Mobile, Wireless and Pervasive Computing

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Mobile Evolution

- Komputer dibuat kecil: tablet, smart phone
  - Mudah dibawa, dilengkapi processor dan OS, bisa sinkronisasi dgn komputer / ponsel lain
- Replace wired dgn wireless communication
  - Wi-fi, bluetooth, irDA
- Mobile Computing
  - Dimungkinkan dgn adanya dukungan chip laptop/notebook dan infrastruktur 3G dan 4G
  - **Ubiquity**: memungkinkan komputasi dimanapun dan kapanpun
  - **Convinience**, instant connectivity, personalisasi, localization of product & services

Wearable Device

Suatu computer yang “ditanamkan / embedded” di dalam sebuah peralatan yang dapat digunakan oleh manusia

DigiLens DL40

Photo of a Polar RC3 GPS heart rate monitor watch - chest strap not shown

Wearable Device (2) – in fiction

- Wearable computers in fiction is that of **James Bond**, usually in the form of a **watch**.
- In the manga and anime **Dragon Ball** series, the **Scouter** is a **Head-mounted** display worn over one eye to determine the relative strength of combatants.
- In the movie **The Tuxedo Jackie Chan** is using a state-of-the-art spy suit with an advanced wearable computer and electronics.
- In the video game series **Splinter Cell**, the main character **Sam Fisher** has almost always used a wrist computer called an **OPSAT** on his wrist.

Keuntungan Mobile Technology

- Extreme Personalization
  - Ponsel diantara dompet dan kunci motor
  - Tempat menyimpan segala informasi pribadi
- Pengaksesan Informasi setiap saat dan dimanapun
  - Memungkinkan kita untuk bekerja, belanja atau bermain tanpa batasan waktu dan tempat (asal terhubung!)
- Mobilitas tinggi tanpa kerumitan kabel (W-LAN) & Instalasi jaringan yang cepat
- Kompatibel yang tinggi dengan teknologi lain
  - Standarisasi perangkat
- Cocok untuk daerah yang belum ada infrastruktur
- Reduksi biaya : dalam kasus pengembangan, pemindahan maupun perubahan konfigurasi LAN

Kekurangan Mobile Technology

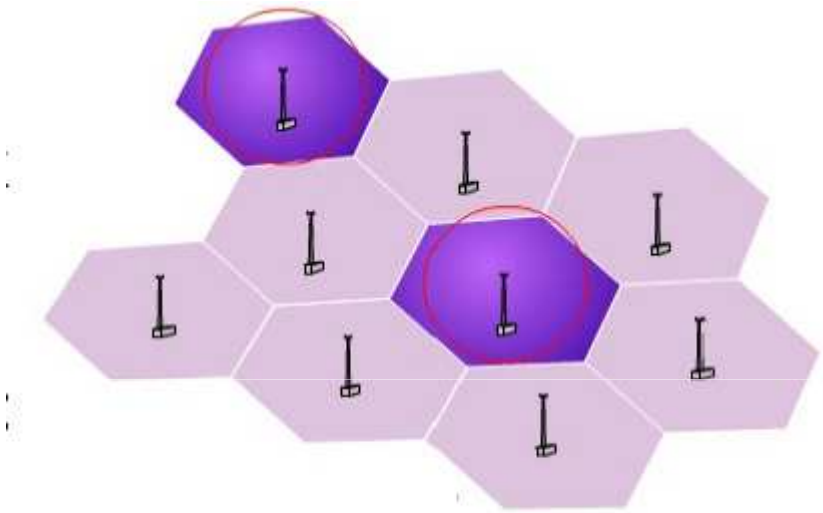
- Harus **LoS** (Line of Sight)
- Protocol Security
- Interferences (Pesawat? Gelombang?)
- Sensitif terhadap cuaca
- Keterbatasan jarak (10-100m)
- Izin penggunaan Frequency
  - Menggunakan frekuensi 2.4 GHz

Mobile Phone

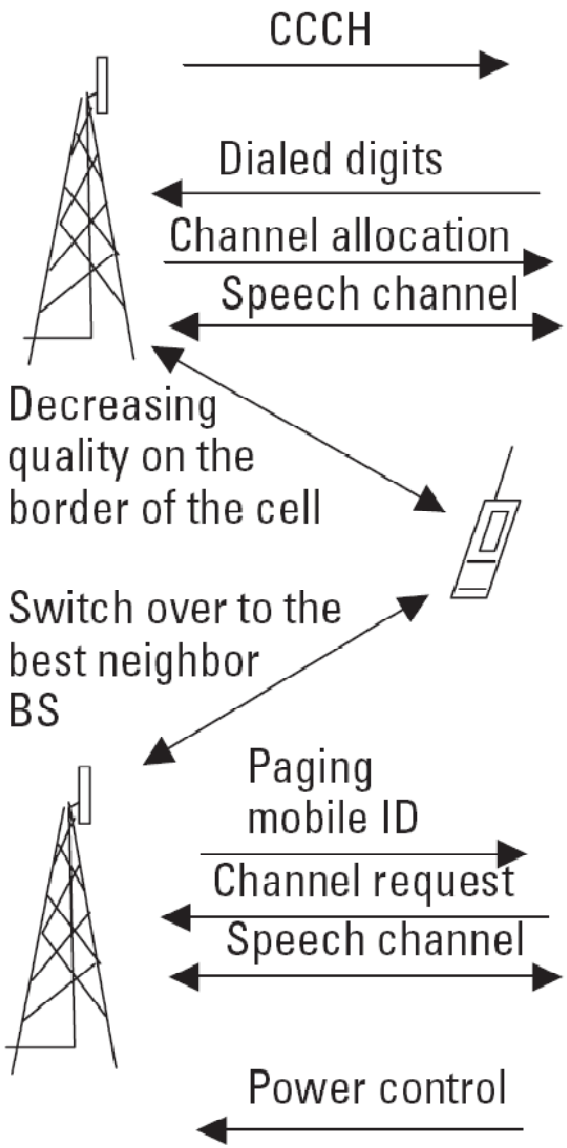
- **Mobile phone** = cell phone: adalah perangkat elektronik portabel yang berfungsi sebagaimana pesawat telepon normal, yang dapat bergerak pada suatu area yang luas. (bandingkan dengan cordless phone).
- Kebanyakan mobile phone saat ini menggunakan kombinasi **transmisi radio** dan **telephone circuit switching** (PSTN) konvensional, walaupun **packet switching** sudah digunakan untuk beberapa bagian jaringan mobile phone, khususnya untuk layanan akses Internet dan WAP.
- Mampu:
  - Voice function, SMS, packet switching untuk Internet, MMS, EMS

Konsep Detail Telepon Selular

- Suatu area (misalnya **kota**), dibagi menjadi beberapa sub area (**sel**)
- Setiap sel berukuran rata-rata **26** km^2
- Ruang lingkup suatu sel berbentuk **hexagon** dan membentuk suatu hexagon grid besar.
- Oleh karena ponsel dan base station menggunakan transmiter bertenaga rendah, frekuensi yang sama **dapat digunakan ulang** pada sel yang **tidak** berdekatan
- Setiap sel memiliki sebuah **base station** yang terdiri dari tower dan bangunan kecil berisi perangkat radio



