Cutting Edge Technologies
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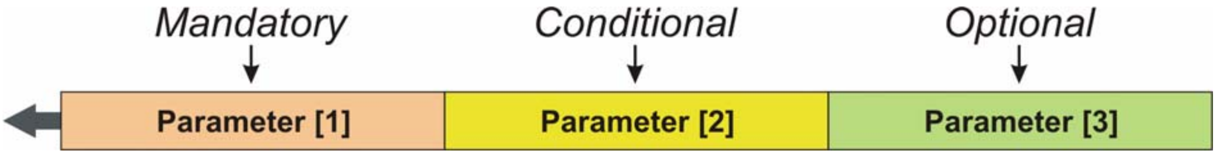
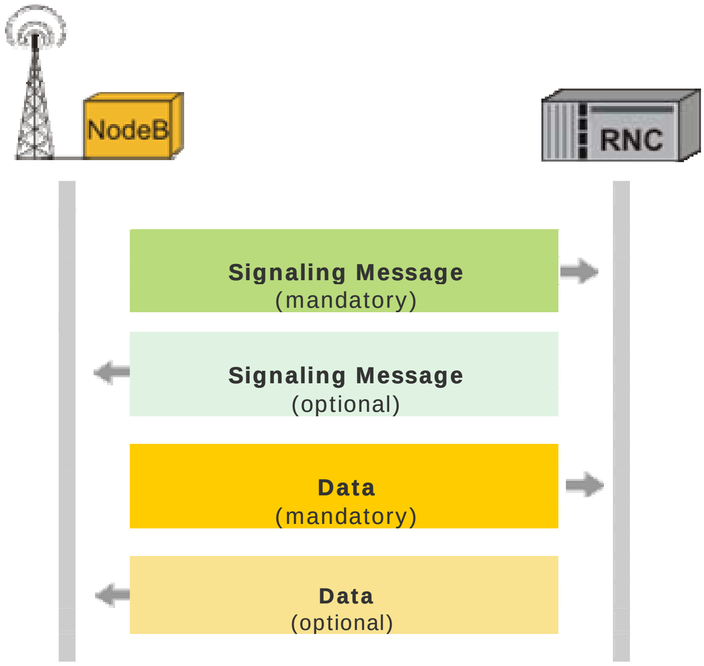
Legend:

All INACON publications use the same color codes to distinguish mandatory from optional or conditional parts in frame formats or optional from mandatory data blocks or signaling messages in scenarios. The different color codes are explained underneath:

- **Color Codes in Frame Formats:**



- **Color Codes in Scenarios:**



Foreword of the Publisher:

Dear Reader:

Note that this book is primarily a training document because the primary business of INACON GmbH is the training and consulting market for mobile communications. As such, we are proud to providing high-end training courses to many clients worldwide, among them operators like AT&T Wireless, INMARSAT or T-MOBILE and equipment suppliers like ERICSSON, MOTOROLA, NOKIA or SIEMENS.

INACON GmbH is not one of the old-fashioned publishers. With respect to time-to-market, form-factor, homogenous quality over all books and most importantly with respect to after-sales support, INACON GmbH is moving into a new direction. Therefore, INACON GmbH does not leave you alone with your issues and this book but we offer you to contact the author directly through e-mail (inacon@inacon.de), if you have any questions. All our authors are employees of INACON GmbH and all of them are proven experts in their area with usually many years of practical experience.

The most important assets and features of the book in front of you are:

- **Extreme degree of detailed information about a certain technology.**
- **Extensive and detailed index to allow instant access to information about virtually every parameter, timer and detail of this technology.**
- **Incorporation of several practical exercises.**
- **If applicable, incorporation of examples from our practical field experiences and real life recordings.**
- **References to the respective standards and recommendations on virtually every page.**

Finally, we again like to congratulate you to the purchase of this book and we like to wish you success in using it during your daily work.

Sincerely,

Gunnar Heine / President & CEO of INACON GmbH

PS: Please check for our UMTS online encyclopaedia at www.inacon.com.

