(1) List of Acronyms

Term	Explanation
3GPP	Third Generation Partnership Project
8-PSK	8 Symbol Phase Shift Keying
AA	Anonymous Access
A-Bit	Acknowledgement Request Bit (LLC ⇔ Logical Link Control)
ABM	Asynchronous Balanced Mode
ACCH	Associated Control Channel
ADM	Asynchronous Disconnected Mode
AGCH	Access Grant Channel
AM	Amplitude Modulation
APN	Access Point Name (⇔ Reference to a GGSN)
ARFCN	Absolute Radio Frequency Channel Number
ARQ	Automatic Repeat Request
AT-Command	ATtention-Command
AuC	Authentication Center
BCCH	Broadcast Control Channel

(2) List of Acronyms

Term	Explanation
BG	Border Gateway
BIB	Backward Indicator Bit
BS_CV_MAX	Maximum Countdown Value to be used by the mobile station (⇔ Countdown Procedure)
BSC	Base Station Controller
BSIC	Base Station Identity Code
BSN	Block Sequence Number (⇔ RLC) / Backward Sequence Number (⇔ SS7)
BSS	Base Station Subsystem
BSSAP	Base Station Subsystem Application Part
BSSGP	Base Station System GPRS Protocol
BSSMAP	Base Station Subsystem Mobile Application Part
BTS	Base Transceiver Station
BVCI	BSSGP Virtual Connection Identifier
C/R-Bit	Command / Response Bit
CBCH	Cell Broadcast Channel
CC	Call Control

(3) List of Acronyms

Term	Explanation
CCCH	Common Control Channel
CDMA	Code Division Multiple Access
CDR	Charging / Call Data Record
CEPT	Conférence Européenne des Postes et Télécommunications
CG	Charging Gateway
CGF	Charging Gateway Function
CHAP	Challenge Handshake Authentication Protocol (⇔ PPP)
CS-X	Coding Scheme (1 – 4)
CV	Countdown Value (not Curriculum Vitae ;-)
DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DLR	Destination Local Reference
DNS	Domain Name System
DPC	Destination Point Code
DRX	Discontinuous Reception

(4) List of Acronyms

Term	Explanation
DTAP	Direct Transfer Application Part
DTX	Discontinuous Transmission
ECSD	Enhanced Circuit Switched Data (⇔ HSCSD + EDGE)
EDGE	Enhanced Data Rates for Global Evolution
EGPRS	Enhanced General Packet Radio Service
E-GSM	Extended GSM (GSM 900 in the Extended Band)
EIR	Equipment Identity Register
ERAN	EDGE Radio Access Network
ESN	Electronic Serial Number (North American Market)
ETSI	European Telecommunications Standard Institute
FACCH	Fast Associated Control Channel
FBI	Final Block Indicator
FCCH	Frequency Correction Channel
FCS	Frame Check Sequence (CRC-Check)
FDD	Frequency Division Duplex

(5) List of Acronyms

Term	Explanation
FDMA	Frequency Division Multiple Access
FIB	Forward Indicator Bit
FISU	Fill In Signal Unit
FMC	Fixed Mobile Convergence
FN	Frame Number
FR	Fullrate or Frame Relay
FRMR	Frame Reject
FSN	Forward Sequence Number
GEA	GPRS Encryption Algorithm
GGSN	Gateway GPRS Support Node
GMM	GPRS Mobility Management
G-MSC	Gateway MSC
GMSK	Gaussian Minimum Shift Keying
G-PDU	T-PDU + GTP-Header
GPRS	General Packet Radio Service

(6) List of Acronyms

Term	Explanation
GSM	Global System for Mobile Communications
GTP	GPRS Tunneling Protocol
HDLC	High level Data Link Control
HLR	Home Location Register
H-PLMN	Home PLMN
HR	Halfrate
HSCSD	High Speed Circuit Switched Data
HTTP	HyperText Transfer Protocol
I+S	Information + Supervisory
IAM	Initial Address Message (ISUP ⇔ ISDN User Part)
IETF	Internet Engineering Task Force (www.ietf.org)
IHOSS	Internet Hosted Octet Stream Service
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IMT-2000	International Mobile Telecommunications for the year 2000

(7) List of Acronyms

Term	Explanation
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
ISDN	Integrated Services Device Network
ISP	Internet Service Provider
ITU-T	International Telecommunication Union – Telecommunication Sector
L2TP	Layer 2 Tunneling Protocol
LA	Location Area
LAC	Location Area Code
LAI	Location Area Identification
LAPB	Link Access Procedure Balanced
LAPD	Link Access Protocol for the ISDN D-Channel
LCP	Link Control Protocol (⇔ PPP)
LLC	Logical Link Control
LPD	Link Protocol Discriminator
LSB	Least Significant Bit

(8) List of Acronyms

Term	Explanation
LSSU	Link Status Signal Unit
MAC	Medium Access Control
MCC	Mobile Country Code
MCS-X	Modulation Coding Scheme (1 – 9)
MIME	Multipurpose Internet Mail Extensions
MIN	Mobile Identity Number (North American Market)
MM	Mobility Management
MNC	Mobile Network Code
MOC	Mobile Originating Call
MRU	Maximum Receive Unit (⇔ PPP)
MS	Mobile Station
MSB	Most Significant Bit
MSC	Mobile Services Switching Center
MSU	Message Signal Unit
MT	Mobile Terminal or Mobile Terminating

(9) List of Acronyms

Term	Explanation
MTC	Mobile Terminating Call
MTP	Message Transfer Part
NCC	Network Colour Code
NCP	Network Control Protocol (⇔ PPP)
NI	Network Indicator
N-PDU	Network-Protocol Data Unit (⇔ IP-Packet, X.25-Frame)
NS	Network Service
NSAPI	Network Service Access Point Identifier
NSS	Network Switching Subsystem
OMC	Operation and Maintenance Center
OPC	Originating Point Code
OSI	Open System Interconnection
OSP	Octet Stream Protocol
P/F-Bit	Polling/Final - Bit
PACCH	Packet Associated Control Channel

(10) List of Acronyms

Term	Explanation
PAD	Packet Assembly Disassembly
PAGCH	Packet Access Grant Channel
PAP	Password Authentication Protocol (⇔ PPP)
PBCCH	Packet Broadcast Control Channel
PCCCH	Packet Common Control Channel
PCM	Pulse Code Modulation
PCU	Packet Control Unit
PD	Protocol Discriminator
PDCH	Packet Data Channel
PDP	Packet Data Protocol
PDTCH	Packet Data Traffic Channel
PDU	Protocol Data Unit or Packet Data Unit
PLMN	Public Land Mobile Network
PNCH	Packet Notification Channel
POP	Post Office Protocol

(11) List of Acronyms

Term	Explanation
PPCH	Packet Paging Channel
PPP	Point-to-Point Protocol
PRACH	Packet Random Access Channel
PSTN	Public Switched Telephone Network
PT	Protocol Type (⇔ GTP or GTP')
PTCCH	Packet Timing Advance Control Channel
PTCCH/D	Packet Timing Advance Control Channel / Downlink Direction
PTCCH/U	Packet Timing Advance Control Channel / Uplink Direction
PTM	Point to Multipoint
P-TMSI	Packet TMSI
PTP	Point to Point
QoS	Quality of Service
RA	Routing Area
RAC	Routing Area Code
RACH	Random Access Channel

