DTG202 BENGKEL KOMUNIKASI NIRKABEL

Telkom University

Diploma of Telecommunication Engineering

By Dwi Andi Nurmantris

Software Defined Radio (SDR)

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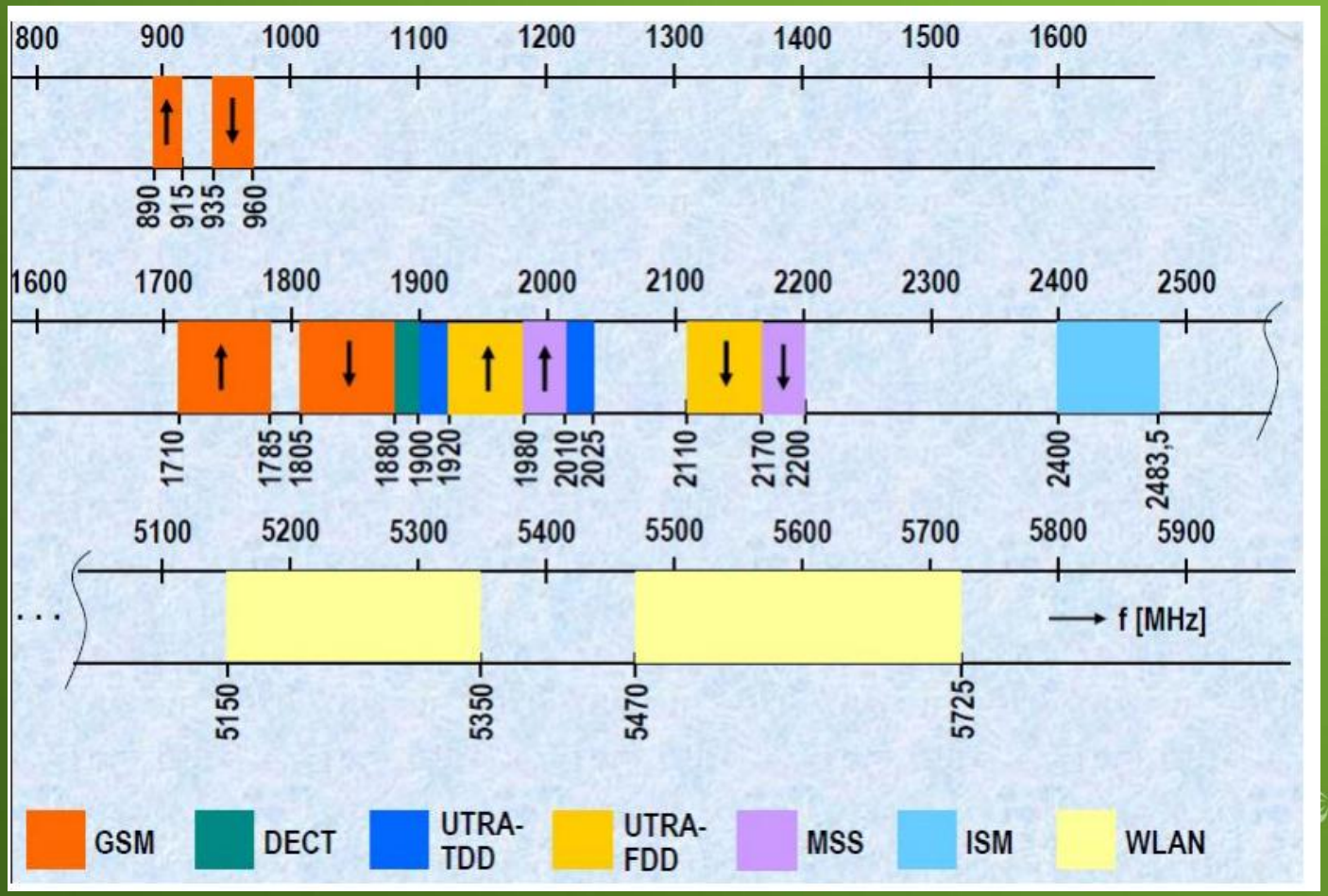
Pendahuluan

MOBILE SPECTRUM



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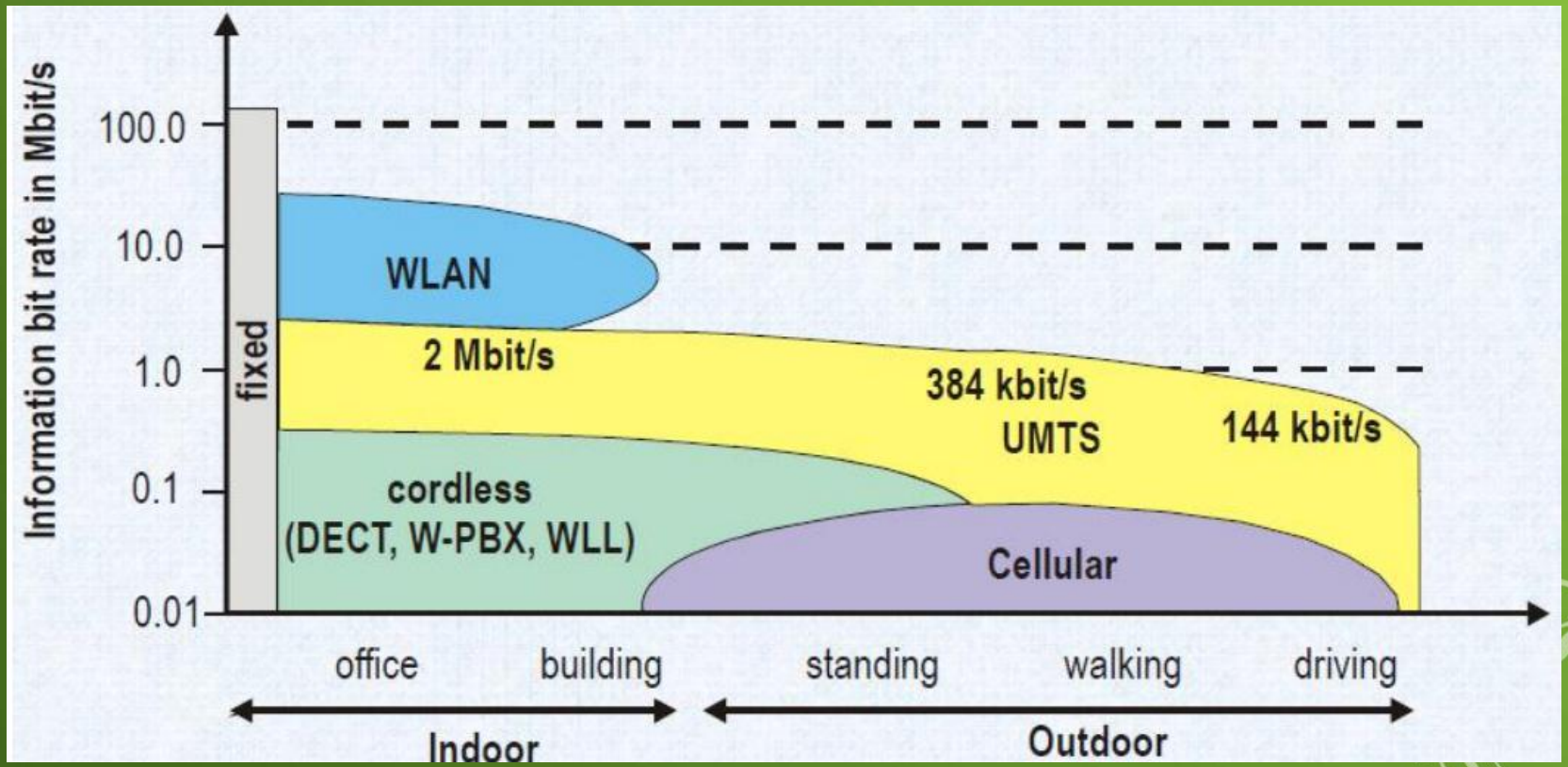
Pendahuluan

MOBILE RADIO STANDARD



A Communication Standard is a set of documents that described the functions of a communication system in such a way that a manufacturer can develop terminals or infrastructure equipment on this basis

