirkabel (disederhanakan)



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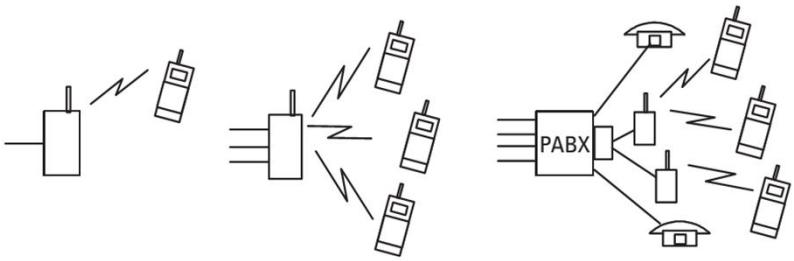
Cordless Telephones



Residential use

Telepoint or wireless local loop, WLL

Cordless corporate network

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Aplikasi Cordless Telephones

- Residential Use
  - First generation cordless phones (CT1)
  - Cakupan hanya seluas rumah dan halaman.
- Telepoint dan Wireless local loop (WLL)
  - Second generation cordless telephone technology (CT2)
  - Misalnya pada stasiun kereta dan bandara.
  - Pemakaiannya berkurang dgn semakin murahnya biaya telepon seluler.
- Cordless Corporate Network
  - Digital European Telecommunications (DECT).
  - Personal access communication system (PACS) di Amerika.

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PMR

(Professional or Private Mobile Radio)

- The PMR systems are dedicated and independent mobile radio systems.
- Some of them are just simple “walkie-talkie” type radios, others are complex networks that use a technology similar to that of public cellular mobile radio systems.
- One typical PMR is owned by a taxi operator.
- Standar PMR digital modern: Terrestrial Trunked Radio (TETRA).

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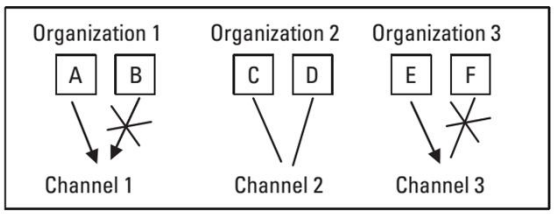
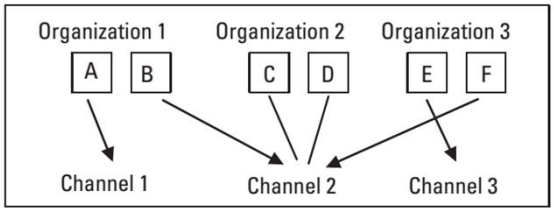
Resource sharing dan Trunked network pada PMR

Conventional PMR (dispatch) network:
One channel for each organization



Trunked network:
Radio channels (spectrum) are shared by all users who may belong to separate networks



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Paging Networks

- Paging networks merupakan komunikasi unidirectional saja.
- Pager merupakan sistem komunikasi wireless (nirkabel/nirkawat) yg low-cost.
- Pager sederhana hanya dpt menyampaikan “beep”, tetapi yg lbh maju dpt menyampaikan pesan (message) yg cukup panjang.
- Keberadaannya telah dikalahkan oleh munculnya sistem selular.

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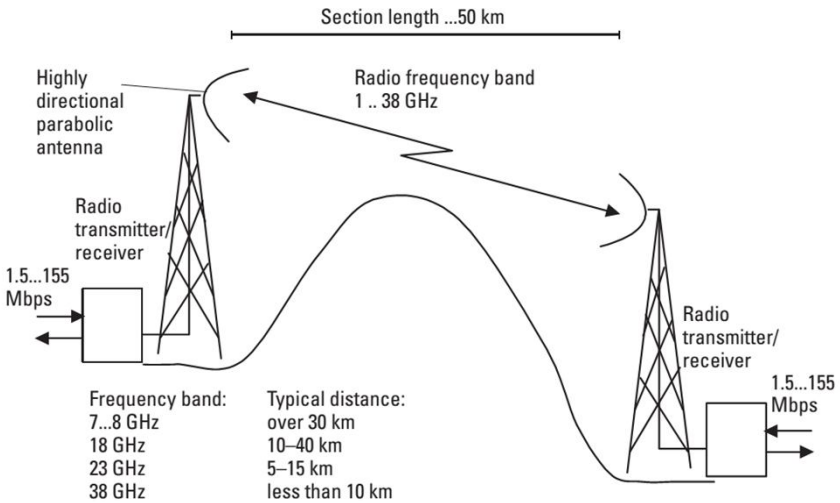
Microwave Relay Systems



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Sistem Komunikasi Satelit

- Pada dasarnya, aplikasi dari sistem komunikasi satelit adlh utk komunikasi point-to-point.
- Namun, satelit jg menyediakan layanan komunikasi bergerak utk kapal dan pesawat terbang, sbg sistem komunikasi cadangan. Satelit yg digunakan adlh satelit geostasioner pd ketinggian 36.000 km.
- Lalu, satelit jg menyediakan layanan utk handy MS, menggunakan satelit-satelit yg berorbit pd ketinggian 700 – 10.000 km. Misalnya: Iridium dan Globalstar.

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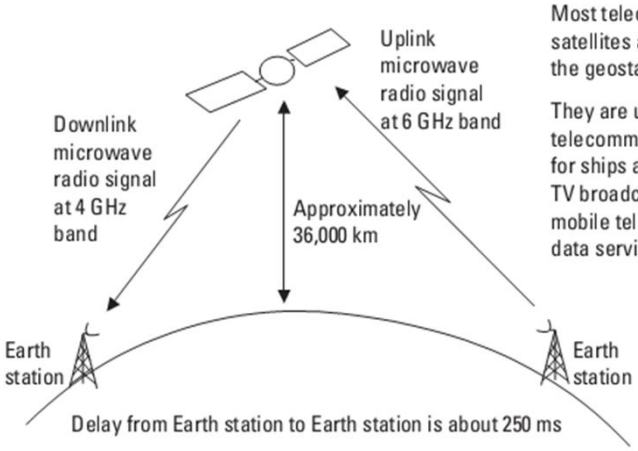
Satellites for Fixed Communications



Most telecommunication satellites are placed in the geostationary orbit.

