UMTS

- Part of the IMT 2000 ”family”
- 3nd Generation digital cellular mobile system
- Approximately ”old” (GSM + GPRS) core network + ”new” radio access network (UTRAN) including ”new” radio interface (WCDMA)
- New service standardisation approach
- 3GPP Specifications (www.3gpp.org)

New service standardisation approach

Existing systems have largely standardised the teleservices, applications and supplementary services which they provide. As a consequence, substantial re-engineering is required to enable new services to be provided.

3GPP therefore standardises service capabilities and not the services themselves. Service capabilities consist of bearers defined by QoS parameters and the mechanisms needed to realise services. These mechanisms include the functionality provided by various network elements, the communication between them and the storage of associated data.

Connection-oriented / connectionless bearer service

In a connection oriented mode, a logical association called *connection* needs to be established between the source and the destination entities before information can be exchanged between them. Connection oriented bearer services lifetime is the period of time between the establishment and the release of the connection.

In a connectionless mode, no connection is established beforehand between the source and the destination entities. The source and destination network addresses need to be specified in each message. Transferred information cannot be guaranteed of ordered delivery. Connectionless bearer services lifetime is reduced to the transport of one message.

CAMEL

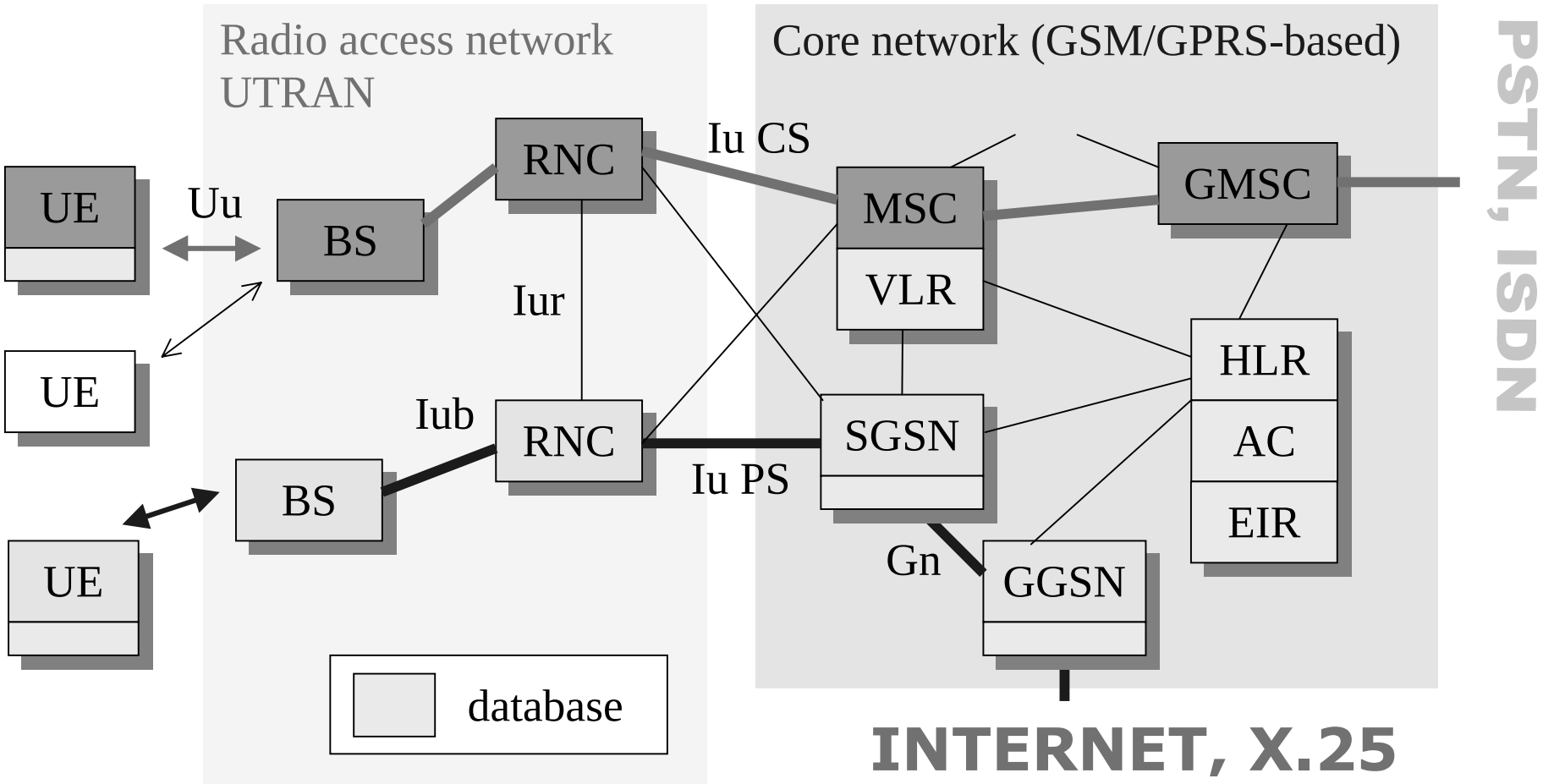
The CAMEL feature (Customised Applications for Mobile network Enhanced Logic) provides the mechanisms to support services independently of the serving network.
Note: CAMEL is not simply a supplementary service.

The CAMEL feature is applicable to

- MOC / MTC related activities (phase 1)
- supplementary service invocations (phase 2)
- GPRS sessions and PDP contexts, etc. (phase 3)

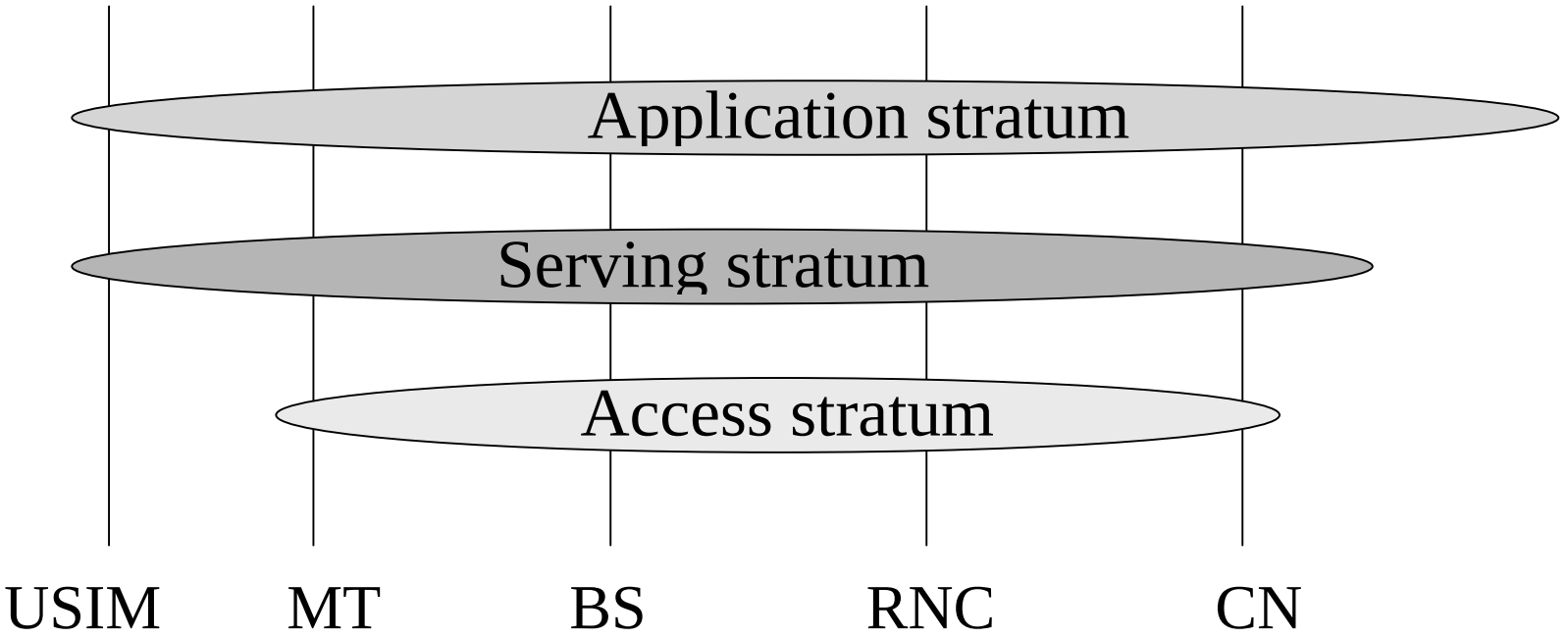
CAMEL Service Environment (CSE): A CSE is a logical entity which processes activities related to Operator Specific Services (OSS)

