Module 4-Introduction to LTE

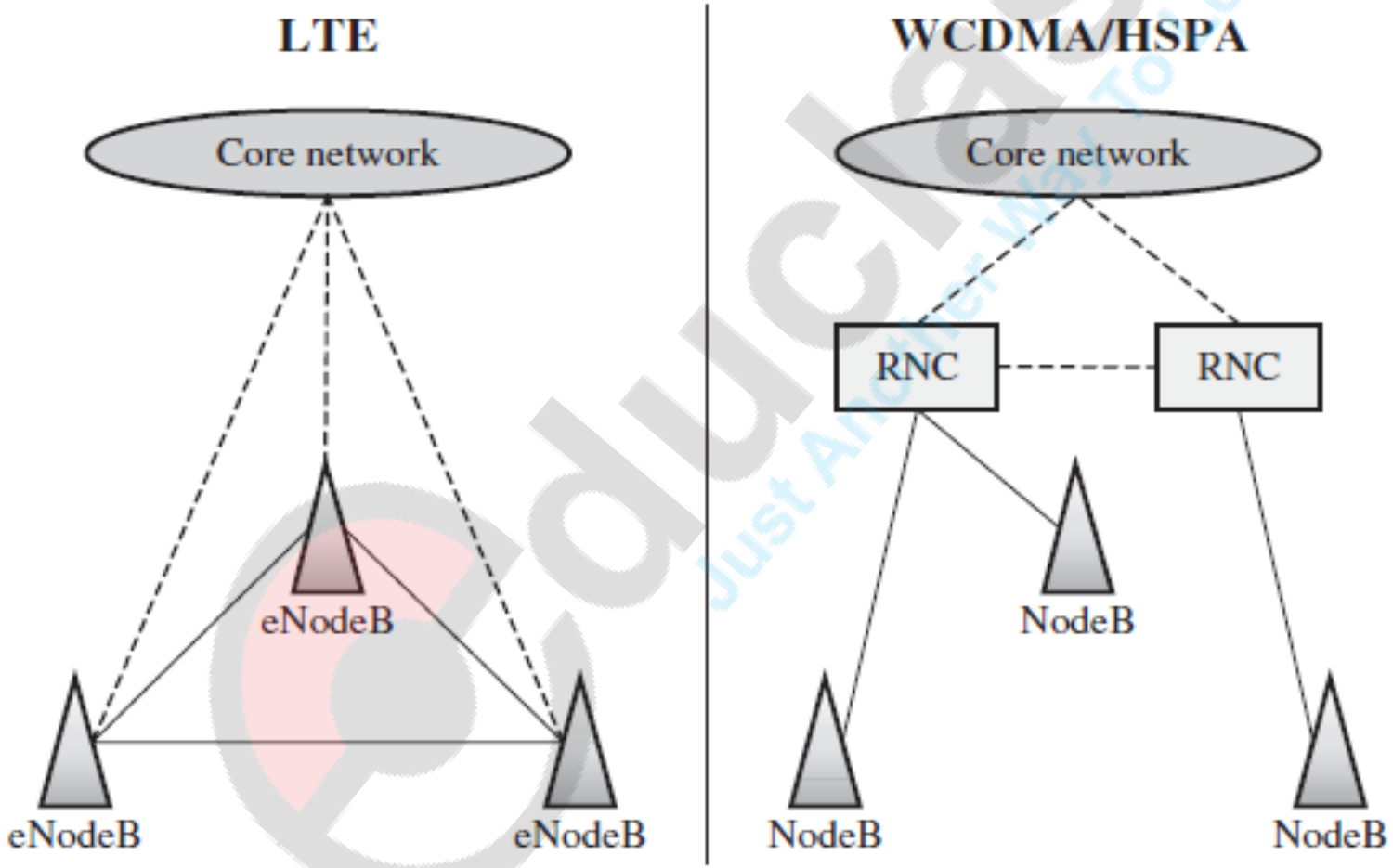
LTE

- Long Term Evolution
- Evolution of WCDMA
- also referred to as evolved universal terrestrial radio access (E-UTRA) or Super 3G (S3G)
- Uses OFDM downlink and single-carrier FDMA uplink- to increase data rates
- Targeted data rates of 100 Mbit/s in the downlink and 50 Mbit/s in the uplink

