UNIT- III

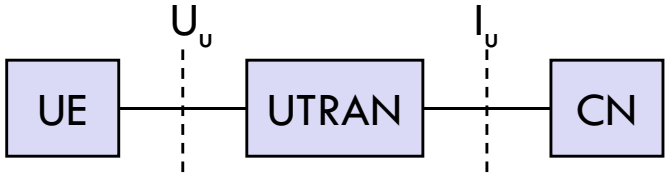
UMTS : UNIVERSAL MOBILE TELECOMMUNICATION SYSTEM

MADHESWARI.K/AP/CSE 15/02/2017

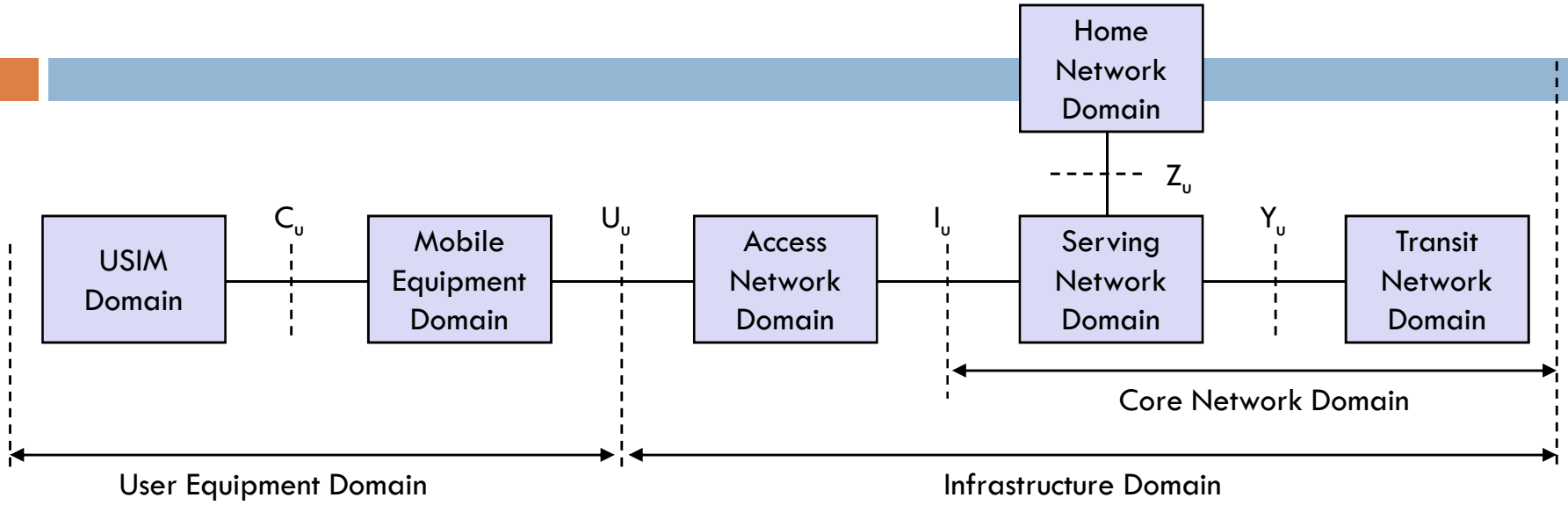
UMTS architecture (Release 99 used here!)

Main components of UMTS

- **UTRAN (UTRA Network)**
  - Handles Cell level mobility
  - Consists of many Radio Network Subsystem (RNS)
  - Encapsulation of all radio specific tasks
- **UE (User Equipment)**
- **CN (Core Network)**
  - Inter system handover
  - Location management if there is no dedicated connection between UE and UTRAN



UMTS domains and interfaces



- User Equipment Domain
  - Assigned to a single user in order to access UMTS services
- Infrastructure Domain
  - Shared among all users
  - Offers UMTS services to all accepted users