UMTS network architecture

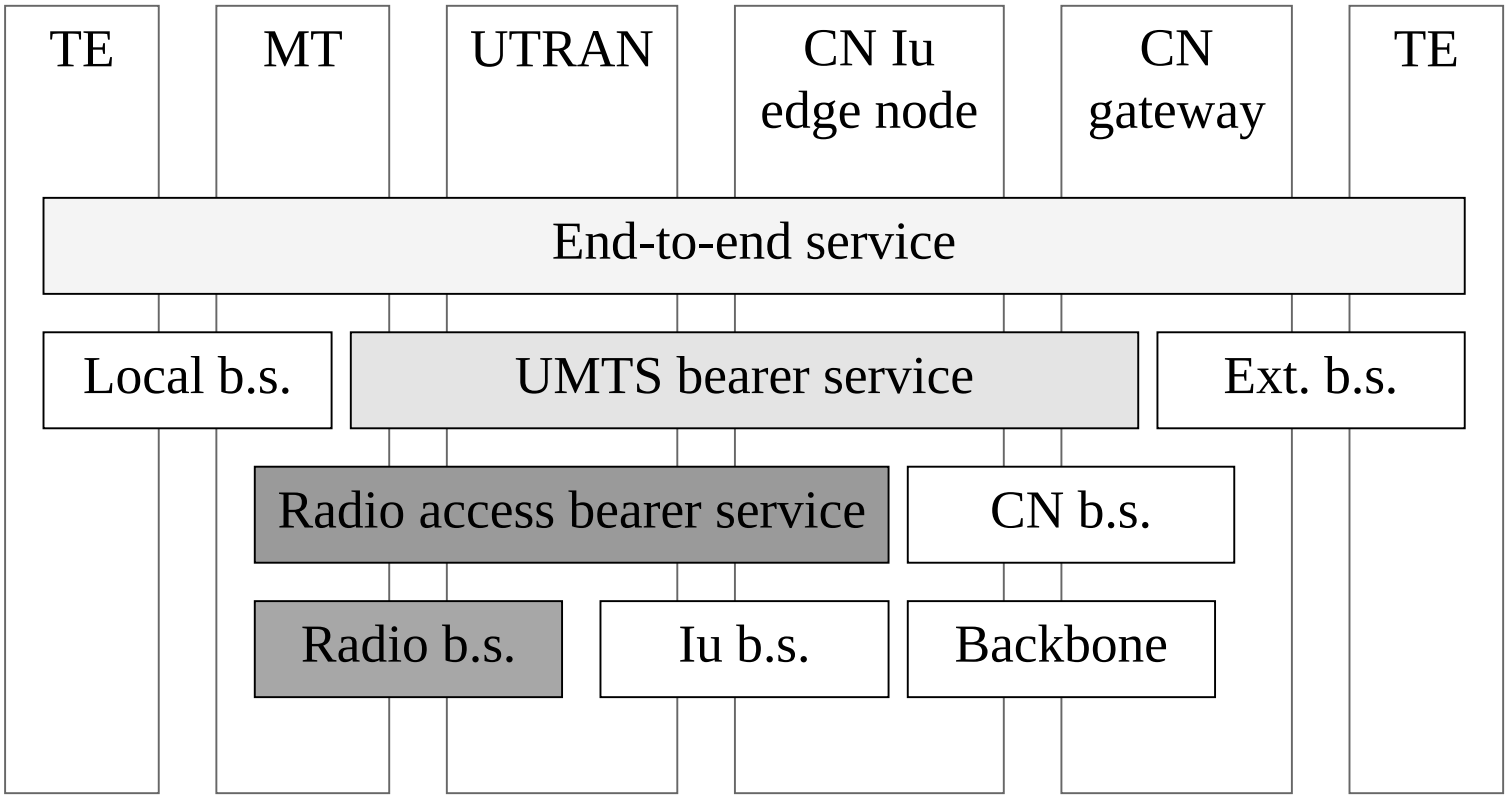


UMTS ”stratum” concept

Stratum: Grouping of protocols related to one aspect of the services provided by one or several domains



UMTS bearer service architecture



What is the bearer concept?

Bearer: a bearer capability of defined capacity, delay and bit error rate, etc. (as defined in the 3GPP specs)

Bearer is a flexible concept designating a kind of ”bit pipe”

- at a certain network level
- between certain network entities
- with certain QoS attributes and capacity

UMTS QoS Classes

- conversational, streaming, interactive, background

UMTS protocols

Different protocol stacks for user and control plane

User plane (for data transport):

circuit switched domain: data within ”bit pipes”

packet switched domain: protocol stack for implementing packet connections to external networks (Internet, X.25)