Requirements for LTE

Parameter	Target figures
Peak data rates	100 Mbit/s for downlink 50 Mbit/s for uplink
Average user throughput per MHz compared to HSPA Release 6	3–4 times higher for downlink 2–3 times higher for uplink
Spectrum efficiency in bit/s/Hz/cell compared to HSPA Release 6	3–4 times higher for downlink 2–3 times higher for uplink
Mobility	0–15 km/h (optimized for this range) 15–120 km/h (high performance guaranteed) 120–350 km/h (connection maintained)
Supported bandwidths	1.25–20 MHz
Spectrum allocation	Operation in paired spectrum (FDD) and unpaired spectrum (TDD) should be supported
Latency	5 ms user-plane latency at IP layer, for one-way 100 ms control-plane latency from idle to active state
Number of users per cell	At least 200 at 5 MHz bandwidth At least 400 at bandwidth higher than 5 MHz

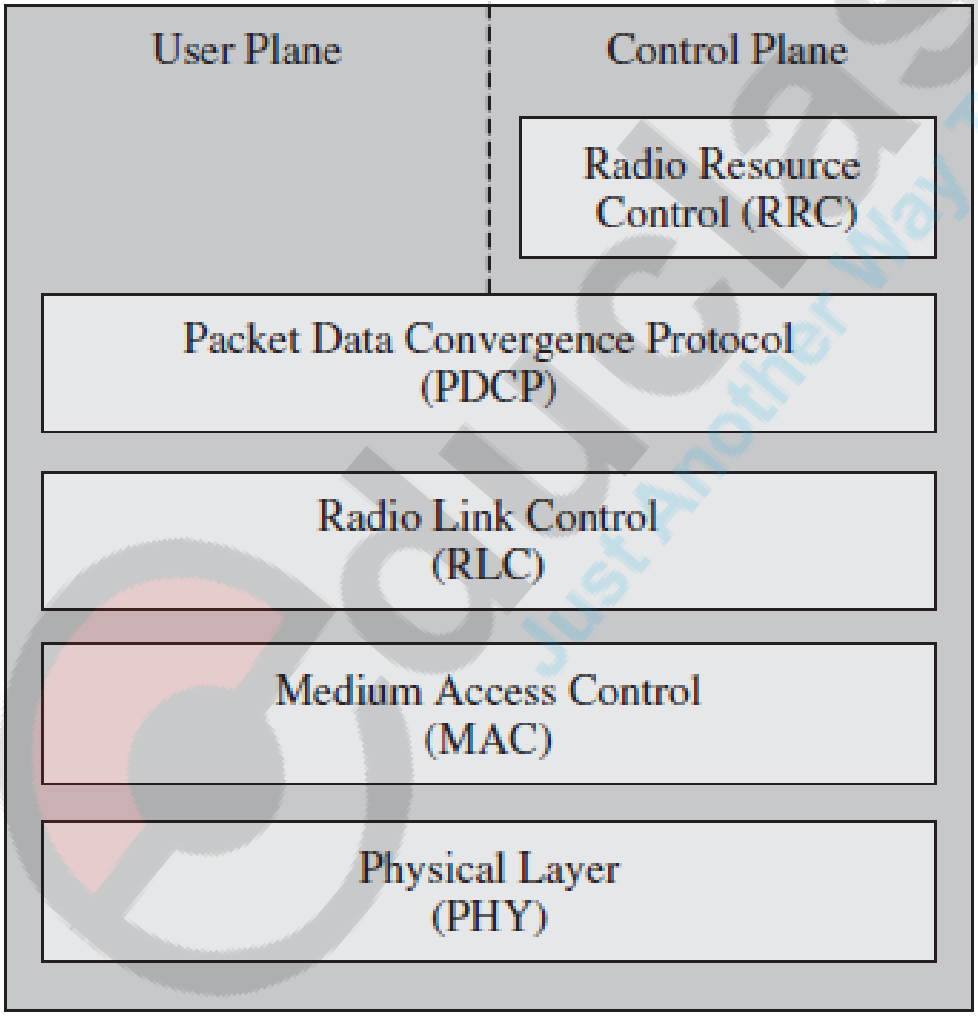
RAN (Radio Access Network) Architecture



RAN (Radio Access Network) Architecture-Cont..