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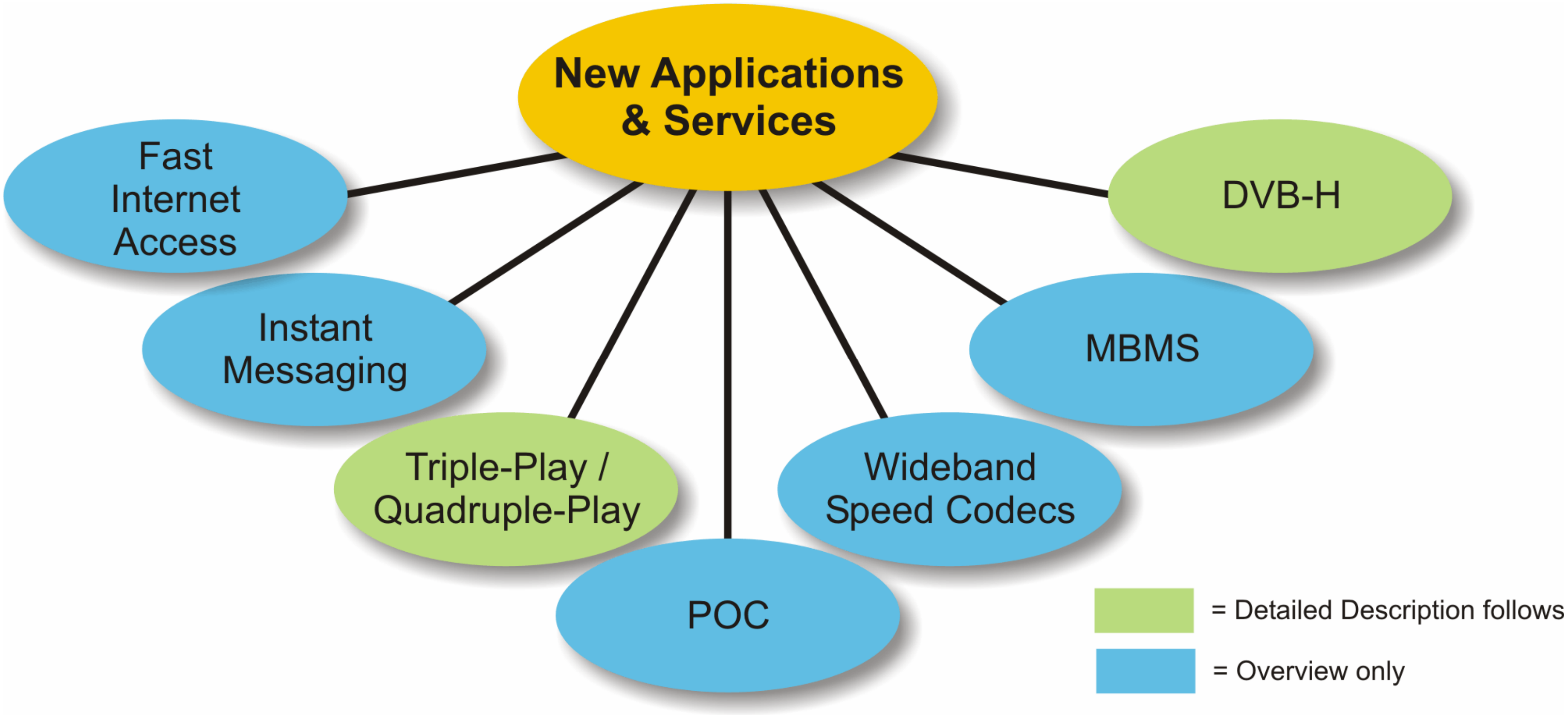
Evolution of the Applications & Services Domain



Evolution of the Applications & Services Domain

Fast Internet Access
Fast internet access allows mobile subscribers to use different services than with slower access technologies. Fast internet access is the enabler of many other enhancements like video telephony and multimedia services in general.

Instant Messaging
Instant messaging is perceived as a chance to revolutionize mobile messaging another time. Opposed to standard messaging services like e-mail and SMS, instant messaging allows an almost real-time conversation experience.

Triple-Play / Quadruple Play
Triple-Play relates to the possibility to deliver fast internet access, telephony and video services altogether to customers. Quadruple play adds mobility to these services.

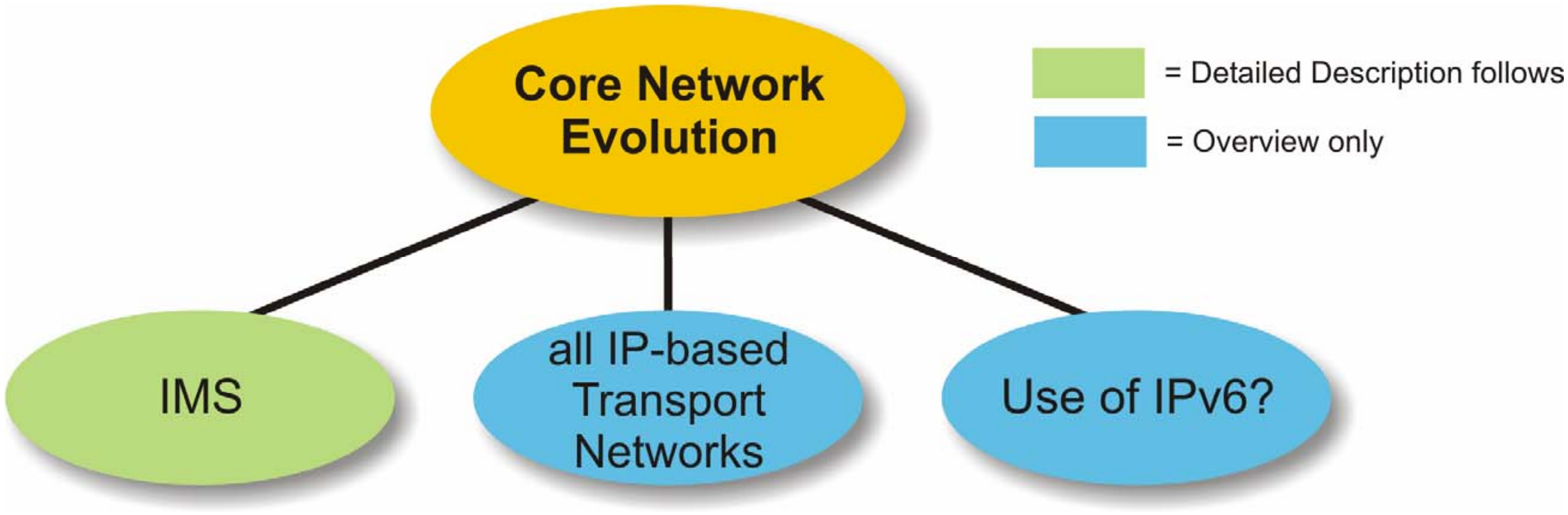
PoC (Push to talk over Cellular)
Initially a MOTOROLA proprietary technology which was exclusively used by the operator NEXTEL in the US, PoC was standardized as SIP- and IP-based technology for 3GPP-based networks.