UMTS domains and interfaces

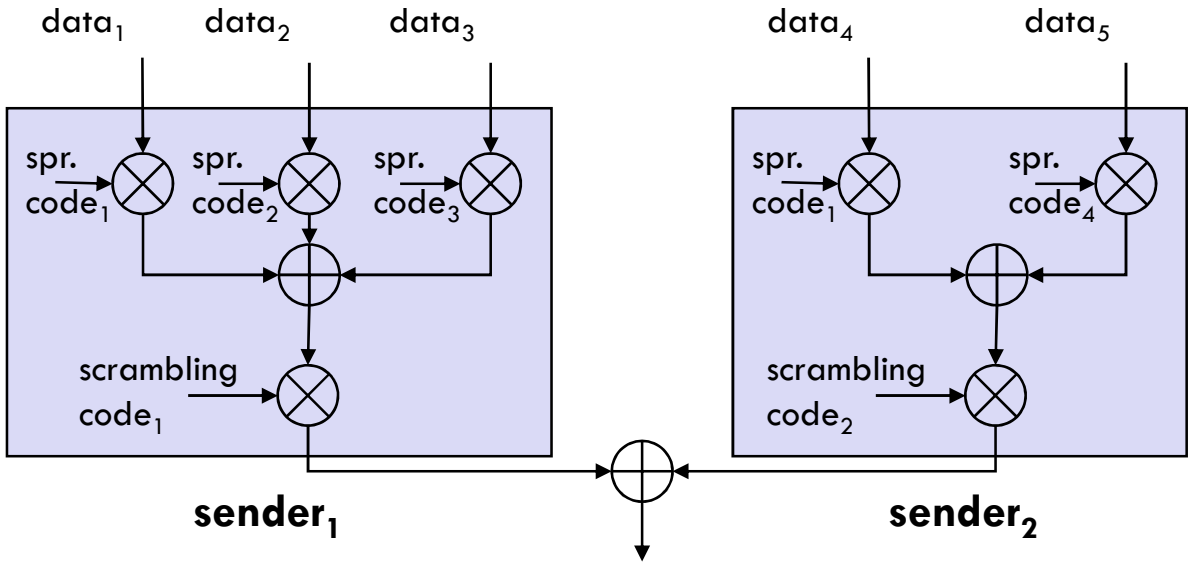
- Universal Subscriber Identity Module (USIM)
  - Functions for encryption and authentication of users
  - Located on a SIM inserted into a mobile device
- Mobile Equipment Domain
  - Functions for radio transmission
  - User interface for establishing/maintaining end-to-end connections
- Access Network Domain
  - Access network dependent functions
- Core Network Domain
  - Access network independent functions
  - Serving Network Domain
    - Network currently responsible for communication
  - Home Network Domain
    - Location and access network independent functions

Components of RNS

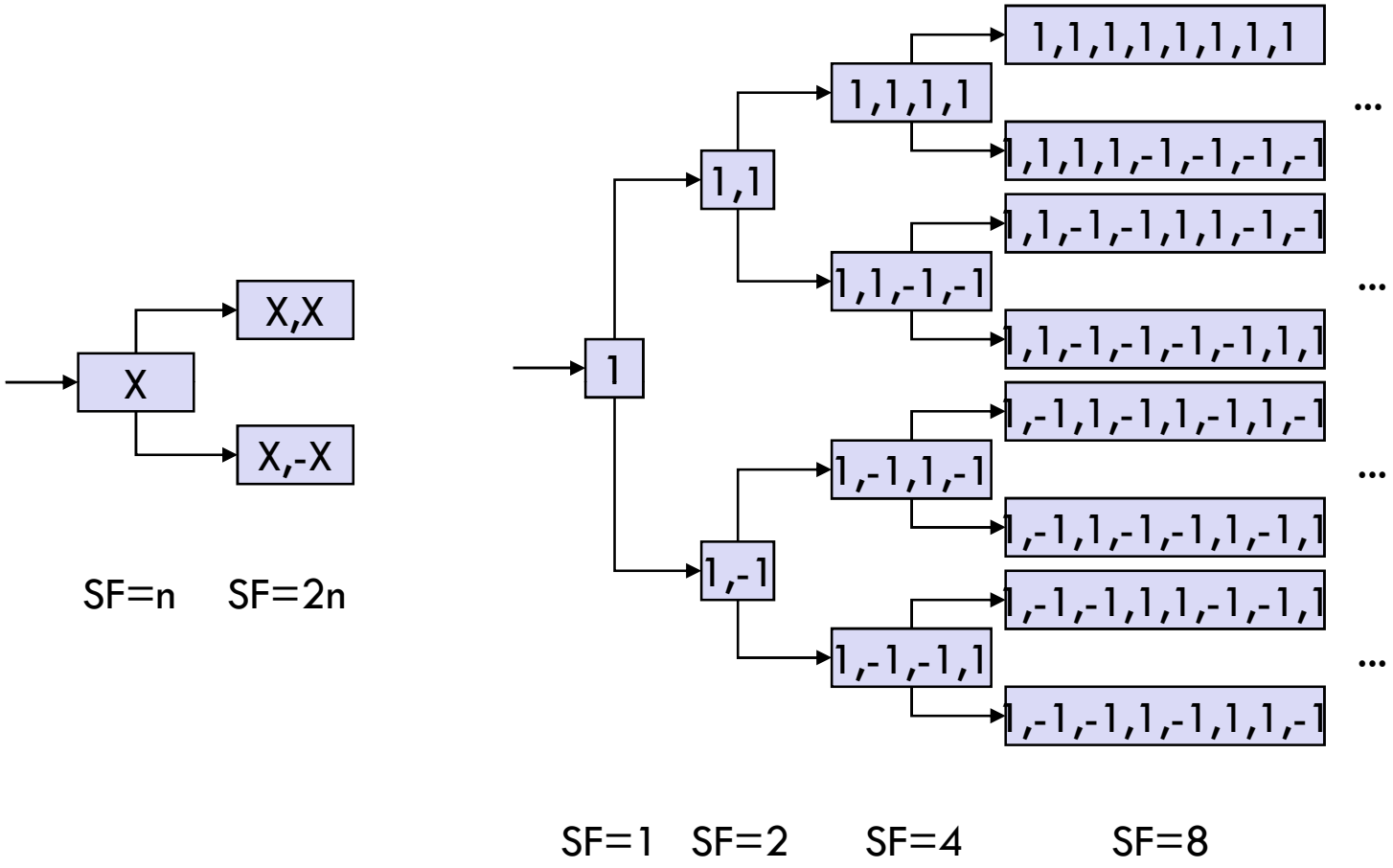
- Spreading and scrambling of user data
- OVSF (Orthogonal Variable Spreading Factor) coding
- UTRA-FDD (W-CDMA)
- UTRA-TDD (TD-CDMA)