(12) List of Acronyms

Term	Explanation
RAI	Routing Area Identification
RAND	Random Number
REJ	Reject
RFC	Request for Comment (⇔ Internet Standards)
R-GSM	Railways-GSM
RLC	Radio Link Control
RNC	Radio Network Controller
RNR	Receive Not Ready
RNS	Radio Network Subsystem
RR	Radio Resource Management
RR	Receive Ready
RRBP	Relative Reserved Block Period
SABM(E)	Set Asynchronous Balanced Mode (Extended)
SACCH	Slow Associated Control Channel
SACCH/MD	SACCH Multislot Downlink (related control channel of TCH/FD)

(13) List of Acronyms

Term	Explanation
SAPI	Service Access Point Identifier
SCH	Synchronization Channel
SDCCH	Stand Alone Dedicated Control Channel
SDMA	Space Division Multiple Access
SDU	Service Data Unit
SGSN	Serving GPRS Support Node
SI	Service Indicator
SIF	Signalling Information Field
SIM	Subscriber Identity Module
SIO	Service Information Octet
SLC	Signaling Link Code
SLR	Source Local Reference
SLS	Signaling Link Selection
SLTA	Signaling Link Test Acknowledge
SLTM	Signaling Link Test Message

(14) List of Acronyms

Term	Explanation
SM	Session Management
SMS	Short Message Service
SMSCB	Short Message Services Cell Broadcast
SMS-G-MSC	SMS Gateway MSC (for Short Messages destined to Mobile Station)
SMS-IW-MSC	SMS Interworking MSC (for Short Messages coming from Mobile Station)
SMTP	Simple Mail Transfer Protocol
SNDCP	Subnetwork Dependent Convergence Protocol
SNMP	Simple Network Management Protocol
SNN	SNDCP N-PDU Number Flag
SN-PDU	Segmented N-PDU (SN-PDU is the payload of SNDCP)
SPC	Signaling Point Code
SRES	Signed Response
SSN	Send Sequence Number
SUERM	Signal Unit Error Rate Monitor
TA	Timing Advance

(15) List of Acronyms

Term	Explanation
TAI	Timing Advance Index
TBF	Temporary Block Flow
TCAP	Transaction Capabilities Application Protocol
TCH	Traffic Channel
TCH/FD	Traffic Channel / Fullrate Downlink
TCP	Transmission Control Protocol
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TE	Terminal Equipment
TFI	Temporary Flow Identity
TI	Transaction Identifier
TID	Tunnel Identifier
TLLI	Temporary Logical Link Identifier
TLV	Tag / Length / Value Notation
TMSI	Temporary Mobile Subscriber Identity

(16) List of Acronyms

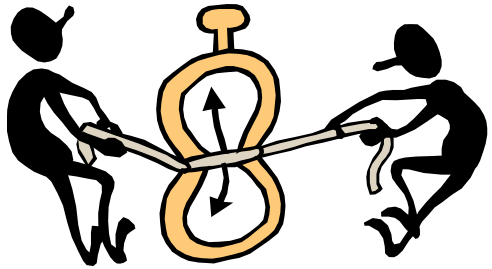
Term	Explanation
TQI	Temporary Queuing Identifier
TRAU	Transcoding Rate and Adaption Unit
TS	Timeslot
TSC	Training Sequence Code
UA	Unnumbered Acknowledgement
UDP	User Datagram Protocol
UI	Unnumbered Information (⇔ LAPD) / Unconfirmed Information (⇔ LLC)
UL	Uplink
UMTS	Universal Mobile Telecommunication System
USF	Uplink State Flag
UTRAN	UMTS Terrestrial Radio Access Network
UWC	Universal Wireless Convergence (Merge IS-136 with GSM)
VLR	Visitor Location Register
V-PLMN	Visited PLMN
XID	Exchange Identification

(17) List of Acronyms

Term	Explanation
XOR	Exclusive-Or Logical Combination

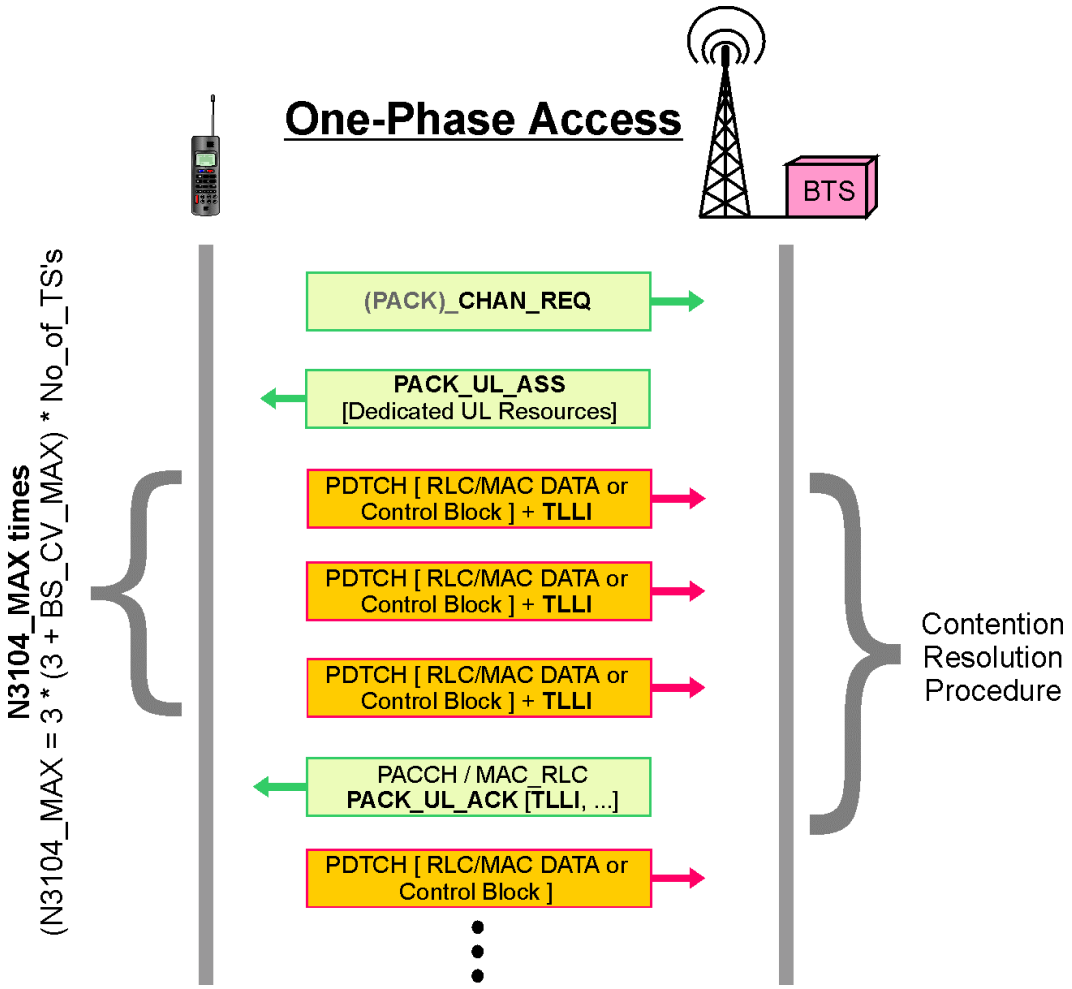
One-Phase Access and Contention Resolution:

- The initial access message cannot uniquely identify the sending mobile station
- Ambiguities cannot be avoided.
- Different mobile stations may consider the same resource allocation to be destined to itself and start using it.
- Contention resolution is required.

