WCDMA

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Outline

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- Key features of WCDMA
- Conclusion

Motivation: 3G

- Introduce multimedia capabilities into mobile communications
  - Demands much higher bandwidth than is available today
- Use multiple services simultaneously.
  - Browse Internet while downloading a file from a corporate intranet server in the background
- Research for these was conducted by ITU and other bodies worldwide.
- These research efforts have been denoted “Third-Generation (3G) mobile communications.”

Third Generation (3G)

- 3rd Generation adds multimedia capabilities to 2nd Generation platforms
  - High bit rates (2 Mb/s)
  - Packet data / IP access
- Also called Universal Mobile Telecommunications System / International Mobile Telecommunications 2000 (UMTS/IMT-2000).
- Part of the 2 GHz band is allocated for IMT-2000 usage.

Standardization of 3G

- Various standards bodies are in the process of making standards for IMT-2000.
  - ETSI in Europe
  - ARIB in Japan
  - TIA and T1P1 in the USA
  - TTA in South Korea
- ARIB and ETSI have now harmonized their standards, and their air interface is now commonly referred as WCDMA
- WCDMA is written without a dash when used for the ARIB/ETSI system. For other wideband CDMA proposals it can be written as W-CDMA.

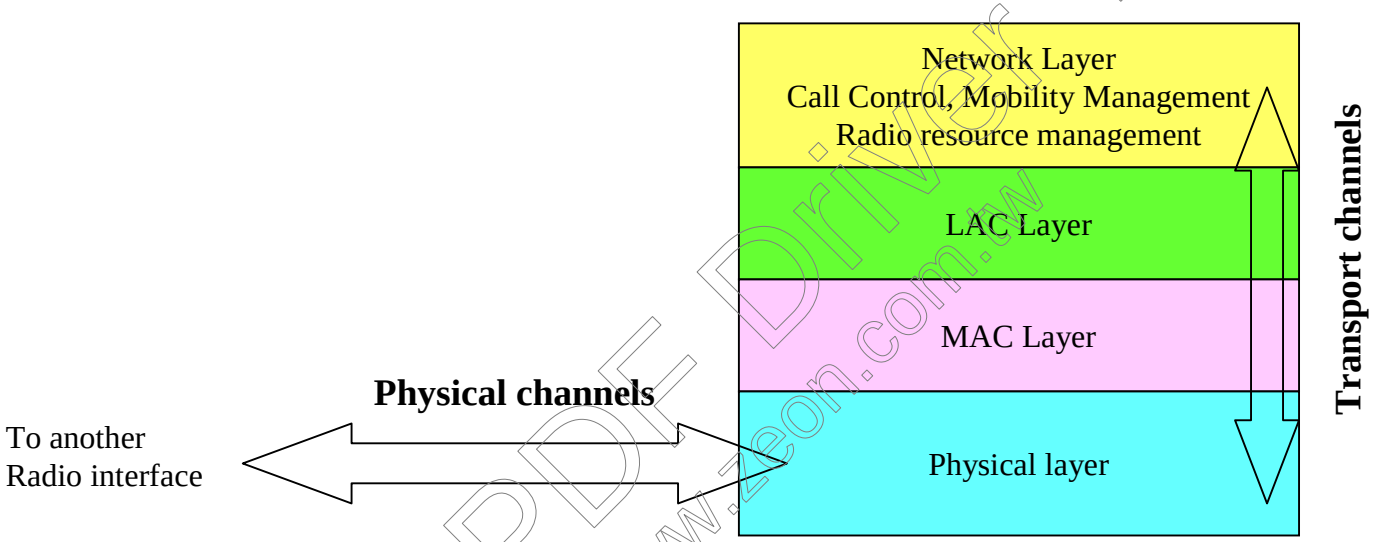
WCDMA: Key Features

- Highly efficient spectrum utilization
- Release from frequency management
- Low mobile station transmit power
- Use of independent resources for uplink/downlink
- Wide variety of data rates
- Improvement of multi-path resolution