UMTS radio interface - Spreading and scrambling of user data

- Constant chipping rate of 3.84 Mchip/s
- Different user data rates supported via different spreading factors (# of chips/bit)
  - higher data rate: less chips per bit and vice versa
- User separation via unique, quasi orthogonal (their cross-correlation should be almost zero) scrambling codes
  - users are not separated via orthogonal spreading codes
  - much simpler management of codes: each station can use the same orthogonal spreading codes
  - precise synchronization not necessary as the scrambling codes stay quasi-orthogonal



OVSF (Orthogonal Variable Spreading Factor) coding



UTRA-FDD (W-CDMA)

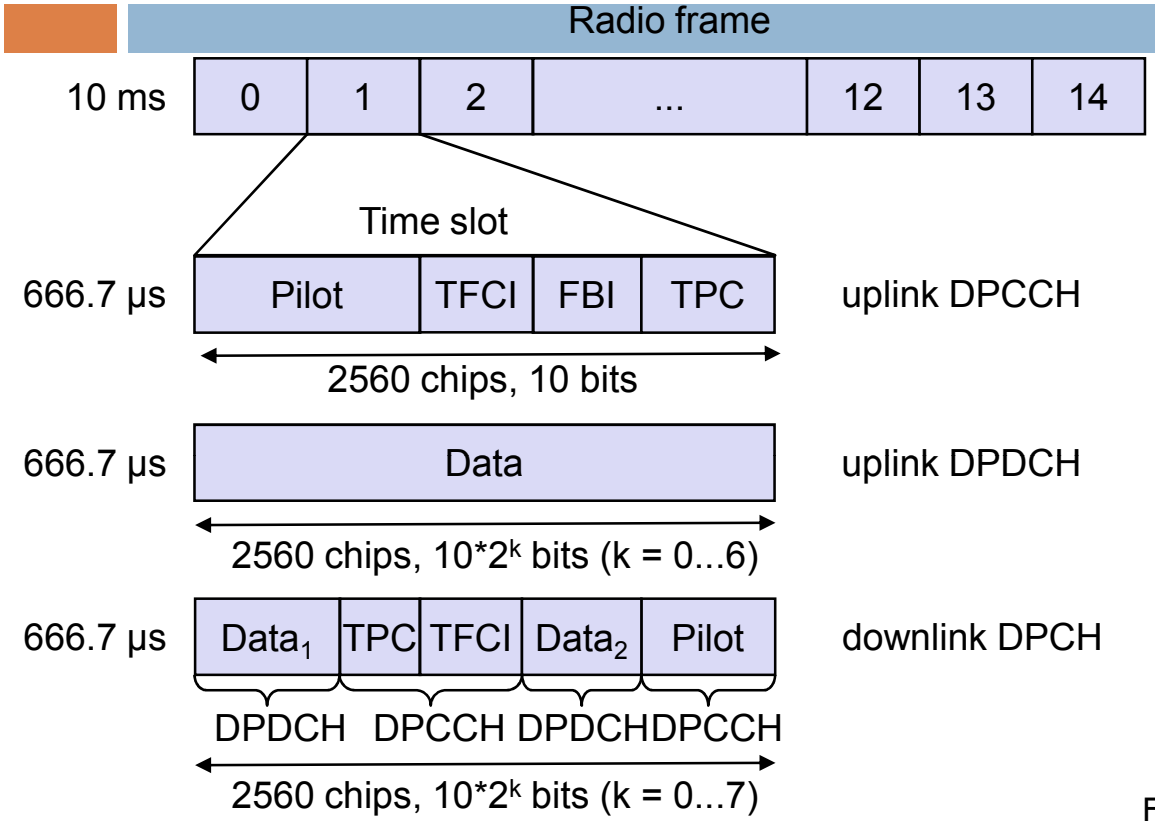
- UTRA-FDD (W-CDMA)
  - The FDD mode for UTRA uses wideband CDMA (W-CDMA) with direct sequence spreading.
  - Uplink and downlink use different frequencies. Uplink (1920 ~ 1980 MHz) and downlink (2110 – 2170 MHz).
  - Time slots are not used for user separation but to support periodic functions. Each time slot is 38,400 chips/s x 10 ms x 1/15 = 2560 chips (≈2/3 ms).
  - The occupied bandwidth per W-CDMA channel is 4.4 to 5 MHz.
  - In Germany, the FDD spectrum was sold over 50 billion Euros.
  - The provide higher data rates, the infrastructure should be improved: Twice as many base stations as GSM (500 m cell diameters)

