

# WCDMA – Technology for 3G Cellular Systems

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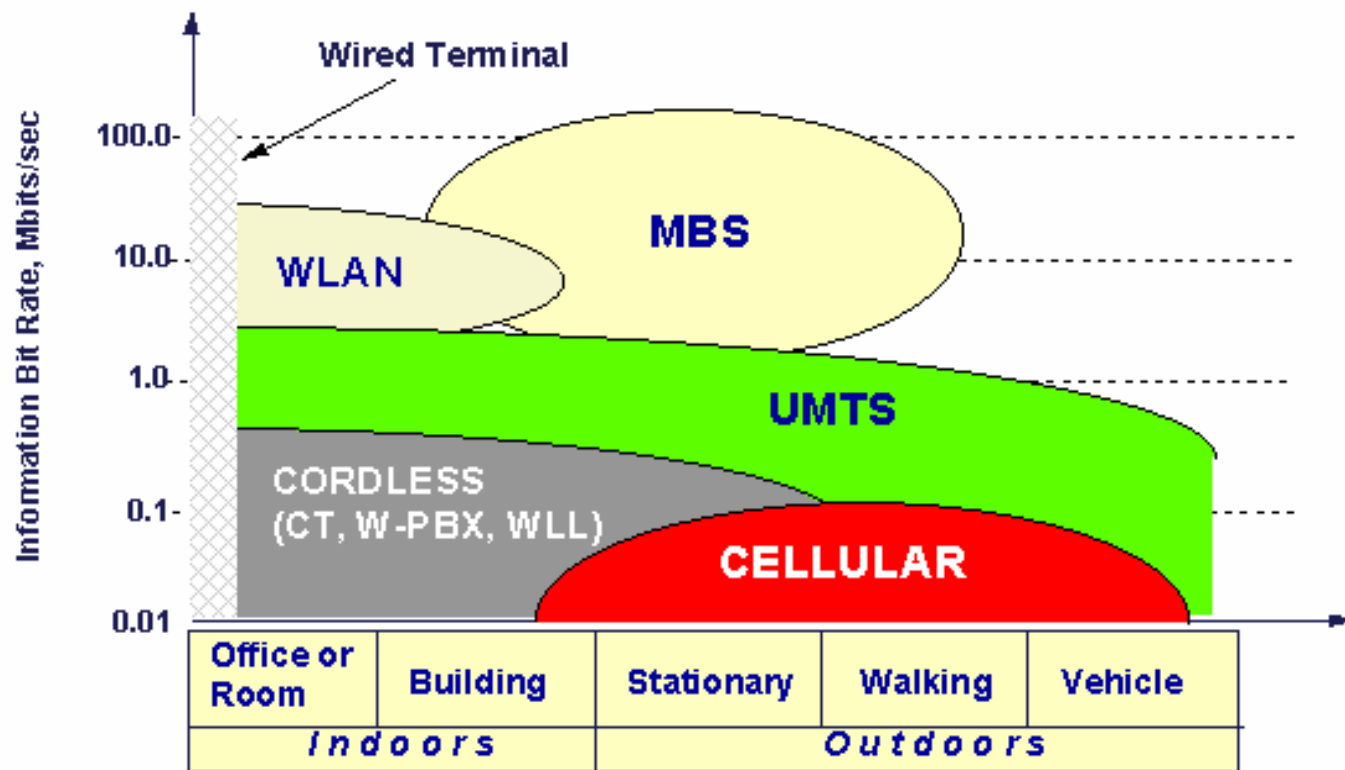
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# What is 3G Mobile System

- Broadband Service
- Packet Based Transmission
- Transmission of text, digitized voice, video at data rate higher than 2 Mbps
- Consistent set of services to mobile computer and phone users wherever they are located in the world

# Universal Mobile Telecommunication System



One can directly dive straight into the mobile multimedia wave

# UMTS Network

It consists of

- UMTS Terrestrial Radio Access Network (UTRAN)
  - WCDMA and FDD are used here
  
- Core Network

# Spread Spectrum System

- A kind of modulation system in which the modulated (spread spectrum) signal bandwidth is much greater than the message signal bandwidth
- The spectral spreading is performed by a code that is independent of the message signal. The same code is used at receiver to despread the received signal and to recover the message signal.