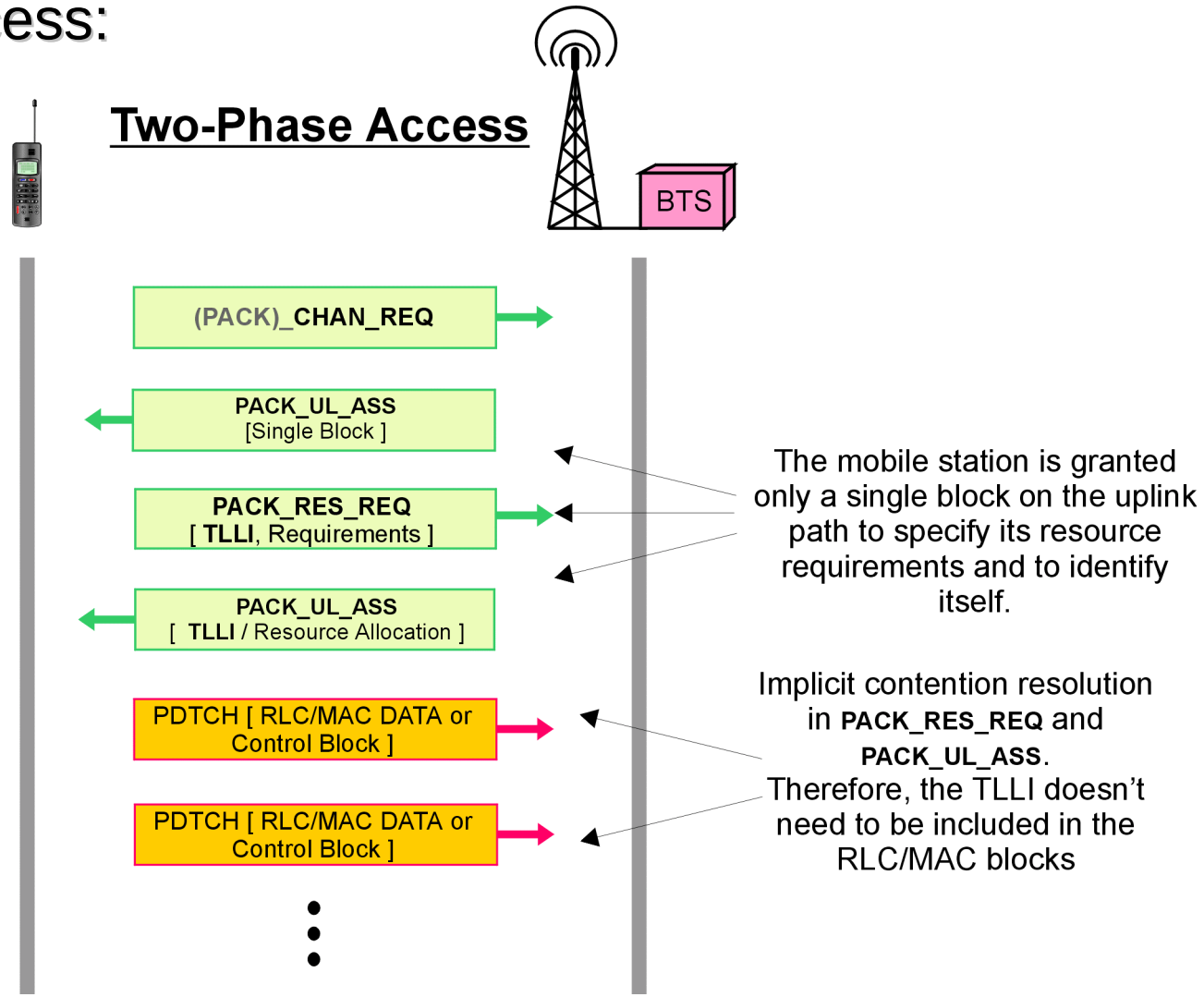


The Contention Resolution Procedure at One-Phase Access:

- *The **(PACK)_CHAN_REQ** indicates One-Phase Access.*
- *The network will assign sufficient resources.*
- *The mobile station shall include its identification (⇔ TLLI) in the first uplink blocks that are sent (max. N3104_MAX times)*
- *The network shall reply asap with a **PACK_UL_ACK** that includes the TLLI of the addressed mobile station.*
- *If there is a second mobile station using the same uplink resource, it needs immediately to stop its transmission.*



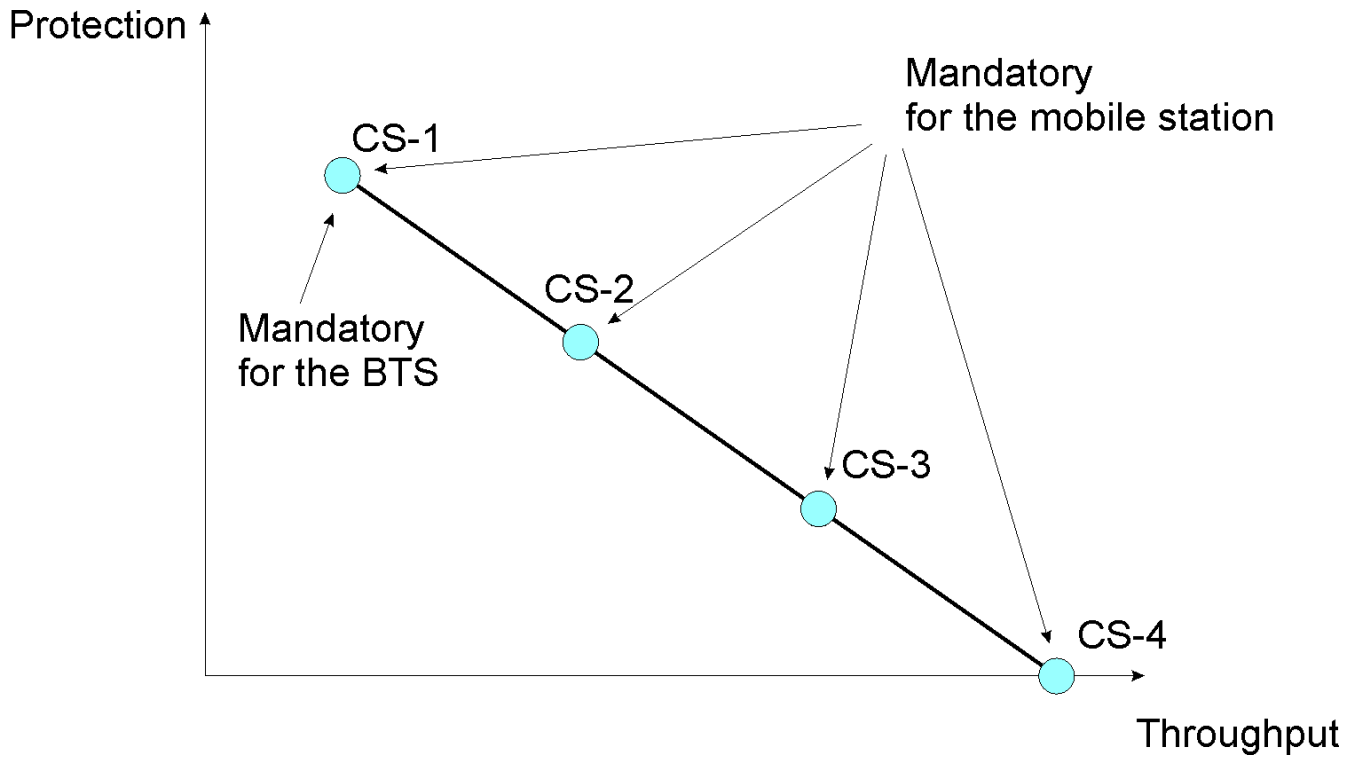
Two-Phase Access:



(1) The Coding Schemes 1 - 4 in GPRS:

- In addition to the channel coding schemes used in GSM, GPRS introduces three new coding schemes (CS-2 - CS-4)
- CS-2 - CS-4 offer higher throughput rates but less protection against transmission errors.
- Note that coding schemes CS-2 - CS-4 are applicable only for PDTCHs while information on all other PDCHs will be encoded using CS-1.
  With the exception of PTCCH/U and PRACH !
  Of course, CS-1 can also be used on PDTCH.
- The mobile station needs to be able to process all coding schemes while the network is only required to support coding scheme 1.
  The network selects the coding scheme to be used.

