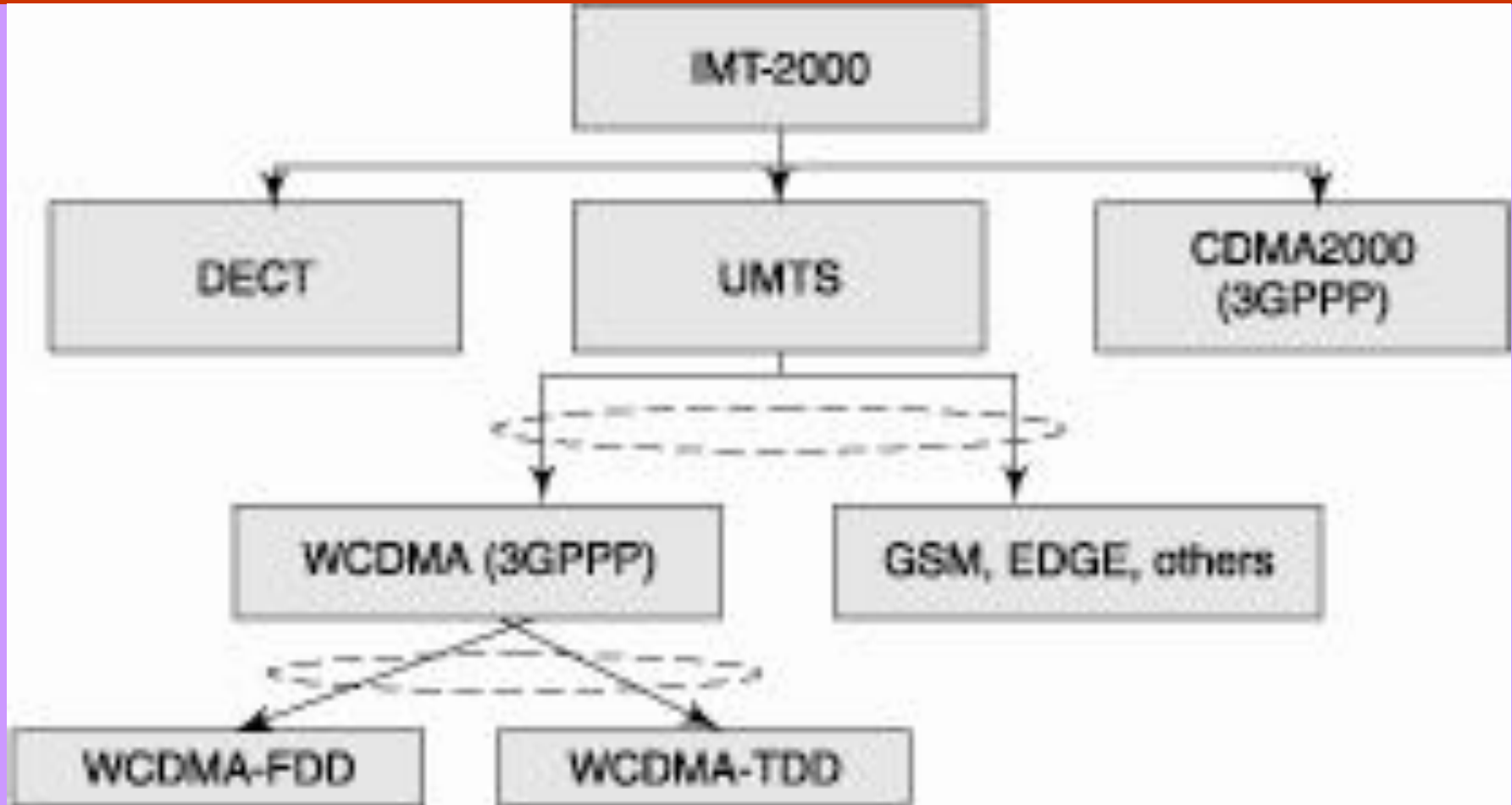


# WIRELESS MEDIUM ACCESS CONTROL AND CDMA, 3G AND 4G COMMUNICATION

## Lesson 11

### WCDMA

# 3G TECHNOLOGIES COVERED IN IMT-2000 GLOBAL STANDARDS



# WCDMA

- Supports data rates of 2 Mbps or higher for short distances
- 384 kbps for long distances