Wideband Speech Codecs
The use of wideband speech codecs shall lift the voice quality to and beyond wireline standards. Adaptive codecs can bargain voice quality for redundancy and allow maintaining a speech call under harshest conditions.

MBMS (Mobile Broadcast/Multicast Services)
MBMS is a development to offer audio and (lightweight) video services to mobile subscribers. MBMS has been standardized within 3GPP (Rel 6) and distinguishes two operation modes: broadcast and multicast. In case of multicast, subscribers are able to provide requests and feedback information through an uplink channel.

DVB-H (Digital Video Broadcast – Handheld)
Essentially, DVB-H is an adaptation of Digital Video Broadcast – Terrestrial (DVB-T) that supports smaller screen sizes and requires less throughput rate to transmit video information.

Evolution of the Core Network Domain



Evolution of the Core Network Domain

IMS (IP-Multimedia Subsystem)

The most important change within the core network is the implementation of the IMS. The IMS represents the next generation of providing carrier based services to subscribers and it will enable long announced features like FMC (Fixed Mobile Convergence) and multimedia services.
Within 3GPP, the IMS and the updates HSDPA and HSUPA are frequently referred to as 3G+.

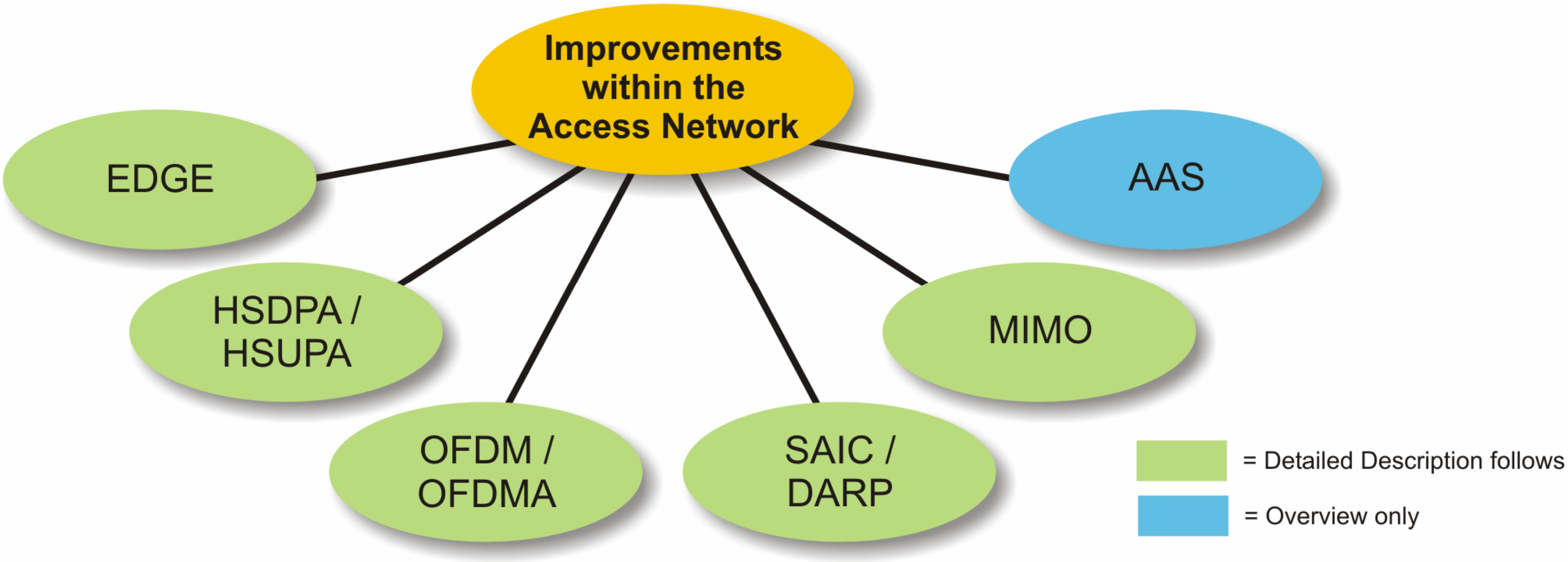
All IP-based Transport Network

The entire core network is more and more IP-based. This statement applies also to the updated circuit-switched core network architecture in which the MSC has been replaced by MSC-Servers and Media Gateways.
One important change is therefore a converged core network architecture that covers both, the packet-switched and the circuit-switched parts

Use of IPv6?