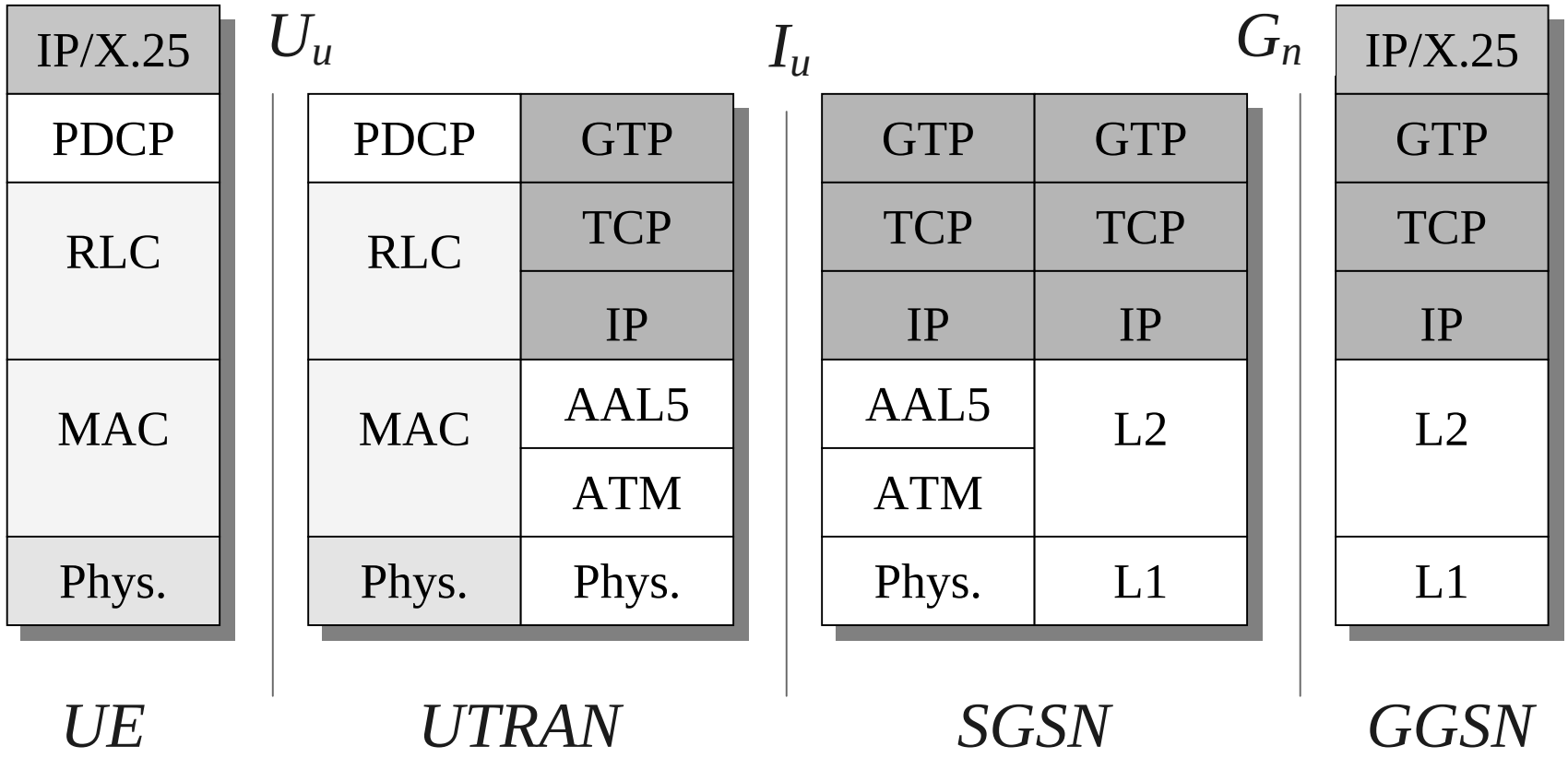
Control plane (for signaling):

circuit switched domain: SS7 based (in core network)

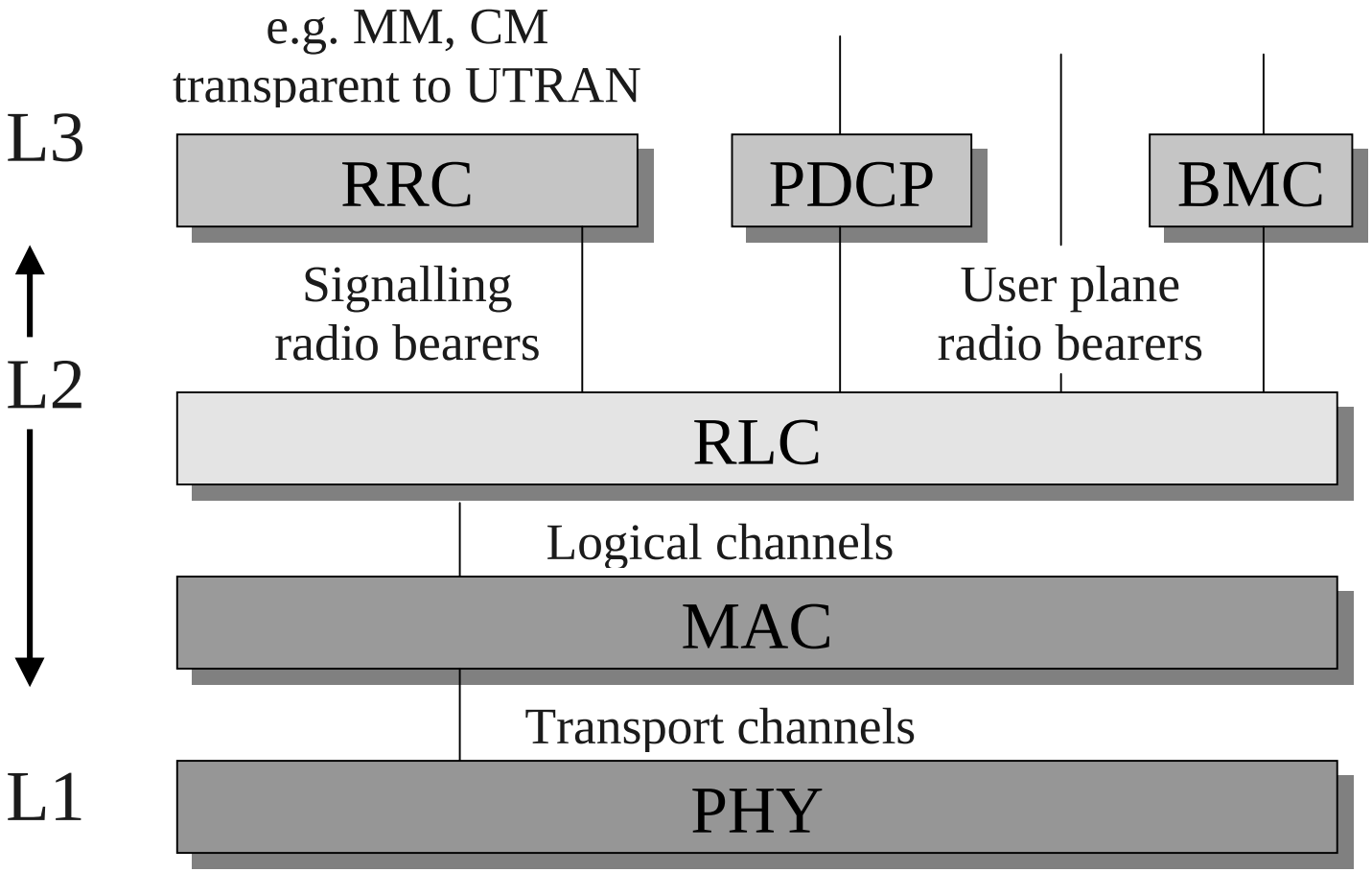
packet switched domain: IP based (in core network)

(note: special protocol model for radio access network)

User plane protocol stacks (PS domain)



Uu interface protocols



Main tasks of Uu interface protocols

MAC (Medium Access Control):

- Mapping between logical and transport channels

RLC (Radio Link Control):

- Segmentation and reassembly
- Link control (flow & error control)

PDCP (Packet Data Convergence Protocol):