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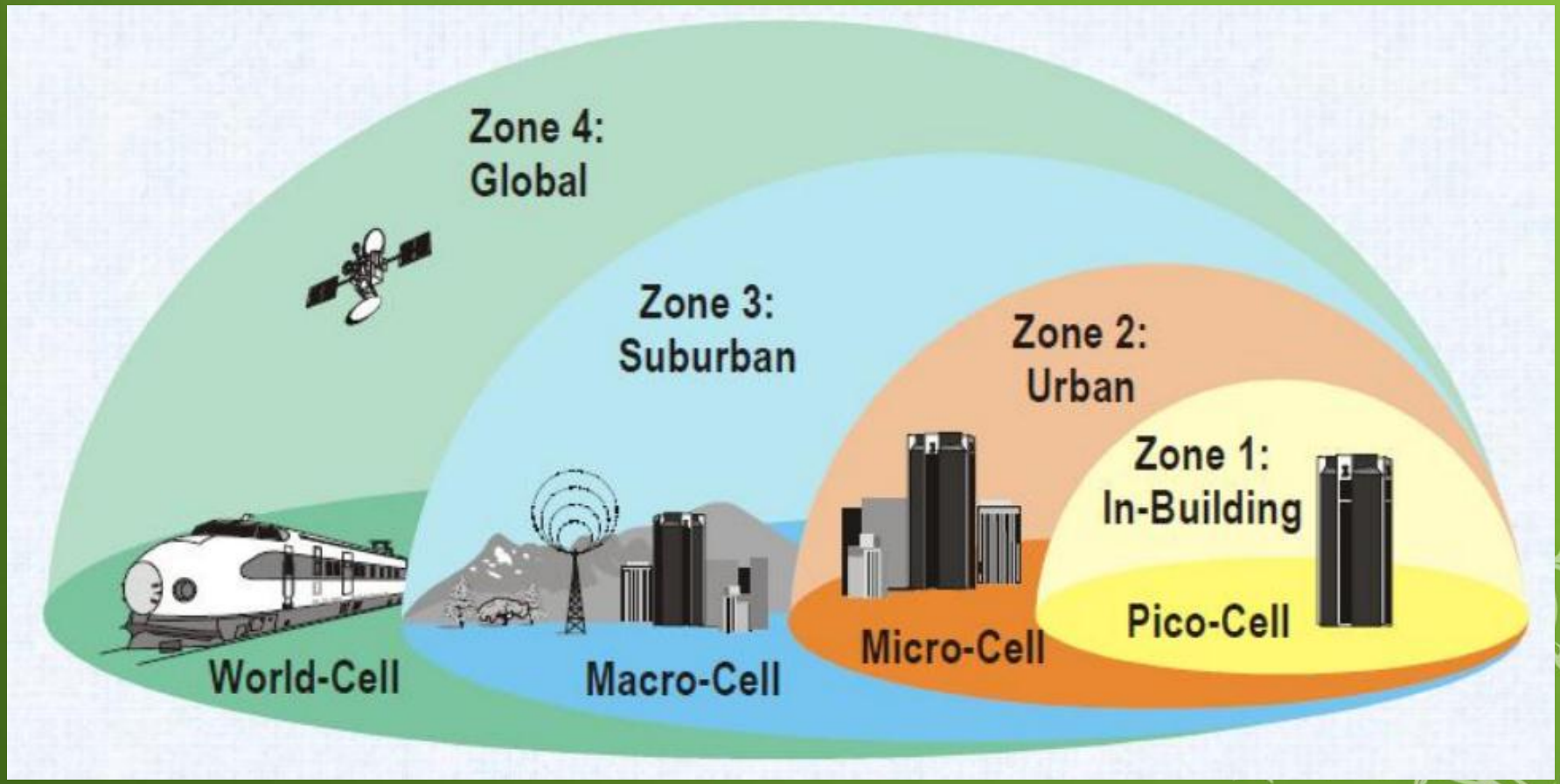
Pendahuluan

HIERARCHI CELL



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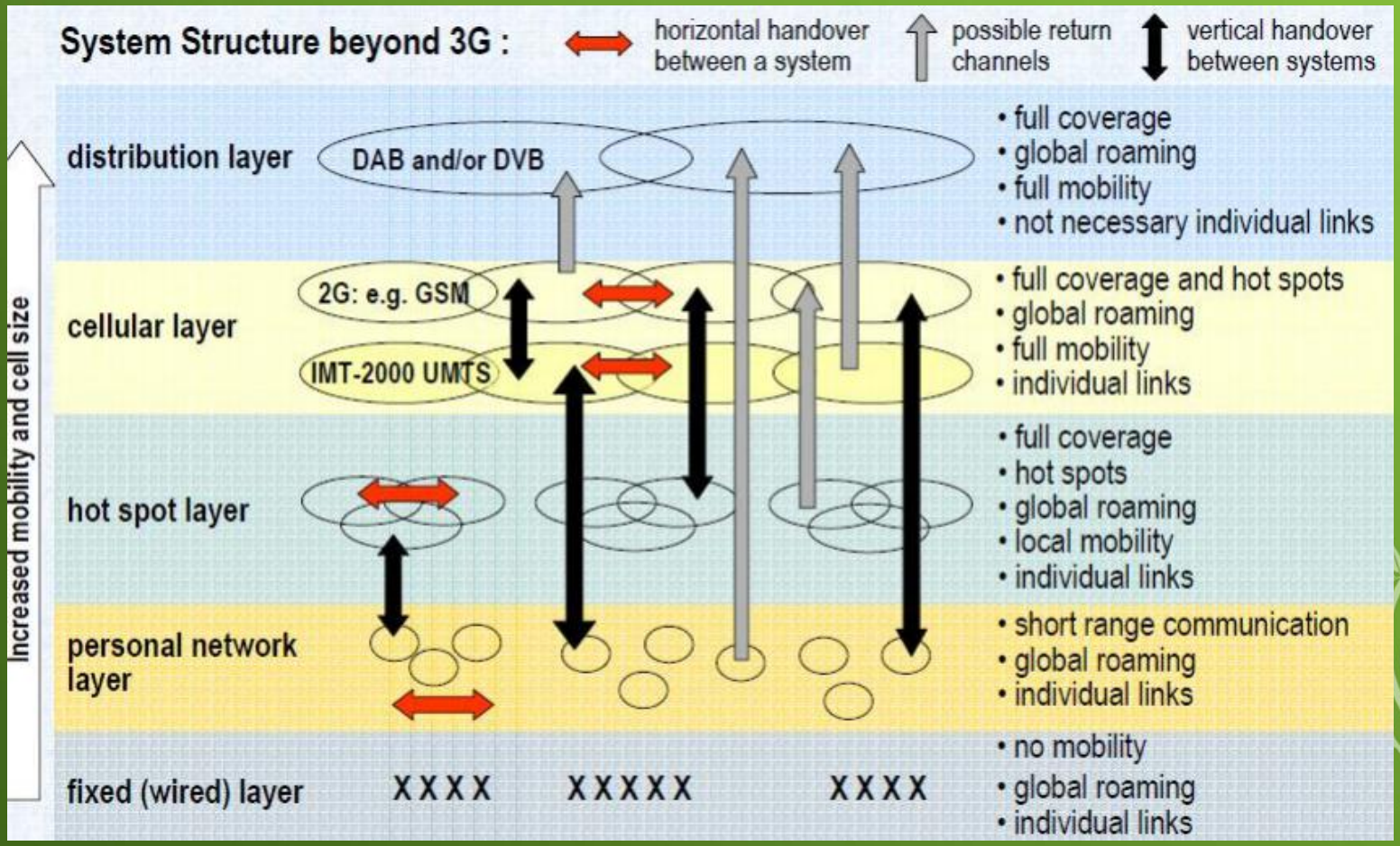
Pendahuluan