3GPP foresaw a widespread adaptation of IPv6 when it started the standardization of the IMS some years ago (2001). Yet, even today IPv6 can still be considered as an exotic variant of IP and IPv4 is still dominant. The reason is that the IPv4-specific problems related to SIP have been overcome. Therefore, it is questionable whether real-life IMS-implementations will be IPv6-based in the next years. Even 3GPP relaxed their mandatory requirement of using IPv6.

Access Network Improvements



Access Network Improvements

EDGE (Enhanced Data Rates for GSM Evolution)

EDGE has been around for a number of years. The most important improvement of EDGE is the alternative use of 8-PSK modulation in GSM to provide for a higher spectral density. Still, EDGE also provides other enhancements like enhanced forward and backward error correction compared to legacy GSM/GPRS.

HSDPA / HSUPA (High Speed Downlink Packet Access / High Speed Uplink Packet Access)

Similarly to EDGE in GSM, HSDPA in UMTS achieves its higher throughput rates mainly by allowing an alternative modulation scheme. This is 16-QAM in case of HSDPA. Another important advantage of HSDPA is the faster MAC-scheduling function for resource allocation which is more IP-centric.
HSUPA does not introduce new modulation schemes and mainly prospers from the parallel use of multiple channels per mobile station which increases the throughput rates.

OFDM / OFDMA (Orthogonal Frequency Division Multiplexing / Orthogonal Frequency Division Multiple Access)

Initially in mobile communication, there was FDMA, then GSM introduced TDMA, in 1997 we saw the introduction of CDMA with IS-95 in the US and now another new resource sharing and multiple access technology is introduced: OFDM / OFDMA. In that respect, OFDM represents the resource sharing part and OFDMA represents the multiple access technology.
Essentially, OFDM/OFDMA represent a special FDM-technology which allows for a higher spectral density.

SAIC / DARP (Single Antenna Interference Cancellation / Downlink Advanced Receiver Performance)

SAIC is a co-channel interference cancellation technology that was developed by German scientists at the University of Erlangen-Nuremberg and which has been adopted by 3GPP. Technically, SAIC allows operating GSM base stations with a higher spectral density. The mobile station receiver needs to be equipped with the SAIC software that subtracts the energy of co-channel interferers from the serving cell’s signal.
DARP is 3GPP’s name of SAIC. DARP is part of Rel 6 but may also be applied by older mobile stations.

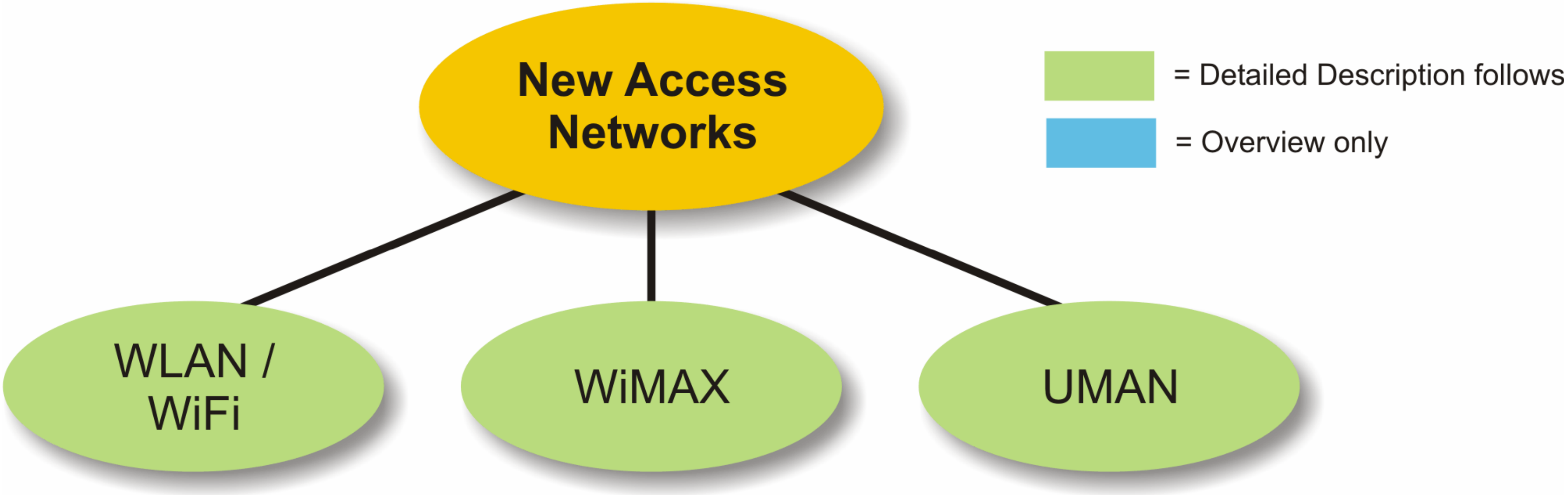
MIMO (Multiple Input / Multiple Output)

MIMO is yet another technology which operates on the physical layer level. Opposed to SAIC, MIMO operates with multiple receive and multiple transmit antennas to increase the throughput rate. Still, the basic target is to increase the spectral efficiency.

AAS (Adaptive Antenna Systems)

Like SAIC and MIMO, AAS operates on the physical layer. In AAS, an antenna array is used on the transmitter side to send differently phased, differently amplified versions of the same signal at the same frequency to a (mobile) receiver. The target is beamforming at the receiver’s location and signal extinction at other places.