Prinsip kerja jaringan seluler



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

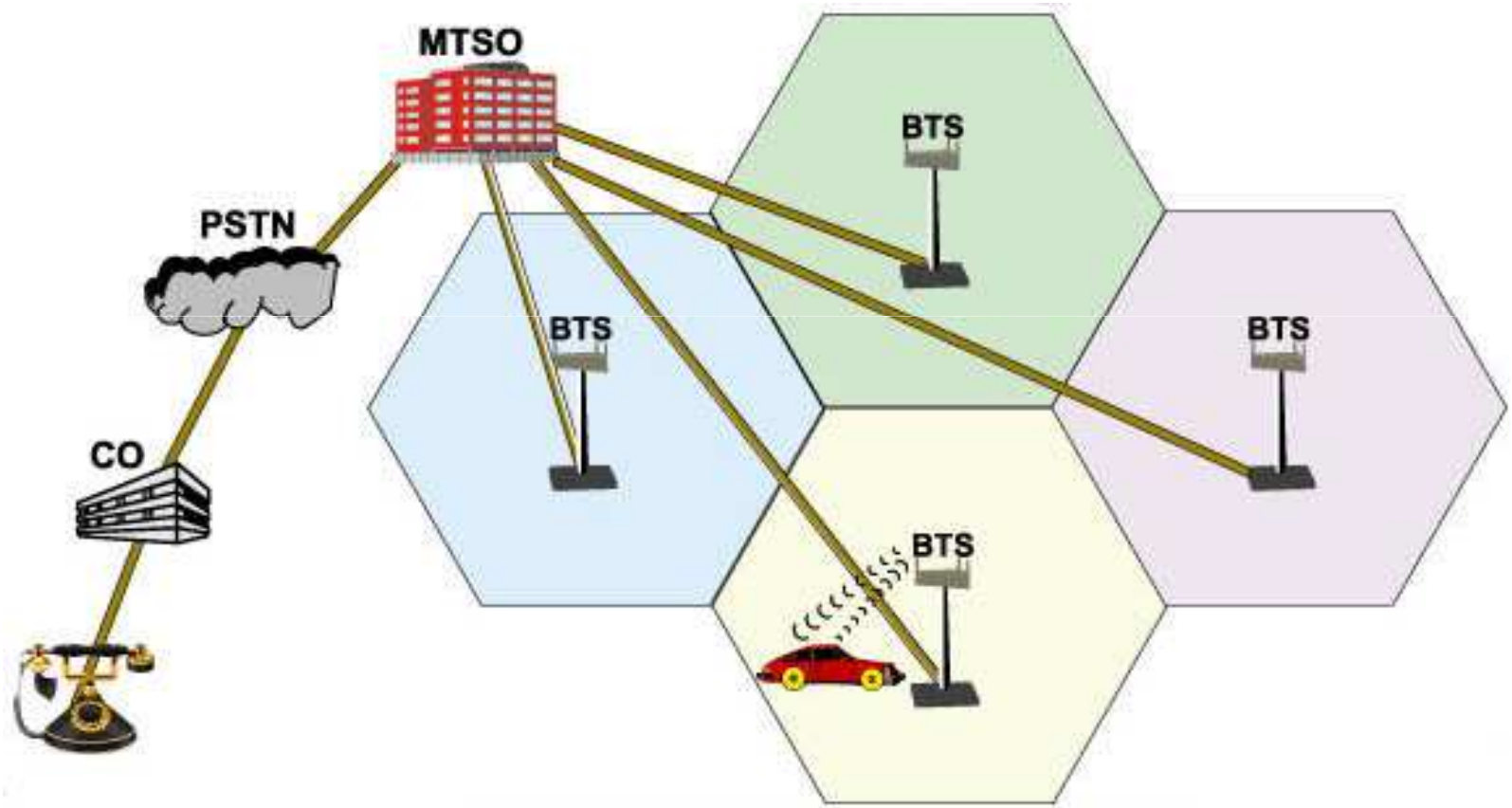
Outgoing call: The dialed digits are sent to the network and a voice channel is allocated.

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.