- A radio network controller (RNC) is omitted with LTE, which reduces the latency in the RAN.
- This leads LTE to shift more complexity into the eNodeB, which in LTE terminology refers to the base station.
- Tasks of eNode:
  - Physical layer processing
  - Mobility management
  - Radio Resource management
- The eNodeBs in the LTE RAN are directly connected to each other and the handover decisions are taken by the eNodeB.

Radio Protocol Architecture



Radio Protocol Architecture-Cont..

- The LTE protocol stack is split into the user plane and the control plane.
- All protocols are located in the base station (eNodeB) and mobile terminal station (UE).

Radio Resource Control (RRC)

- part of the control plane
- responsible for configuring the layer 1 and layer 2 protocols PDCP, RLC, MAC, and PHY.
- Main functions- admission control, handover management, QoS management, terminal station measurement reporting and control, paging.

Packet Data Convergence Protocol (PDCP)

- At the user plane: IP header compression, transfer of user data, and ciphering.
- At the control plane: transfer of control data and ciphering.

Radio Protocol Architecture-Cont..

Radio Link Control (RLC)

- Segmentation and reassembly of packets from higher layers
- error correction through ARQ(Automatic Repeat Request)
- flow control between the eNodeB and the mobile terminal

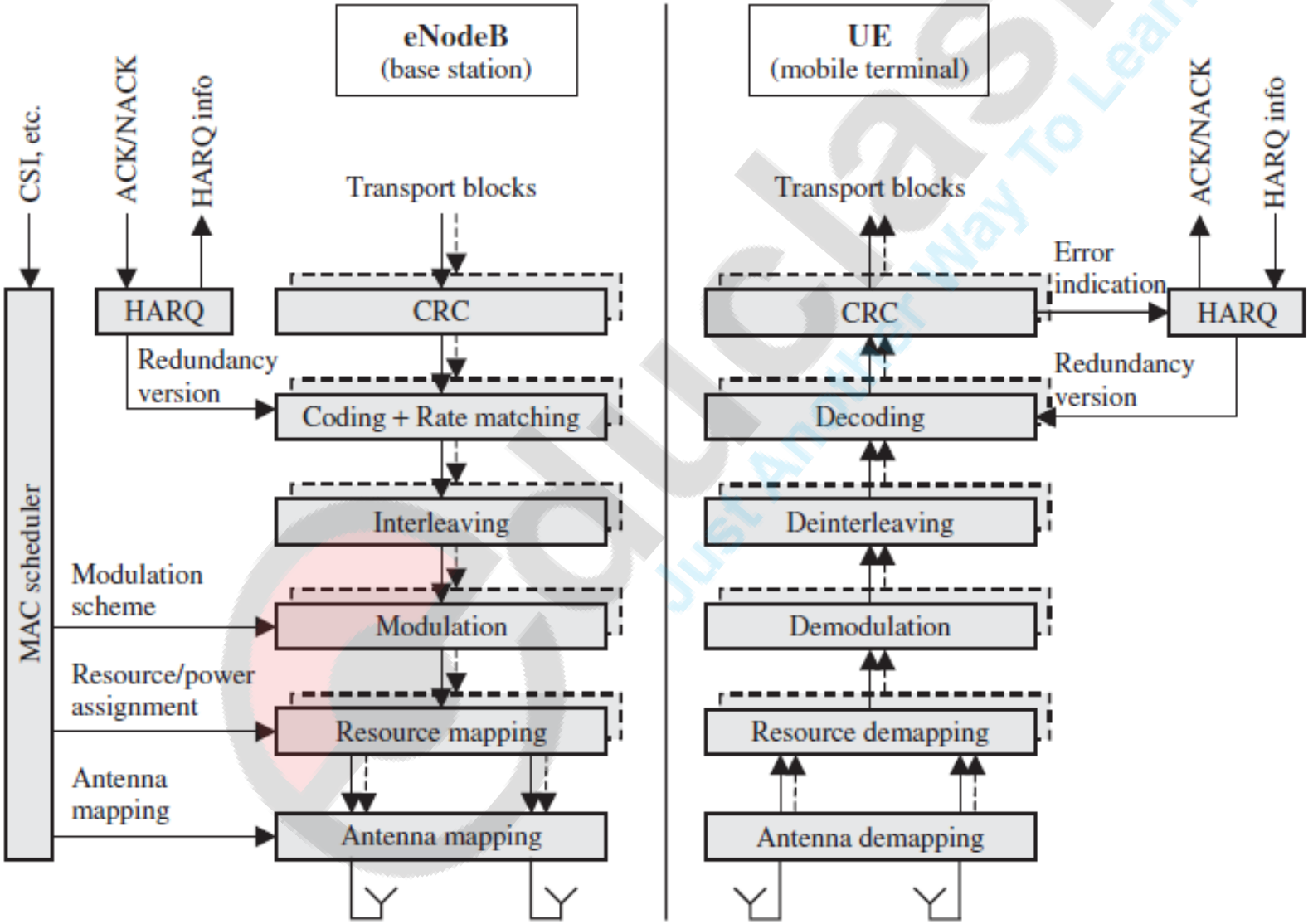
Medium Access Control (MAC)