# WCDMA-FDD

- WCDMA access is either FDD or TDD (time division duplex)
- WCDMA-FDD Also referred to as UTRA-FDD (universal (or sometimes UMTS) terrestrial radio access-frequency division duplex)
- FDD separates reverse link (called uplink in GSM) and forward link (called downlink in GSM) frequencies

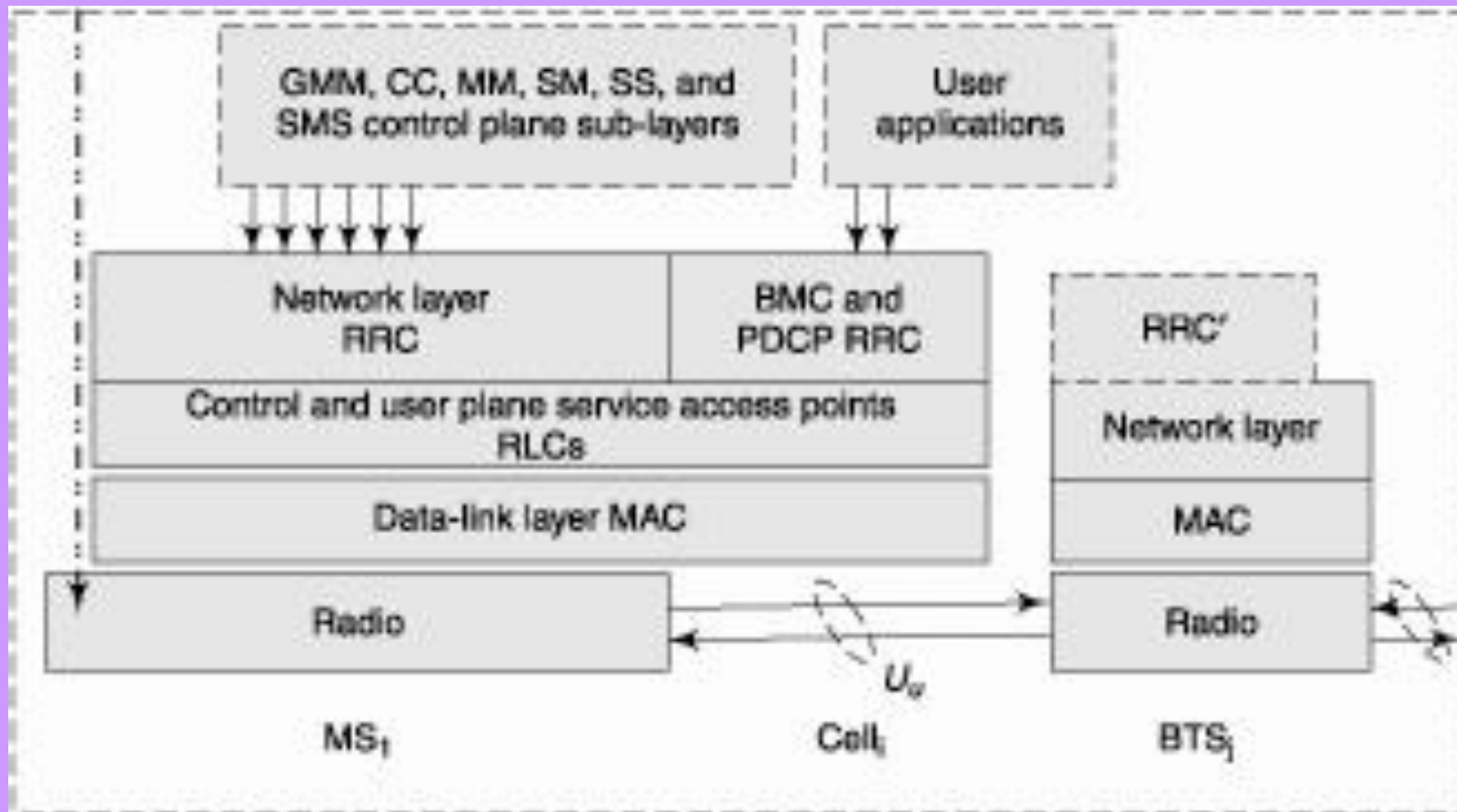
# WCDMA-FDD

- FDD separates reverse link (called uplink in GSM) and forward link (called downlink in GSM) frequencies

# WCDMA-FDD

- 1.920–1.980 GHz for uplink
- 2.110–2.170 GHz for downlink
- Each 5 MHz bandwidth
- Wider than the 1.25 MHz of the IS-95 (2G CDMA) system

# PROTOCOL LAYERS IN THE WCDMA UPLINK TERMINAL (MS) AND DOWNLINK EQUIPMENT (BTS)



# ALL THE PROTOCOL LAYERS IN THE WCDMA UPLINK TERMINAL (MS) AND DOWNLINK EQUIPMENT (BTS)

## Radio

- FDD, asynchronous or (optionally) synchronous
- Dedicated physical channel
- Compressed mode
- Bursting and 10 ms, 15-slot framing
- Power control
- Synchronizing the MSs and MS path-delay corrections, identification of primary and secondary synchronization codes
- Identification of scrambling code
- 3.84 Mcchip/s chipping, spreading and scrambling
- Channelization (OVSF) and scrambler (S2 or long 38400 Gold) coding
- Transport channel combining, data interleaving, and encryption
- Measurements and soft handover
- QPSK modulation and transmission
- QPSK demodulation and reception



# PHYSICAL LAYER

- Physical layer  $U_u$  radio interface
- Supports asynchronous transmission
- Can also support synchronous transmission

# DATA-LINK LAYER MAC

- Controls the flow of packets to and from the network layer
- Ciphering function
- Sends and receives data from control and user plane service access points at the radio link control (RLC) layer and sends it to the physical layer