MOBILITY



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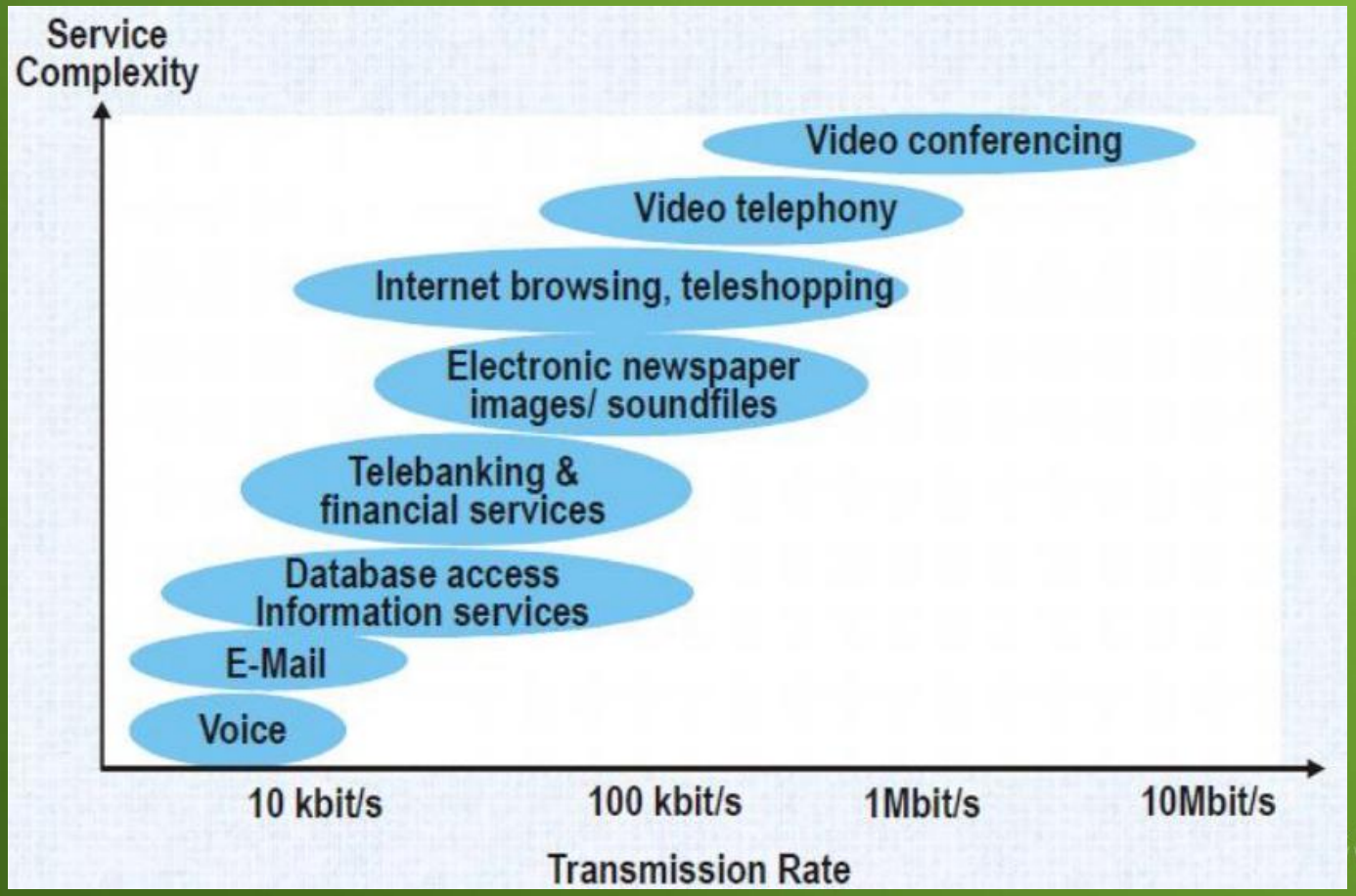
MOBILE SERVICE



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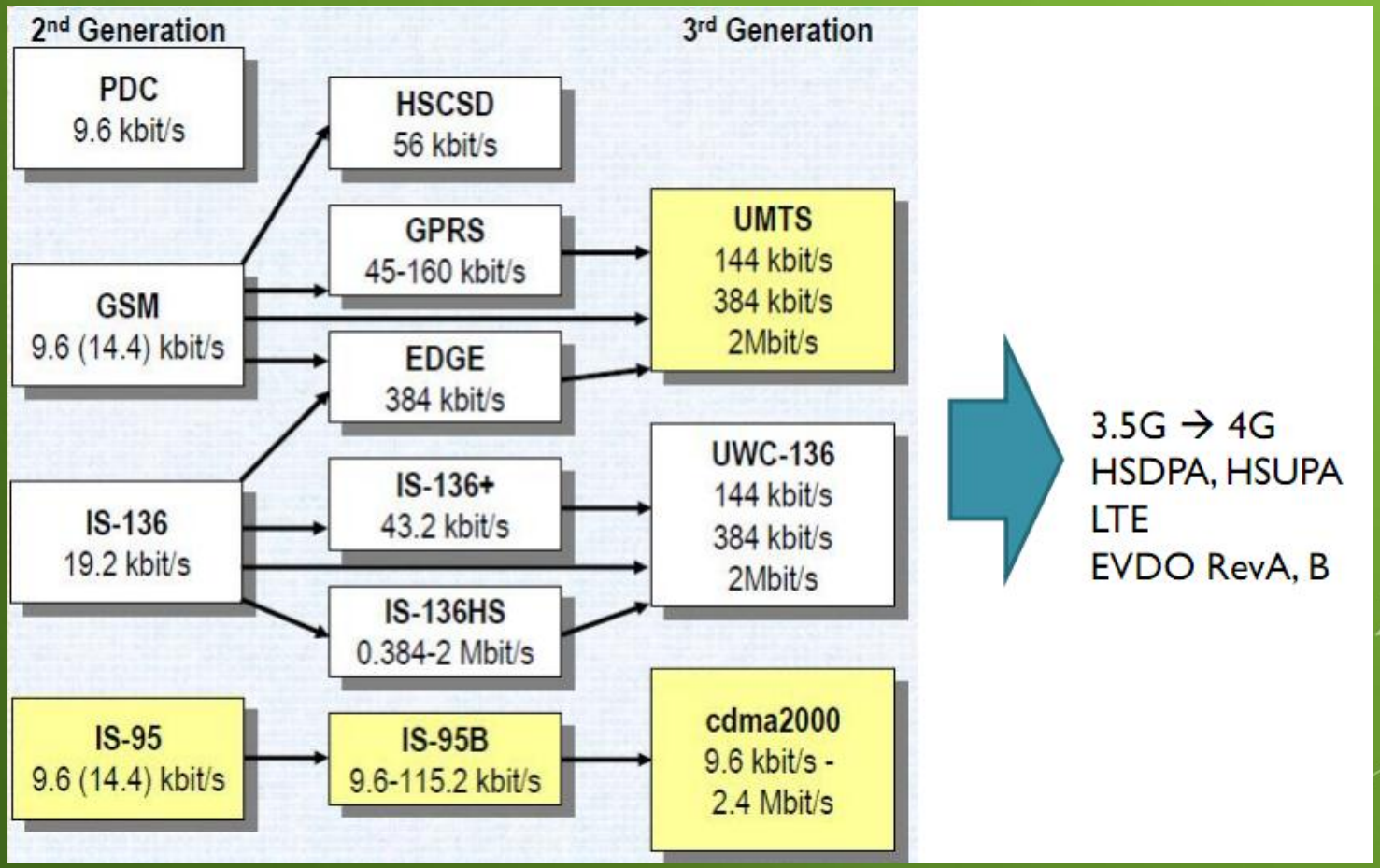
Pendahuluan

MOBILE CELLULAR EVOLUTION



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Pendahuluan

KEY QUESTION

What does a subscriber need:

One Specific Device for each and every situation or one device that seves all situation

Software Defined Radio (SDR)

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Pendahuluan

LATAR BELAKANG

Penggunaan teknologi komunikasi nirkabel sejak tahun 1980 hingga sekarang mengalami perkembangan yang pesat. Perkembangan yang semakin maju ini akan mendorong peningkatan standar pada area nirkabel. Hal ini akan mengurangi siklus produk komunikasi nirkabel dan memerlukan prototype untuk standar yang berbeda dalam waktu yang sangat cepat. Selain itu permintaan untuk desain yang fleksibel dan ketersediaan Digital Signal Processing (DSP) serta reconfigurable logic (FPGA, PLD) juga meningkat. Sehingga diperlukan desain yang ideal yaitu sebuah platform yang fleksibel dengan user interface tunggal untuk prototype standar nirkabel yang berbeda-beda. Hal inilah yang mendasari munculnya konsep radio yang didefinisikan sebagai software (Software Defined Radio, SDR)

https://id.wikipedia.org/wiki/Software-defined_radio

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Apa itu SDR?

Software Defined Radio (SDR) adalah suatu teknologi dimana software dijalankan pada platform hardware, yaitu pada Digital Signal Processing (DSP) processor, dan Field Programmable Gate Array (FPGA), untuk mengimplementasikan fungsi-fungsi radio seperti proses modulasi pada transmitter dan proses demodulasi pada receiver.

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Apa itu SDR?

Software Defined Radio (SDR) di definisikan sebagai radio yang menggunakan software untuk bagian teknik modulasi, wide-band atau narrow-band operation, fungsi keamanan komunikasi (seperti hopping), dan waveform requirement untuk standar saat ini dan yang akan datang pada daerah frekuensi broad band.