They are used to provide telecommunication services for ships and aircrafts, TV broadcasting, and mobile telephone and data services.

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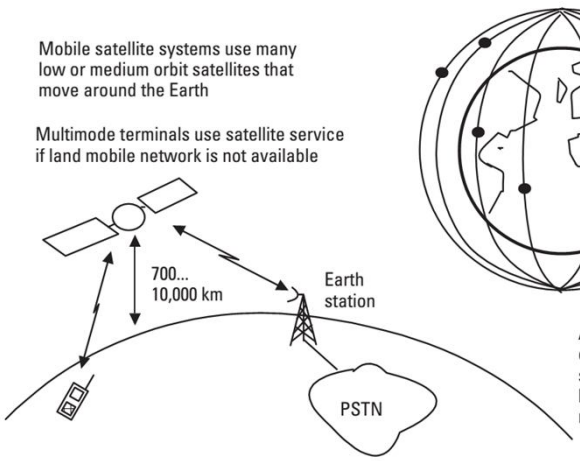
Satellites for Mobile Communications

Mobile satellite systems use many low or medium orbit satellites that move around the Earth

Multimode terminals use satellite service if land mobile network is not available



A satellite that operates as a base station of a public land mobile network, PLMN.

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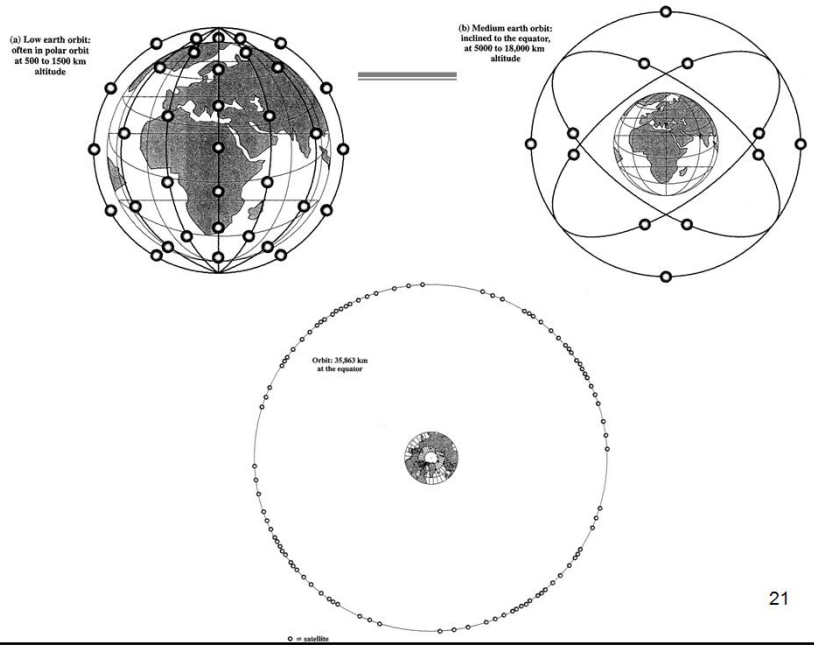
Orbit Satelit: LEO, MEO, GEO



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Aplikasi Satelit

Traditionally	-Weather satellites -Radio and TV broadcast satellites -Military satellites -Satellites for navigation and localization (e.g., GPS)
Telecommunication	-Global telephone connections -Backbone for global networks -Connections for communication in remote places or underdeveloped areas -Global mobile communication

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Bluetooth

- **Bluetooth technology** allows for the replacement of proprietary cables that connect one digital device to another with a universal short-haul radio link.
- Mobile computers, cellular handsets, printers, keyboards, and many other devices can be embedded with Bluetooth radios.
- Bluetooth was developed by the Bluetooth Special Interest Group (SIG, http://www.bluetooth.com), founded by Ericsson, IBM, Intel, Nokia, and Toshiba.
- A small wireless Bluetooth network connecting, for example, a user's computer to its peripherals is called a **personal area network (PAN)**
- Bluetooth systems use the same 2.4-GHz license free frequency band as WLANs and they can coexist in the same area.
- Bluetooth uses frequency hopping spread-spectrum (FHSS) technology.
- The modulation rate of Bluetooth is 1 Mbps.

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Wireless Communications

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- Bluetooth
- **WLAN (Wireless Local Area Network)**
- Cellular Communications

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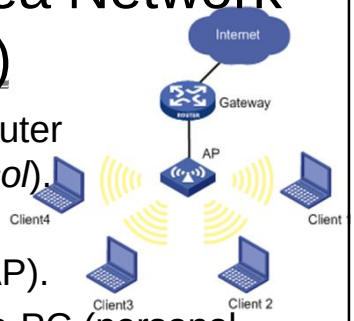
Wireless Local Area Network (**WLAN**)

- Berasal dari jaringan komputer berbasis IP (*internet protocol*).
- BS pada WLAN dinamakan *access point* (AP).
- MS pada WLAN dpt berupa PC (personal computer), laptop, smartphone, dll.
- Standar WLAN: IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, dll.
- Pita frekuensi yg digunakan adlh *license free frequency band* 2.4 GHz dan 5 GHz.



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Sistem Komunikasi Seluler

- **Masalah utama** pd jaringan komunikasi bergerak tradisional adlh **rendah kapasitas** akibat **terbatasnya pita frekuensi**.
- **Jaringan selular** menyediakan solusi dgn adanya **penggunaan frekuensi yg sama** pd beberapa area dlm jaringan (dikenal dgn ***frequency reuse***).
- Mekanisme kunci lainnya adlh **handoff** atau **handover** yg memungkinkan komunikasi tdk terputus saat pengguna bergerak menuju sel (area) lain dlm jaringan.