Arsitektur Seluler



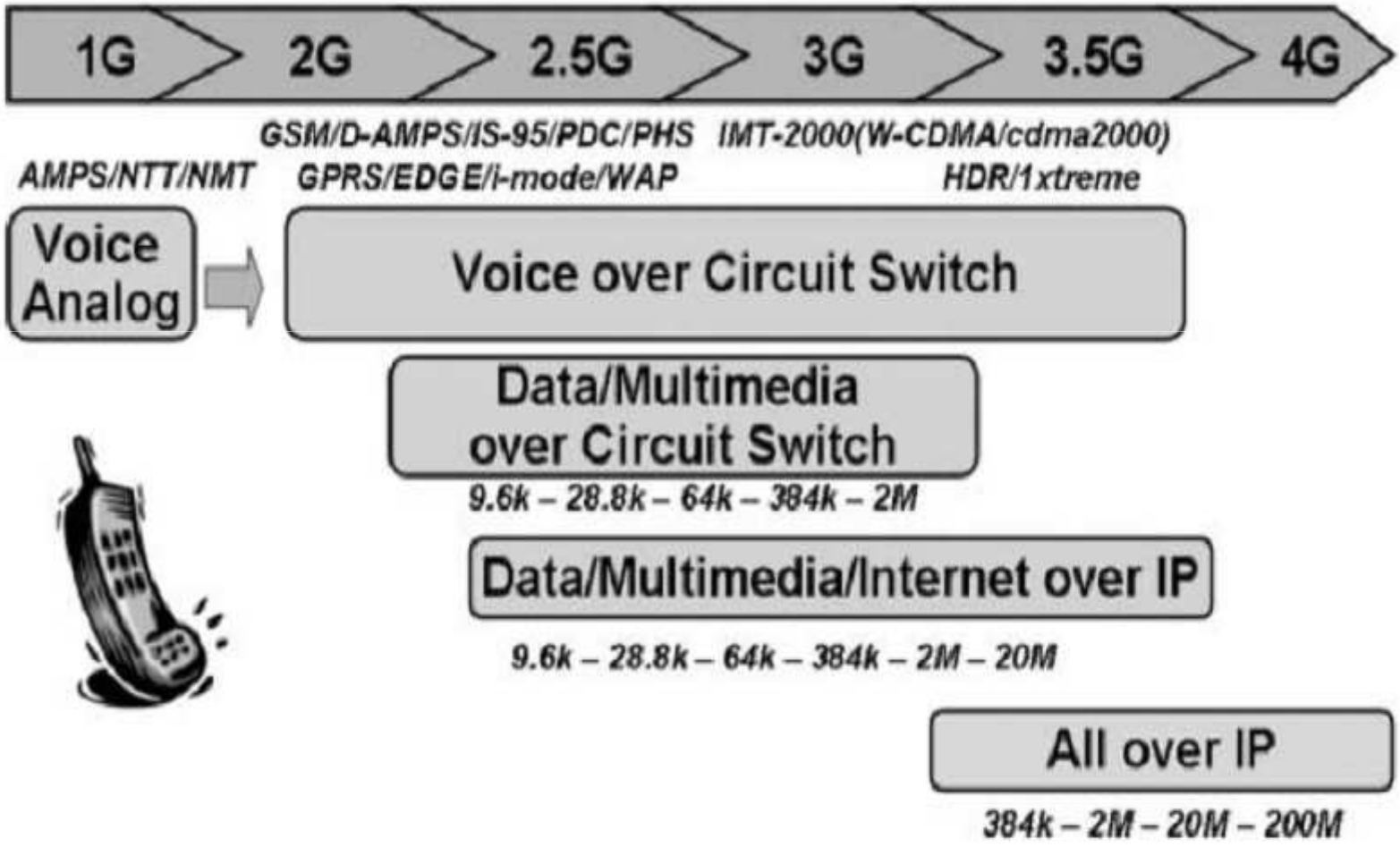
Kode-kode ponsel

- Setiap ponsel memiliki kode khusus untuk menunjukkan identitas ponsel, pemilik dan penyedia layanan.
- **Electronic Serial Number** (ESN)
  - Nomor unik 32 bit yang ditanam waktu pembuatan ponsel
    - 8 digit kode manufaktur, 18 digit SN, 6 digit reserved
  - Skrng diganti IMEI (International Mobile Equipment Identity)
    - 14 digit
- **Mobile Identification Number** (MIN)
  - 10 digit dari nomor SIM Card
- **System Identification Code** (SID)
  - 5-digit angka yang dapat menghubungkan ponsel dengan provider cellular (bisa juga BTS)

SIM CARD

- Tahun 1991 -> munich card (Giesecke & Devrient)
  - 3 digit = Mobile Country Code
  - 2 digit = Mobile Network Code
  - 10 digit = Mobile Station Identification Number
- **SIM** = Subcriber Identity Module => Smart Card
- **RUIM** = Removable User Identity Module
  - Untuk CDMA

Generation Mobile Technology



1G : AMPS (Advanced Mobile Phone System)

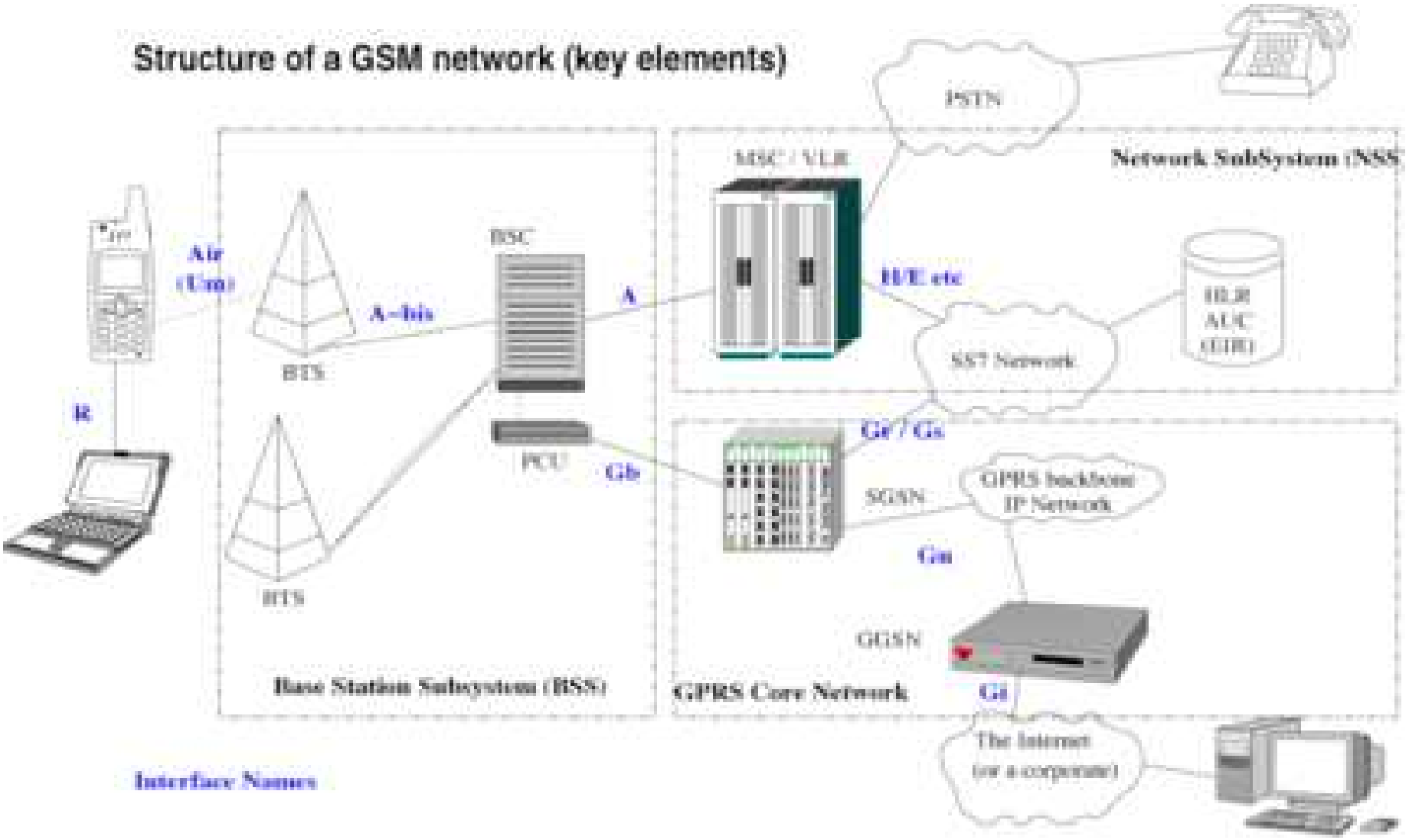
- Menggunakan rentang frekuensi 824 Mhz – 894 Mhz
  - 824 – 849 Mhz untuk **uplink**: sinyal dari ponsel
  - 869 – 894 Mhz untuk **downlink**: sinyal ke ponsel
- Setiap operator memiliki 832 frekuensi: 790 untuk suara dan 42 untuk data (kontrol)
- Dua frekuensi digunakan membentuk 1 kanal
  - Total ada 416 kanal dan dibagi dalam 7 sel
- Menerapkan modulasi FM.
- Lebar kanal suara 30 Khz

GSM (Global System for Mobile Communication)