New Access Network Technologies



New Access Network Technologies

WLAN / WiFi (Wireless LAN)

WLAN has been around for a few years (since 1998). Still its adaptation into the mobile domain became an issue only when GPRS turned out to be rather slow in terms of bandwidth and user unfriendly when it came to installation and use.
With the release 6 of 3GPP-standards, WLAN is an alternative radio access technology to UTRA and GSM/GPRS/EDGE. And with UMA, WLAN gets even further integrated into 3GSM.

WIMAX (Worldwide Interoperability for Microwave Access)

WIMAX represents yet another access network technology and therefore is an alternative to WLAN, GSM/GPRS/EDGE or UTRA. There are many different variants of WIMAX that can be distinguished in terms of their targeted applications.

UMAN (Unlicensed Mobile Access Network)

UMA represents an interesting approach of several system and mobile vendors to standardize the access to the standard GSM/UMTS-core network through alternative access networks that require no frequency licensing. As of today, UMA supports Bluetooth and WLAN (802.11) as unlicensed access network types.

Overview of Broadcasting Technologies

Stationary | In-car | Handset

Satellite	**DVB-S**	**Digital Video Broadcast Satellite**
Satellite	**S-DAB**	**Satellite - Digital Audio Broadcast** Data and radio broadcast only
Satellite	**S_DMB**	**Satellite - Digital Multimedia Broadcast** Broadcast in IMT2000 satellite bands to UMTS handsets. Based on DAB standard
Satellite	**MBSAT**	**Digital Video and Audio Broadcast** South Korea and Japan
Terrestrial	**DVB-T**	**Digital Audio Broadcast Terrestrial** TV, data and radio broadcast. Fixed and in-car reception
Terrestrial	**DVB-H**	**Digital Audio Broadcast Handheld** Based on DVB-T transmissio, mobile reception on handhelds
Terrestrial	**T-DMB**	**Terrestrial Digital Multimedia Broadcasting -** South Korea. Data and TV reception on handhelds. Expansion planned in Europe
Terrestrial	**ISDB-T**	**Integrated Services Digital Broadcasting - Terrestrial** HDTV broadcast - Japan only. Fixed in-car mobile reception. Extension for handsets planned
Terrestrial	**ATSC**	**Advanced Television Systems Committed** HDTV broadcast - North America only. Fixed reception only (rooftop)
Cellular	**MBMS**	**Multimedia Broadcast / Multimedia Service** UMTS evolution by 3GPP for content broadcast to a user group(multicast)
Cellular	**BCMCS**	**Broadcast and Multicast Service** CDMA2000 evolution for content broadcast to a user group (multicast)

Interactive Return Channel for payment, content selection, subscription, votting, ...