Typical UTRA-FDD uplink data rates

- Dedicated physical data channel (DPDCH)
  - conveys user or signaling data
- Dedicated physical control channel (DPCCH)
  - Conveys control data for the physical layer and uses the constant spreading factor 256.
- Dedicated physical channel (DPCH)
  - The downlink time multiplexes control and user data.
- Physical random access channel (PRACH)
  - Used for coordinating medium access on the uplink.

User data rate [kbit/s]	12.2 (voice)	64	144	384
DPDCH [kbit/s]	60	240	480	960
DPCCH [kbit/s]	15	15	15	15
Spreading	64	16	8	4

UMTS FDD frame structure



Slot structure NOT for user separation but synchronisation for periodic functions!

W-CDMA

- 1920-1980 MHz uplink
- 2110-2170 MHz downlink
- chipping rate: 3.840 Mchip/s
- soft handover
- QPSK
- complex power control (1500 power control cycles/s)
- spreading factors: Uplink: 4-256; Downlink:4-512

FBI: Feedback Information
TPC: Transmit Power Control
TFCI: Transport Format Combination Indicator
DPCCH: Dedicated Physical Control Channel
DPDCH: Dedicated Physical Data Channel
DPCH: Dedicated Physical Channel

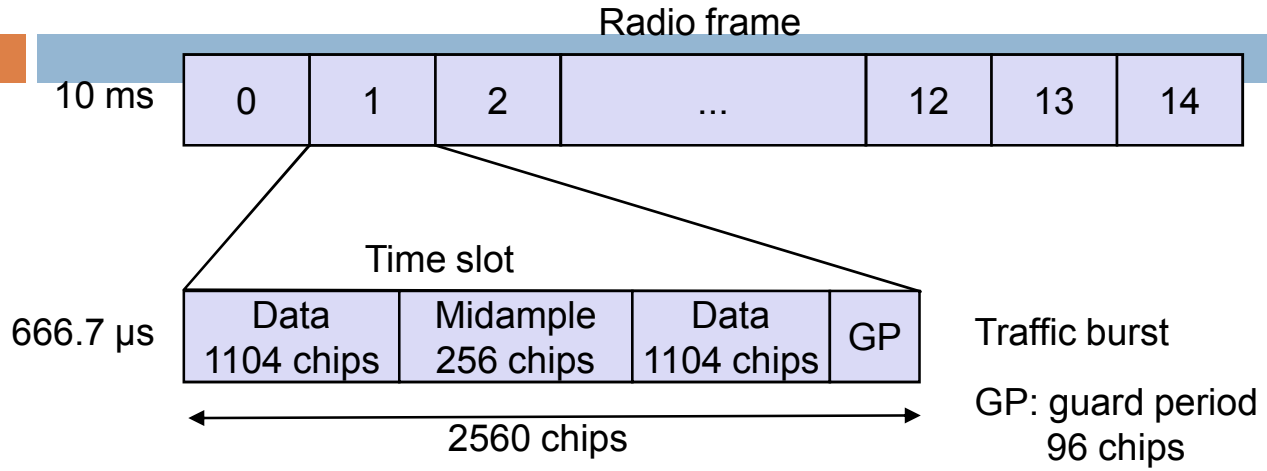
UE in UTRA-FDD (W-CDMA)

- A UE has to perform the following steps during the search for a cell after power on:
  - **Primary synchronization**: A UE has to synchronize with the help of a 256 chip primary synchronization code.
  - **Secondary synchronization**: This defines the group of scrambling codes.
  - **Identification of the scrambling code**: the UE tries all scrambling codes within the group of codes to find the right code with the help of a correlator.
- After these three steps the UE can receive all further data over a broadcast channel.