- scheduling in the up- and downlink
- error correction through hybrid ARQ (HARQ)
- adaptive modulation
- resource and power assignment
- antenna mapping

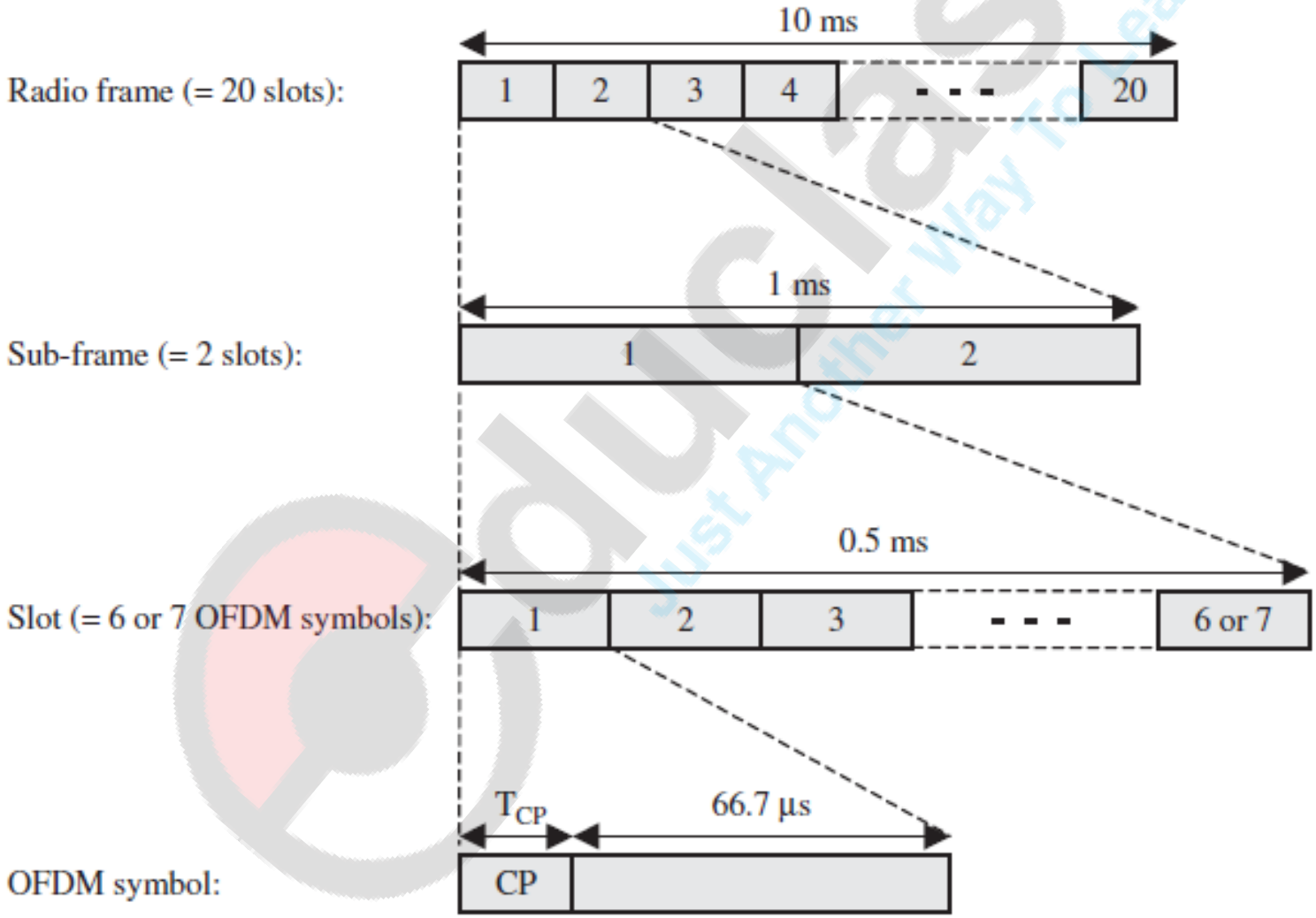
Physical Layer (PHY)