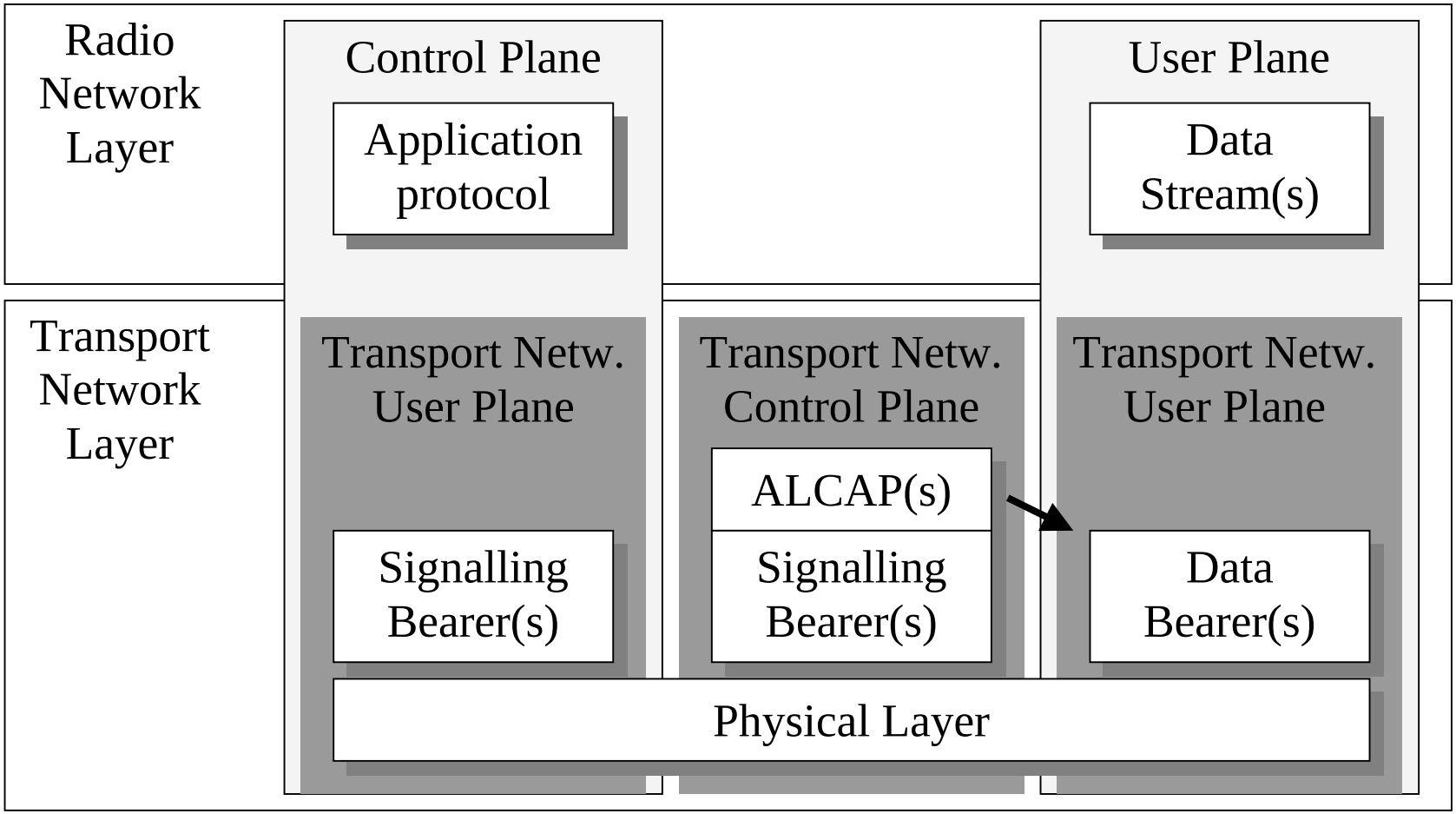
- IP packet header compression (user plane only)

RRC protocol

Over the Uu (air) interface, Radio Resource Control (RRC) messages carry all the relevant information required for setting up, modifying, and releasing links (at lower layers) between the UE and UTRAN. RRC also participates in the coordination of other Radio Resource Management (RRM) operations, such as measurements and handovers.

In addition, RRC messages may carry in their payload higher layer signalling information (MM = Mobility Mangement, CM = Connection Management, SM = Session Management) that is not related to the air interface or UTRAN.

General protocol model for UTRAN



Control Plane (Iub, Iur and Iu interfaces)

Radio Network Layer: application protocols (NBAP, RNSAP and RANAP) are used for the actual signalling between base stations, RNCs and the core network (CS and PS domains)

Transport Network Layer: signalling bearer for the transport of application protocol messages are set up by O&M actions (in present 3GPP standards: AAL5+Convergence protocols)

Transport Network Control Plane

Used for signalling within the Transport Network Layer and for setting up the data bearer(s)

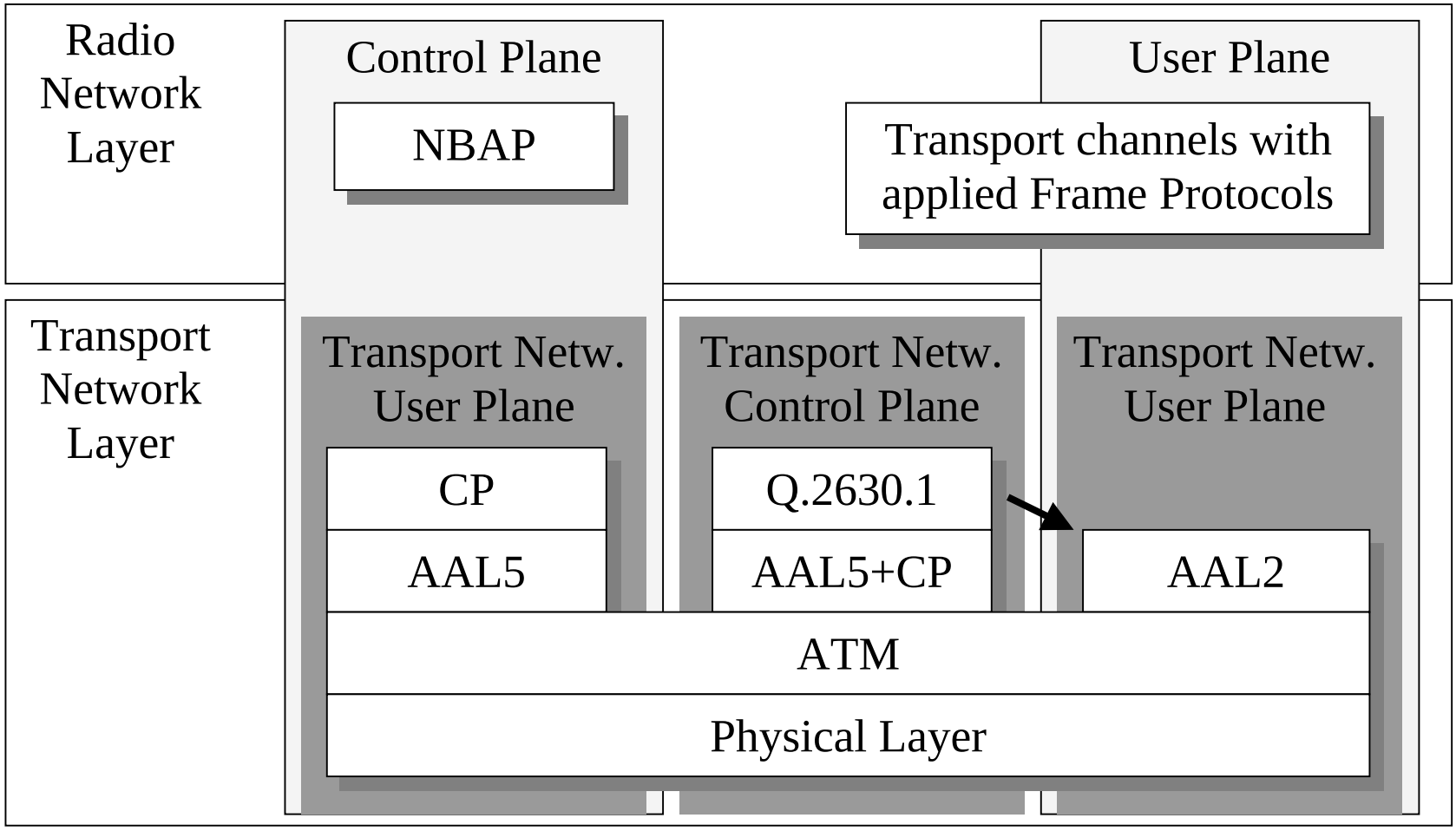
User Plane (Iub, Iur and Iu interfaces)