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SDR Definition

- The SDR Forum:
  - *"Radio in which some or all of the physical layer functions are software defined"*
  - **A radio** is any kind of device that wirelessly transmits or receives signals in the radio frequency (RF) part of the electromagnetic spectrum to facilitate the transfer of information → cell phones, computers, car door openers, vehicles, and televisions

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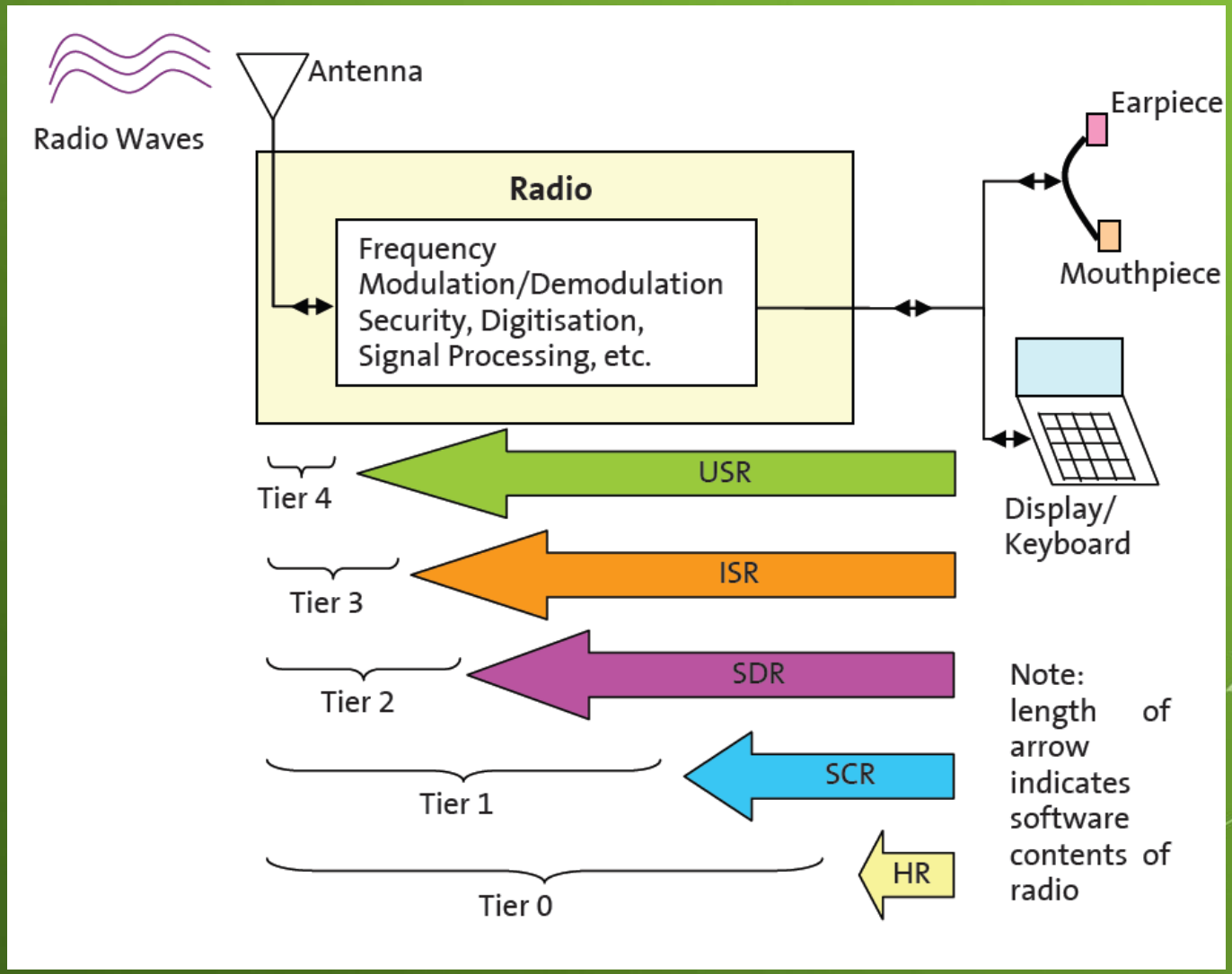
Multitier SDR Definition



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Multitier SDR Definition

Tier	Name	Description
0	Hardware radio (HR)	Baseline radio with fixed functionality.
1	Software-controlled radio (SCR)	The radio's signal path is implemented using application-specific hardware, i.e., the signal path is essentially fixed. A software interface may allow certain parameters, e.g., transmit power, frequency, etc., to be changed in software.
2	Software defined radio (SDR)	Much of the waveform, e.g., frequency, modulation/demodulation, security, etc., is performed in software. Thus, the signal path can, with reason, be reconfigured in software without requiring any hardware modifications. For the foreseeable future, the frequency bands supported may be constrained by the RF front-end.
3	Ideal software radio (ISR)	Compared to a 'standard' SDR, an ISR implements much more of the signal path in the digital domain. Ultimately, programmability extends to the entire system with analogue/digital conversion only at the antenna, speaker and microphones.
4	Ultimate software radio (USR)	The USR represents the 'blue-sky' vision of SDR. It accepts fully programmable traffic and control information, supports operation over a broad range of frequencies and can switch from one air-interface/application to another in milliseconds.

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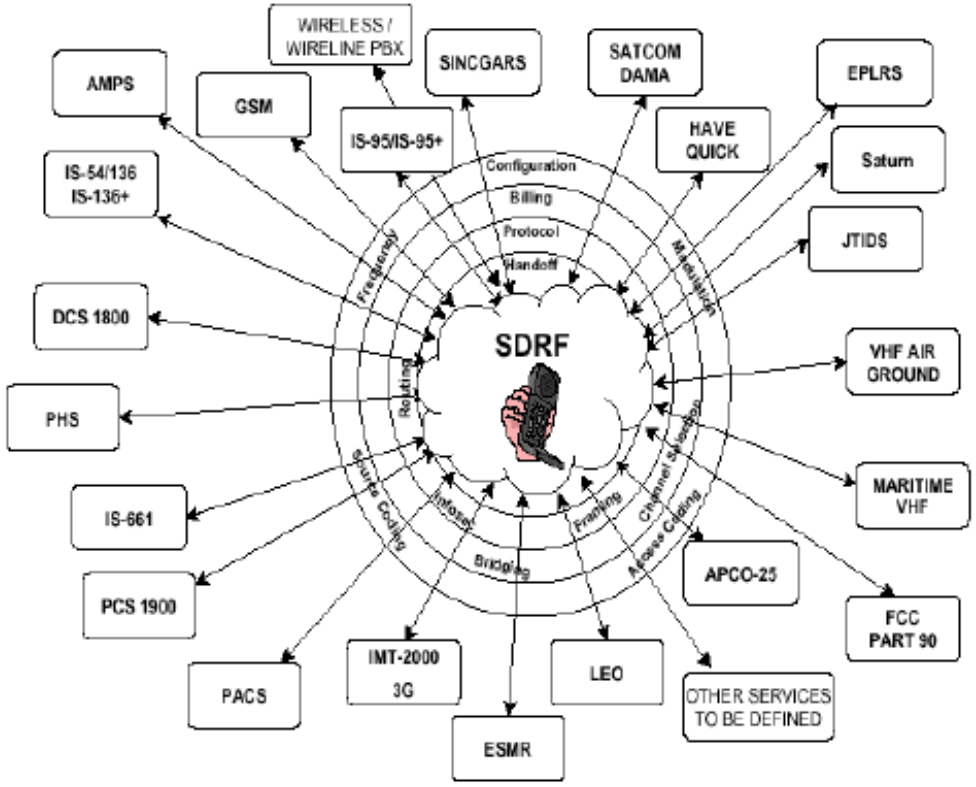
Illustration

An SDR base station can communicate with any kind of terminal (i.e. Cellular, Telephone, PDA) by downloading new software



An SDR terminal can be used for any wireless communication by downloading new software

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Conventional Radio Vs SDR

- Traditional hardware based radio devices limit cross-functionality and can only be modified through physical intervention. This results in higher production costs and minimal flexibility in supporting multiple waveform standards.

- software defined radio technology provides an efficient and comparatively inexpensive solution to this problem, allowing multimode, multi-band and/or multi-functional wireless devices that can be enhanced using software upgrades.