(2) The Coding Schemes 1 - 4 in GPRS:

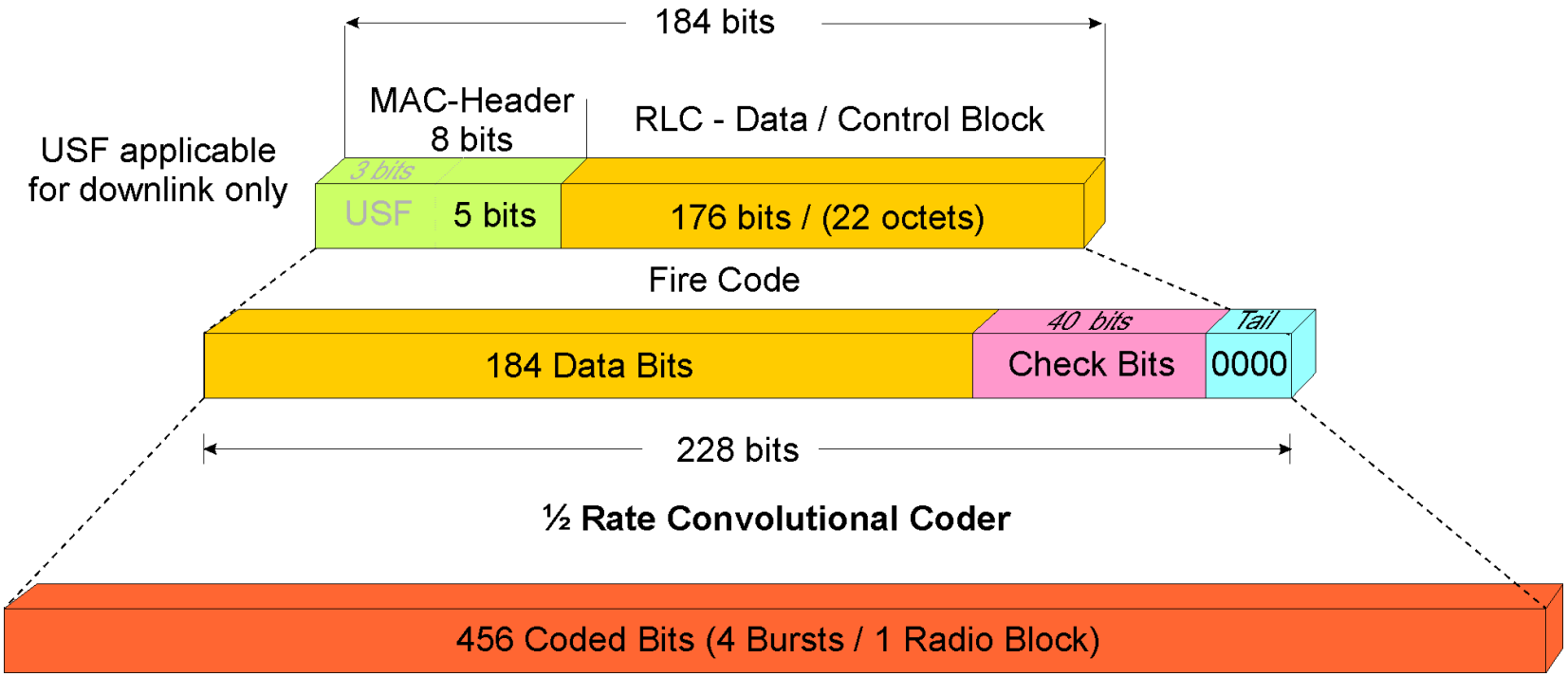


The interdependency between data protection and throughput rate.

(1) Details of CS-1:

- CS-1 is identical to the coding scheme that is being used in GSM for signaling information (on SDCCH, SACCH or FACCH).
- 176 data bits plus 8 bits for the MAC header are delivered to the encoder.
- First, the encoder applies the fire coding scheme which adds 40 check bits and 4 tail bits, coded with '0000'$_{bin}$.
- These 228 bits are the input for the rate ½ convolutional coder which provides an output of 456 encoded bits.
- Since one burst can carry 114 coded bits, 4 bursts are required to transmit one package of 456 bits.

(2) Details of CS-1:



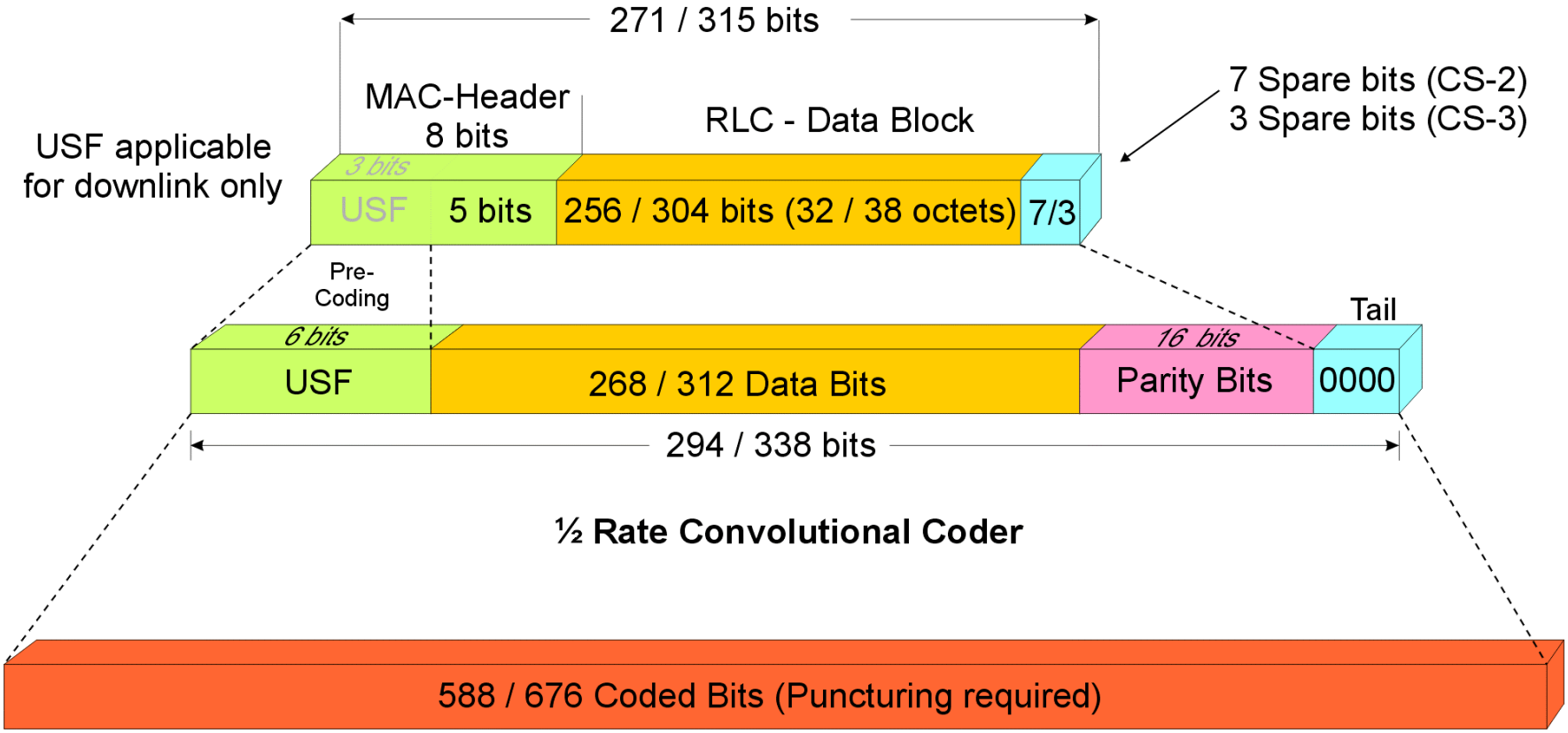
(1) Details of CS-2 and CS-3:

"The processes that apply for CS-2 and CS-3 have to be considered as being completely different from CS-1 and CS-4!"