- coding, modulation, and multiple antenna transmission

Downlink Transmission Scheme



LTE Downlink Frame Structure



Uplink Transmission Scheme

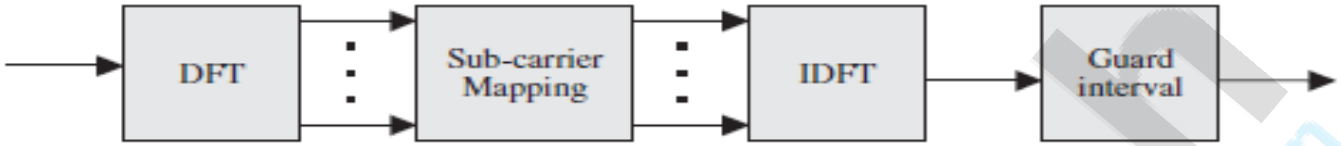


Figure 5-11 DFT-spread OFDM transmission scheme

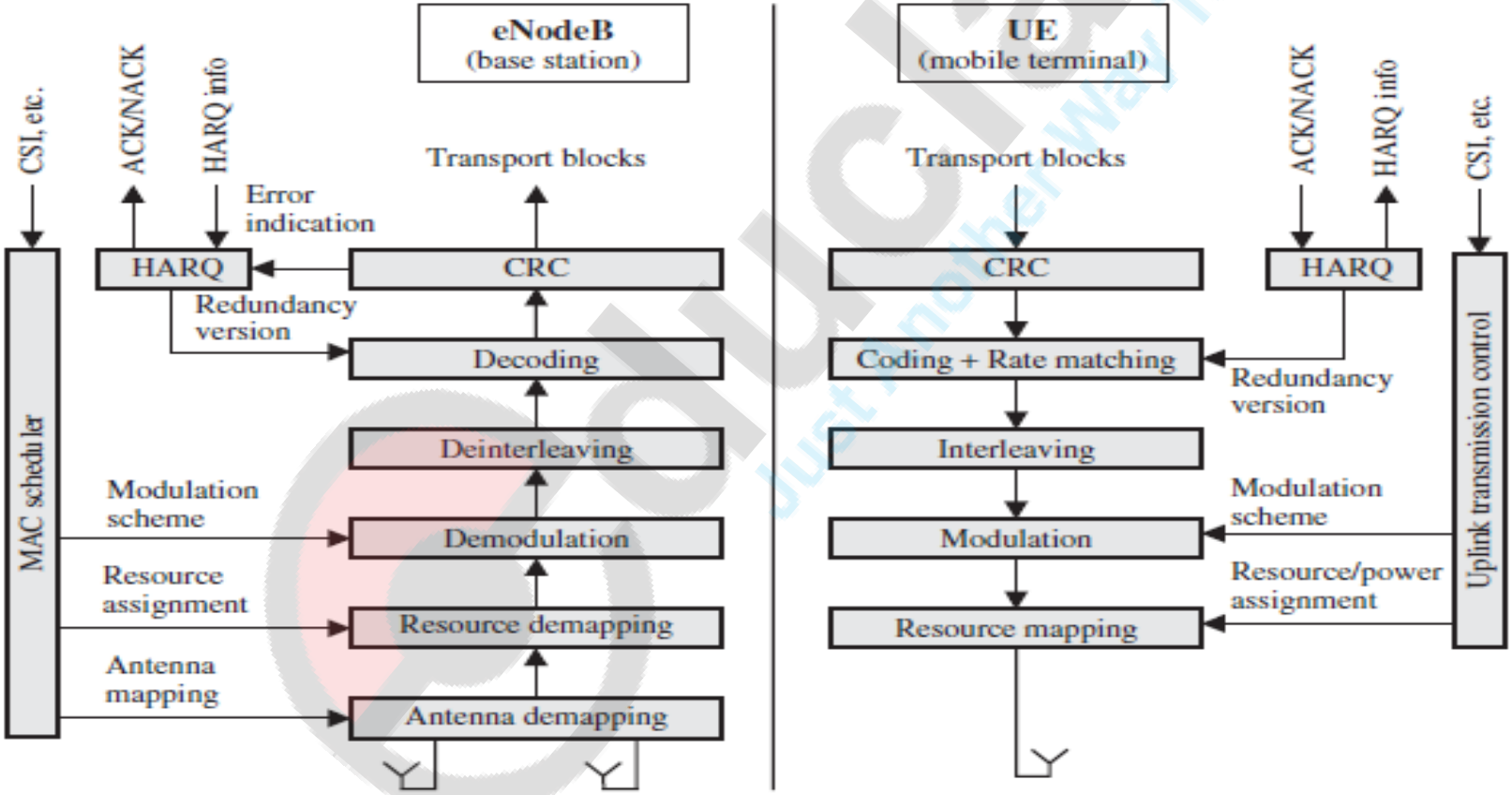
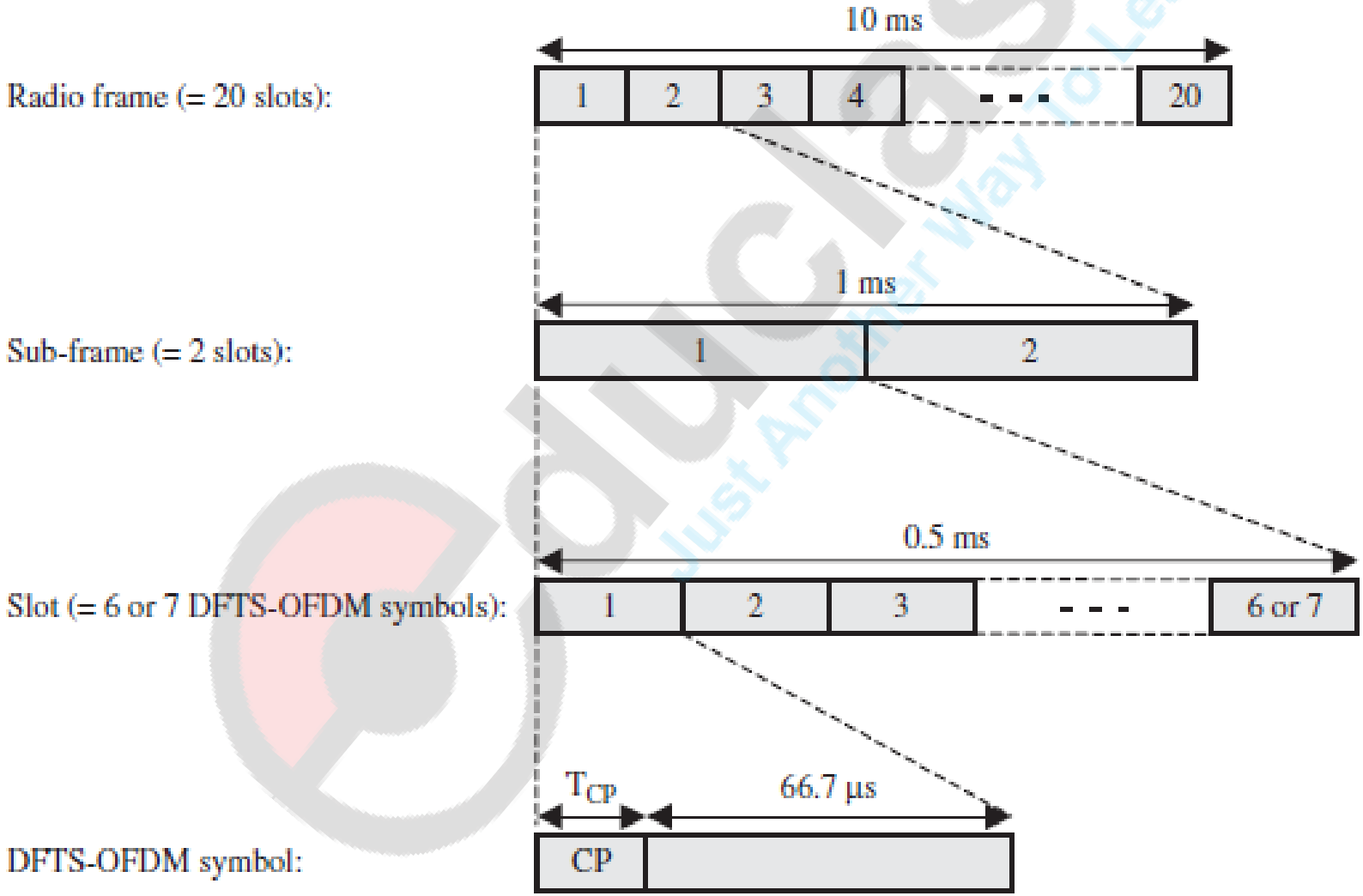