# Advantages of Spread Spectrum System

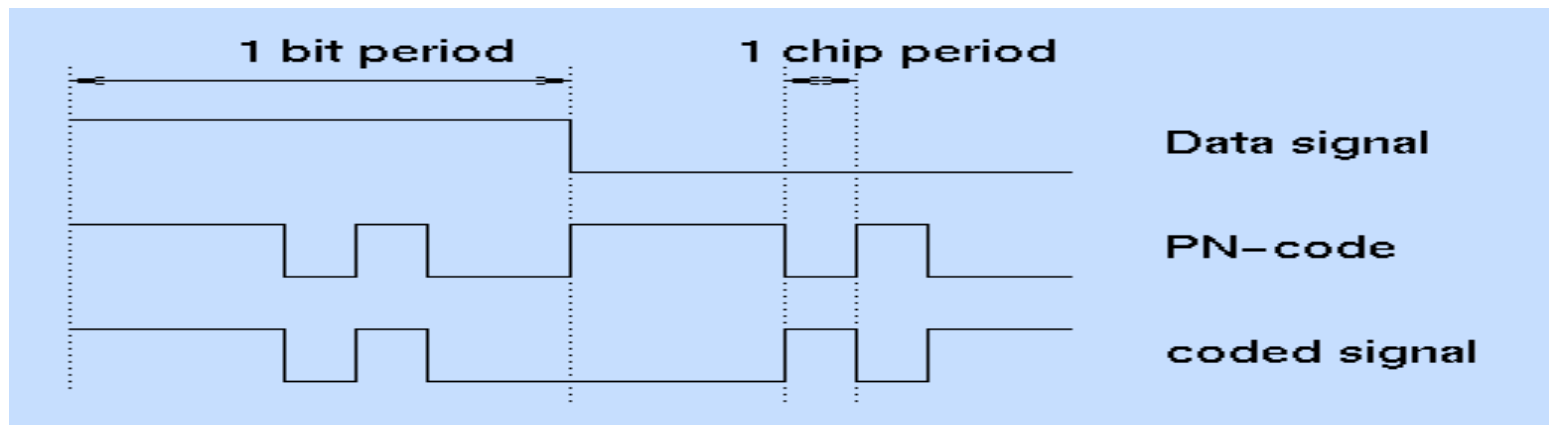
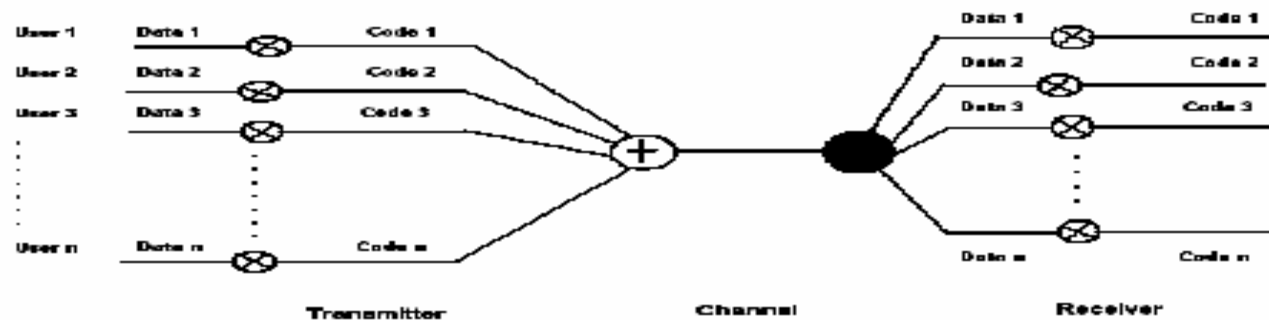
- It is Secure, difficult to intercept
- A large number of codes can support a large number of users
- As a large bandwidth is used the system is less prone to distortion
- Resistant to jamming
- Asynchronous multiple access technology