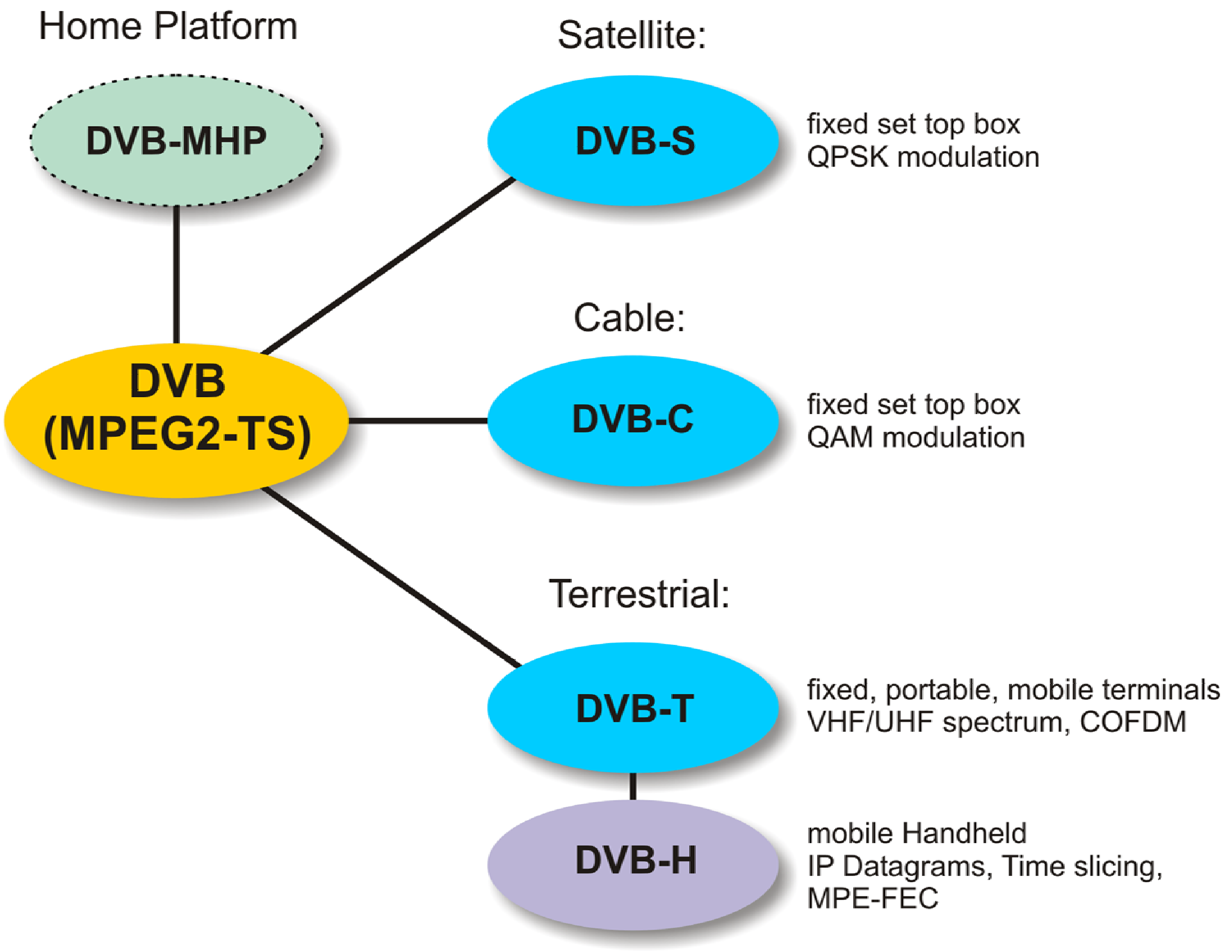
Overview of Broadcasting Technologies

The table shows an overview over actual and popular broadcasting technologies.

The technologies are dedicated to different applications: stationary (fixed) reception, reception with moving devices – fast moving for in-car usage and slow moving (pedestrian usage) for handheld devices. Some technologies will cover both fast and slow moving reception.

Typically, the satellite and terrestrial broadcasting channels lack an interactive return channel which would be available by nature on the cellular channels.
For interactive services it is expected that such return channels are provided through cooperation with cellular or wireless access technologies (⇔ GPRS, UMTS).

Digital Video Broadcast (DVB) Standards



Digital Video Broadcast (DVB) Standards

As a forum to agree technical specifications for transmission among suppliers, the DVB project has been established in 1993. The resulting specifications are being passed to standards bodies (ETSI, ISO/IEC) for ratification. Work items in the DVB project forum are driven by commercial requirements which then result in technical transmission specifications. One of the early fundamental decisions of the group was to re-use existing generic international standards, such as MPEG-2 (ISO/IEC 13818, parts 1,2,3) for the source coding of audio, video and the creation of elementary streams (TS).
The main focus has been on the specification for baseband signals over all sorts of delivery channels, via satellite (DVB-S), cable delivery (DVB-C) and for terrestrial transmission (DVB-T). Latest developments cover the terrestrial transmission to mobile (handheld) stations (DVB-H), interactive services and IP datacast.

DVB-S

The first specification finalized (EN 300 421) covers channel coding, error correction mechanisms and modulation for DVB signals for delivery over satellite links. DVB-S uses QPSK for the modulation.

DVB-C

Signal delivery on cable systems (CATV) is defined in EN 300 429. For DVB-C transmission systems, QAM modulation schemes have been defined.

DVB-T

The usage of digital terrestrial transmission is defined in EN 300 744. For DVB-T transmission systems, COFDM and QPSK, 16-QAM and 64-QAM have been defined in Europe (and 8VSB in the US). The system is designed to operate in the existing VHF and UHF spectrum allocated for analogue transmissions. Single Frequency Network (SFN) operation can provide maximum spectrum efficiency in this case. TS 101 191 defines a Mega-frame for SFN synchronization.
The EU sponsored Multimedia Car Platform (MCP) project revealed the ability of DVB-T to serve fixed, portable and mobile terminals.