UTRA-TDD (TD-CDMA)

- UTRA-TDD (TD-CDMA)
  - Separates up and downlink in time using a frame structure similar to FDD.
  - 15 slots with 2560 chips per slot for a radio frame with a duration of 10 ms.
  - The chipping rate is 3.84 Mchips/s.
  - TDD frame can be symmetrical or asymmetrical.
  - The switching points is used to indicate the switching between up and downlink.
  - At least one slot must be allocated for the uplink and downlink respectively.
  - UTRA TDD occupies 5 MHz bandwidth per channel.
  - Germany paid less than 300 million Euros.
  - It is unclear to what extend this system will be deployed.
  - The coverage per cell is less than using UTRA-FDD.
  - UEs must not move too fast (like WLANs).

UMTS TDD frame structure (burst type)



Midample is used for tranning and channel estimation.

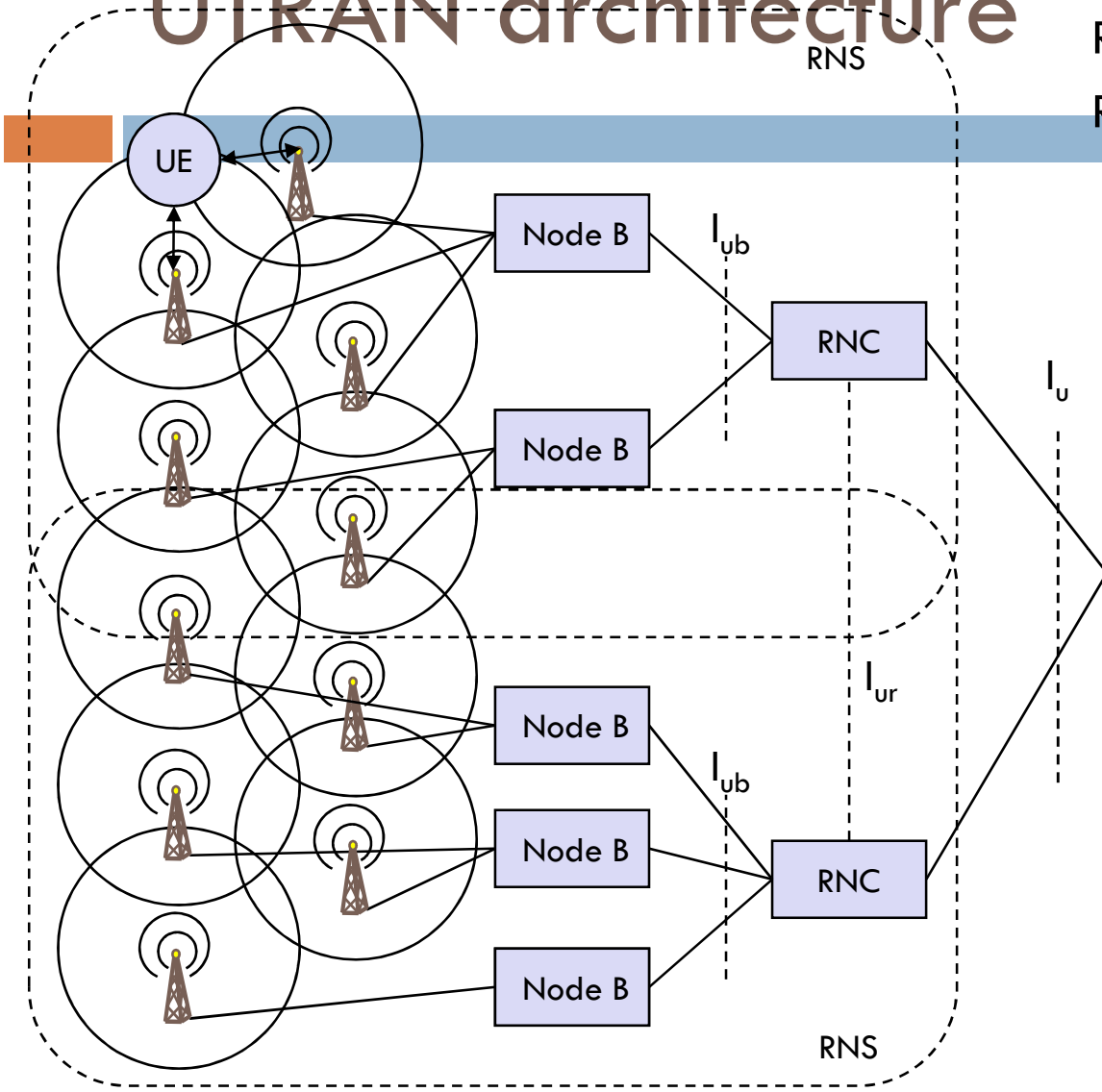
TD-CDMA

- 2560 chips per slot
- spreading: 1-16
- symmetric or asymmetric slot assignment to UpLink/DownLink (min. 1 per direction)
- tight synchronisation needed
- simpler power control (100-800 power control cycles/s)

UTRA architecture

- UTRA architecture
  - Radio network subsystems (RNS)
    - Radio network controller (RNC) controls several node Bs over the interface (Iub) and is connected with the core network (CN) over Iu. The interface Iur is the interface for connecting two RNCs.
    - Each node B can control several antennas which make a radio cell.
    - The mobile device, user equipment (UE), can be connected to one or more antennas.
  - Core network
    - The circuit switched domain (CSD) comprises the classical circuit switched services and connects to the RNS via the IuCS.
    - The packet switched domain (PSD) uses the GPRS components SGSN and GGSN and connects to the RNS via the IuPS.