- *In downlink direction, for CS-2 and CS-3, the three bit long USF is precoded and extended to 6 bits.*
- *CS-2 is providing 256 data bits to the encoder while CS-3 allows for an impressive number of 304 data bits.*
  Please compare that number to the 176 input bits of CS-1.
- *The 256 / 304 data bits plus MAC header plus the precoded USF are appended by 16 parity bits plus 4 tail bits that are hardcoded with '0000'$_{bin}$.*
- *These 294 / 338 bits are input for the same ½ rate convolutional coder, already known from CS-1. The ½ rate convolutional coder provides an output of 588 / 676 encoded bits.*

"The difference between CS-2 and CS-3 on one hand and CS-1 and CS-4 on the other hand is related to the Puncturing Process !"

(2) Details of CS-2 and CS-3:

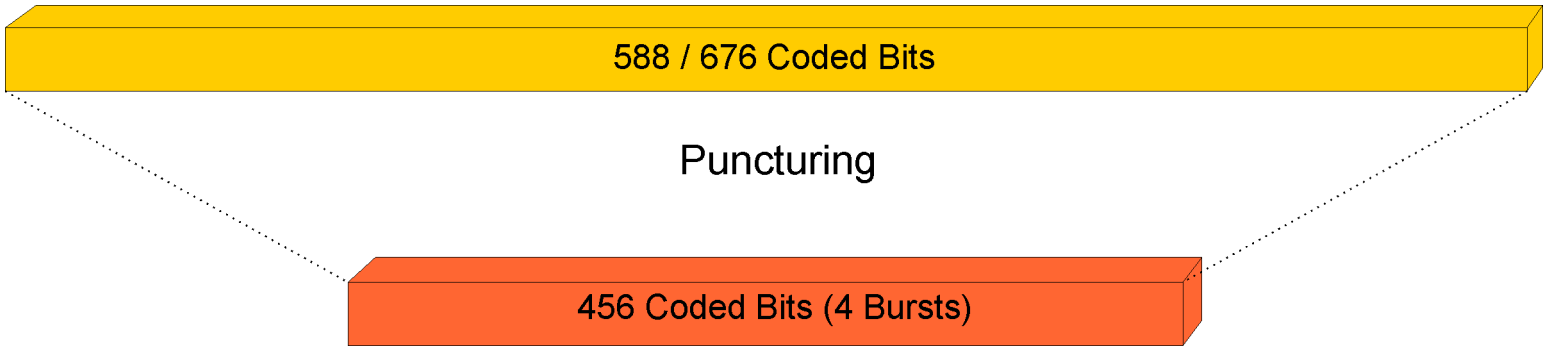


(1) Puncturing:

- In GSM and CS-1, the output of the encoder are 456 coded bits. These 456 bits fit exactly into 4 bursts.
- Note that GSM has not been altered to fit the 588 / 676 coded bits from CS-2 / CS-3 into only 4 bursts to achieve their higher throughput rates.
- The rather surprising approach is to rely on the protection and redundancy, added by the ½ rate convolutional coder.
- Therefore, a number of 132 / 220 bits at pre-defined positions is deleted from the output bit sequence. After that process, only 456 bits are left for transmission.
- This process is called *puncturing* and obviously makes CS-2 and CS-3 more vulnerable to transmission errors than CS-1.
- On the other hand, puncturing provides for a more flexible coding rate (3/4, 2/3, ...) compared to the other option, which is changing the coder (1, 1/2, 1/3, ...)
- It is the task of the decoder to recover the original bitstream from the received signal. The code rate for CS-2 is appr. $^{2}/_{3}$ compared to CS-3 with appr. ¾.

(2) Puncturing:

The figure below illustrates the puncturing process for CS-2 and CS-3.

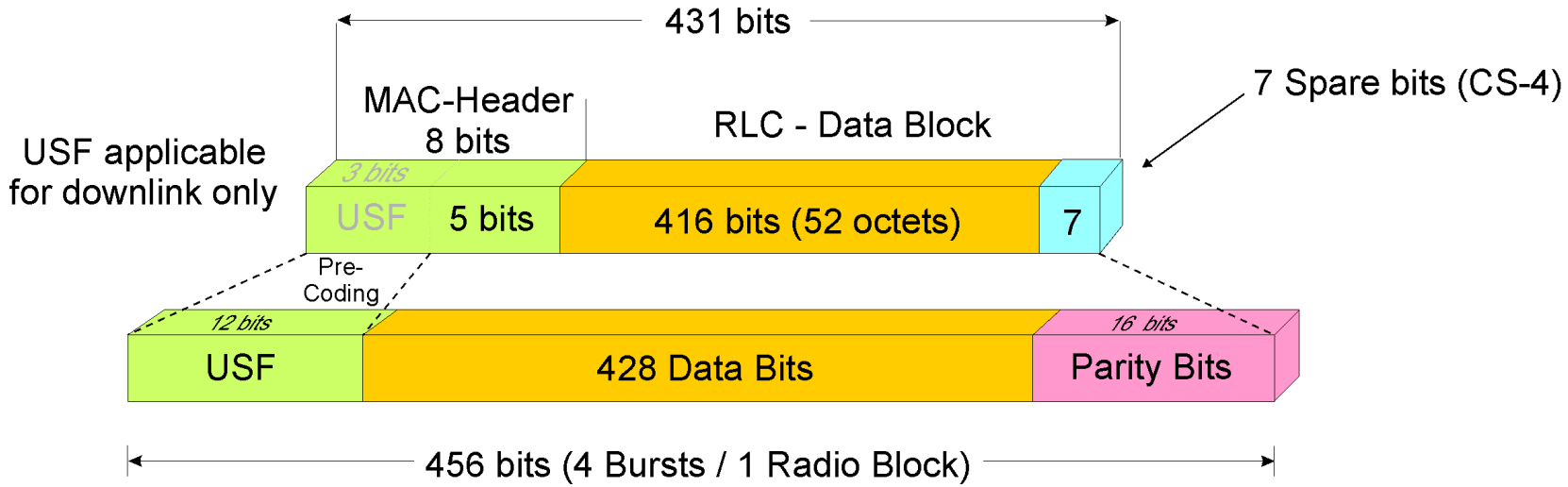


(1) Details of CS-4:

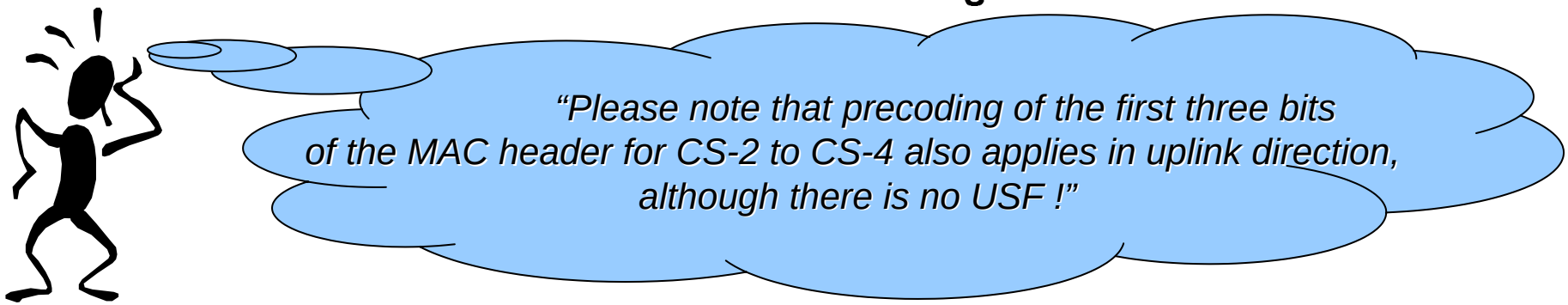
- While CS-3 impressed with a number of 304 input data bits for the encoder, CS-4 comes with even 416 bits.
- To fit this number of bits into only four bursts, obviously no more channel coding can be applied.