WCDMA: Parameters

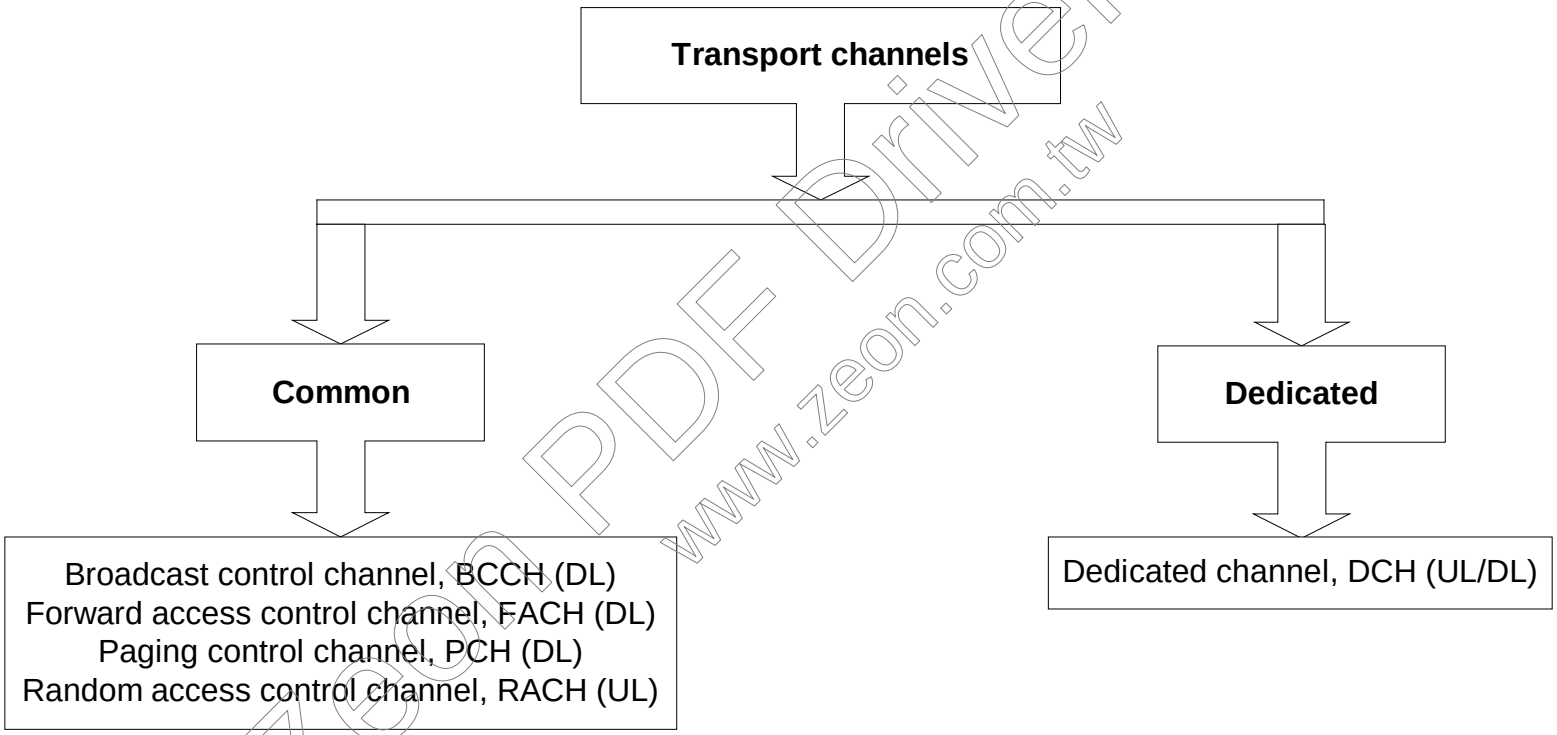
Bandwidth	1.25 / 5 / 10 / 20 MHz
Chip rate	1.024 / 4.096 / 8.192 / 16.384 Mcps
Carrier spacing	Flexible with 200 KHz carrier raster
Duplex scheme	FDD and TDD
Inter-cell synchronization	Asynchronous
Modulation scheme (DL/UL)	QPSK / BPSK (FDD) QPSK / QPSK (TDD)
Multi-rate	Variable spreading (4-256)
Power control	Open and fast closed loop
Handover	Soft handover Inter-frequency handover