The User Plane is used for transport of

- user information (circuit switched speech, Internet packets)
- control information packed into various transport channels and sent transparently over radio links

User data streams are carried by data bearers (using AAL2) and may utilize so-called frame protocols (FP) for framing, error control and flow control at the Iub and Iur interfaces

Example (Iub interface)



Application protocols in UTRAN

Iu interface (between RNC and core network)

- RANAP (Radio Access Network Application Part)
  - Radio Access Bearer (RAB) management
  - SRNS Relocation
  - Transfer of higher-level signalling messages

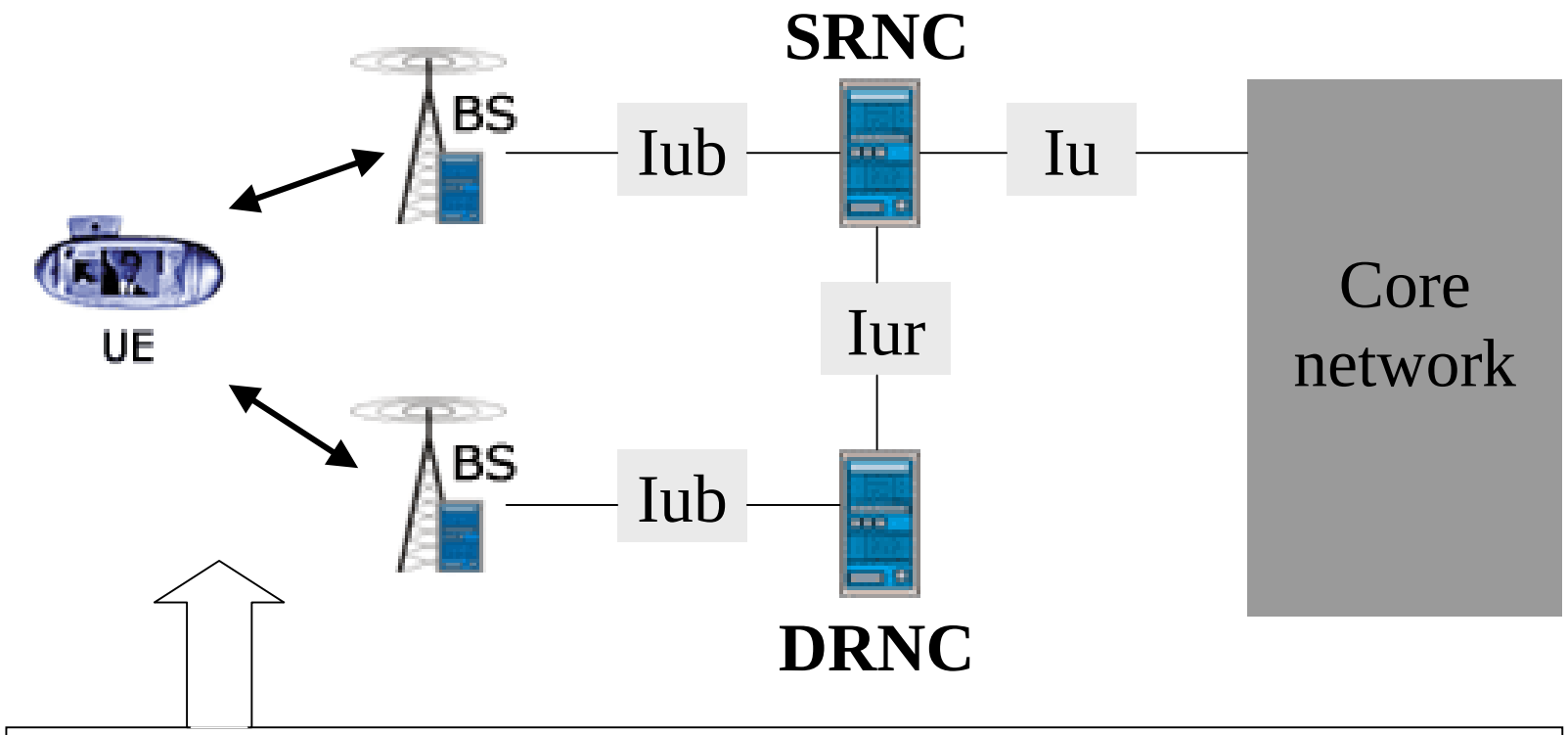
Iur interface (between Serving RNC and Drift RNC)

- RNSAP (Radio Network Subsystem Application Part)
  - Link management for inter-RNC soft handover

Iub interface (between RNC and base station)

- NBAP (Node B Application Part)