- Therefore, the code rate of CS-4 is 1.
- As the figure on the following slide shows, only 16 parity bits are appended to the data bits to provide for a minimum protection level.
- More protection is granted for the USF which is precoded to 12 bits.
- Accordingly, even with CS-4 the USF is much more robust against transmission errors than the remaining data bits.

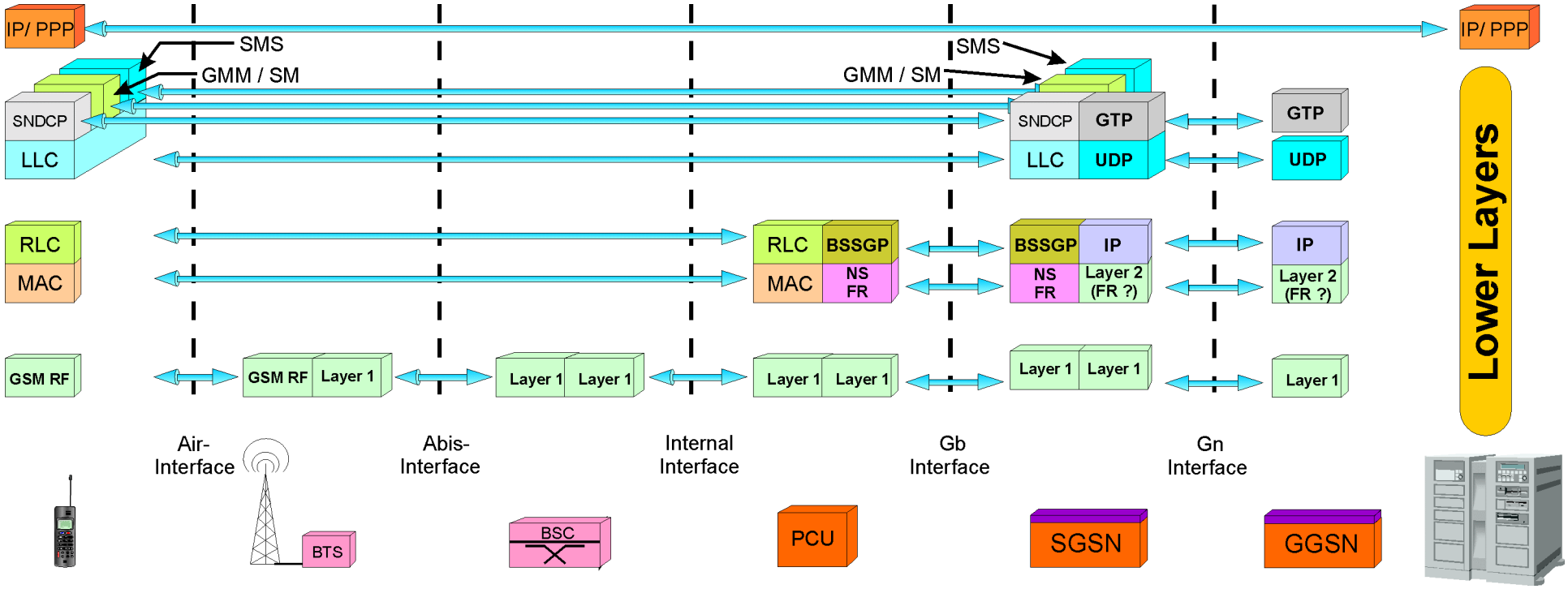
(2) Details of CS-4:



No Convolutional Coding!



The GPRS Protocol Stack between MS and Application Service:



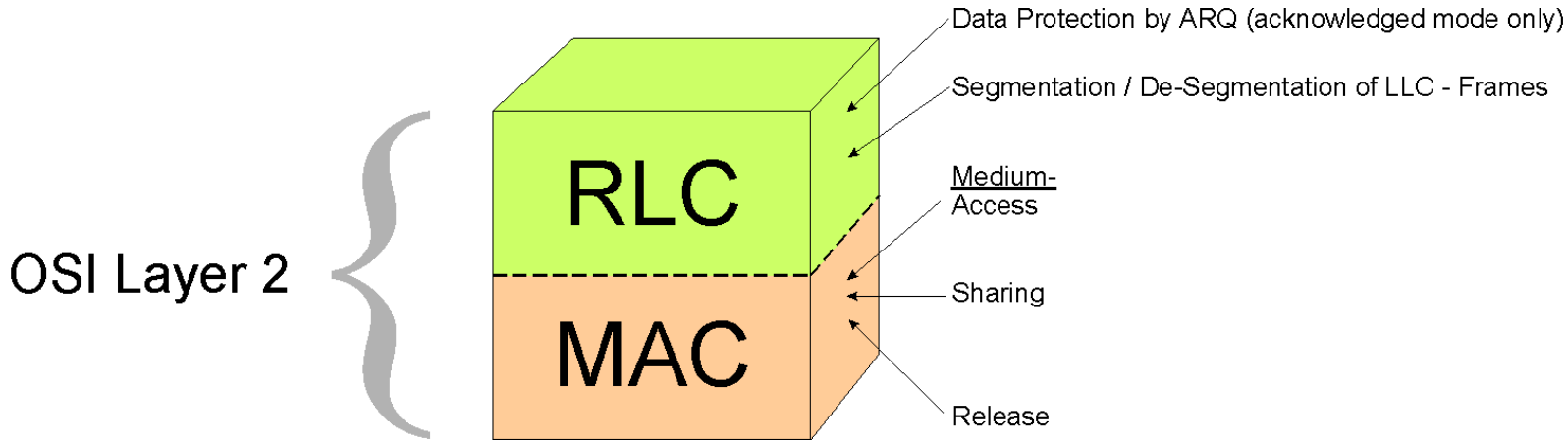
Implications from the Previous Slide:

- ➔ Obviously, the BSC and the BTS are almost transparent to the GPRS. The PCU takes care of most packet related tasks that concern the BSS.
  Note that the MSC isn't included at all.
- ➔ The SGSN and the mobile station are the main peers within the GPRS protocol stack.
- ➔ Note that LLC is the lowest GPRS protocol which is independent from the underlying air interface standard (⇔ IS-136).