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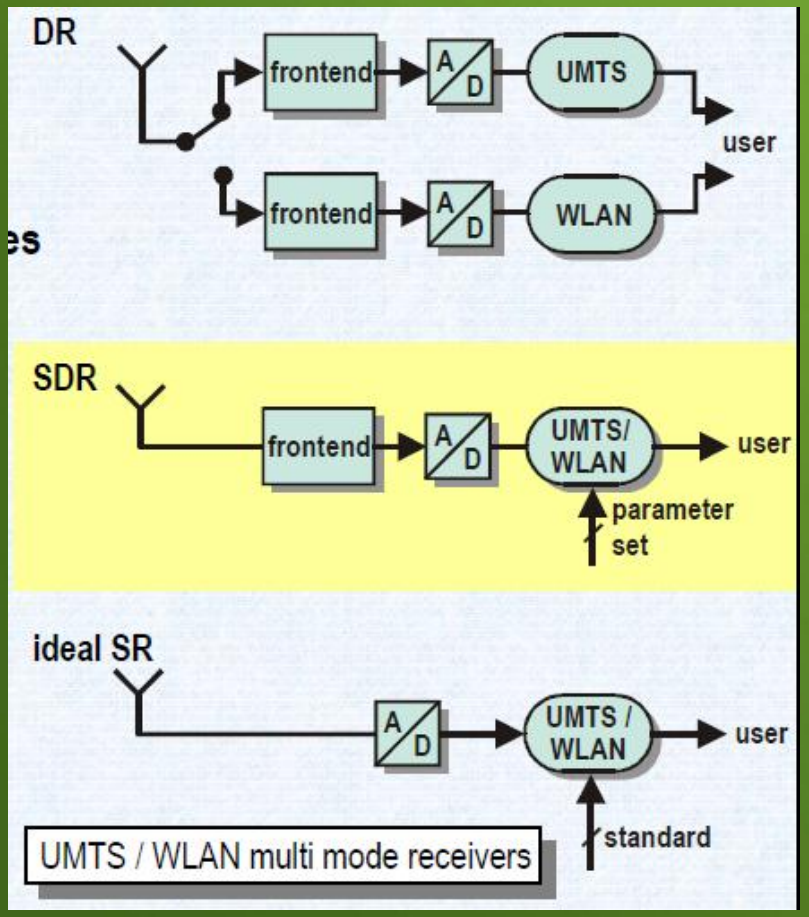
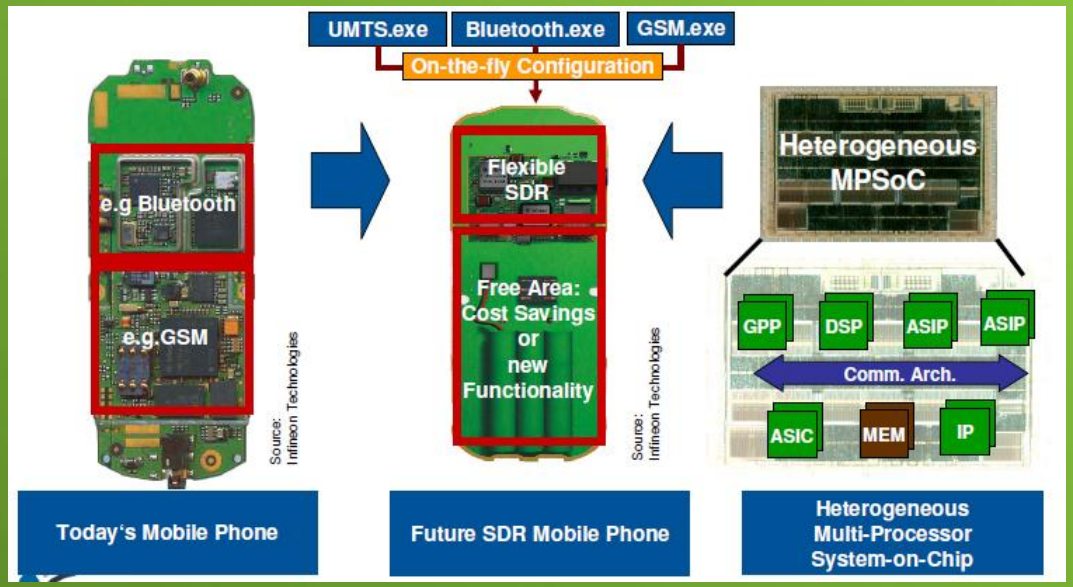
Example





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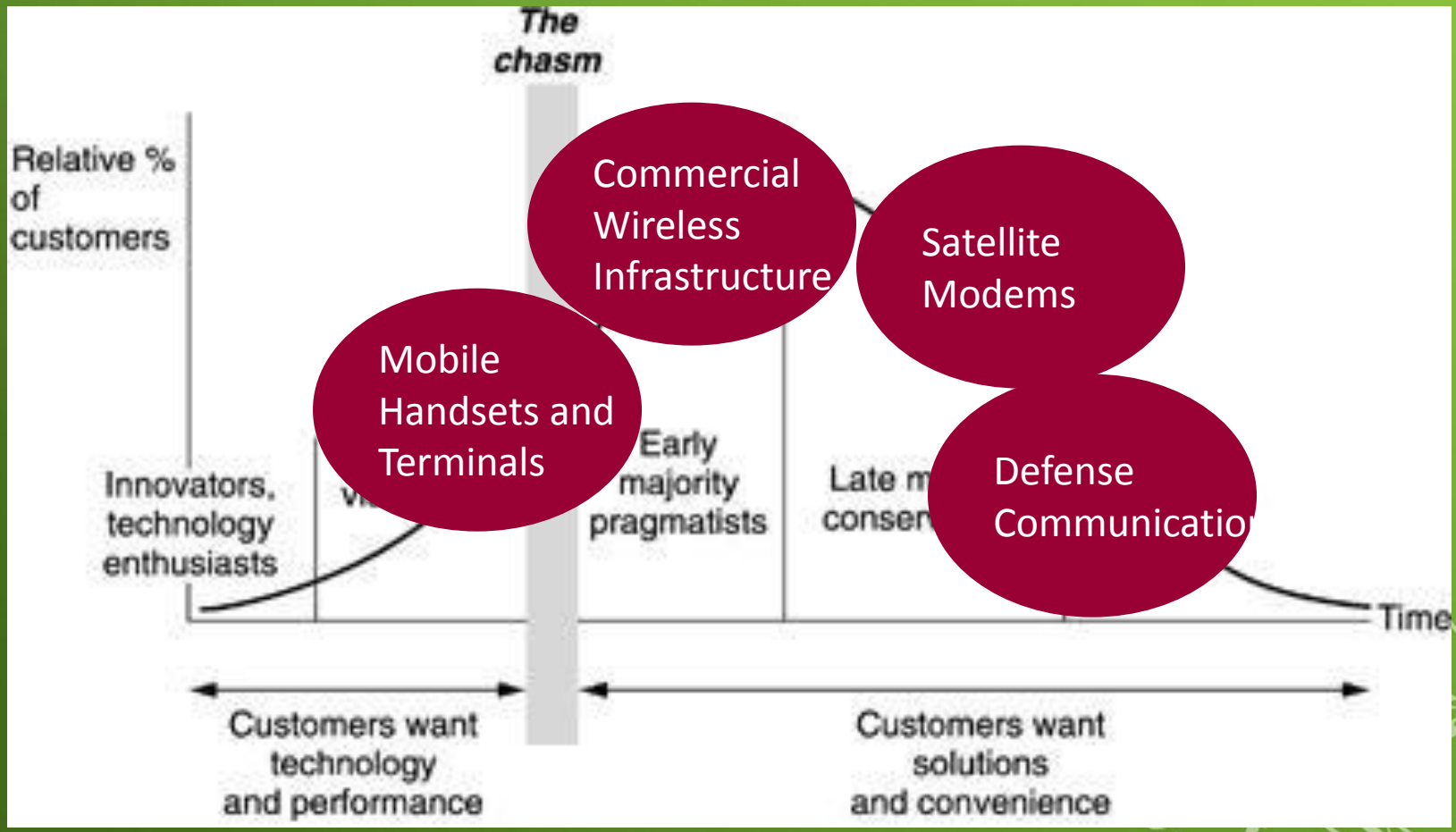
The current state of technology adoption for SDR in various market domains