# Different Spread Spectrum System

- Direct Sequence Spread Spectrum
- Frequency Hoping
- Hybrid System

# Code Division Multiple Access

- A multiple access technology using DS/SS





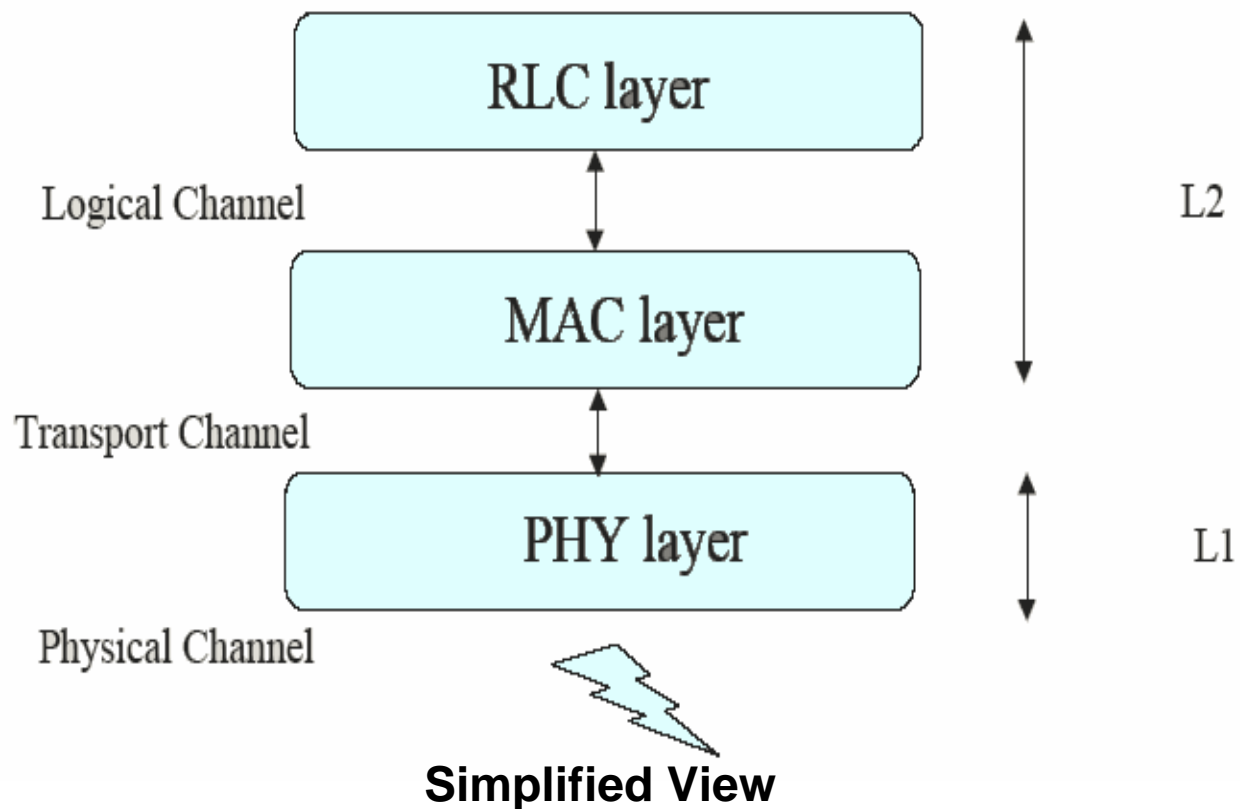
# Why WCDMA

- WCDMA is a step further in the CDMA technology. It uses a 5 MHz wide radio signal and a chip rate of 3.84 Mcps, which is about three times higher than the chip rate of CDMA2000 (1.22 Mcps)
- Higher spectrum efficiency thanks to improved trunking efficiency (i.e. a better statistical averaging)
- Higher QoS