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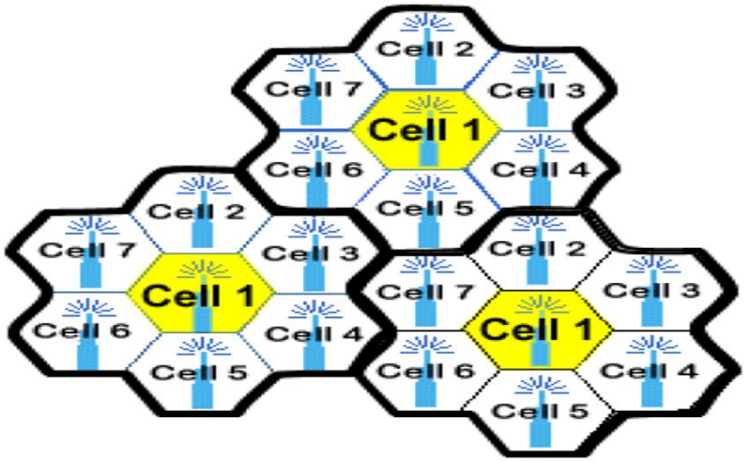
Struktrur Sel dan *Frequency Reuse*



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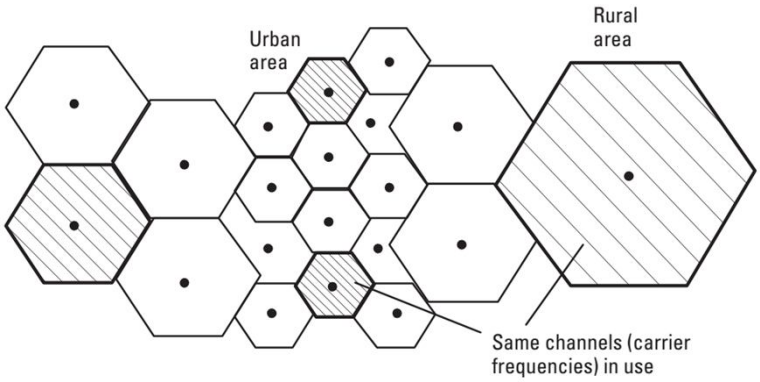
Struktrur Sel dan *Frequency Reuse* (2)



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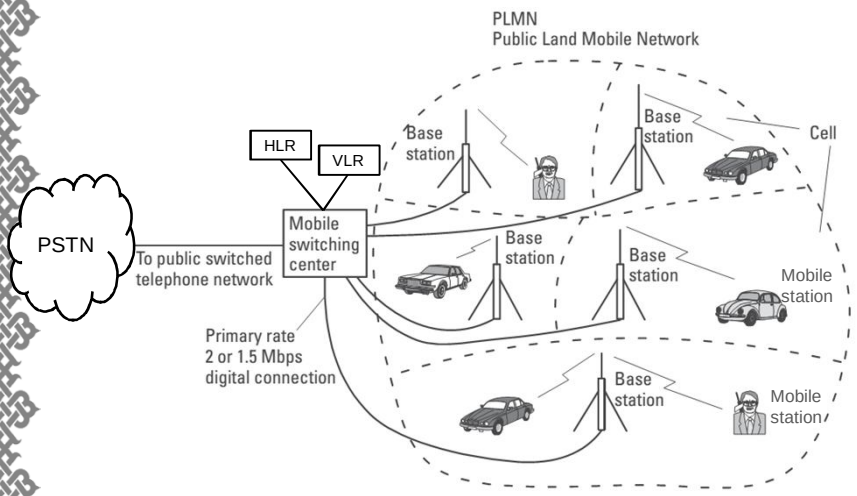
Struktur Dasar Sistem Komunikasi Seluler



Elemen-elemen dasar pd jaringan seluler

- **Base tranceiver station (BTS)** atau terkadang disebut **base station (BS)** saja. → transceiver = transmitter/receiver.
- **Mobile station (MS)**, misalnya pesawat telepon bergerak.
- **Mobile switching center (MSC)**, yang bertindak seperti sentral lokal pd jaringan tetap (PSTN).
- Jaringan seluler dirancang utk jaringan akses, karena itu tdk memiliki hirarki swicthing dan untuk sambungan jarak jauh dan internasional menggunakan jaringan tetap *(fixed network)* sbg penghubung.

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Karakteristik penting dari sistem seluler

- **Frequency reuse** provides a much larger number of communication channels than the number of channels allocated to the system.
- Automatic intercellular transfer, or a **handover** (or **handoff**), ensures continuity of communication when there is a need to change BSs.
- **Continuous monitoring** of communication between the mobile and BS verifies the quality and detects the need for a cell transfer.
- **Automatic location** of mobile stations within the network ensures that calls can be routed to mobiles.
- Mobile stations **continuously listen** to a common channel of the network in order to receive a call.

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Karakteristik penting dari sistem seluler (2)

- Area pd jaringan seluler dibagi menjadi beberapa **sel**.
- **Daya** BS dan MS secara otomatis berkurang dgn berkurangnya ukuran sel.
- **Daya transmisi** BS dan MS dikontrol agar sekecil mungkin, utk mencegah interferensi pd sel lain yg menggunakan frekuensi yg sama ***(reuse of frequency)***.
- Dgn adanya *frequency reuse,* operator dpt menambah **kapasitas jaringan** dgn memperkecil ukuran sel.
- ***Low transmission power*** menjadikan masa operasi baterai lbh lama dan pelanggan lbh aman.
- Database: ***home location register*** **(HLR)** dan ***visitor location register*** **(VLR)**.