- Eropa & Asia menerapkan GSM 900 dan GSM 1800. Sedangkan untuk US, GSM 1900
- GSM distandardisasi oleh "**Groupe Spécial Mobile**".
- Untuk dapat terhubung pada jaringan GSM, pemakai harus memiliki **subscriber identification module** (SIM) card.
- GSM 900 menyediakan 124 kanal full duplex, 25 MHz
- GSM1800 menyediakan 374 kanal full duplex, 25 MHz
- ***Roaming technology***: complete communication from anywhere in world
  - Providers establish *roaming areas*: higher cost for users when outside home area
- GSM offers SMS dan MMS service

GSM®
GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

infrastruktur GSM



Arsitektur GSM

- **Base Station Subsystem**
  - BSC (Base Station Controller), menyediakan fungsi kontrol dan link antara Mobile Station dan BTS
  - BTS (Base Transceiver Station), merupakan radio equipment (transceiver dan antena).
    - Sekelompok BTS dikontrol oleh satu BSC
- **Mobile Station (MS)**
  - Mobile Equipment (ME) => handset
  - Subscriber Identity Module (SIM) card, merupakan card yang berisi informasi mengenai user subscription

Arsitektur GSM

- Switching Subsystems:
  - **HLR** (Home Location Register), merupakan database yang digunakan untuk manajemen dan penyimpanan subscriptions
  - **MSC** (Mobile services Switching Centre), melakukan fungsi telephone switching
  - **VLR** (Visitor Location Register), database untuk menyimpan informasi mengenai subscribers yang diperlukan oleh MSC untuk melayani visiting subscribers
  - **AUC** (Authentication Centre), menyediakan fungsi autentikasi dan enkripsi
  - **EIR** (Equipment Identity Register), merupakan database yang menyimpan informasi mengenai identitas mobile equipment (IMEI)

GPRS

- **GPRS**: General Packet Radio Service (2.5G)
  - Layanan WAP dan MMS
  - Wireless access to packet data networks, e.g. to the Internet
  - Volume-based billing
  - Instant Messaging; Push to Talk
  - Data rate: 160 kbps (real: 30 – 70 kbps)

3 Class of Message Services of GSM/GPRS

- In GSM/GPRS network, conventional circuit switched services (speech, data, and SMS) and GPRS services can be used in parallel.
- Three classes are defined:
  - **Class A** mendukung GPRS dan GSM (voice, SMS) secara bersama-sama
  - **Class B** mendukung GPRS dan GSM, namun hanya aktif salah satu saja pada suatu saat (suspended)
  - **Class C** mendukung GPRS dan GSM, namun harus di switch secara manual

EDGE & 3G

- **EDGE**: Enhanced Data rates for GSM Evolution (2.75G)
  - Data rate: 473,6 kbps (384) – 3G
  - Aplikasi:
    - Mobile TV
    - Video on demand
    - Video Conferencing
    - Telemedicine
    - Location-based services
    - Global Positioning System (GPS)

3.5 G

- **HSDPA** (High-Speed Downlink Packet Access)
  - Downlink speeds: 1.8, 3.6, 7.2 dan 14.4 Mbps
  - Modulation: QPSK dan 16-QAM
- **HSUPA** (High-Speed Uplink Packet Access)
  - Uplink speeds up to 5.76 Mbps

4G

- **4G** Working Group has defined following objectives of 4G wireless communication standard (LTE)
  - High network capacity, more simultaneous users per cell
  - 100 Mbps in moving (car/train), 1 Gbps while in fixed position (house)
  - Mendukung HDTV (720p / 1080p)
  - CDMA2000 EV-DO Rev. C
  - Based on an all-IP packet switched network, packet-switched network

Perbandingan Kecepatan

		Real World (avg)		Theoretical (max)		Availability
		Download	Upload	Download	Upload	
2.5G	GPRS	32-48Kbps	15Kbps	114Kbps	20Kbps	Today
2.75G	EDGE	175Kbps	30Kbps	384Kbps	60Kbps	Today
3G	UMTS	226Kbps	30Kbps	384Kbps	64Kbps	Today
	W-CDMA	800Kbps	60Kbps	2Mbps	153Kbps	Today
	EV-DO Rev. A	1Mbps	500Kbps	3.1Mbps	1.8Mbps	Today
	HSPA 3.6	650Kbps	260Kbps	3.6Mbps	348Kbps	Today
	HSPA 7.2	1.4Mbps	700Kbps	7.2Mbps	2Mbps	Today
Pre-4G	WiMAX	3-6Mbps	1Mbps	100Mbps+	56Mbps	Today
	LTE	5-12Mbps	2-5Mbps	100Mbps+	50Mbps	End 2010
	HSPA+	-	-	56Mbps	22Mbps	2011
	HSPA 14	2Mbps	700Kbps	14Mbps	5.7Mbps	Today*
4G	WiMAX 2 (802.16m)	-	-	100Mbps mobile / 1Gbps fixed	60Mbps	2012
	LTE Advanced	-	-	100Mbps mobile / 1Gbps fixed	-	2012+

Mobile Killer Applications

- **Mobile Entertainment**
  - Th 2003, $3,5 juta diperoleh dari bisnis ringtone (RBT)
  - **Multiplayer Games**
  - Location Based Entertainment
  - Content-based applications
  - High-impact visual games
  - Ringtone