Serving RNC and Drift RNC in UTRAN



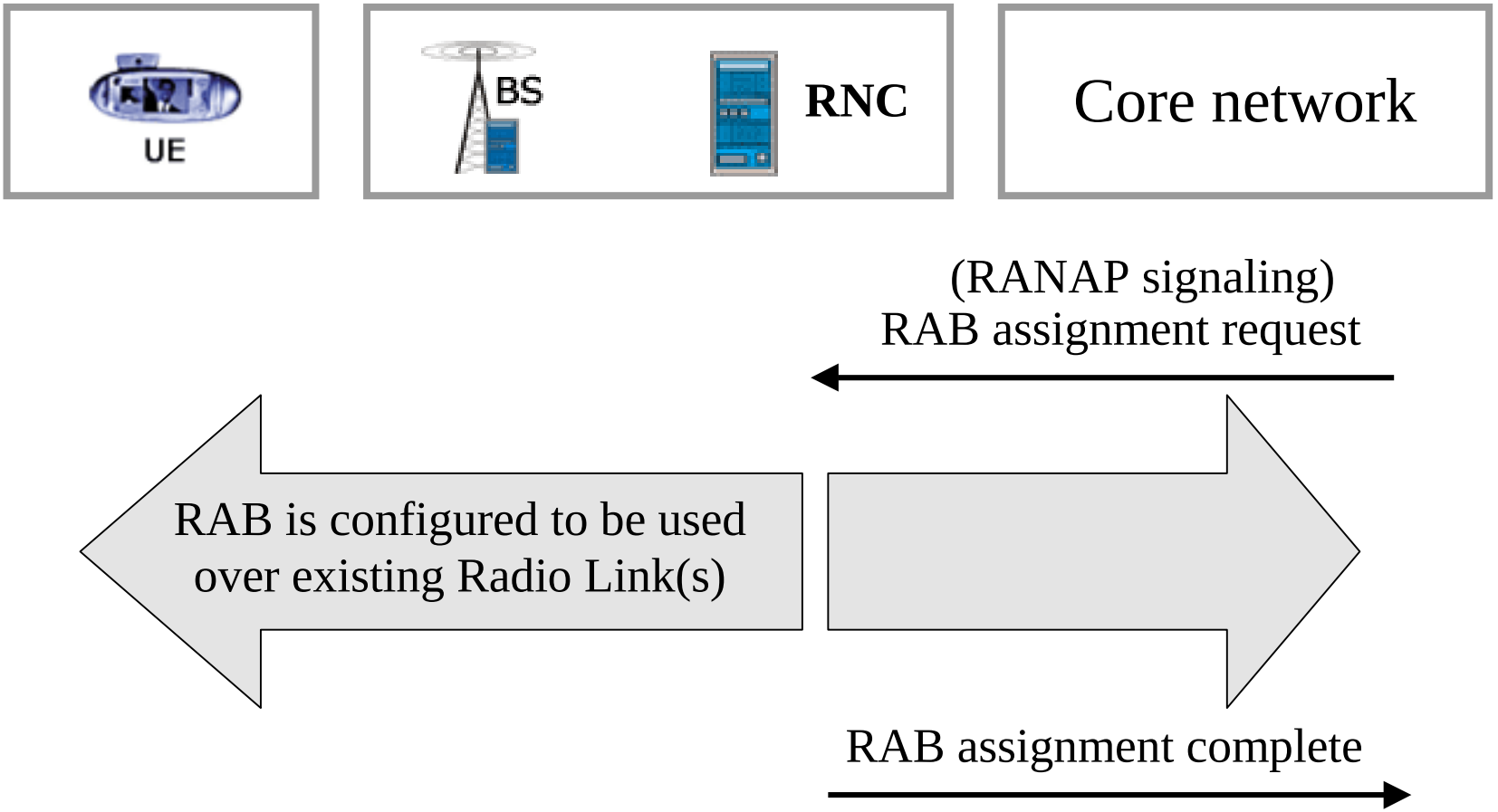
Serving RNS (SRNS) Relocation

RNS = Radio Network Sub-system =
RNC + all base stations controlled by this RNC

SRNS Relocation means that the Serving RNC functionality is transferred from one RNC (the “old” SRNC) to another (the “new” SRNC, previously a DRNC) without changing the radio resources and without interrupting the user data flow.

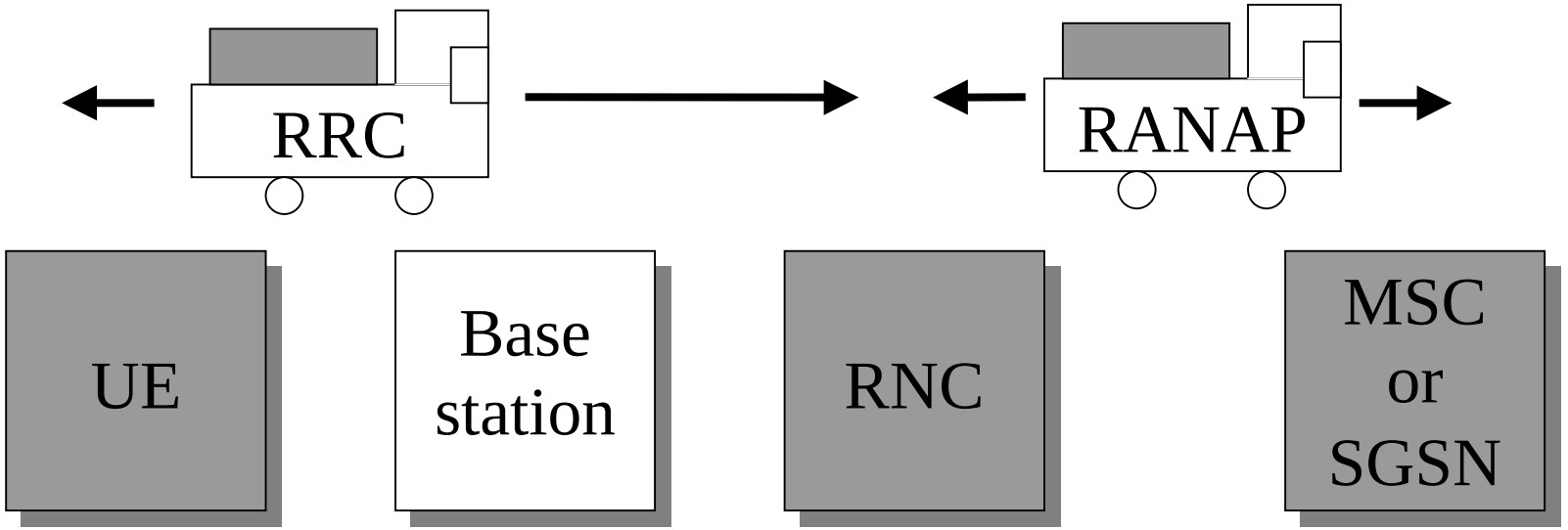
RANAP provides the signalling facilities over the two Iu interfaces involved (Iu interfaces to “old” and “new” SNRC) for performing SRNC Relocation in a coordinated manner.

Radio Access Bearer (RAB) establishment



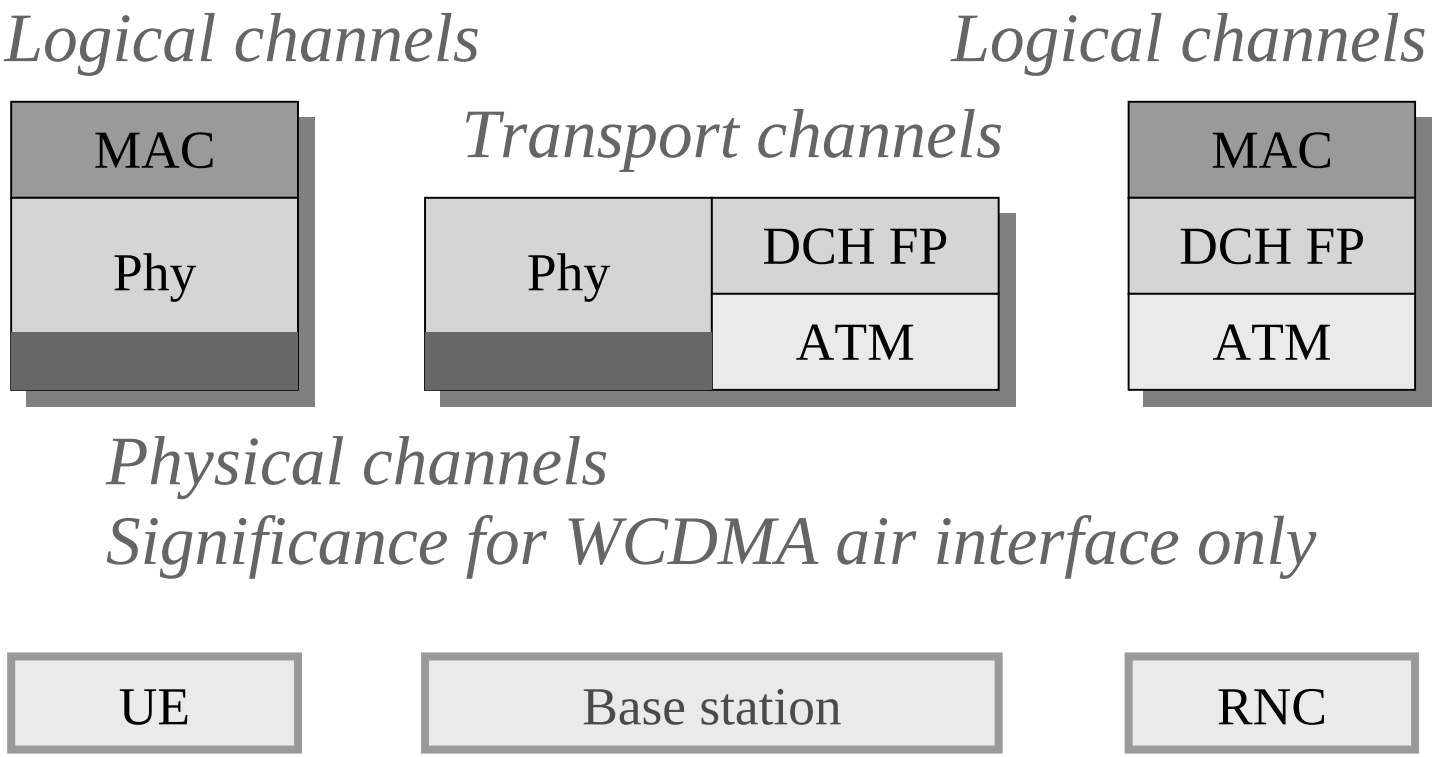
Signalling between UE and Core network

NAS signalling messages (NAS = non access stratum = “not related to UTRAN”) are sent transparently through UTRAN in the payload of RRC and RANAP protocol messages