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HLR dan VLR

- Setiap pelanggan didaftarkan pd suatu HLR oleh operator-nya.
- **HLR** menyimpan informasi ttg seluruh pelanggan yg terdaftar pd-nya, misalnya: dimana lokasinya saat ini, layanan apa digunakan, ke nomor nama panggilan harus ditransfer.
- **VLR** menyimpan informasi ttg seluruh pelanggan yg berada dlm area-nya.
- VLR biasanya terpadu dlm MSC, tp HLR biasanya terpisah secara fisik.

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Kanal radio pd jaringan seluler

- **Duplexing:**
  - **Downlink** atau **forward link** adlh kanal transmisi dari jaringan (BTS) ke MS.
  - **Uplink** atau **reverse link** adlh kanal transmisi dari MS ke BTS.
  - Pilihan duplexing: FDD dan TDD
- **Kanal kendali dan kanal trafik:**
  - Kanal kontrol ***(control channel)*** utk signalling dan kebutuhan kontrol lainnya.
  - Kanal trafik ***(traffic channel*** atau ***dedicated channel)*** utk mengalirkan trafik (suara, data, dll.)

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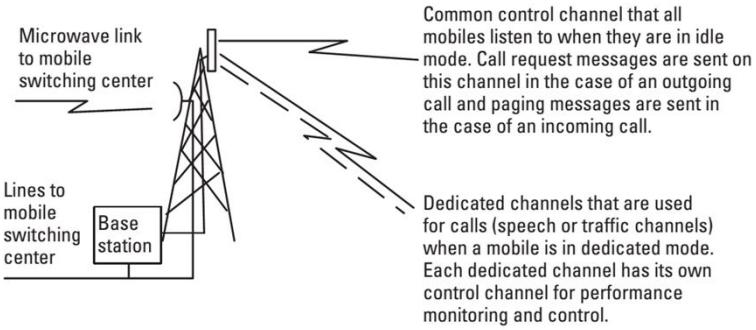
Jenis-jenis kanal radio pd sistem komunikasi seluler

HLR, home location register, stores subscriber information and updated location information (VLR address). Each subscriber is registered in one fixed HLR. VLR, visitors location register, stores subscriber information of each MS located in its area.



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Prinsip kerja (operasi dasar) jaringan seluler

- Setiap MS mendapat identifikasi (identitas), berupa nomor telepon atau kode lain.
- Beberapa modus operasi:
  - MS in idle mode
  - Outgoing call
  - Incoming call
  - Handover (handoff)
  - MS transmitting power

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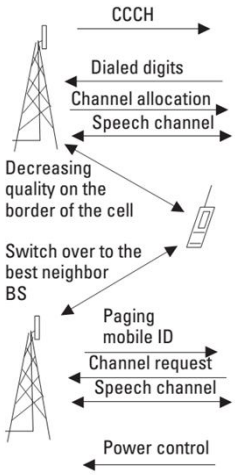
Operasi dasar pd jaringan seluler



In idle mode the mobile station listens to the common control channel, CCCH.

Outgoing call: The dialed digits are sent to the network and a voice channel is allocated.

Handover: When the MS moves towards the edge of the base station area, communication quality is decreased. A new cell is selected with the help of measuring results of the neighbor cells. A new channel is then allocated and BS and MS switch to it at the same time.

Incoming call: Paging message is sent over the common control channel. When MS receives its own identification, it requests a traffic or voice channel, which is then allocated.

Transmission power is controlled to be as low as possible to minimize interference with other cells.

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Generasi Jaringan Seluler

Generation	Name	Features
1 (1980)	NMT (*Nordic Mobile Telephone*), …	Analog Voice
2 (1992)	GSM (*Global System for Mobile communications*) - GSM 900, GSM 1800 IS95 (*Interim Standard*) based on CDMA - IS95a,b …cdmaOne	Digital Voice + data
2,5 (1999)	GPRS (*General Packet Radio Service*) EGPRS/EDGE (*Enhanced GPRS/Enhanced Data rates for Global Evolution*)	
3 (2001)	WCDMA/UMTS (*Universal Mobile Telecommunication System*) cdma2000 (*code division multiple access*)	Multimedia
4 (2011)	LTE/LTE-A (*Long Term Evolution – Advanced*), WiMAX IEEE802.16	OFDMA, high speed data, full mobility, and convergence
5 (2020)..?	…… ?	

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1G

Year	Events
1970s	Developments of radio and computer technologies for 800/900 MHz mobile communication
1976	WARC (world administrative radio conference) allocates spectrum for cellular radio
1979	NTT (Nippon Telephone & Telegraph) introduces the first cellular system in Japan
1981	NMT (Nordic Mobile Telephone) 900 system introduced by Ericsson Radio System AB and deployed in Scandinavia
1984	AMPS (advanced mobile phone service) introduced by AT&T in North America

1G (lanjutan)

Table 4.5 First Generation Cellular Standards

Parameter	*AMPS*	*TACS*	*NMT900*	*NTT*
Frequency (MHz)				
Reverse	824–849	890–905	890–905	860–885 843–846
Forward	869–894	935–960	935–960	915–940 898–901
Duplex separation (MHz)	45	45	45	55
Channel spacing (kHz)	30	25	25/12.5	25/12.5/6.25
Number of full-duplex channels	832	600	1,999	600–2,400
Voice transmission	FM with ±8-kHz deviation	FM with ±9.5-kHz deviation	PM with ±5-kHz deviation	FM with ±5-kHz deviation
Data transmission	FSK with ±8-kHz deviation, 10 kbit/s	FSK with ±6.4-kHz deviation, 8 kbit/s	FFSK with ±3.5-kHz deviation, 1.2 kbit/s	FFSK with ±4.5-kHz deviation, 0.3 kbit/s
Mobile Tx. power (W)	3	7	6	5
Base station ERP (W/channel) max	100	100	100	100