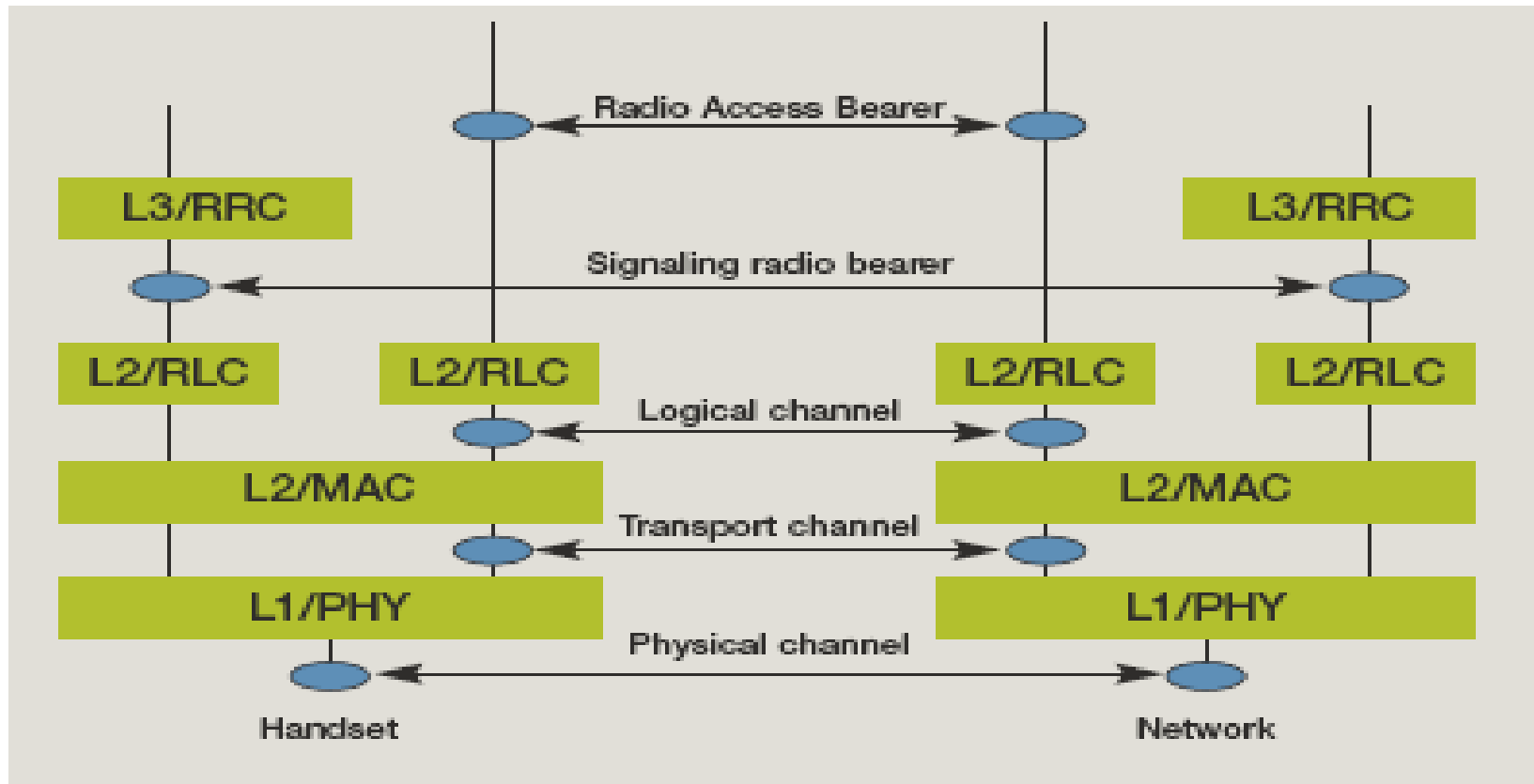
# WCDMA Protocol Architecture

- Three separate channels concepts in the UTRA: logical, transport, and physical channels.
- Logical channels define what type of data is transferred.
- Transport channels define how and with which type of characteristics the data is transferred by the physical layer.
- Physical data define the exact physical characteristics of the radio channel.