Source: http://mitpress.mit.edu/books/NORVH/2-3.jpg

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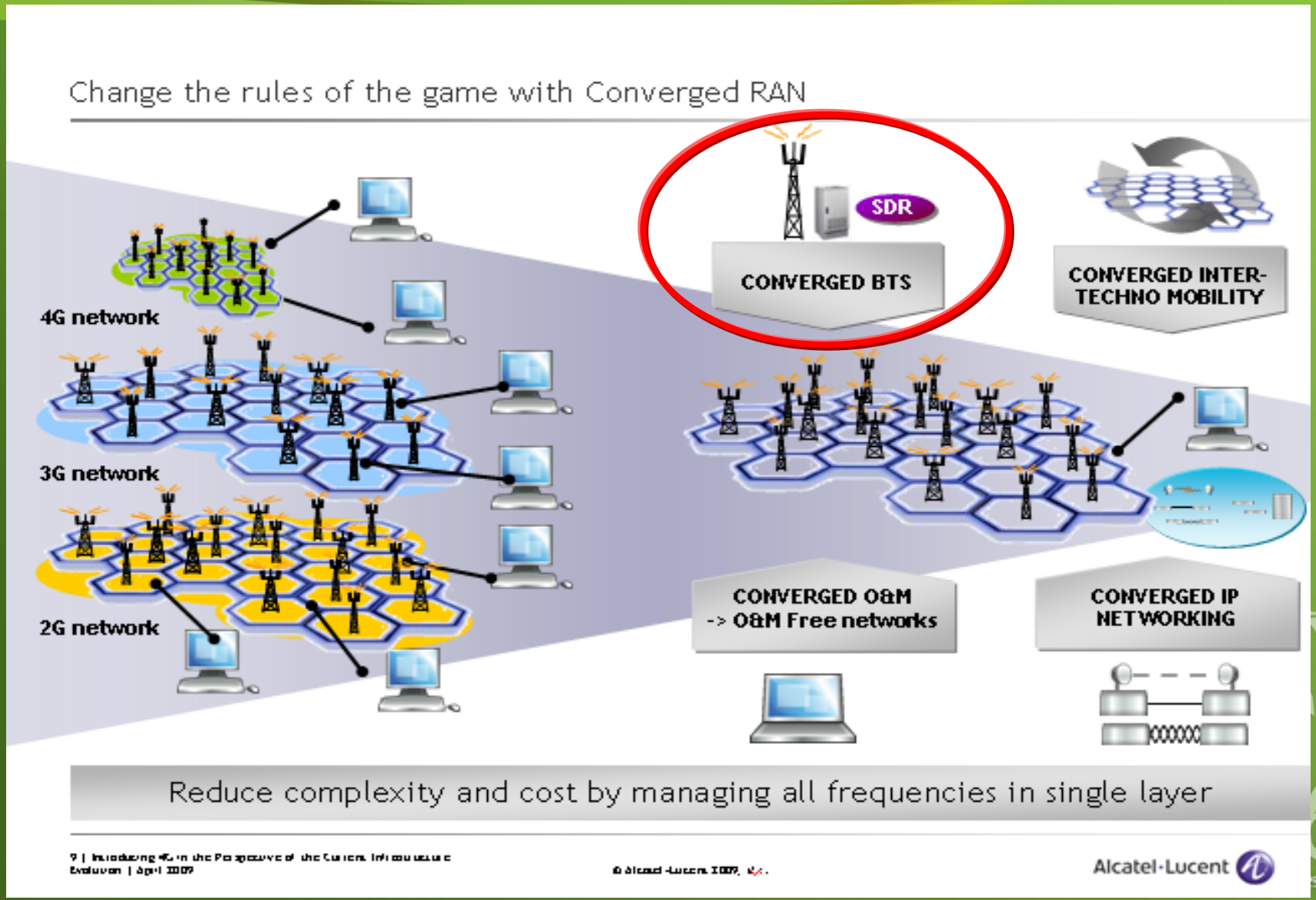
SDR in Commercial Wireless Infrastructure



SDR Evolution

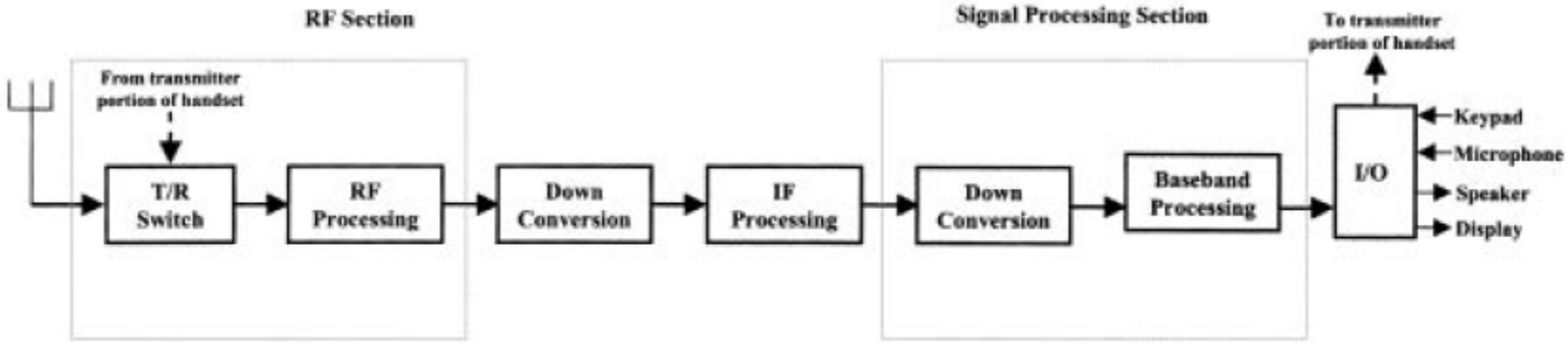


Figure 1.2 SDR evolution – stage 1: cellular /PCS generic single mode, single band handset. This figure is representative of ANY single mode (i.e. AMPS, TDMA, CDMA, GSM, PHS, etc.) and single frequency band (i.e. 850, 900, 1800, 1900, etc.) handset. This is considered to be the traditional design product implementation. Reproduced by permission of Cingular Wireless.

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SDR Evolution

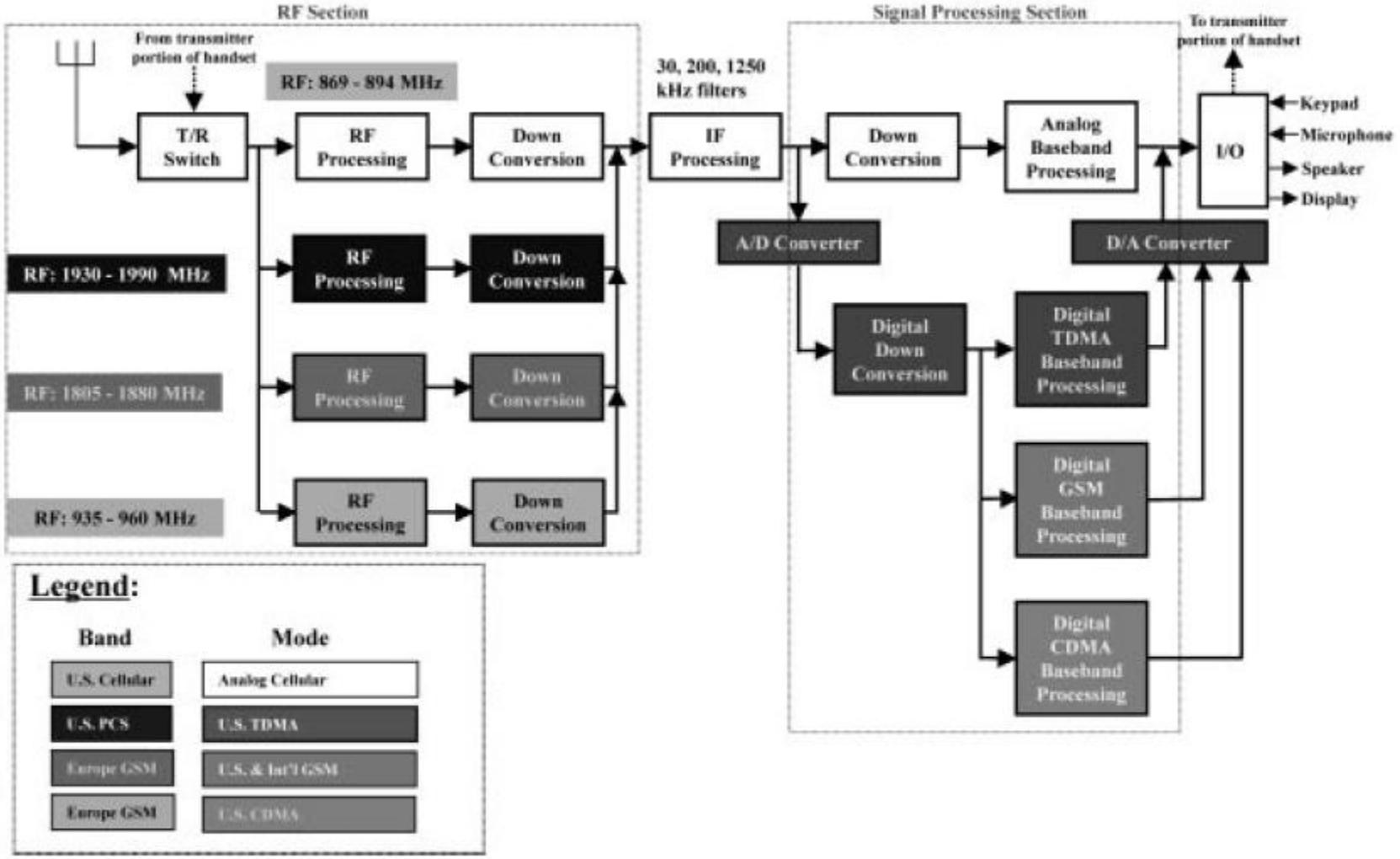

Figure 1.3 SDR Evolution – stage 2: quadruple-band (800, 900,1800, and 1900 MHz), quadruple-mode (AMPS, TDMA, GSM, CDMA), traditional-design, multiband, multimode handset. Reproduced by permission of Cingular Wireless.