2G

Year	Events
1982	CEPT (Conference European des Post of Telecommunications) establishes GSM (global special mobile) to define future Pan-European cellular radio standards
1990	Interim Standard IS-54 (USDC: United States digital cellular) adopted by TIA (Telecommunications Industry Association)
1990	Interim Standard IS-19B (NAMPS: narrowband AMPS) adopted by TIA
1991	Japanese PDC system standardized by the MPT (Ministry of Posts and Telecommunications)
1992	Phase I GSM system is operational
1993	Interim Standard IS-95 (CDMA) adopted by TIA
1994	Interim Standard IS-136 adopted by TIA
1995	PCS Licenses issued in North America
1996	Phase II GSM is operational
1997	North American PCS deploys GSM, IS-54, IS-95
1999	IS-54: used in North America; IS-95: used in North America, Hong Kong, Israel, Japan, South Korea, and China; GSM: used in 110 countries

Standar-standar pokok 2G

- GSM (TDMA) Eropa & Dunia
- PDC (TDMA) Jepang
- IS-54/IS-136 (TDMA) Amerika Utara
- IS-95 (CDMA) Amerika Utara

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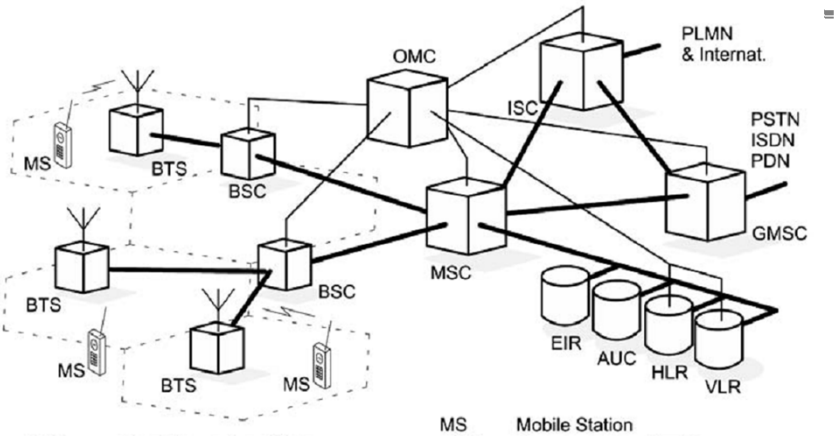
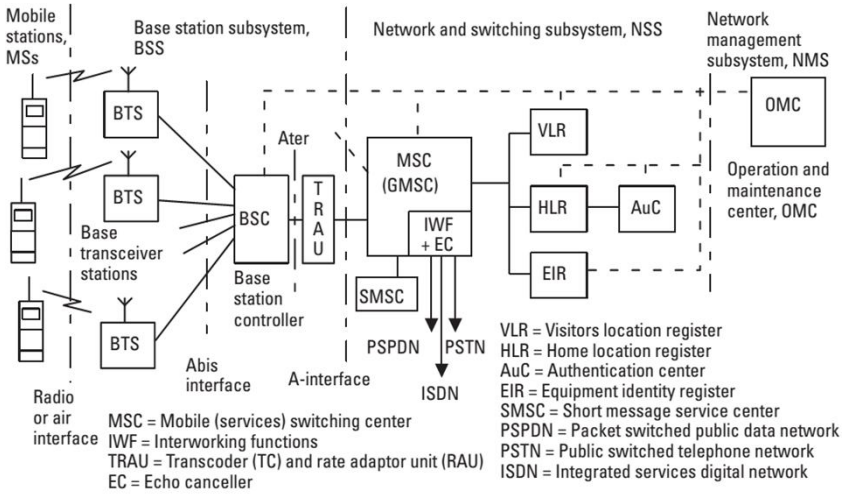
Arsitektur GSM



BTS	Base Transceiver Station	MS	Mobile Station
BSC	Base Station Controller	HLR	Home Location Register
MSC	Mobile Switching Center	VLR	Visited Location Register
GMSC	Gateway MSC	EIR	Equipment Identity Register
ISC	International Switching Center	AUC	Authentication Center
		OMC	Operation and Maintenance Center

Arsitektur GSM (lengkap)



Characteristics of TDMA-Based Digital Cellular Systems

Table 4.6 Characteristics of TDMA-Based Digital Cellular Systems

Standard	*Mobile Tx/Base Tx (MHz)*	*Access Method*	*Carrier Spacing (kHz)*	*Modulation*	*Channel Bit Rate kbit/s*	*Full-Rate Speech Coding kbit/s*	*Channels per Carrier (fr/hr)*
IS-54 (D-AMPS)	824–849/ 869–894	FDMA/TDMA/ FDD	30	$\pi/4$- differential quadrature phase shift keying (DQPSK)	48.6	7.95 (13 w/FEC)	3 /6
PDC	810–915/ 940–960	FDMA/TDMA/ FDD	25	$\pi/4$-DQPSK	42.0	6.7 (11.2 w/FEC)	3/6
GSM	890–915/ 935–960	FDMA/TDMA/ FDD	200	GMSK	270.8	13 (22.8 w/FEC)	8/16

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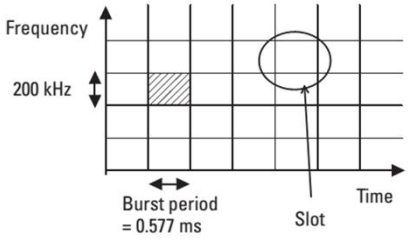
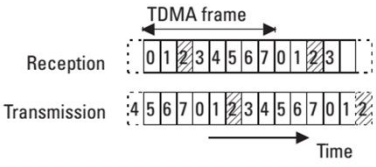
Multiple-Access pada GSM: TDMA-FDMA

A transmission burst occupies a window in time and frequency called a slot.
There are eight time slots on each carrier frequency.
Eight simultaneous calls may use the same frequency.



Emission of a mobile station takes place 3 burst periods later than reception.