# WCDMA Protocol Architecture



# WCDMA Protocol Architecture



**Detailed View**

# WCDMA Protocol Architecture

## Physical Layer

### Main 3G Requirements

- High Bit Rates
- Flexible Variable bit rate both in Uplink and Downlink
- Different services have been multiplexed on a single physical connection
- Support for All-IP RAN
- High Spectral Efficiency

# WCDMA Protocol Architecture

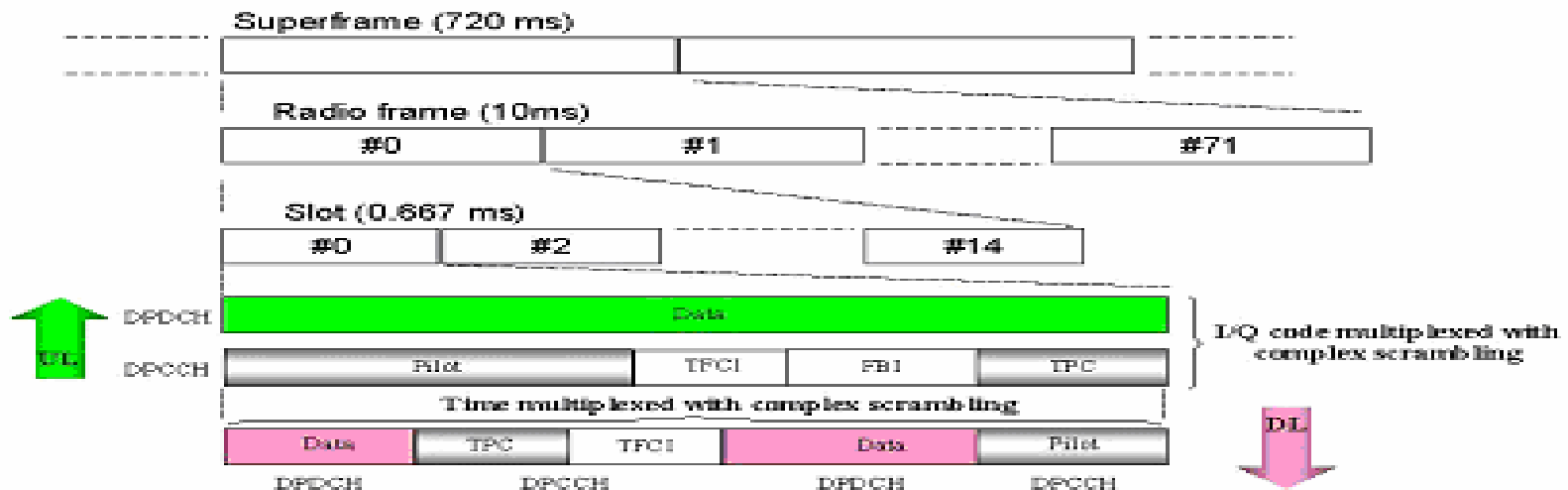
## Main Functions of Physical Layer

- Error Detection
- Multiplexing Demultiplexing
- Modulation Demodulation
- Spreading Despreading
- Synchronization
- Measurement of Bit Error Rate, Tx Power, Signal to Interference ratio
- Handover

# WCDMA Protocol Architecture

## Physical Layer

- $W = 3.84$  Mcps, one time slot 2560 chips
- Physical channel is characterized with frequency, code, duration, and in uplink with phase shift
- 1 radio frame (10 ms) includes 15 time slots (one slot equal to power control period,  $1/(10 \text{ ms}/15) = 1500$  Hz). Slot structure is just for controlling the physical channel and radio performance



# WCDMA Protocol Architecture

## Physical Layer to Transport Layer

- Several transport channels can be multiplexed together by physical layer to form a single Coded Composite Transport Channel (CCTrCh)
- The physical layer combines several TFI information into the Transport Format Combination Indicator (TFCI), which indicate which transport channels are active for the current frame.
- Two types of transport channels: **dedicated** channels and **common** channels.
  - Dedicated channel –reserved for a single user only.
    - Support fast power control and soft handover.
  - Common channel – can be used by any user at any time.
    - Don't support soft handover but some support fast power control.
- In addition to the physical channels mapped from the transport channels, there exist physical channels for *signaling* purposes to carry only information between network and the terminals.