(1) Radio Link Control / Medium Access Control (RLC / MAC):

➔ Tasks and Objectives of MAC:

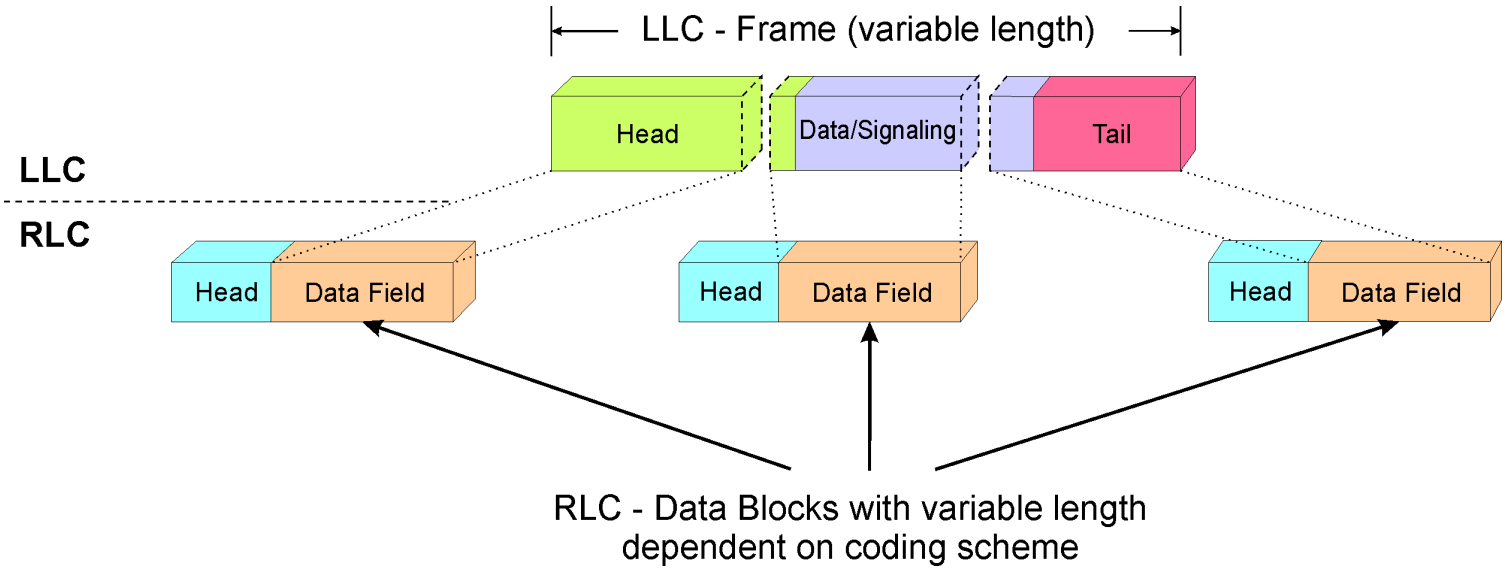
As the acronym *medium access control* suggests, the MAC sublayer is in charge to control the access of a device to a given transmission medium. Obviously, every protocol requires a more or less extensive MAC function. In case of GPRS, MAC is applicable to the air interface where it deals with tasks like access, sharing and release of the physical medium. When it comes to the OSI reference model, the tasks of the MAC sublayer best match the OSI layer 2.



(2) Radio Link Control / Medium Access Control (RLC / MAC):

➔ Tasks and Objectives of RLC:

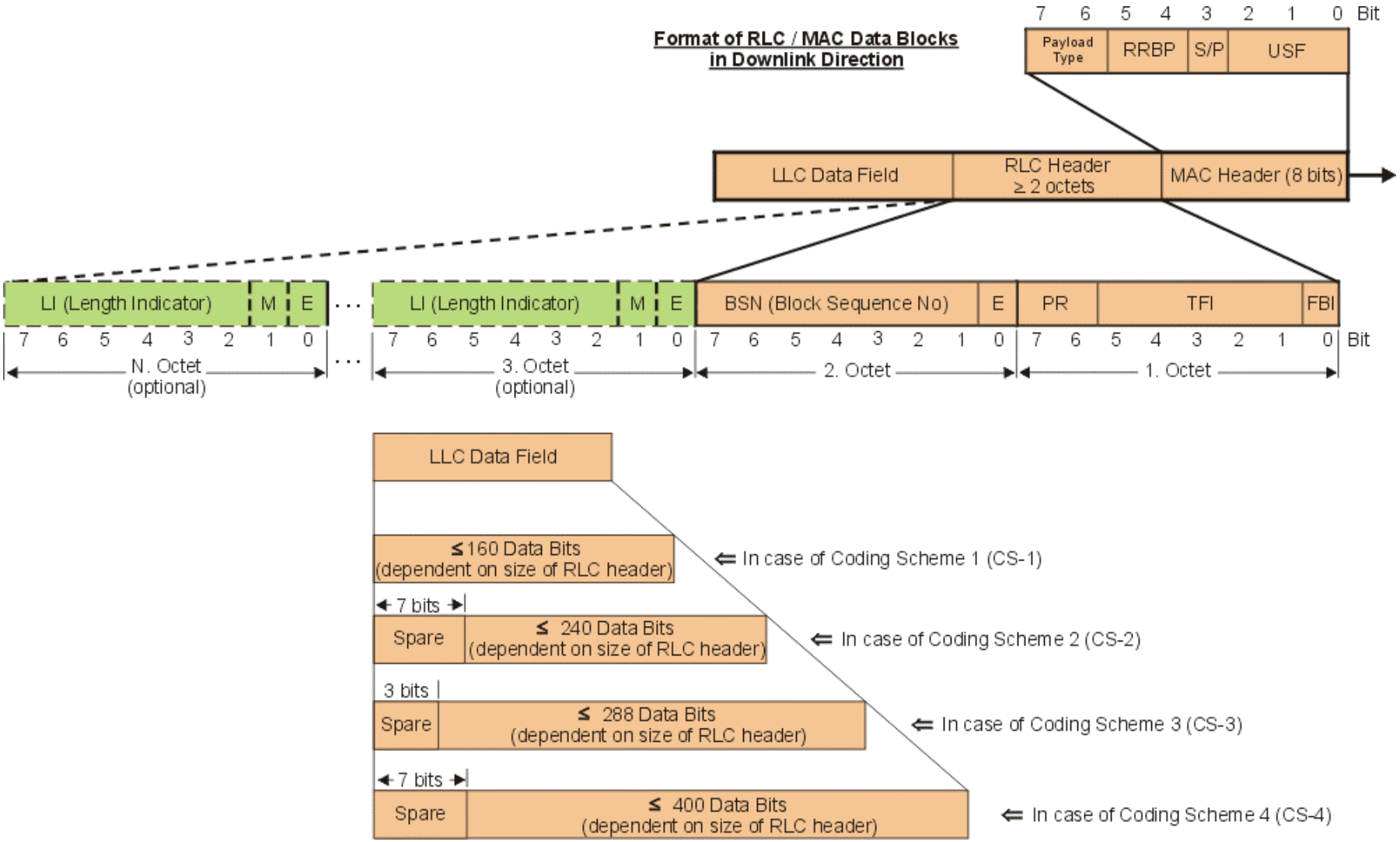
Radio link control deals with the tasks of segmentation and de-segmentation of data units from higher layers (⇔ LLC). In case of acknowledged operation mode, RLC also ensures data protection during transmission over the air interface by applying ARQ measures. As is the case for MAC, RLC is a sublayer of OSI layer 2.