Bidirectional radio transmission has fixed duplex distance:
45 MHz (900 MHz band) and
95 MHz (1,800 MHz band).

A mobile station receives, shifts the frequency by 45 or 95 MHz, and emits a moment later.

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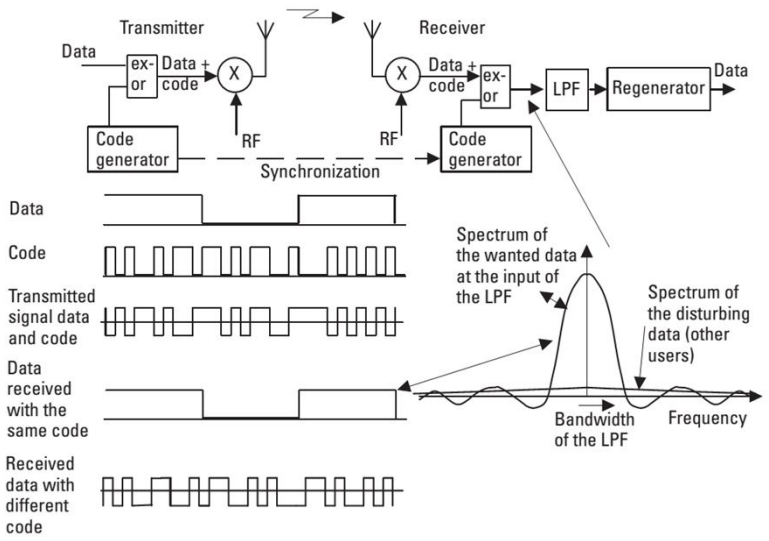
Multiple-Access pada IS-95: CDMA

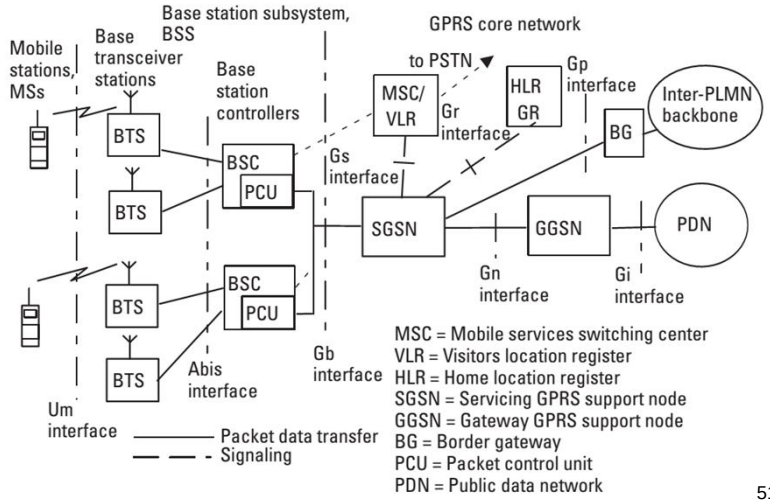


Pita Frekuensi yg Digunakan pd (beberapa) 1G dan 2G

Table 1.10: ▶
Frequency Range Used in Different Systems (an Example)

Systems	BS Transmitting Range/MS Receiving Range	BS Receiving Range/MS Transmitting Range	RF Channel
FDMA (AMPS)	870–890 MHz	825–845 MHz	0.03 MHz
TDMA (GSM 900)	935–960 MHz	890–915 MHz	0.20 MHz
TDMA (GSM 1800)	1805–1880 MHz	1710–1785 MHz	0.20 MHz
CDMA (IS-95)	869–894 MHz	824–849 MHz	1.25 MHz

2.5G; GPRS



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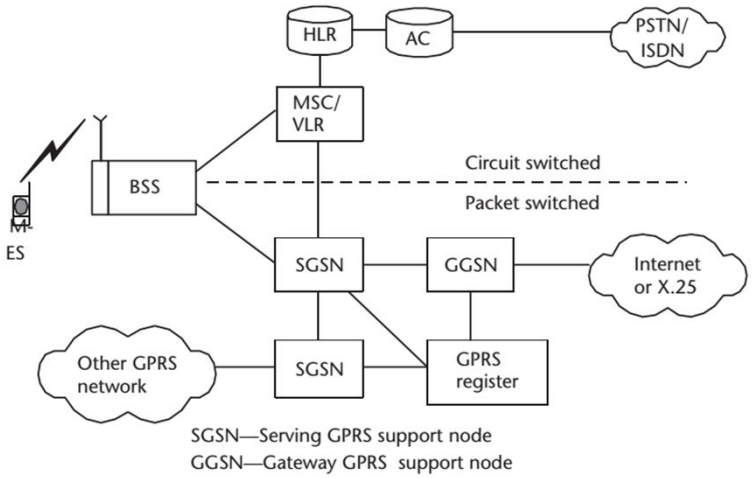
GPRS (lanjutan)



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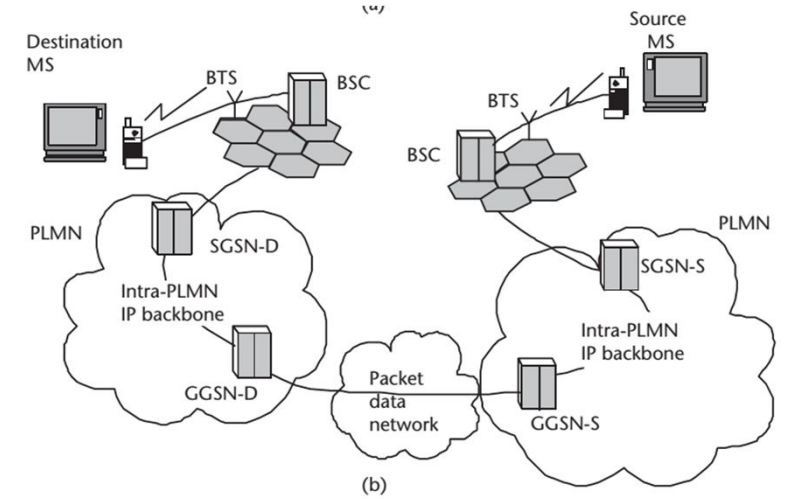
GPRS (lanjutan)