Figure 5-12 Block diagram of the LTE uplink

Uplink Frame Structure



Supported Bandwidths

E-UTRA band	Uplink (UL) (MHz)	Downlink (DL) (MHz)	UL-DL guard band (MHz)	Duplex mode
1	1920–1980	2110–2170	130	FDD
2	1850–1910	1930–1990	20	FDD
3	1710–1785	1805–1880	20	FDD
4	1710–1755	2110–2155	355	FDD
5	824–849	869–894	20	FDD
6	830–840	875–885	35	FDD
7	2500–2570	2620–2690	50	FDD
8	880–915	925–960	10	FDD
9	1749.9–1784.9	1844.9–1879.9	60	FDD
10	1710–1770	2110–2170	340	FDD
11	1427.9–1452.9	1475.9–1500.9	23	FDD
12	[TBD]	[TBD]	[TBD]	FDD
. . .				
33	1900–1920	1900–1920	N/A	TDD
34	2010–2025	2010–2025	N/A	TDD
35	1850–1910	1850–1910	N/A	TDD
36	1930–1990	1930–1990	N/A	TDD
37	1910–1930	1910–1930	N/A	TDD
38	2570–2620	2570–2620	N/A	TDD
39	1880–1920	1880–1920	N/A	TDD
40	2300–2400	2300–2400	N/A	TDD

Reference book

- Multi-Carrier and Spread Spectrum Systems - From OFDM and MC-CDMA to LTE and WiMAX, Second Edition, K. Fazel, S. Kaiser, wiley publications- Chapter 5- Section 5.2