UTRAN architecture



RNC: Radio Network Controller

RNS: Radio Network Subsystem

UTRAN comprises several RNSs

Node B can support FDD or TDD or both

RNC is responsible for handover decisions requiring signaling to the UE

Cell offers FDD or TDD

UTRAN RNC functions

- Call admission control
- Congestion control
- Radio channel encryption/decryption
- ATM switching and multiplexing, protocol conversion - Radio network configuration
- Channel quality measurements
- Macro diversity
- Radio resource control
- Radio carrier control – bearer setup and release
- Data transmission over the radio interface
- Channel allocation (coding)
- Outer loop power control (FDD and TDD)
- Handover control and RNS relocation (moving)
- Management - System information including current load, current traffic, error states

UTRAN Components

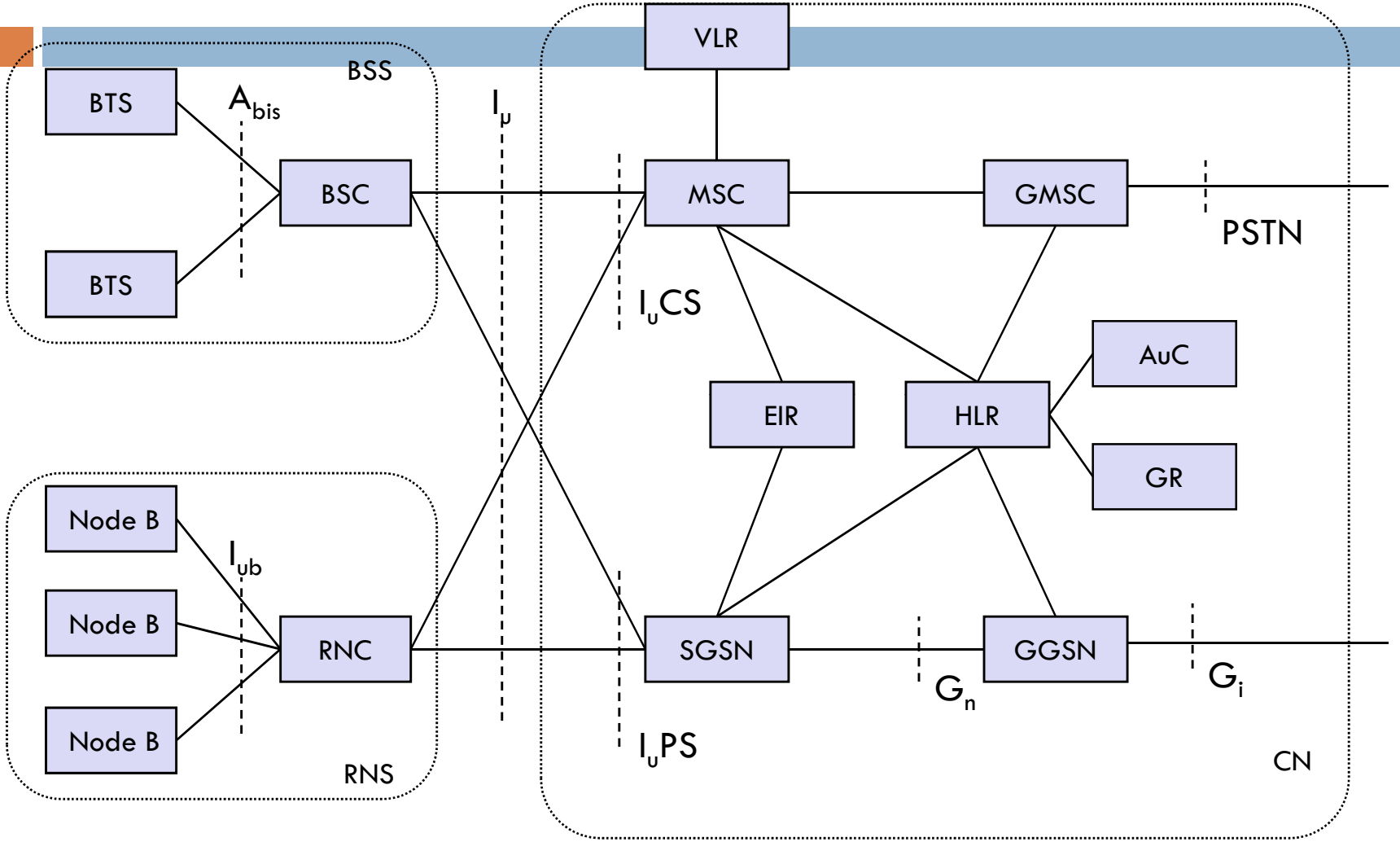
- Node B
  - The name node B was chosen during standardization until a new and better name was found.
  - The main task is the inner loop power control to mitigate near-far effect.
  - Measures connection qualities and signal strengths.
  - Supports a special case of handover (soft-handover).
- User Equipment (UE)
  - The UE performs signal quality measurements, inner loop power control, spreading and modulation, and rate matching. (counterpart of a node B).
  - The UE has to cooperate during handover and cell selection, performs encryption and decryption. (RNC)
  - The UE has to implement mobility management. (CN)