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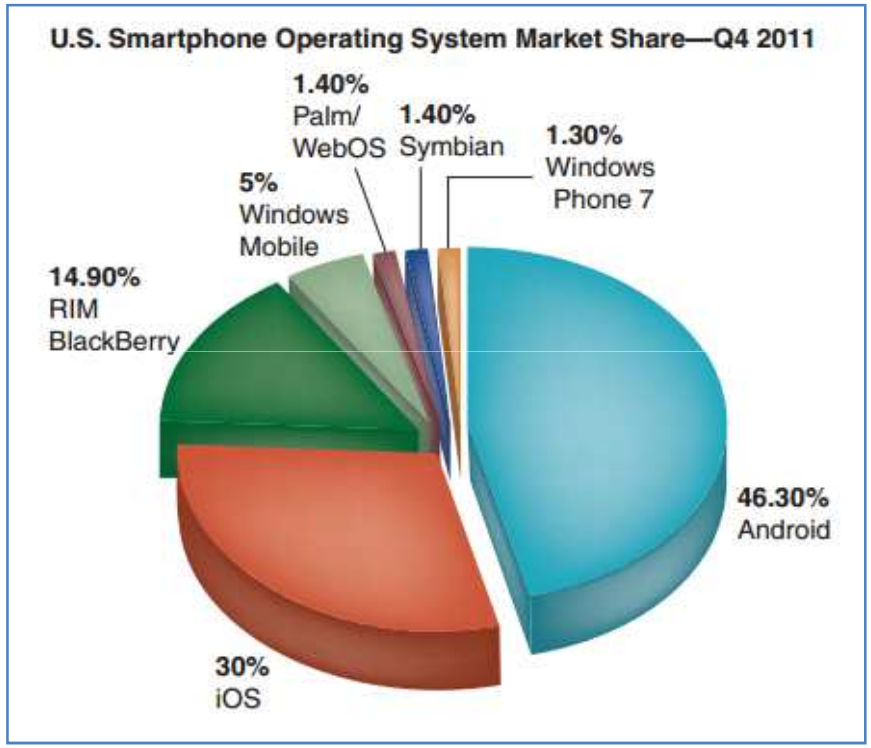
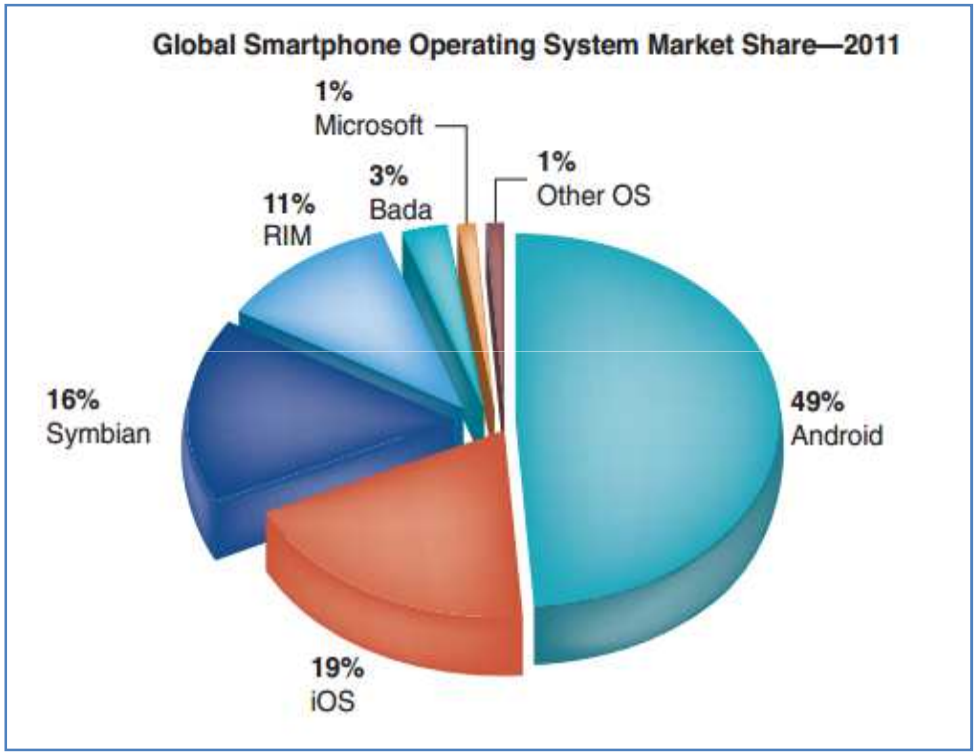
Figure 7.11 Angry Birds is such a popular mobile game that it generates additional revenue from sales of clothing, plush toys, posters, lunch boxes, and even bed linens.

Mobile technology

Market Share Q4 - 2011





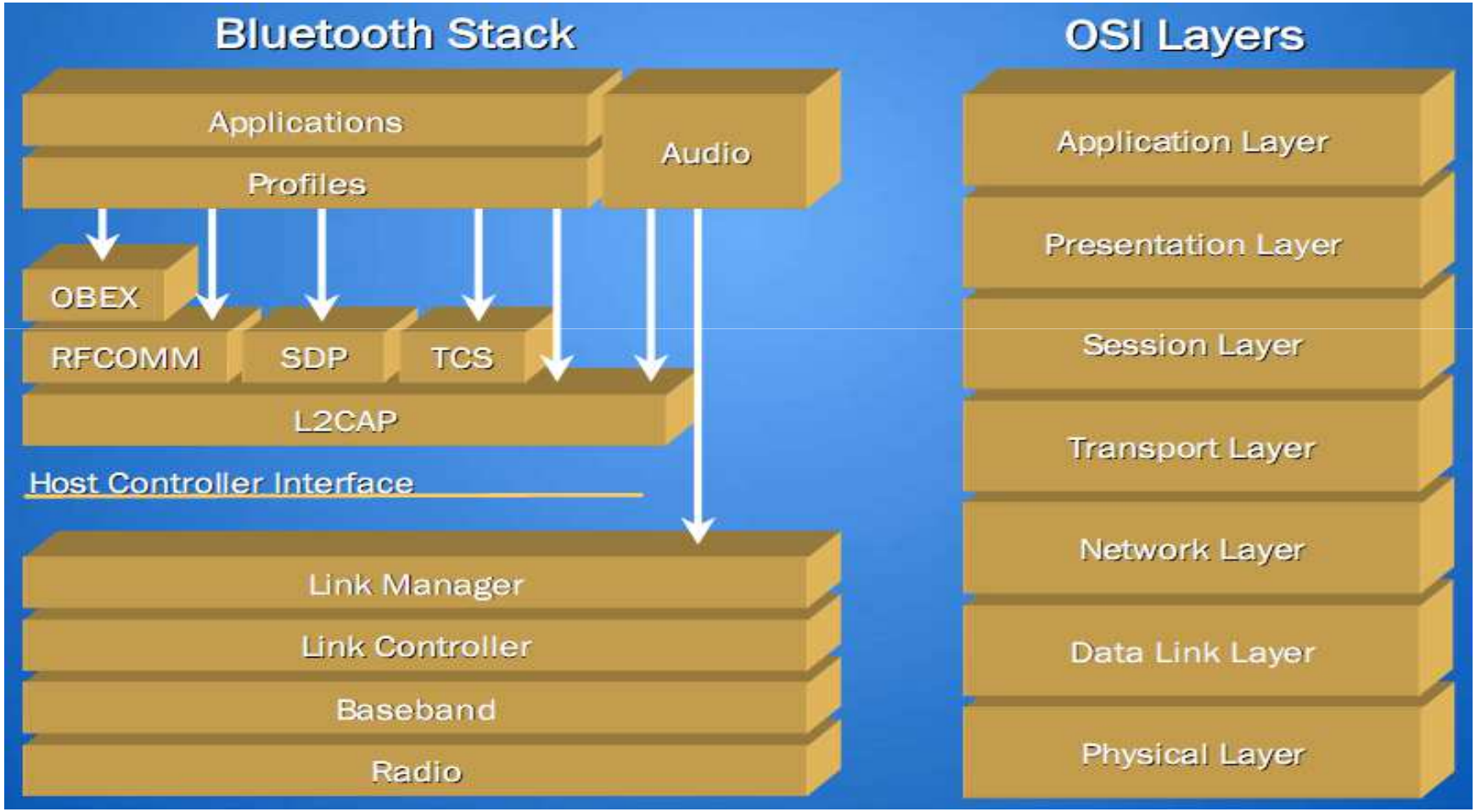
Bluetooth

- Bluetooth adalah sebuah teknologi komunikasi wireless (tanpa kabel) yang beroperasi dalam pita frekuensi **2,4 GHz**
- Menyediakan layanan komunikasi data dan suara secara **real-time** antara **host-host** bluetooth dengan jarak jangkauan layanan yang terbatas.
  - Bisa juga untuk bluetooth kelas 1: 100 m
- IEEE Standard (via the 802.15.1 working group)
- Supports open-ended list of applications
  - Data, audio, graphics, video

