WCDMA Packet Access (Chapter 10)

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Introduction

- This lecture discusses packet access in WCDMA:
  - Types of Packet Data Traffic
  - WCDMA Packet Access
  - Transport Channels for Packet Data
  - Packet Scheduling Algorithms
  - Interaction between Packet Scheduler and other RRM algorithms
  - Packet Data Performance

Types of Packet Data Traffic (1/2)

- Four basic types of traffic classes
  - Conversational class -> real-time connection, performed between human users, really low delay, nearly symmetric, e.g., speech
  - Streaming class -> real-time connection, transferring data as a steady and continuous, low delay, asymmetric, e.g., video
  - Interactive class -> non-real-time packet data, response requested from other end-user, reasonable round-trip delay, e.g., Web browsing
  - background class -> non-real-time packet data, no immediate action expected, less sensitive to delivery time, e.g., e-mail

Types of Packet Data Traffic (2/2)

- Packet data traffic is a non-real-time packet services including Interactive and Background traffic classes. Their properties are
  - Packet data is bursty. Sometimes a large amount of data is transferred. At the other times no data is sent. Thus, the required bit rate can change rapidly.
  - Packet data tolerates longer delay than real-time services. It is controllable traffic from the RNC; thus, RNC can decide when and how to send the data.
  - Packets can be transmitted by the radio link control layer which provides retransmission and error correction services. Therefore, it allows high frame error rate with low transmission power.
- One example of packet data traffic is ETSI packet data model for web browsing.

WCDMA Packet Access

- In WCDMA packet allocations, e.g., time and bit rate, are controlled by the packet scheduler (PS) located in RNC. PS functions include:
  - properly allocate the available resources (time, code or power) between the packet data users
  - decide the allocated bit rates and the length of the allocation
  - decide to use the transport channel
  - monitor the packet allocations and the systems loads
- PS can allocate common, dedicated or shared channels to packet data users. It can also change the bit rate during active connection.
- PS can increase or decrease the network load by increasing or decreasing the bit rates of the packet bearers respectively.

Transport Channels for Packet Data (1/3)

- Common channels - RACH in the uplink and FACH in the downlink
  - One or few RACH or FACH per sector
  - Low setup time
  - No feedback channel -> no fast closed loop power control, no soft handover, use fixed power
  - Poor link-level radio performance and generated more interference
  - Suitable for small data amounts
- Common channels - CPCH in the uplink
  - Bit rate can be high
  - Support fast power control
  - Suitable for small or medium data amounts

Transport Channels for Packet Data (2/3)

- Dedicated Channel - DCH in the uplink and downlink
  - Use fast power control and soft handover
  - Better link-level radio performance and less interference
  - Longer setup time
  - Up to 2 Mbps
  - Suitable for large data amounts
  - Not suitable for bursty data
  - In case of changing bit rate in the downlink, the downlink orthogonal code is reserved according to maximum bit rate.

Transport Channels for Packet Data (3/3)

- Shared Channel - uplink and downlink
  - Use fast power control, but no soft handover
  - A single orthogonal code is shared with many packet user with established DCH in time division manner - code efficient
  - Fast allocation and rate modification (frame-by-frame basis)
  - Suitable for large data amounts and bursty data

- Summary of these channel types for packet data is in Table 10.1 from the text.

Packet Scheduling Algorithms

- In WCDMA packet scheduling algorithms can be done in two ways, in a time or code division manner.
- Time division scheduling
  - one user is allocated a channel at a time (10 ms frame)
  - all available capacity can be allocated to that user
  - high data rate for a short period of time
  - increase more users, each user has to wait longer
- Code division scheduling
  - many users are allocated the channels simultaneously
  - the capacity is shared with all users
  - low data rate for a long period of time
  - increase more users, each user's bit rate is decreased