Core network

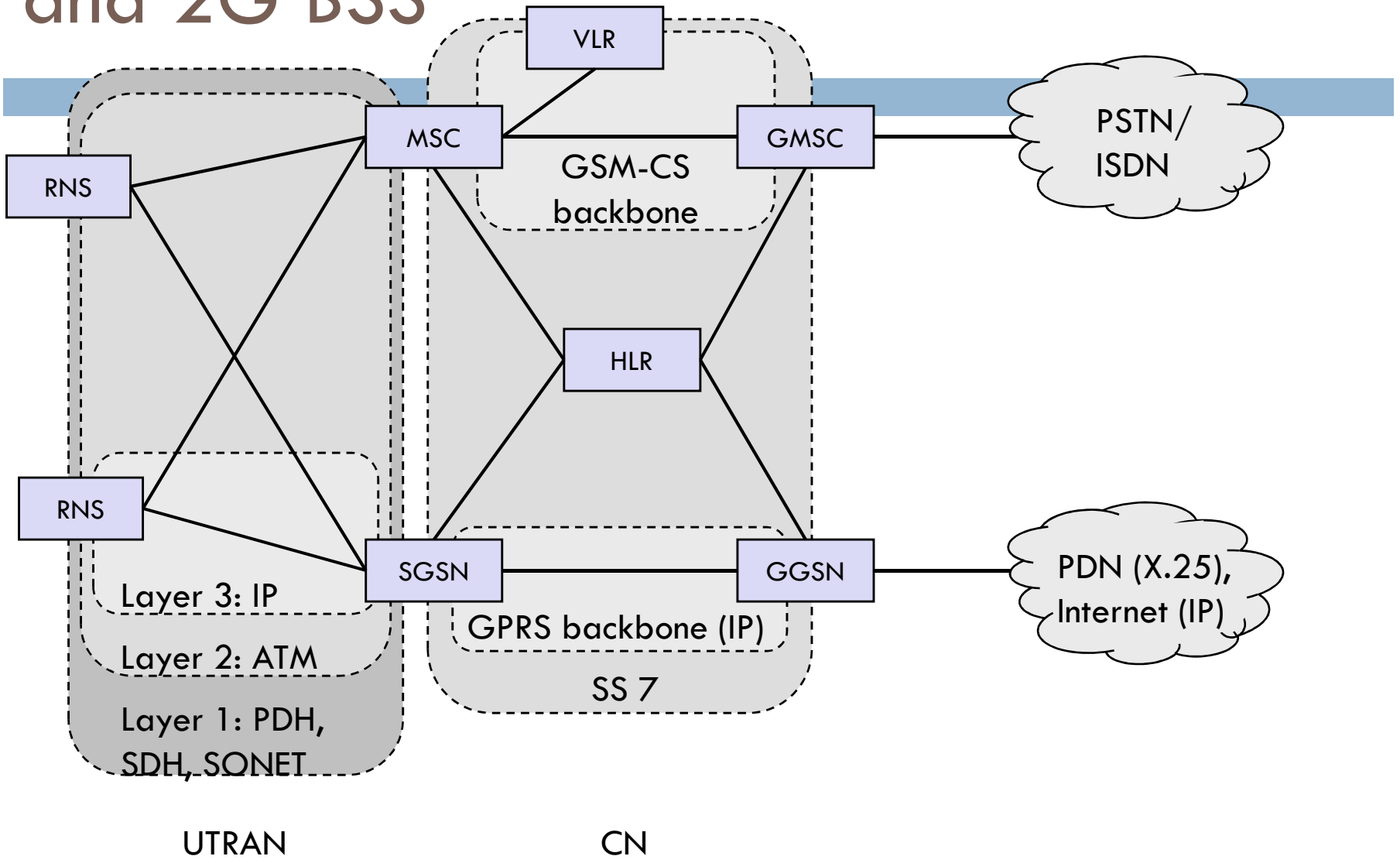
- The Core Network (CN) and thus the Interface I_u, are separated into two logical domains:
- Circuit Switched Domain (CSD)
  - Circuit switched service including signaling
  - Resource reservation at connection setup
  - GSM components (MSC, GMSC, VLR)
  - I_uCS
- Packet Switched Domain (PSD)
  - GPRS components (SGSN, GGSN)
  - I_uPS