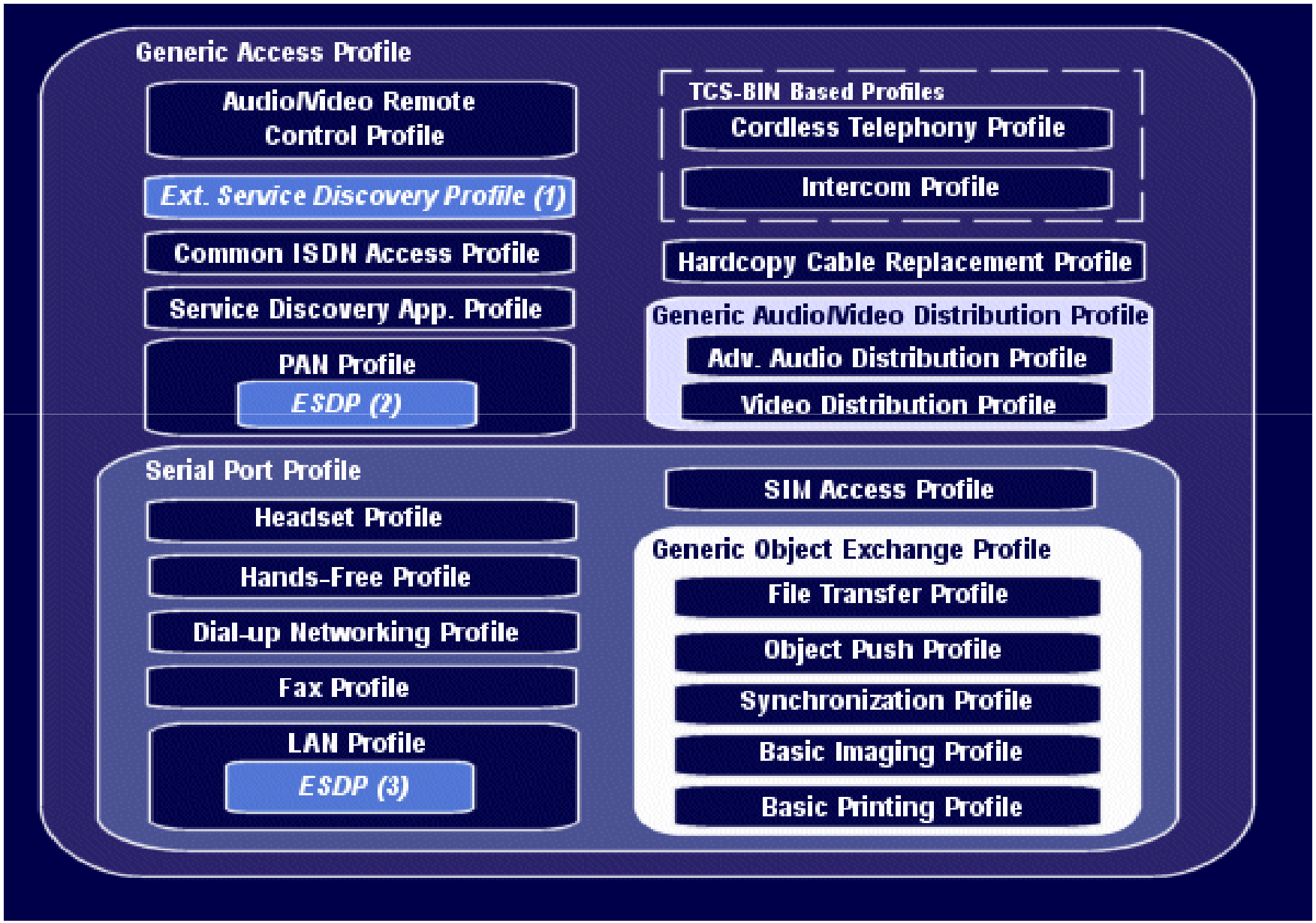
Bluetooth class

	Power	Range
Class 1	20 dBm	100 m
Class 2	0-4 dBm	10 m
Class 3	0 dBm	1 m

Bluetooth Layer



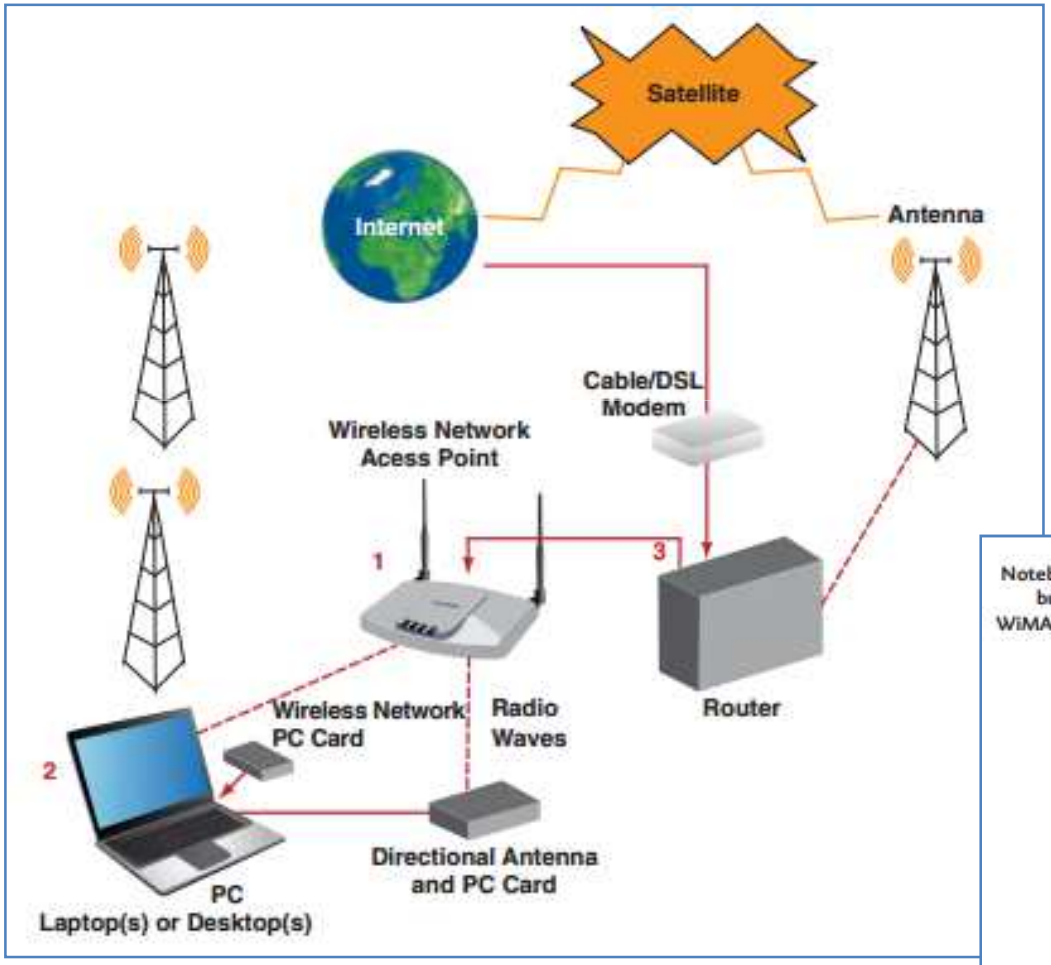
Bluetooth Profile

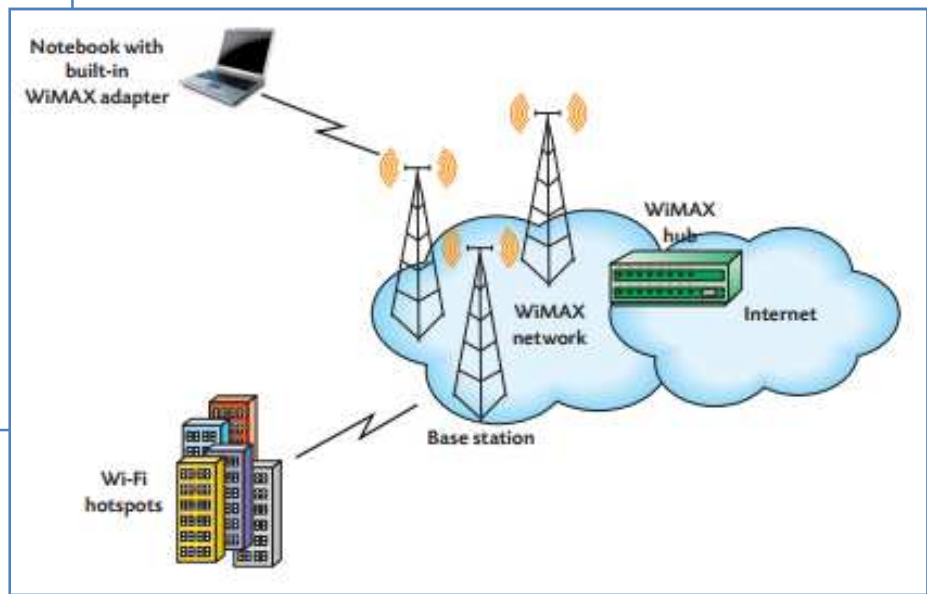


Wi-Fi?

- Short for ***wi****reless* ***fi****delity.*
- It is a wireless technology that uses **radio frequency** to transmit data through the air.
- Wi-Fi is based on the 802.11 standard:
  - 802.11a
  - 802.11b
  - 802.11g
  - 802.11n

Wi-fi architecture





802.11b Standard

- Well-supported, stable, and cost effective, but runs in the **2.4** GHz range that makes it prone to **interference** from other devices (microwave ovens, cordless phones, etc) and also has security disadvantages.
- **Limits** the number of access points in range of each other to three.
- Has 11 channels, with 3 non-overlapping, and supports rates from 1 to 11 Mbps, but realistically about 4-5 Mbps max.
- Uses **direct-sequence spread-spectrum** technology.

802.11g Standard

- **Extension of 802.11b**, with the same disadvantages (security and interference).
- Has a **shorter** range than 802.11b.
- Is **backwards compatible** with 802.11b so it allows or a smooth transition from 11b to 11g.
- **Flexible**, because multiple channels can be combined for faster throughput, but limited to one access point.
- Runs at **54** Mbps, but realistically about **20-25** Mbps and about **14** Mbps when b associated
- Uses **frequency division multiplexing**