# NETWORK LAYER ABOVE THE RLCs

- Provides access to multiple services such as BMC (broadcast and multicast control protocol) for the user applications
- PDCP (packet data convergence protocol) for the user applications

# APPLICATION LAYER

- GMM (GPRS mobility management)
- CC [call (connection) control]
- MM (mobility management)
- SM (session management)
- SS (supplementary service)
- SMS (short message service)
- User Applications

# WCDMA

- Direct access CDMA (DS-SS-SSMA)
- Supports fast power control messages at 1.5 kbps closed loop control (IS-95 uses 0.8 kbps open loop control)
- Frame duration in WCDMA 10 ms
- 15 separate time-slots of 0.666 ms for reverse and forward links for the periodic functions not related to user data bursts

# CHIPPING RATE

- Chipping frequency used in WCDMA 3.84 Mchip/s
- Not compatible with IS-95 as 3.84 Mchip/s — not an integral multiple of the IS-95 chipping rate of 1.2288 Mchip/s
- Modulation type used QPSK for both reverse and forward link frequencies
- Timing synchronization of base stations does not follow GPS system timings

# DEDICATED AND COMMON CHANNELS

- Data link layer MAC two types of channels
- The common channels are control, paging, broadcast, and shared channels
- There are three dedicated channels—dedicated physical control channel (DPCCH), dedicated physical data channel (DPDCH), and dedicated physical channel (DPCH)

# CHANNELS

- Dedicated channels assigned to the MSs for uplink
- Also a common channel for traffic
- Transport channels (like access channel in cdmaOne)
- The channel code and structure different for the uplink DPCCH and for the downlink DPDCH channel