- Release 99 uses the GSM/GPRS network and adds a new radio access!
  - Helps to save a lot of money …
  - Much faster deployment
  - Not as flexible as newer releases (5, 6)

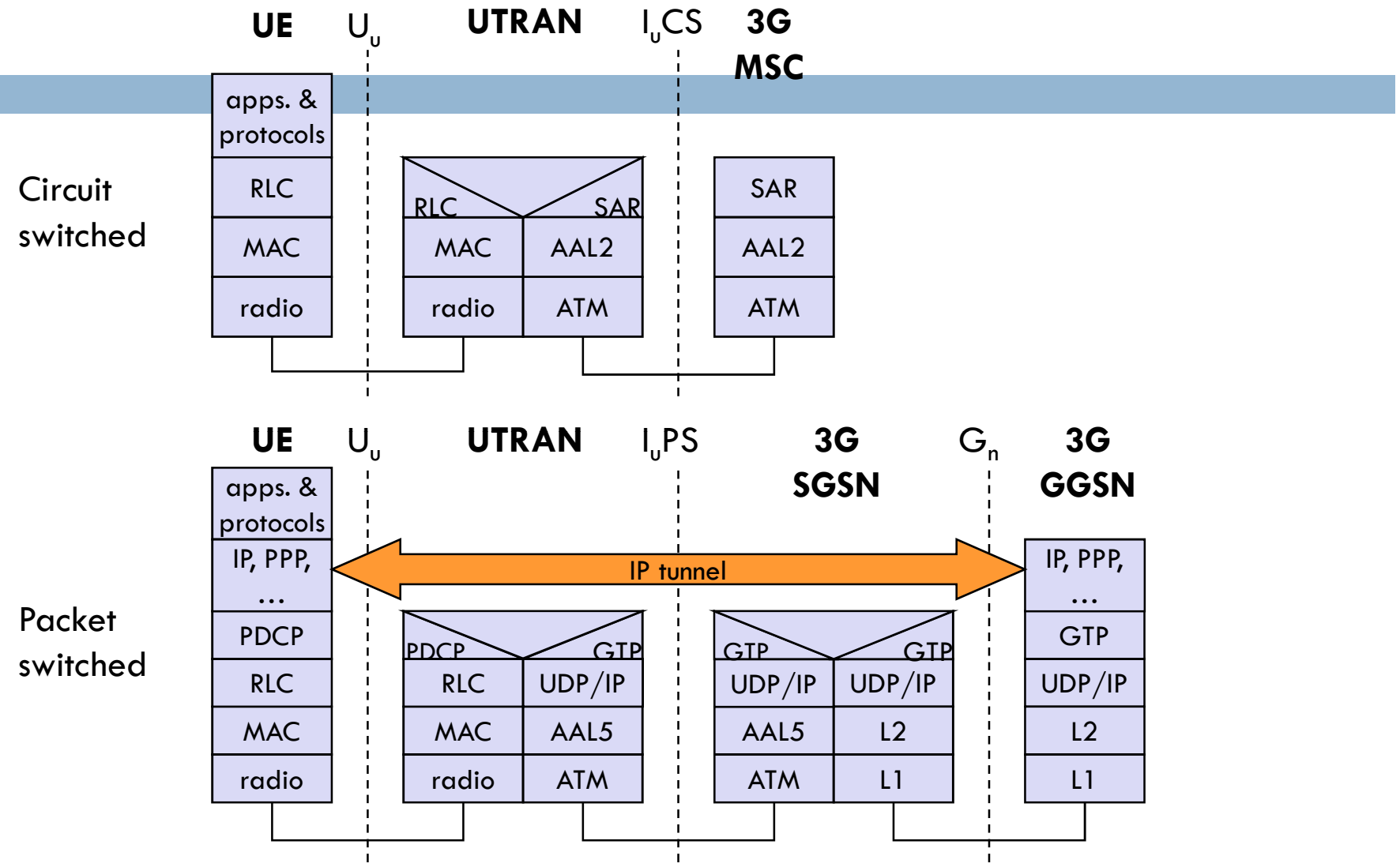
Core network: architecture with 3G RNS and 2G BSS



Core network: protocols with 3G RNS and 2G BSS



UMTS protocol stacks (user plane)



UMTS protocol stacks

- Circuit Switched Domain (CSD)
  - Radio link control (RLC)
  - Segmentation and reassembly (SAR)
  - ATM Adaptation Layer 2 (AAL2)
  - Asynchronous Transfer Mode (ATM)
- Packet Switched Domain (PSD)
  - Packet Data Convergence Protocol (PDCP)
  - GPRS Tunneling Protocol (GTP)