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SDR Evolution

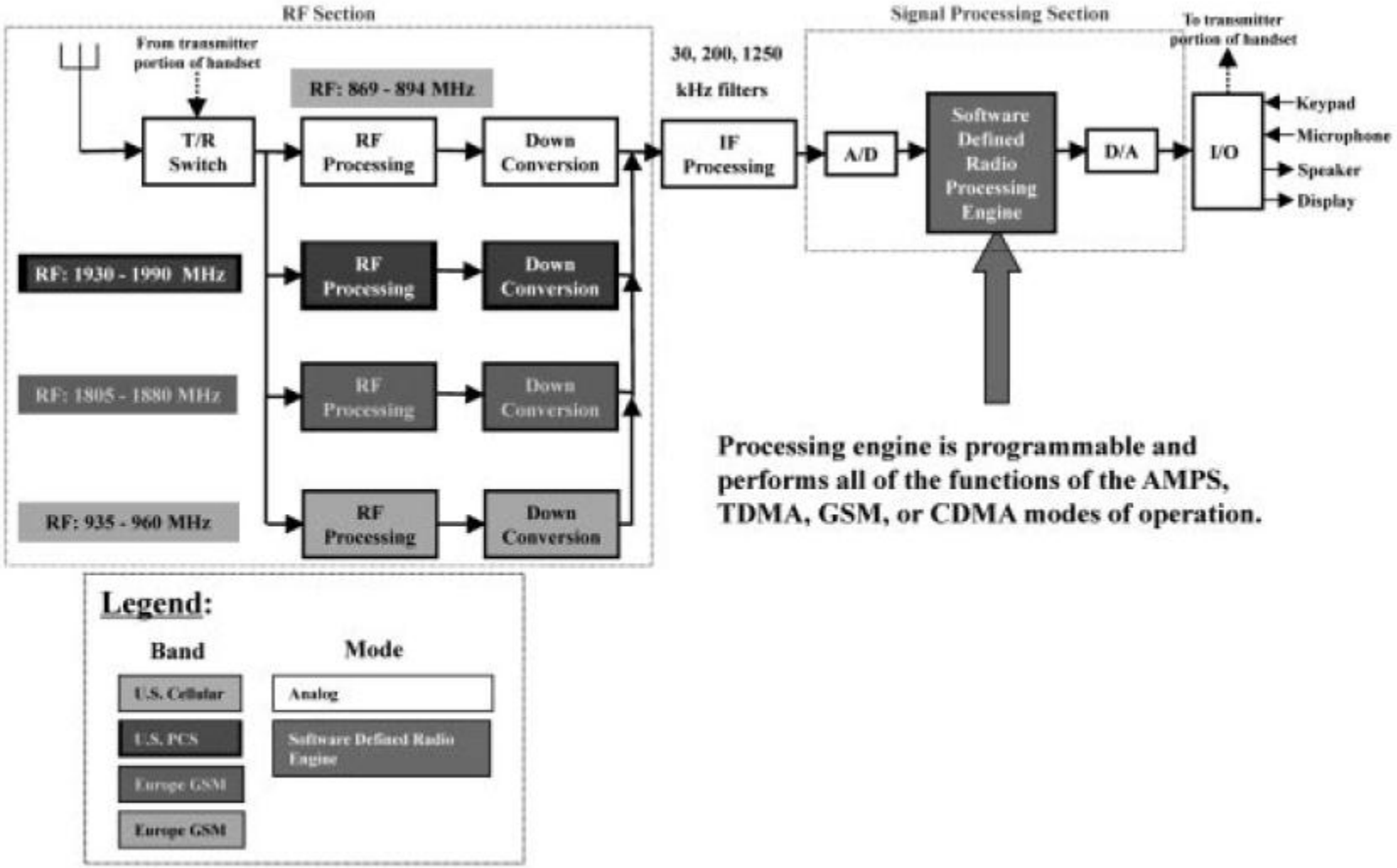

Figure 1.4 SDR Evolution – stage 3: A/D, D/A,and signal processing chips currently have the capacity to perform this IF and baseband processing. Reproduced by permission of Cingular Wireless.

SDR Evolution

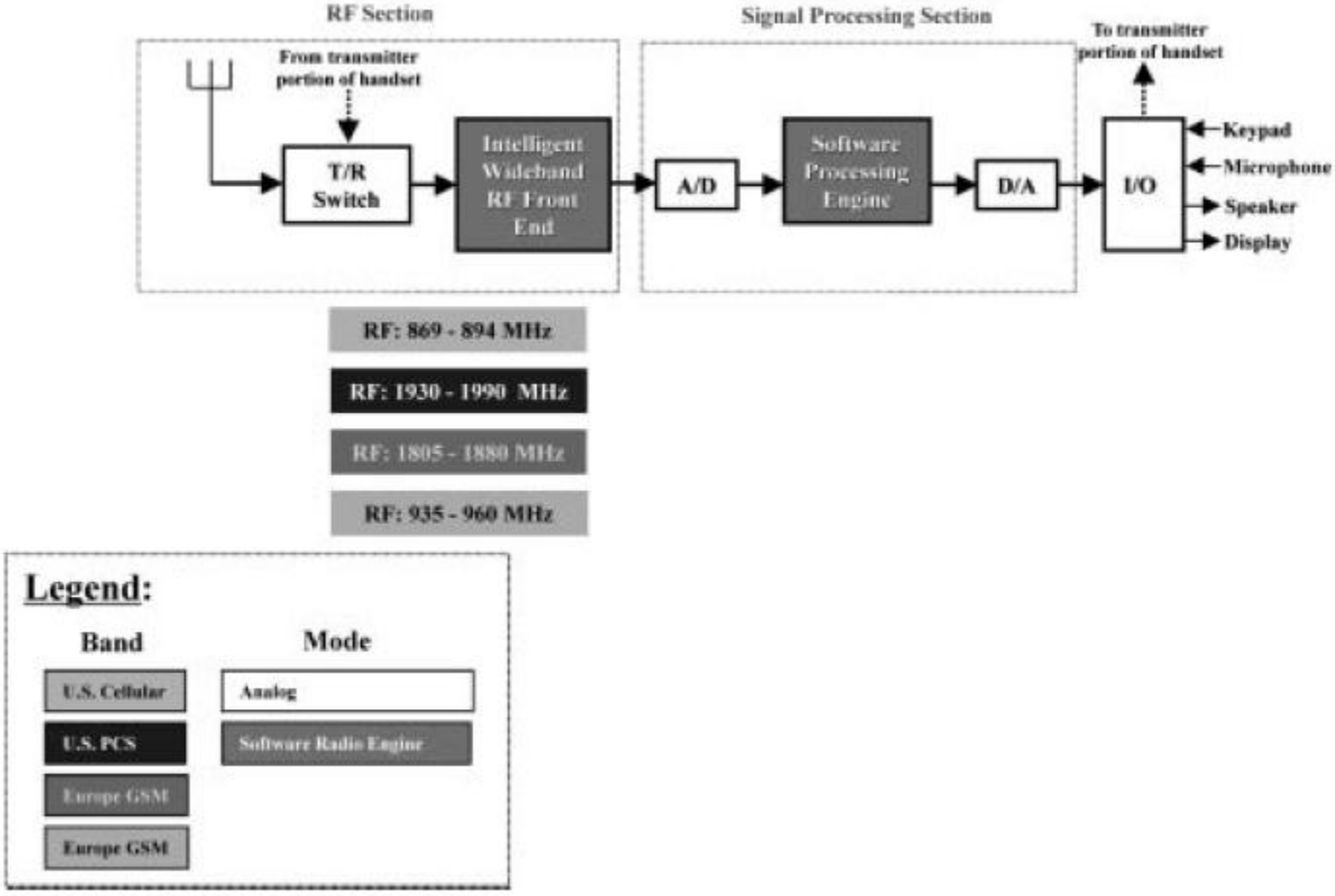

Figure 1.5 SDR Evolution – stage 4: future product as technology evolves in A/D capabilities, etc. Reproduced by permission of Cingular Wireless.

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SEJARAH SDR

- Teknologi Software Defined Radio (SDR) mulai dikembangkan pada tahun 1992 oleh Badan Pertahanan Amerika, Department of Defence (DoD) melalui program penelitian yang disebut SPEAKeasy.
- Pada tahun 1996, pemerintah Amerika menyatukan industri-industri yang bergerak dalam bidang telekomunikasi ke dalam sebuah forum yang disebut dengan forum MMTIS (Modular Multifunction Information Transfer System).
- Forum MMITS kemudian beralih ke pembahasan sistem komunikasi untuk komersial. Pada tahun 1999, forum MMITS diganti namanya menjadi forum SDR. Forum SDR mengembangkan teknologi-teknologi SDR untuk aplikasi pada sistem komunikasi bergerak seluler, dan memunculkan pelayanan-pelayanan komunikasi **seluler generasi ketiga (3G) dan generasi keempat (4G).**

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Kelebihan SDR

- **Mampu beradaptasi**

Sistem SDR mampu untuk beradaptasi ke setiap jenis sistem radio yang ada dengan pemakaian multiband dan multistandard. Standar commercial wireless network yang selalu berkembang, mulai dari 2G ke 2.5G/3G, dan kemudian ke 4G. Setiap generasi network memiliki standar link-layer protocol yang sangat berbeda, yang menyebabkan masalah pada pelanggan, wireless network operator, dan peralatan vendor.