# RANDOM ACCESS BURSTS

- Transmitted in 10 ms slots at fixed rates by a control mechanism and slotted Aloha protocol is used for access

# SHORT DATA PACKETS

- Short data packets directly appended to the random access bursts in common (not dedicated) channel packet transmission

# LONG DATA PACKETS

- Longer packets transmitted by dedicated channels at variable power, controlled by a power control message appended to the user symbols

# DIFFERENT TYPES OF PHYSICAL CHANNELS.

- Special (distinct) waveforms only
- Each pair of spreading and scrambling codes defines the remaining physical channels

# WCDMA UPLINK CHANNELIZATION CODES

- For controlling and synchronizing multiple data rate channels
- UMTS terrestrial radio access network (UTRAN) channelization codes for synchronizing the multiple user terminals (MSs)

# CODE ALLOCATION FUNCTIONS

- The MS performs code allocation functions for uplink channelization code as per the data rate
- BTS performs the code allocation at the downlink radio-planning layer for the scrambling code

# POWER CONTROL SIGNALS

- WCDMA reverse link (mobile terminal uplink) transmits pilot symbols, which are multiplexed with rate information as well as power control messages
- Rate information facilitates coherent detection

# MULTI-RATE TRANSMISSION OF SIGNALS

- Single code used when transmitting small data rate signals multiplexed in time-space and multiple codes are used when transmitting large data rate signals multiplexed in code-space
- A single code for small data rates
- Multiple codes for large data rates



# USE OF VARIABLE RATES BY WCDMA PROCESSING UNITS

- Types of data need to be transmitted at fast rates and some other types of data, for example, voice-data, power control data, and SMS text, require slow transmission rates
- Variable rates required in different types of services to form a system

# USE OF VARIABLE RATES BY WCDMA PROCESSING UNITS

- Orthogonal coding for channelization  
asymmetrical in uplink and downlink
- WCDMA employs a constant chipping rate  
for spreading but variable spread factors,  
called OVSF (orthogonal variable  
spreading factors)

# SPREAD FACTOR CONTROL

- Controls the user data rate. When spread factor = 4, user data rate becomes  $\frac{1}{4}$  of the rate corresponding to spread factor = 1
- OVSF codes support both orthogonality as well as variable data rates for a physical channel
- Uplink OVSF does not separate the users due to different delays expected from the near and far terminals (MSs)

# VARIABLE SPREAD FACTOR

- WCDMA also uses variable spreading codes but ones that are different from the Walsh code
- Use of variable spread factor controls the signals with multiple data rates
- The code length used per symbol is 4 when the downlink user symbol data rate needed is 1.92 Mbps
- 512, when the data rate needed is 15 kbps

# VARIABLE SPREAD FACTOR

- Spreading codes of different lengths thus used and orthogonality of the codes is maintained
- The source (MS) and channel for these symbols when using orthogonal code spreading then gets uniquely identified on de-spreading at the receiver

# REVERSE CHANNELS

- Uses Gold and S(2) codes
- Chipping rates for these codes are 38400 and 256 chips, respectively
- Gold codes used for the MS user symbols
- S(2) codes identify the user at the receiver

# COMPATIBILITY WITH CDMAONE AND CDMA2000 SYSTEMS

- WCDMA systems can be made compatible with cdmaOne and CDMA2000 systems
- Use of synchronous base stations
- Employing multi-carrier mode with a chipping rate of 3.6864 Mchip/s (which is an integral multiple of the IS-95 chipping rate of 1.2288 Mchip/s)
- Adding a CDMA pilot to the direct spread mode data

# SUMMARY

- WCDMA data rates of 2 Mbps or higher for short distances
- 384 kbps for long distances
- FDD asynchronous communication
- Dedicated physical channels
- Bandwidth 5 MHz uplink and 5 MHz downlink



- Different type of physical channels
- Power control open loop
- Multi-rate transmission
- 3.8 Mchips/s
- OVSF
- QPSK

# End of Lesson 11

## WCDMA