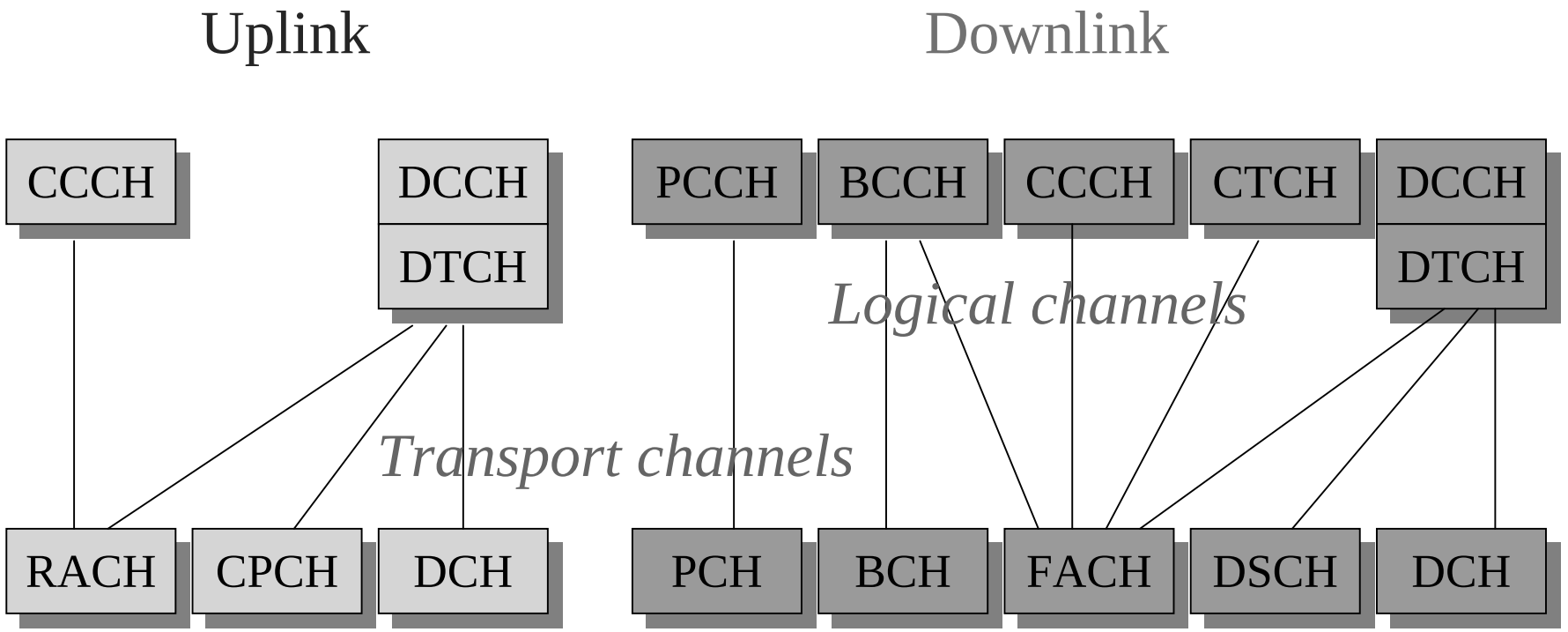


Logical / Transport / Physical channels

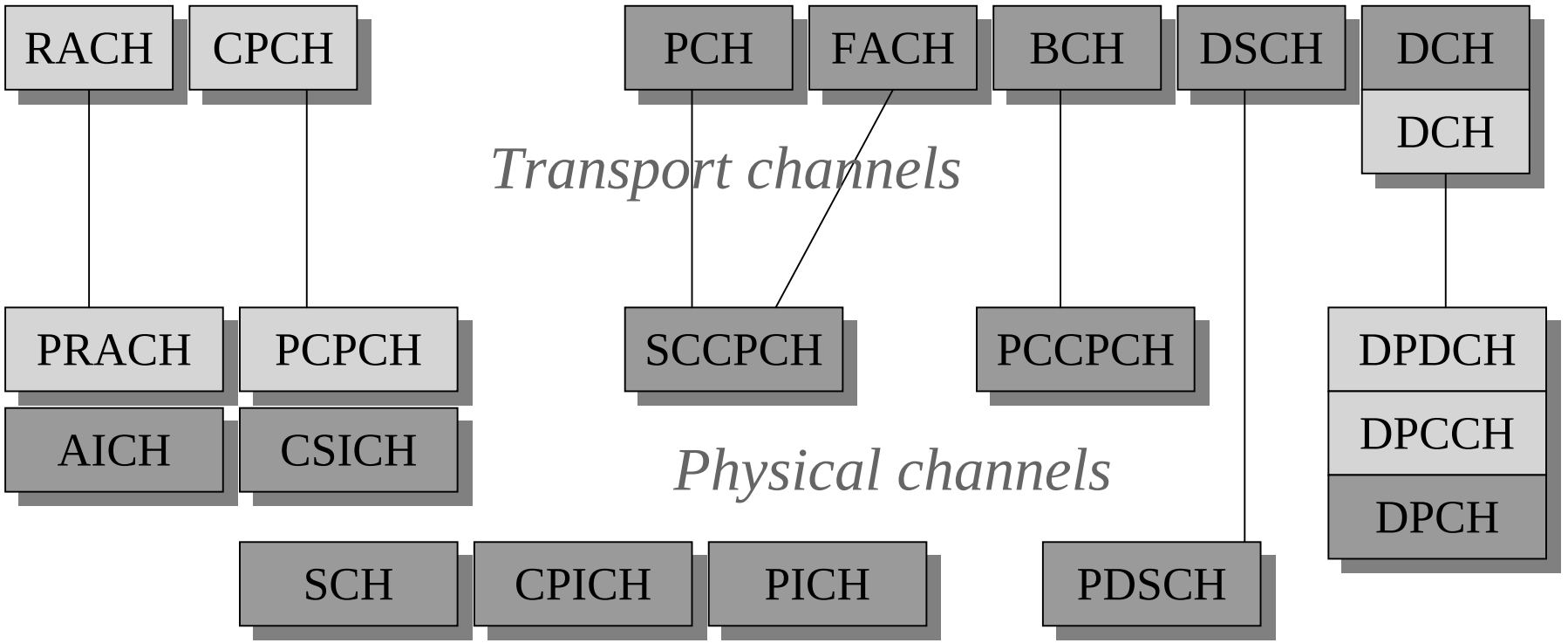
(DCH transport channel is taken as example)