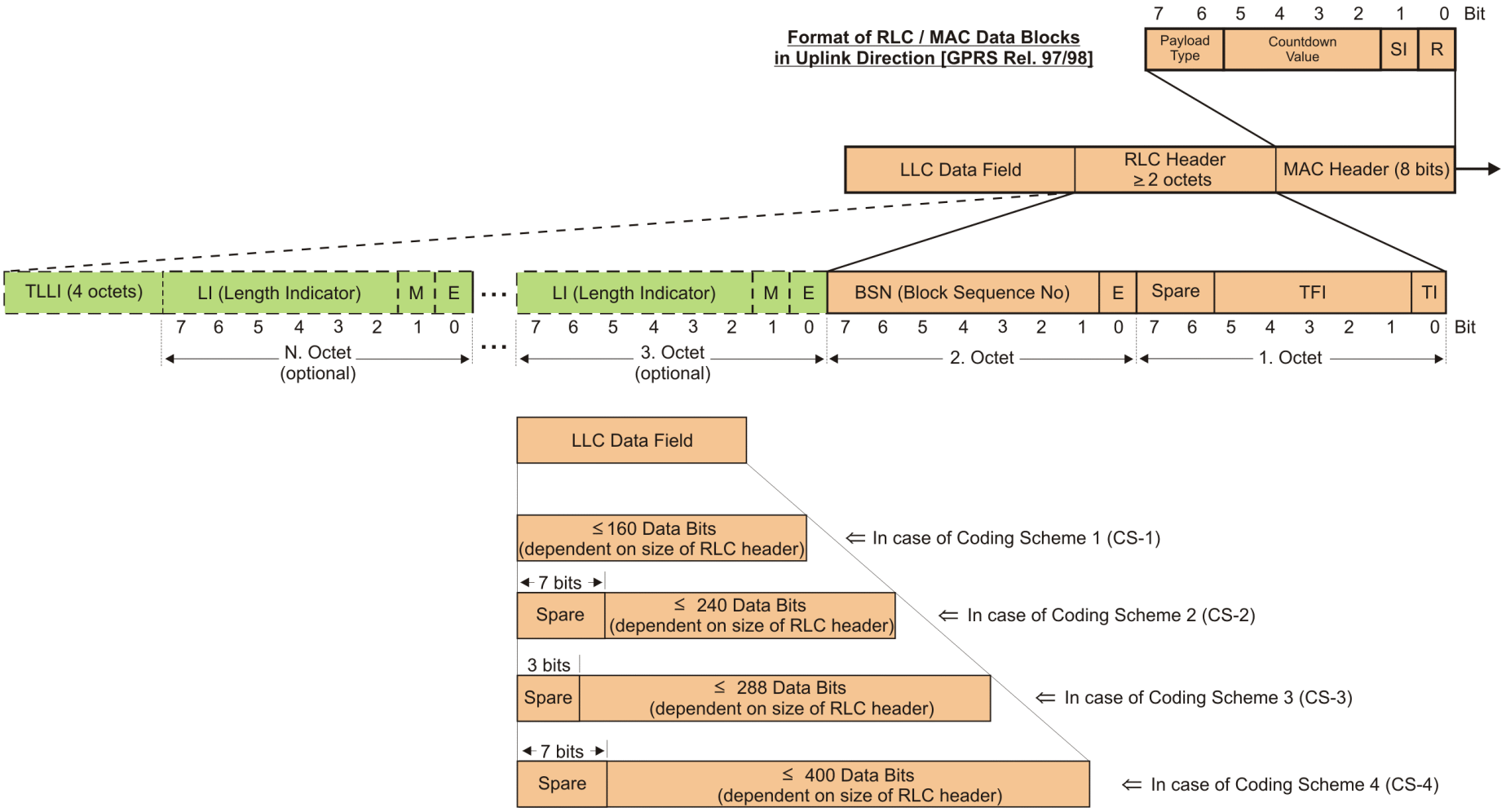


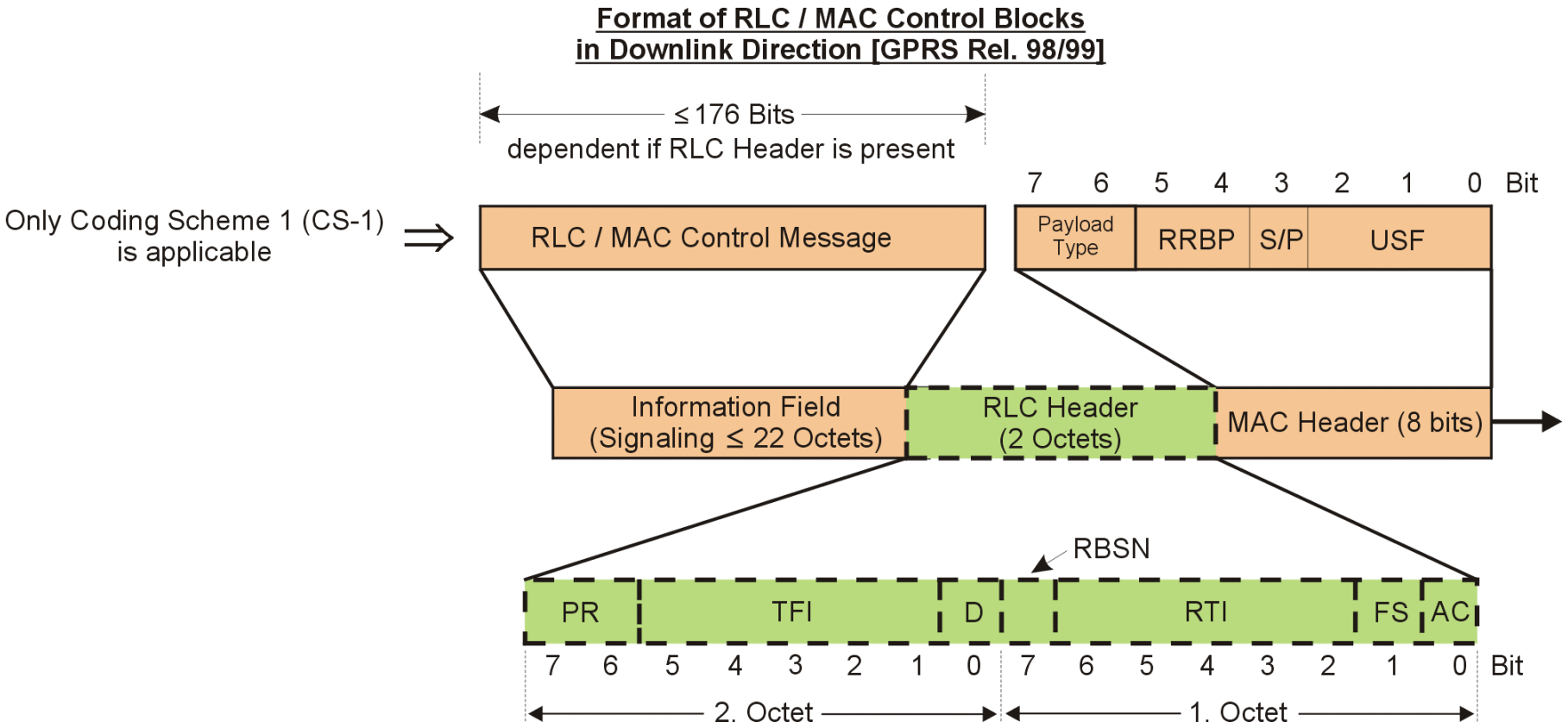
The RLC / MAC Frame Structure:

The following four slides illustrate:

- The RLC/MAC Data Block in Downlink Direction
  This format is used to transfer LLC-frames towards the mobile station
- The RLC/MAC Data Block in Uplink Direction
  This format is used to transfer LLC-frames from the mobile station to the network
- The RLC/MAC Control Block in Downlink Direction
  This format is used to transfer RLC/MAC control messages on PACCH, PBCCH or PCCCH towards the mobile station
- The RLC/MAC Control Block in Uplink Direction
  This format is used to transfer RLC/MAC control messages on PACCH from the mobile station to the network







Format of RLC / MAC Control Blocks in Uplink Direction