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3G

IMT-2000	- Fulfill one's dream of anywhere, anytime communication
Key Features	- High degree of commonality of design worldwide - Compatibility of services within IMT-2000 and with the fixed networks - High quality - Small terminal for worldwide use - Worldwide roaming capability - Capability for multimedia applications and a wide range of services and terminals
Important Component	- 2 Mbps for fixed environment - 384 kbps for indoor/outdoor and pedestrian environment - 144 kbps for vehicular environment
Standardization Work	- In progress (see Table 1.6)
Scheduled Service	- Started in October 2001 in Japan (W-CDMA) - Started in December 2001 in Europe - Started in January 2002 in South Korea - Started in October 2003 in USA

3G (lanjutan)

Table 4.9 Harmonized Family of Four Third Generation Standards

W-CDMA DS-CDMA	*W-CDMA Multicarrier*	*W-CDMA TDD*	*TDMA EDGE/UWC-136*
WCDMA as per 3GPP /UMTS	cdma2000 as per 3GPP2	As per 3GPP	As per ETSI/UWC
New spectrum	IS-95 spectrum overlay	Unpaired spectrum	Existing spectrum, 200-kHz TDMA
FDD	FDD	TDD	High-level modulation with link adaptation
Chip rate 3.84 Mc/s	Chip rate 3.6864 Mc/s	Chip rate 3.84 Mc/s	
Asynchronous (synchronous operation supported)	Synchronous		

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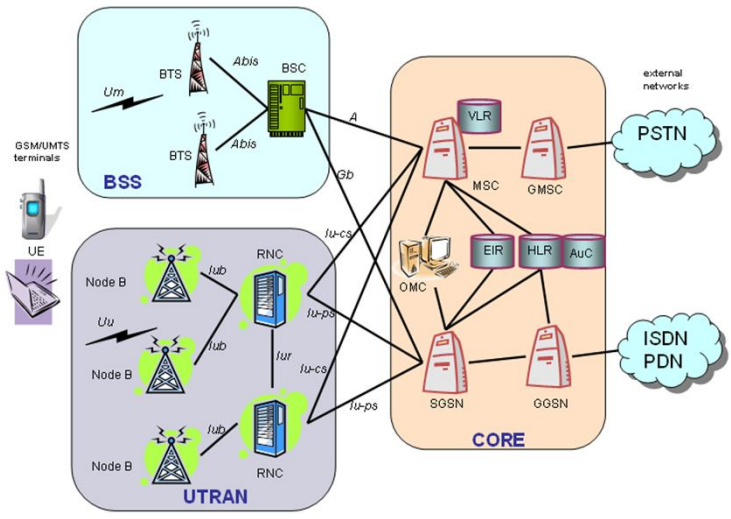
Arsitektur UMTS/WCDMA



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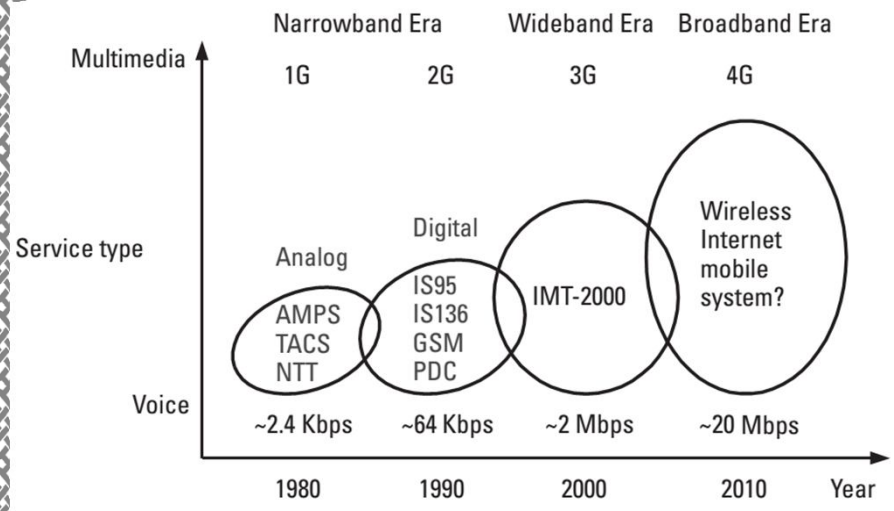
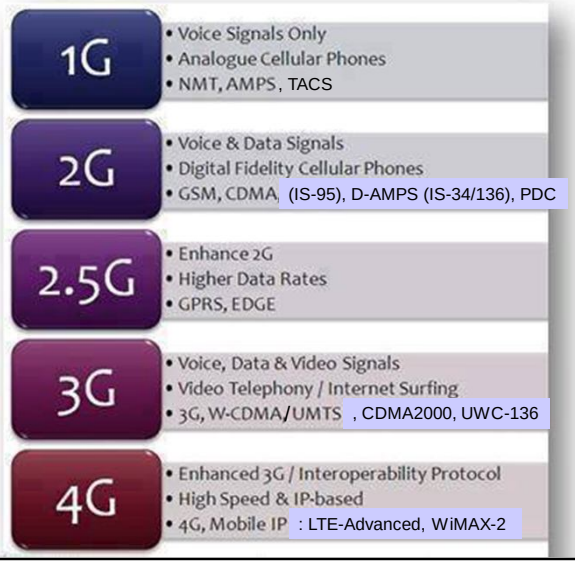
1G, 2G, 3G, 4G