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Kelebihan SDR

- **Tidak memerlukan penambahan/perubahan hardware**

Untuk pembuatan sistem radio yang baru tidak perlu menambah ataupun mengganti hardware (perangkat keras), tetapi cukup dengan penambahan software saja yang dimuat ke dalam DSP.

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Kelebihan SDR

- **Mudah dan sederhana**

Pemilihan sistem radio yang dikehendaki dapat dilakukan dengan perubahan yang mudah dan sederhana yaitu cukup mengaktifkan sistem radio yang dikehendaki tersebut. Begitu juga pengembangan untuk jenis sistem radio dan servis yang baru mudah untuk diaplikasikan.

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Kelebihan SDR

- **Memperkecil ukuran**
- **Sistem SDR mampu mendukung pengembangan sistem komunikasi radio yang lebih maju**

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Kekurangan SDR

- **Memerlukan sistem antena dan tingkat RF yang sesuai untuk berbagai sistem radio. Sistem radio yang ada memiliki frekuensi dan daya pancar yang berbeda.**
- **Diperlukan sebuah arsitektur ADC yang memiliki :**
  a) Laju pencuplikan (sampling rate) yang tinggi (diatas 100 MSampel/detik, MSPS) sehingga mampu mencuplik sinyal RF .
  b) Dynamic range yang mampu berubah-ubah dalam daerah yang cukup lebar sesuai dengan jenis sistem radio yang ada. Untuk GSM diperlukan dinamic range sekitar 91 dB.
  c) Resolusi bit yang tinggi [1],[2], paling tidak 12 bit
  d) Error generator (seperti jitter, thermal noise dan error kuantisasi) yang sangat kecil

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Kekurangan SDR

- **Diperlukan sistem pengolahan sinyal digital dengan pelaksanaan "real-time", sehingga membutuhkan beberapa DSP (Digital Signal Processor) yang diparalel.**

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SDR -- Benefit

- *For Radio Equipment Manufacturers and System Integrators, SDR Enables:*
  - A family of radio “products” to be implemented using a common platform architecture, allowing new products to be more quickly introduced into the market.
  - Software to be reused across radio "products", reducing development costs dramatically.
  - Over-the-air or other remote reprogramming, allowing "bug fixes" to occur while a radio is in service, thus reducing the time and costs associated with operation and maintenance.

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SDR -- Benefit

- *For Radio Service Providers, SDR Enables:*
  - New features and capabilities to be added to existing infrastructure without requiring major new capital expenditures, allowing service providers to quasi-future proof their networks.
  - The use of a common radio platform for multiple markets, significantly reducing logistical support and operating expenditures.
  - Remote software downloads, through which capacity can be increased, capability upgrades can be activated and new revenue generating features can be inserted.

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SDR -- Benefit

- *For End Users - from business travelers to soldiers on the battlefield, SDR technology aims to:*
  - Reduce costs in providing end-users with access to ubiquitous wireless communications – enabling them to communicate with whomever they need, whenever they need to and in whatever manner is appropriate.

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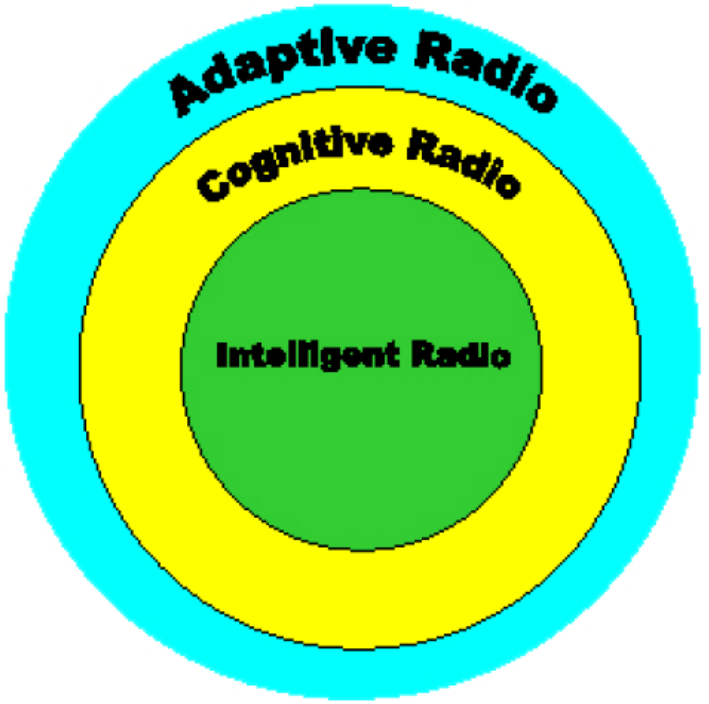
SDR – Related Technology

- SDR can act as a key enabling technology for a variety of other reconfigurable radio equipments commonly discussed in the advanced wireless market
  - ***Adaptive Radio***
    - monitoring their own performance and modifying their operating parameters to improve this performance
  - ***Cognitive Radio***
    - aware of their internal state and environment, such as location and utilization on RF frequency spectrum at that location
  - ***Intelligent Radio***
    - cognitive radio that is capable of machine learning



Venn diagram illustrating relationship between associated advanced wireless technologies

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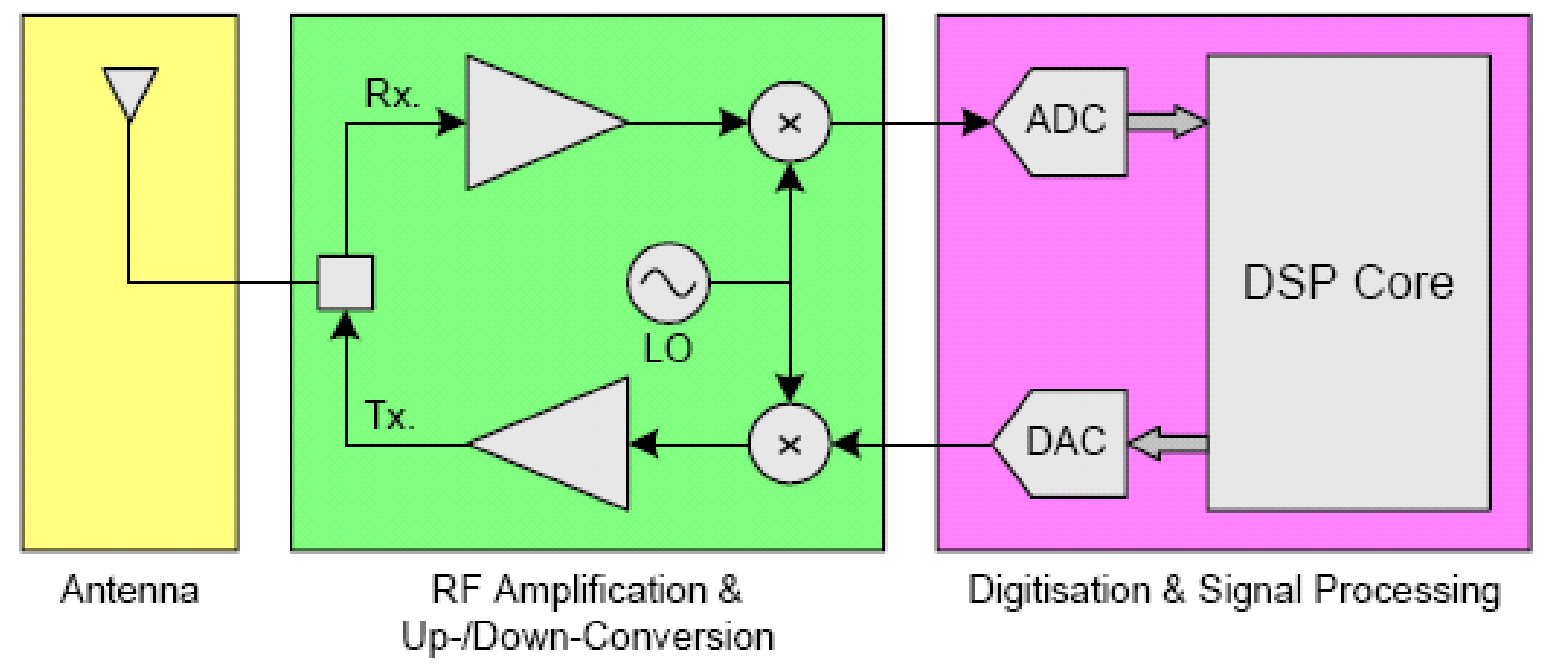
SDR – Key Component



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ANY QUESTION?

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