Logical channels ⇔ Transport channels



Transport channels ⇔ Physical channels



Physical channels in WCDMA

Bit sequences in different physical channels are modulated using different spreading codes, which are code multiplexed

spreading code = channelization code x scrambling code

Downlink channels: conventional QPSK modulation

DPCH = Dedicated physical channel

Uplink channels: Dual-channel QPSK moduation

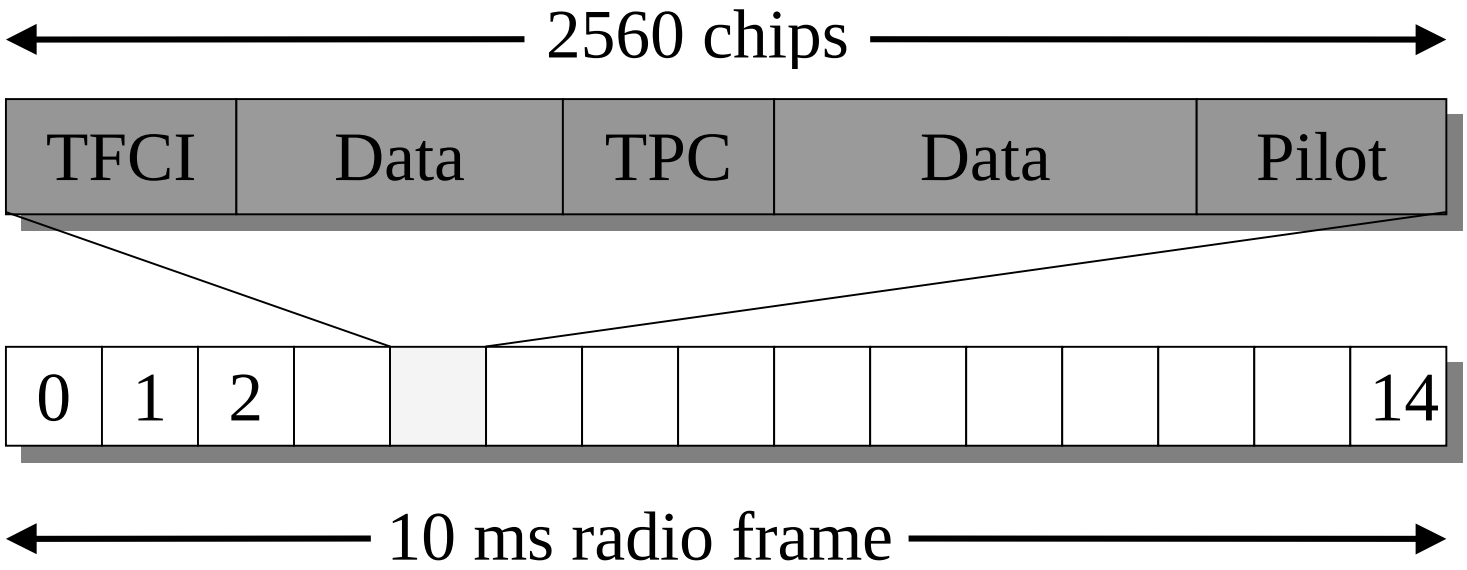
DPDCH = Dedicated physical data channel

DPCCH = Dedicated physical control channel

DPCH structure in downlink

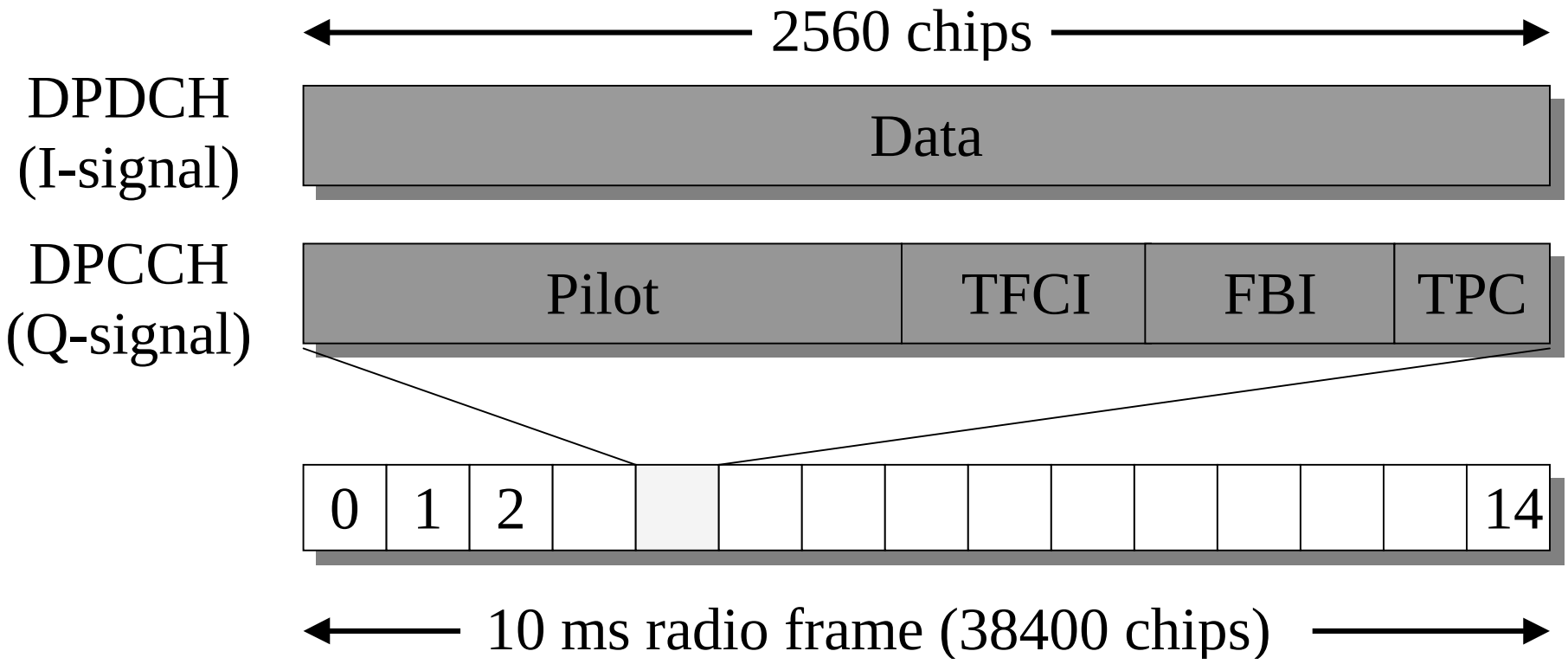
QPSK modulation,

time multiplexed data and control information:



DPDCH / DPCCH structure in uplink

Dual-channel QPSK modulation:



Spreading in WCDMA

spreading code = channelization code x scrambling code

Channelization (Walsh-Hadamard) codes: different codes are completely orthogonal if used for synchronous multiplexing

After scrambling, the spreading codes are near orthogonal even when not synchronized (multipath transmission)

Usage of code	uplink	downlink
Channelization code		user separation
Scrambling code	user separation	cell separation

Spreading facts

Chip rate after spreading = 3.84 Mchips/s

Spreading factor (SF) is important in WCDMA

Chip rate = SF x channel bit rate

Uplink: DPCCH SF = 256, DPDCH SF = 4 - 256

Downlink: DPCH SF = 4 - 512

Uplink DPDCH data rates

SF	Channel bit rate (kb/s)	User data rate (kb/s)
256	15	approx. 7.5
128	30	approx. 15
64	60	approx. 30
32	120	approx. 60
16	240	approx. 120
8	480	approx. 240
4	960	approx. 480

Downlink DPCH data rates

SF	Channel bit rate (kb/s)	User data rate (kb/s)
512	15	approx. 1-3
256	30	approx. 6-12
128	60	approx. 20-24
64	120	approx. 45
32	240	approx. 105
16	480	approx. 215
8	960	approx. 456
4	1920	approx. 936

User data rate vs. channel bit rate