WCDMA: Channel Structure



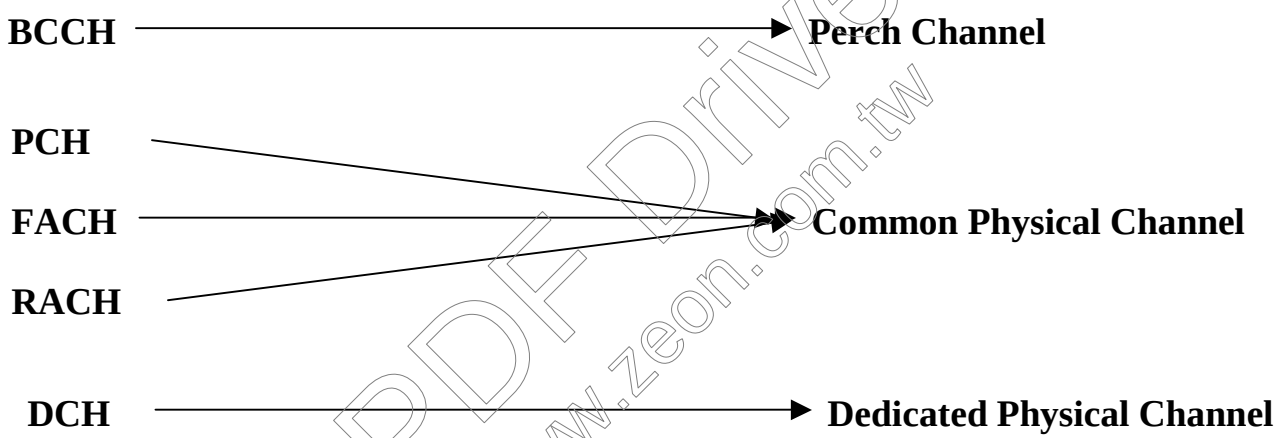
WCDMA: Transport Channels

- Transport channels provide services from physical layer to higher layers



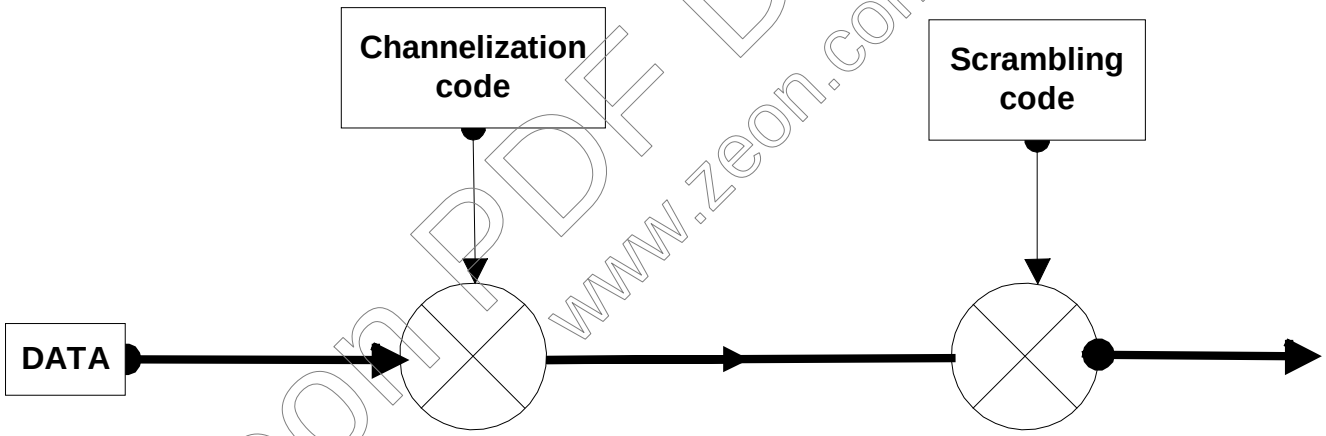
WCDMA: Physical Channels

- Transport channels are mapped to physical channels.



WCDMA: Multiple Spreading

- Channelization code (a.k.a. short code) provides spreading (increase of the transmission bandwidth)
- Scrambling code (a.k.a. long code) provides separation of users / cells, and does not affect the transmission bandwidth



WCDMA: Multiple Spreading

	Forward link	Reverse link
Channelization code	Variable length orthogonal sequences	Variable length orthogonal sequences
Scrambling code	10 ms of a Gold sequence (a common PN for all users of a cell)	Very large set of Kasami sequences (unique to each user)

WCDMA: Asynchronous BS Operation

- 2nd Generation narrowband CDMA systems require tight inter-base-station synchronization.
- For ease of BS deployment in both indoor and outdoor environments, WCDMA supports inter-cell asynchronous operation.
- Asynchronous operation leads to the use of different scrambling codes in different cell sites, and this increases the cell search time.
- A fast cell search algorithm is used to identify the unique long code of the BS

WCDMA: Handover

- **Intra-RF handover:**
  - Handover between cells with the same RF carrier
  - Macro diversity is used
- **Inter-RF handover:**
  - Change of RF carrier
  - Handover between HCS (Hierarchical Cell Structure) layers
  - Hard handover is employed
- **Between GSM and UMTS:**
  - Depends on the type of multi-mode MS implementations
  - Hard handover

WCDMA: Inter-RF Handover

- To support seamless inter-RF handover:
  - MS should be able to carry out cell search on a carrier frequency different from the current one
- Possible ways to achieve this:
  - For MS with receiver diversity, use one diversity branch for this purpose
  - For MS with single receiver, use slotted downlink transmission

WCDMA: Power Control (TPC)

- Transmit Power Control (TPC) is essential to a CDMA architecture:
  - To solve the near-far problem
  - To increase the system capacity
- WCDMA uses two TPC forms:
  - SIR-based fast closed loop TPC
  - Open loop TPC

WCDMA: TPC

- **Open Loop TPC:**
  - Receiver estimates the transmission channel's path loss
  - Transmitter power is calculated on the basis of path loss
- **SIR-based Fast Closed Loop TPC:**
  - Receiver SIR is measured in every power control cycle (0.625 ms)
  - When the measured value is higher than the target SIR value a TPC-down command is sent, otherwise a TPC-up command is sent

WCDMA: Performance Enhancements

- **Receiver diversity**
  - Temporal diversity
  - Multi-path diversity
  - Spatial diversity
- **Transmitter diversity**
  - Orthogonal Transmit Diversity (OTD)
  - Time Switched Transmit Diversity (TSTD)
  - Selection Transmit Diversity (STD)

Conclusion

- WCDMA is the air interface standard proposed by ARIB and ETSI for 3rd generation mobile systems.
- Offers many improvements over 2nd generation N-CDMA systems.
- Its key features are:
  - Asynchronous BS operation
  - Fast TPC
  - Variable data rate transmission
  - Orthogonal multi spreading factors