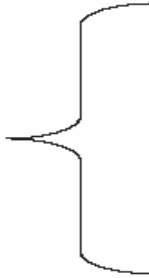
# WCDMA Protocol Architecture

## Transport Channel

- Transport channels contain the data generated at the higher layers, which is carried over the air and are mapped in the physical layer to different physical channels.
- The data is sent by transport block from MAC layer to physical layer and generated by MAC layer every 10 ms.
- The transport format of each transport channel is identified by the Transport Format Indicator (TFI), which is used in the interlayer communication between the MAC layer and physical layer.

# WCDMA Protocol Architecture

## Different Transport Channels and Corresponding Physical Channels

Transport Channel	Physical Channel
(UL/DL) Dedicated channel <b>DCH</b>	Dedicated physical data channel <b>DPDCH</b> Dedicated physical control channel <b>DPCCH</b>
(UL) Random access channel <b>RACH</b>	Physical random access channel <b>PRACH</b>
(UL) Common packet channel <b>CPCH</b>	Physical common packet channel <b>PCPCH</b>
(DL) Broadcast channel <b>BCH</b>	Primary common control physical channel <b>P-CCPCH</b>
(DL) Forward access channel <b>FACH</b> (DL) Paging channel <b>PCH</b>	Secondary common control physical channel <b>S-CCPCH</b>
(DL) Downlink shared channel <b>DSCH</b>	Physical downlink shared channel <b>PDSCH</b>
<b>Signaling physical channels</b> 	Synchronisation channel <b>SCH</b>
	Common pilot channel <b>CPICH</b>
	Acquisition indication channel <b>AICH</b>
	Paging indication channel <b>PICH</b>
	CPCH Status indication channel <b>CSICH</b>
	Collision detection/Channel assignment indicator channel <b>CD/CA-ICH</b>

# WCDMA Protocol Architecture

## RLC Layer

- The ***Radio Link Control (RLC) protocol*** (Layer 2) operates in one of three modes: transparent, unacknowledged or acknowledged mode
- It performs segmentation/re-assembly functions and, in acknowledged mode, provides an assured mode delivery service by use of retransmission
- RLC provides a service both for the RRC signaling (the ***Signaling Radio Bearer***) and for the user data transfer (the ***Radio Access Bearer***).

# WCDMA Protocol Architecture

## RRC Layer

- The ***Radio Resource Control (RRC) protocol*** (Layer 3) provides control of the handset from the RNC
- It includes functions to control radio bearers, physical channels, mapping of the different channel types, handover, measurement and other mobility procedures. Because of the flexibility of the WCDMA radio interface, this is a fairly complex protocol

# WCDMA System Overview

## RAN Architecture

- The main purpose of the WCDMA Radio Access Network is to provide a connection between the hand-set and the core network and to isolate all the radio issues from the core network. The advantage is one core network supporting multiple access technologies.

# WCDMA System Overview

## RAN Architecture

- The WCDMA Radio Access Network consists of two types of nodes:
- Radio Base Station (Node B)
  - The Radio Base Station handles the radio transmission and reception to/from the handset over the radio interface (Uu). It is controlled from the Radio Network Controller via the Iub interface. One Radio Base Station can handle one or more cells.
- Radio Network Controller (RNC)
  - The Radio Network Controller is the node that controls all WCDMA Radio Access Network functions. It connects the WCDMA Radio Access Network to the core network via the Iu interface

# WCDMA System Overview

## RAN Architecture