Time Division Scheduling

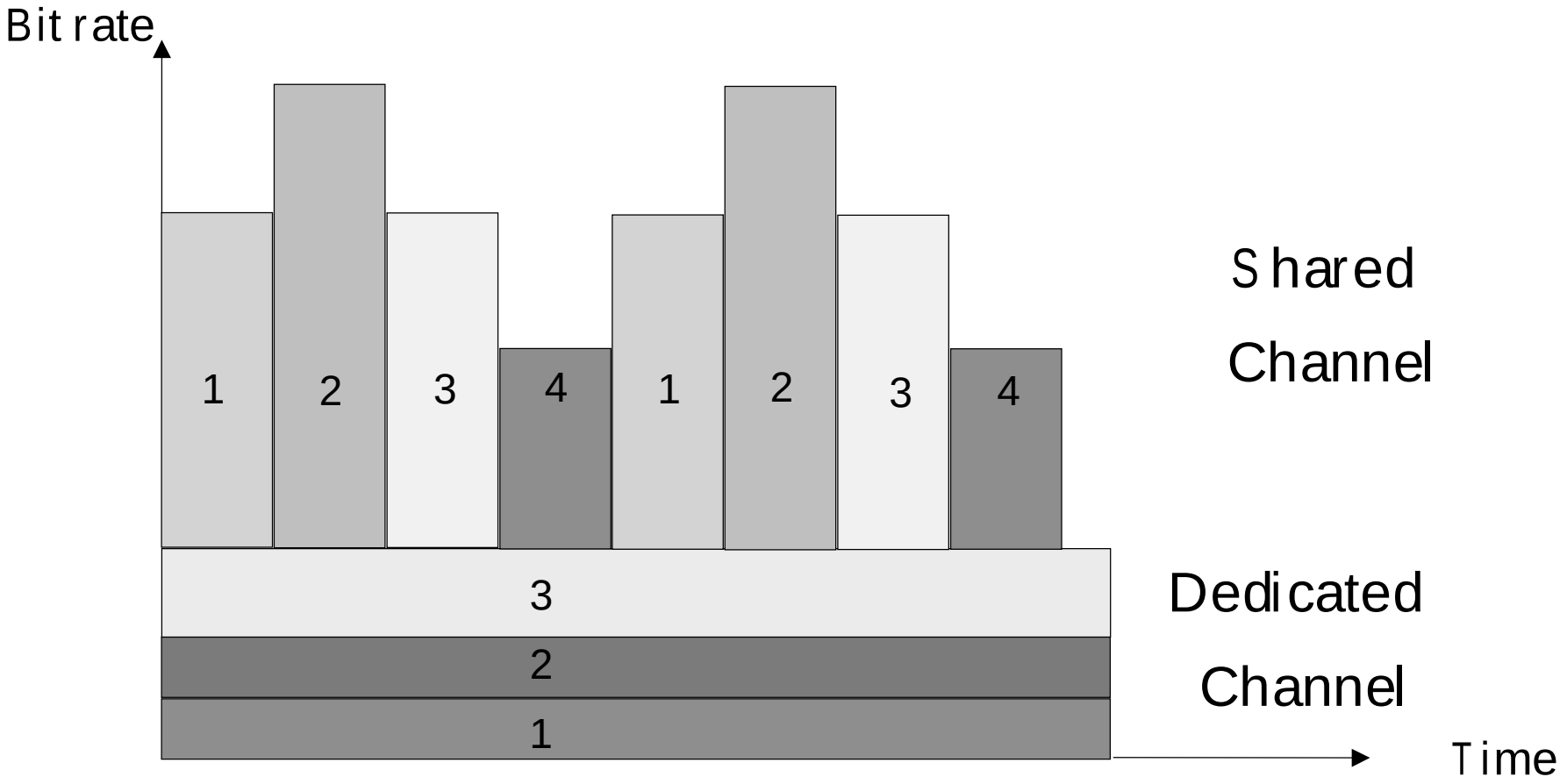
- Advantages
  - high bit rate required less energy per bit
  - less interference
  - shorter delay due to high bit rate
- Disadvantages
  - high unused physical resources due to short transmission time and relatively long set up and release time
  - high variations in the interference levels due to high bit rate and bursty traffic
  - limited uplink range of high bit rate due to mobile's limited transmission power

Code Division Scheduling

- Advantages
  - resources are in full usage due to longer transmission time
  - small variation in interference level
  - longer uplink range due to lower bit rate
- Disadvantages
  - longer transmission delay due to low bit rate
  - high interference due to high energy per bit
  - low total throughput

TD and CD Scheduling

- TD is normally used with shared channels and CD is normally used with dedicated channels.



Transmission Power-based Scheduling

- The bit rate allocated to each packet data users could be based on required transmission power
- Users close to the BS requires less transmission power and can get a higher bit rate, whereas users at the cell edge could get lower bit rate
- Advantages
  - minimize the average power sent per bit
  - less interference
  - increase the throughput
- Disadvantages
  - accurate power estimation
  - unfair resource allocation

Interaction between PS and other RRM Algorithms

- Handover control
  - considers the air interface load and physical resources of the active set of each DCH users
- Load control
  - non-real-time packet traffic is controllable due to no guarantee of delay
  - PS can reduce the load of the controllable non-real-time users if the total load is exceeding the planned target level.
- Admission control
  - If the system load is too high, a new user can still be accepted to the system by reducing the controllable load from the non-real-time connections.

Packet Data Performance (1/2)

- Link-Level Performance
  - frame error rate (FER) and bit error rate (BER)
- Link-Level Simulator
  - Receiver model
  - A chip-level or symbol level simulation model
  - Channel models, interleaving and decoding.

Packet Data Performance (2/2)

- System-Level Performance
  - Capacity or throughput (kbps/cell)
- System-Level Simulator
  - To model system with a large number of mobiles and BSs.
  - Operates with fast power control frequency, 1.5 kHz.
  - Traffic and mobility models.