1G, 2G, 3G, 4G



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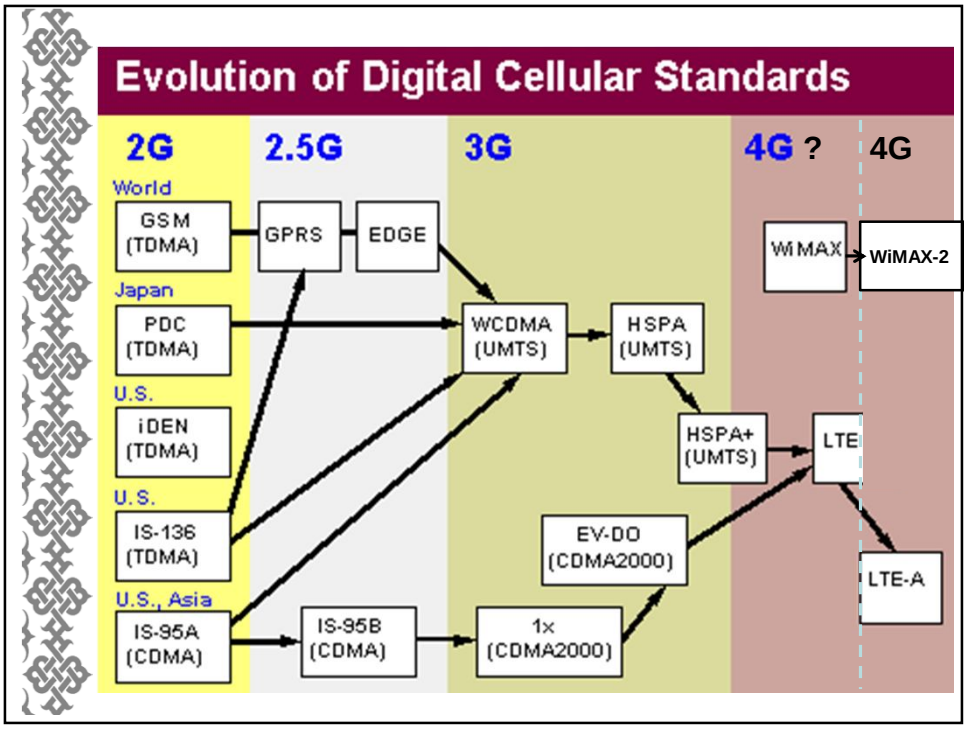
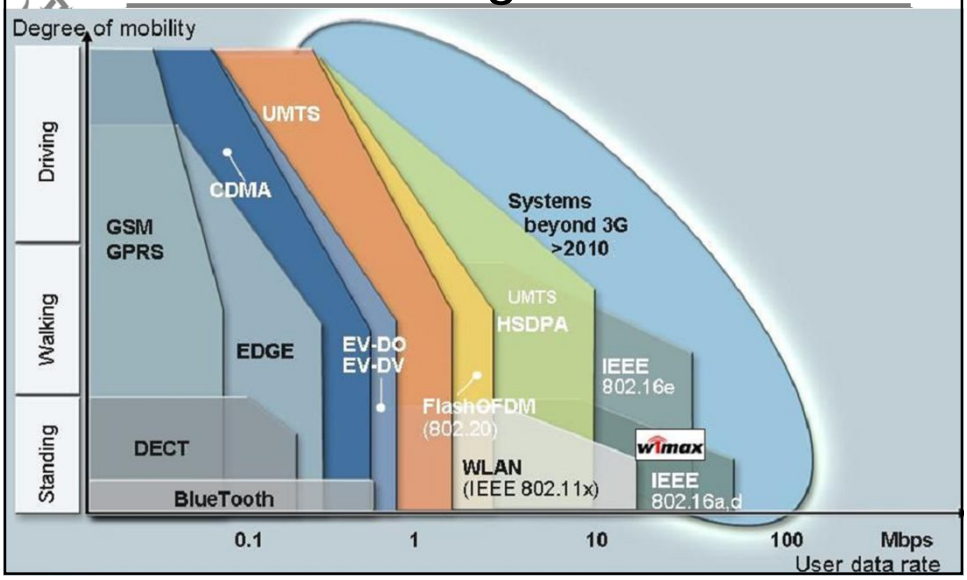
The evolution of mobile standards

Mobile standards	3GPP		Qualcomm	China	IEEE
Carriers using:	AT&T and T-Mobile US, majority of global carriers		Sprint, Verizon Wireless	China Mobile	Sprint
2G: digital + data services	GSM: 2G		CDMAOne		
	GPRS: 2.5G				
	EDGE: 2.75G				
3G: at least 200 kbps iPhone 4 currently delivers up to 7.2Mbps down, 5.8Mbps up	Release 4	UMTS 3G	CDMA2000 EVDO rev 0	TD-SCDMA (up to 2Mbps)	
	Release 5	HSDPA 3.5G (to 21Mbps down)	CDMA2000 EVDO rev A (up to 3.1Mbps down, 1.8 up)		
	Release 6	HSUPA 3.5G (to 5.8Mbps up)	EVDO Rev C / Ultra Mobile Broadband Canceled: Sprint moving to WiMAX, Verizon moving to 3GPP LTE		Mobile WiMAX 3.9G (4 Mbps cap on EVO "4G")
	Release 7	HSPA+ 3.5G			
	Release 8/9	LTE 3.9G			
4G: at least 100 Mbps, IP-based	Release 10	LTE Advanced		TD-LTE	WiMAX 4G



Fleksibelitas Berbagai Teknologi Nirkabel



Spirit Minggu Ini

- *"Dan orang-orang yang bersungguh-sungguh di jalan Kami niscaya Kami akan tunjukkan kepadanya jalan-jalan Kami. Sesungguhnya Allah bersama orang-orang yang berbuat baik."*
  (Q.S. Al Ankabut [29] : 69)

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Sekian, ada pertanyaan?

Terima kasih, semoga berkah.

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