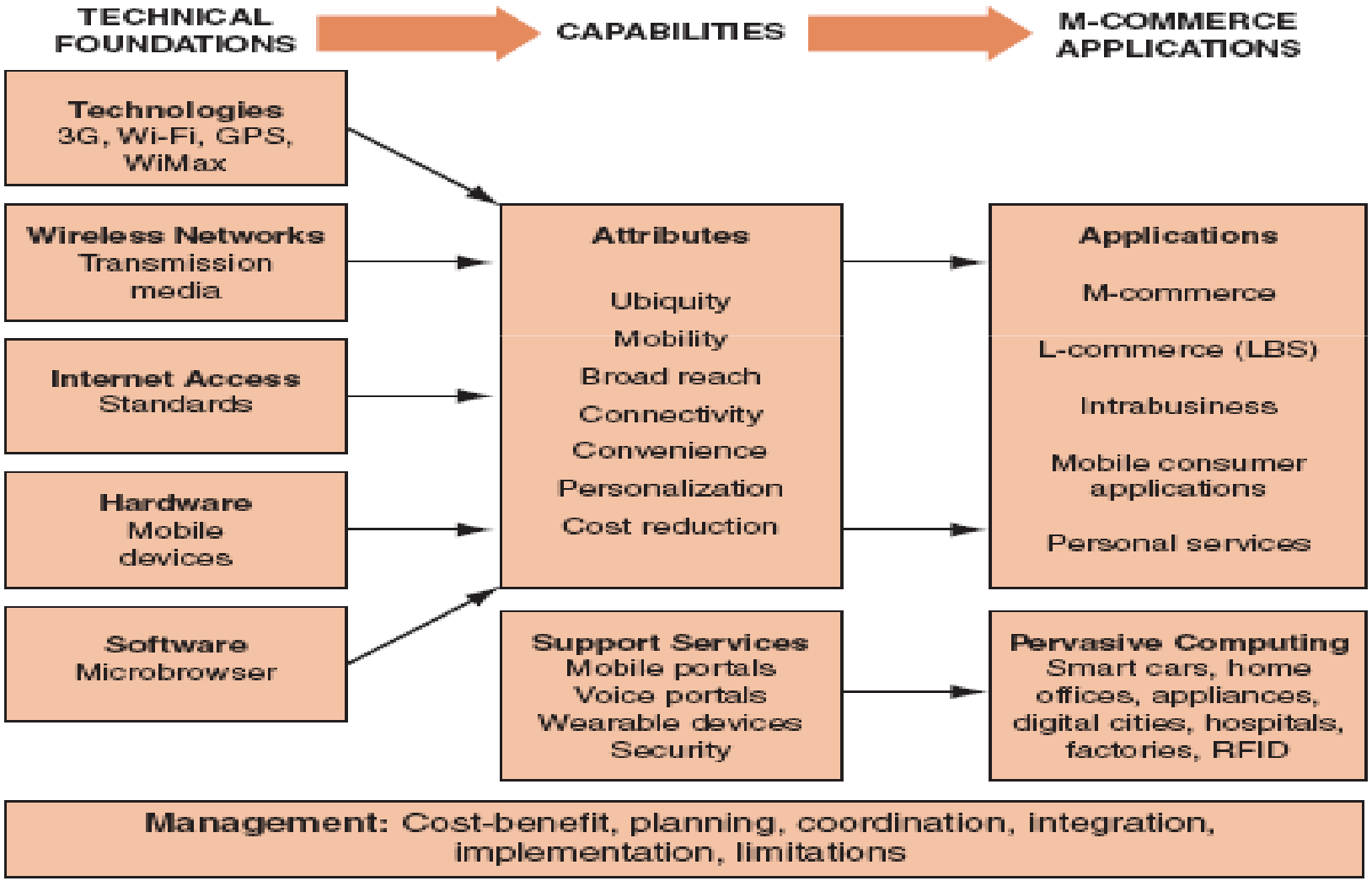
802.11a Standard

- Completely **different** from 11b and 11g.
- **Flexible**, because multiple channels can be combined for faster throughput and more access points can be co-located.
- **Shorter range** than 11b and 11g.
- Runs in the **5** GHz range, so less interference from other devices.
- Has 12 channels, 8 non-overlapping, and supports rates from 6 to 54 Mbps, but realistically about **27** Mbps max
- Uses **frequency division multiplexing**

Mobile Computing

- **Mobile Computing** : A technology that allows transmission of data, via a computer, without having to be connected to a fixed physical link.
- Karakteristik: mobility (**anywhere**) dan broad reach (**anytime**)

Landscape of Mobile Computing



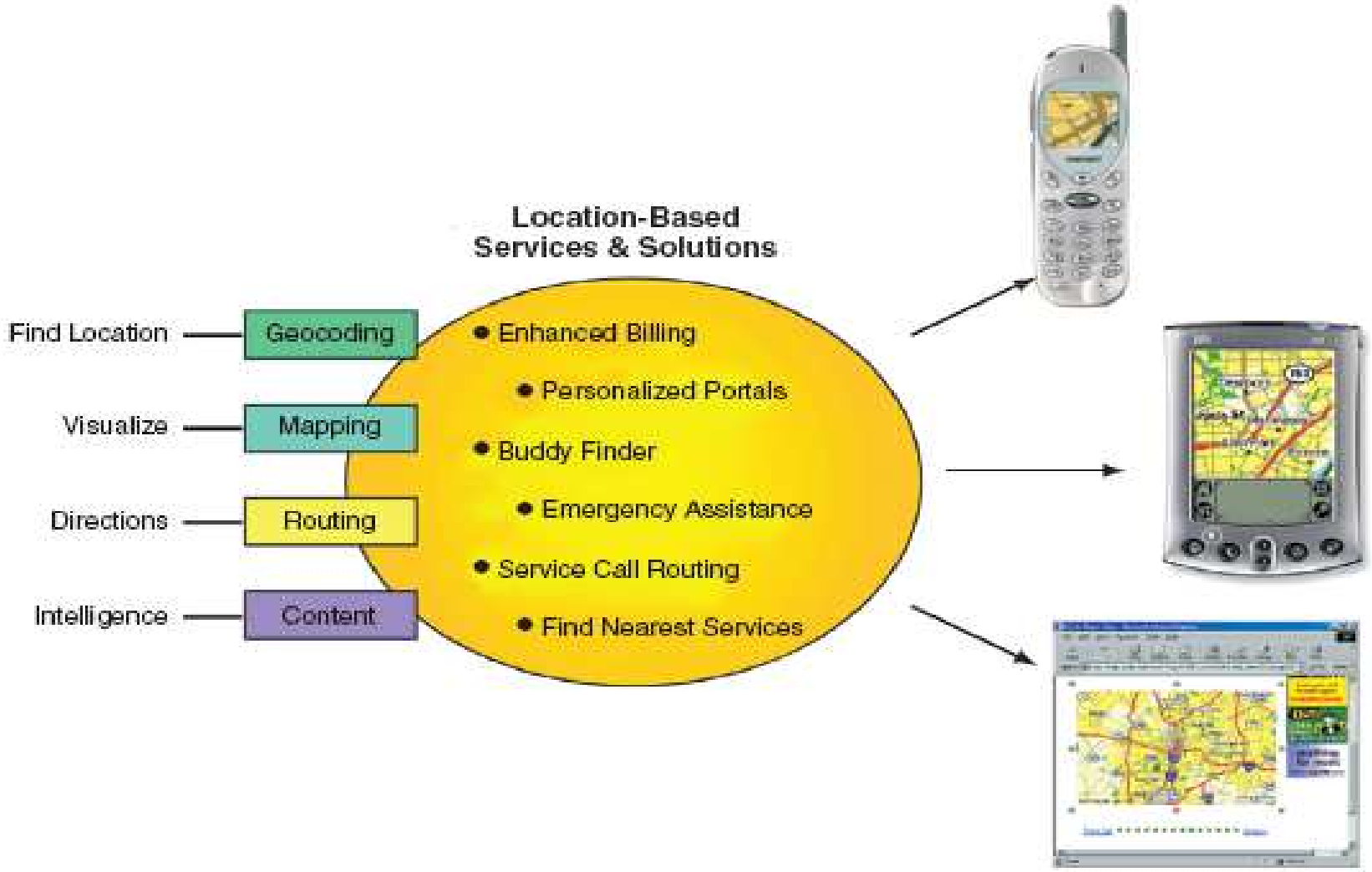
Value Added Attributes of Mobile Computing

- ***Ubiquity*** – refers to the attribute of being available at any location at any given time. (ex: smart phone or PDA)
- ***Convenience*** – Internet enabled; many available hot spots.
- ***Instant Connectivity*** – quick connections to Internet, intranets, other mobile devices & databases.
- ***Personalization*** – preparation of customized information for individual consumers.
- ***Localization of products & services*** – wireless device has GPS.

Location-based Commerce

- **Location-based commerce** (l-commerce)
  - refers to the **localization of products and services**.
  - five key areas
    - **Location**: determining the basic position of a person or a thing (e.g., car or boat).
    - **Navigation**: plotting a route from one location to another.
    - **Tracking**: monitoring the movement of a person or a thing (e.g., a package or vehicle).
    - **Mapping**: creating maps of specific geographical locations.
    - **Timing**: determining the precise time at a specific location

Mobile Computing – L-Commerce Applications



Pervasive Computing

- **Technology View**
  - Computers **everywhere** – embedded into washing machines, door locks, cars, furniture, people
    - intelligent environment
  - Mobile **portable** computing devices
  - **Wireless** communication – seamless mobile/fixed
- **User View**
  - **Invisible** – implicit interaction with your environment
  - **Augmenting** human abilities in context of tasks
  - **Ubiquitous** = mobile computing + intelligent

Aplikasi Pervasive Computing

- Smart home / School
  - Lighting system
  - Energy management
  - Water control
  - Home security
  - Home teather
- Smart cars
- Intelligence Elder care
- Digital cities

Next

- Arsitektur Data: Data Management, Mining, and BI