DVB-H

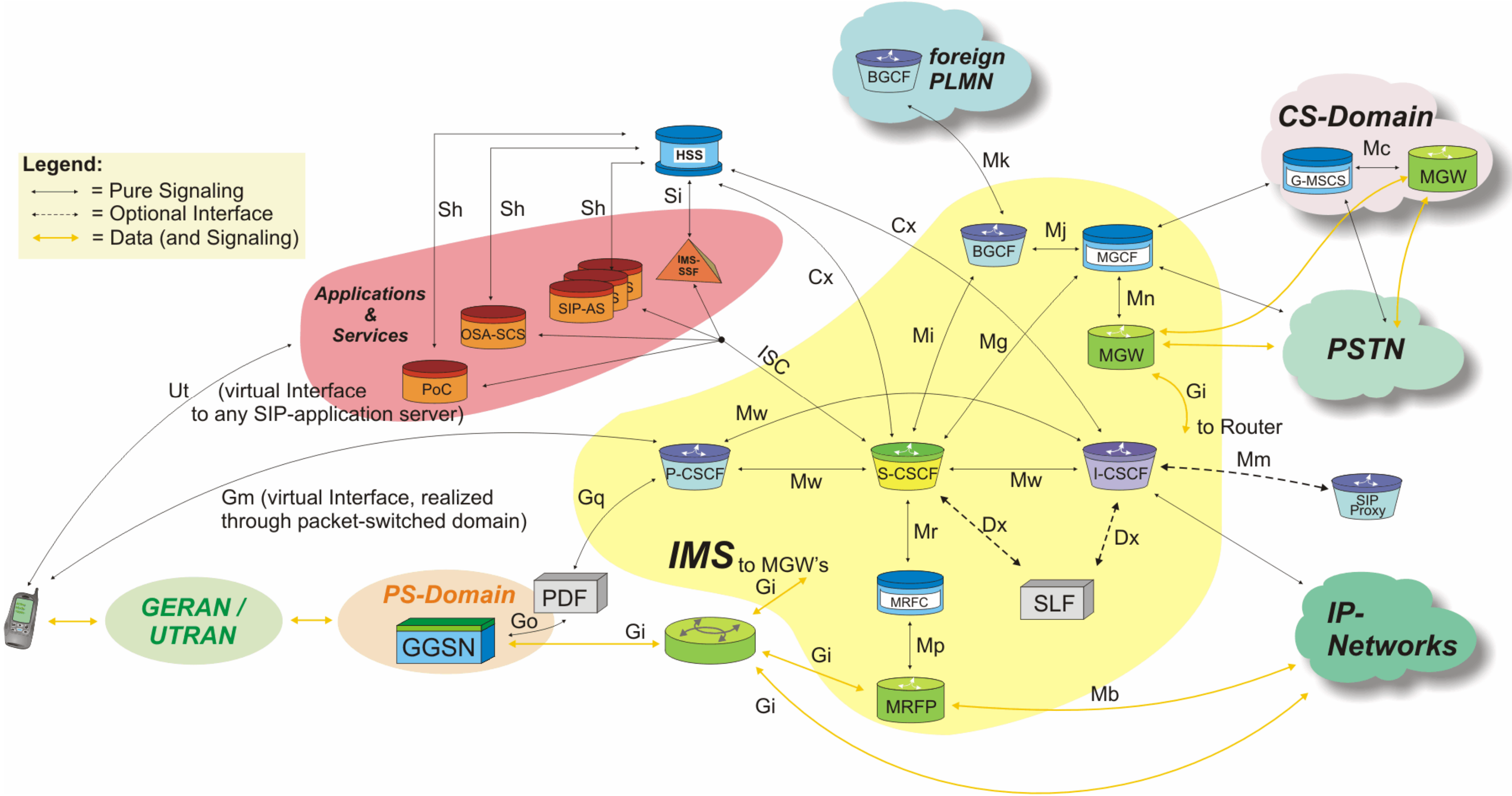
The standard can be viewed as an extension to DVB-T with the focus on specific requirements for mobile handheld terminals, such as power considerations, small displays and mobility. These are defined in EN 300 744 Annex F and in EN 302 304. DVB-H uses the same modulation standards as DVB-T, however MPEG-4 part 10 (H.264/AVC) has been selected for video compression and the payload is IP datagrams

The additions introduced with DVB-H have no impact on the DVB-T physical layer, therefore, DVB-H is totally backwards compatible to DVB-T. TV, Radio and Data may be distributed over common DVB-H channels or multiplexed with DVB-T contents.

DVB-MHP

The Multimedia Home Platform (MHP) defines a generic interface between interactive digital applications and the terminals in order to decouple the provider applications from the specific HW and SW of terminal implementations (e.g. set top boxes, integrated digital TV sets, multimedia PCs).

Detailed View on the IMS



Detailed View on the IMS

The figure illustrates the entire IMS (IP Multimedia Subsystem) architecture with all logical network elements. Note the following:

⇒ There is no requirement that each logical node is represented by a separate physical node.

⇒ In the figure, the orange colored lines represent the way that the media streams take. The black lines represent interfaces with pure signaling information transfer.

⇒ Dotted lines represent optional interfaces.

⇒ The Gm-interface between the UE and the P-CSCF is obviously a virtual interface that is physically realized through the packet-switched core network domain and the respective access network.

⇒ If the PDF is not integral part of the GGSN, then there is an individual PDF network element with a Gq-interface towards the P-CSCF and the Go-interface towards the GGSN.

⇒ Please note that the adjacent "Applications & Services" cloud in this figure only illustrates the IMS-relevant network elements but actually also contains the SM-SC and the MMS-SC. The PoC-server is the "Push-to-talk-over-Cellular"-server.

[3GTS 23.002, 3GTS 23.228]

Abbreviations:

CSCF: ______________________

IMS-SSF: ______________________

SIP-AS: ______________________

PDF: ______________________

ISC-Interface: ______________________

HSS: ______________________

SLF: ______________________

OSA-SCS: ______________________

PoC: ______________________

BGCF: ______________________

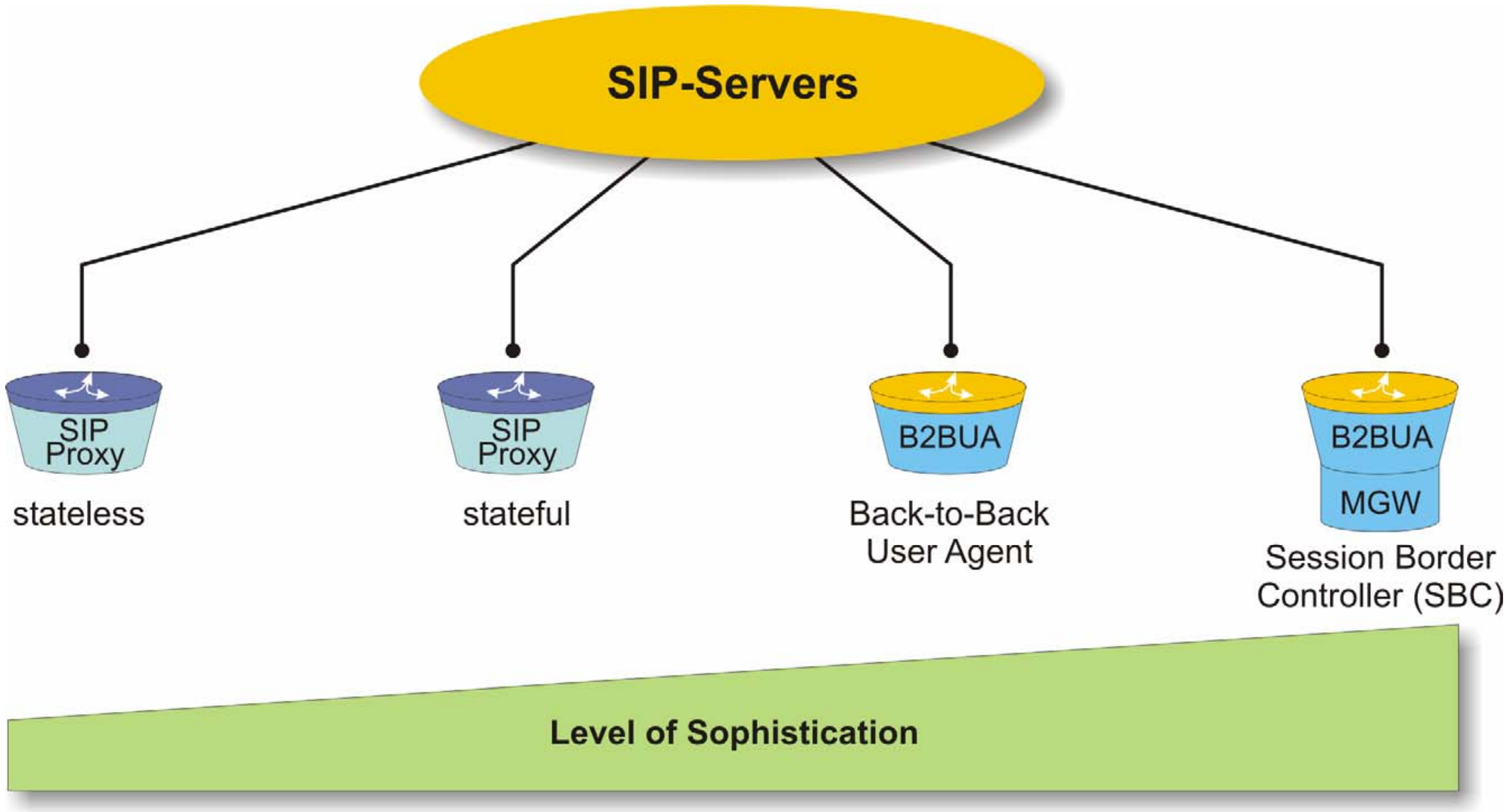
MGCF: ______________________

MRFC: ______________________

MRFP: ______________________

MGW: ______________________

SIP-Servers


SIP-Servers
SIP Proxy
stateless
SIP Proxy
stateful
B2BUA
Back-to-Back User Agent
B2BUA
MGW
Session Border Controller (SBC)
Level of Sophistication

SIP-Servers

Stateless SIP-Proxy Server

Unlike stateful proxies, stateless proxies *do not maintain or observe* the state of a SIP-transaction which is routed through them. That is why we did not include any UAC or UAS functions into the stateless proxy. Stateless proxies will also not retransmit SIP-messages. Still, stateless SIP-proxies will also inspect the content of SIP-messages and they may add header fields autonomously. However, like stateful SIP-proxies, a stateless SIP-proxy is not allowed to autonomously generate SIP-Requests. In contrast to stateful SIP-proxies, the stateless SIP-proxy cannot generate CANCEL-Requests. And stateless SIP-proxies cannot redirect a Request: INVITE-message to a new direction if they receive a redirection response (⇔ Response: 3XX) from a redirect server. And more, stateless proxies cannot be used for forking. More details about stateless SIP-proxies follow later in this section.

[RFC 3261 (16.11)]

Stateful SIP-Proxy Server

In general, a SIP-proxy is a device which is addressable by a SIP-User Agent or by another SIP-proxy server through a SIP-URI (Uniform Resource Identifier). Usually, SIP-proxies will relay SIP-messages somewhat closer to their final destination. However, with one exception a SIP-proxy server is not allowed to generate SIP-requests autonomously. The exception are Request: CANCEL-messages which need to be generated by the proxy server e.g. after a called SIP-device has been ringing for some time and now the call shall be forked to the next possible device. Stateful SIP-proxy servers maintain and observe the *state of every transaction which is routed through them*. Note that they do not maintain *dialog or call state*, this is the domain of B2BUA's.
Only stateful proxies can be used as redirect server or as registrar. And only stateful proxies can be used for forking.

[RFC 3261 (16.2)]

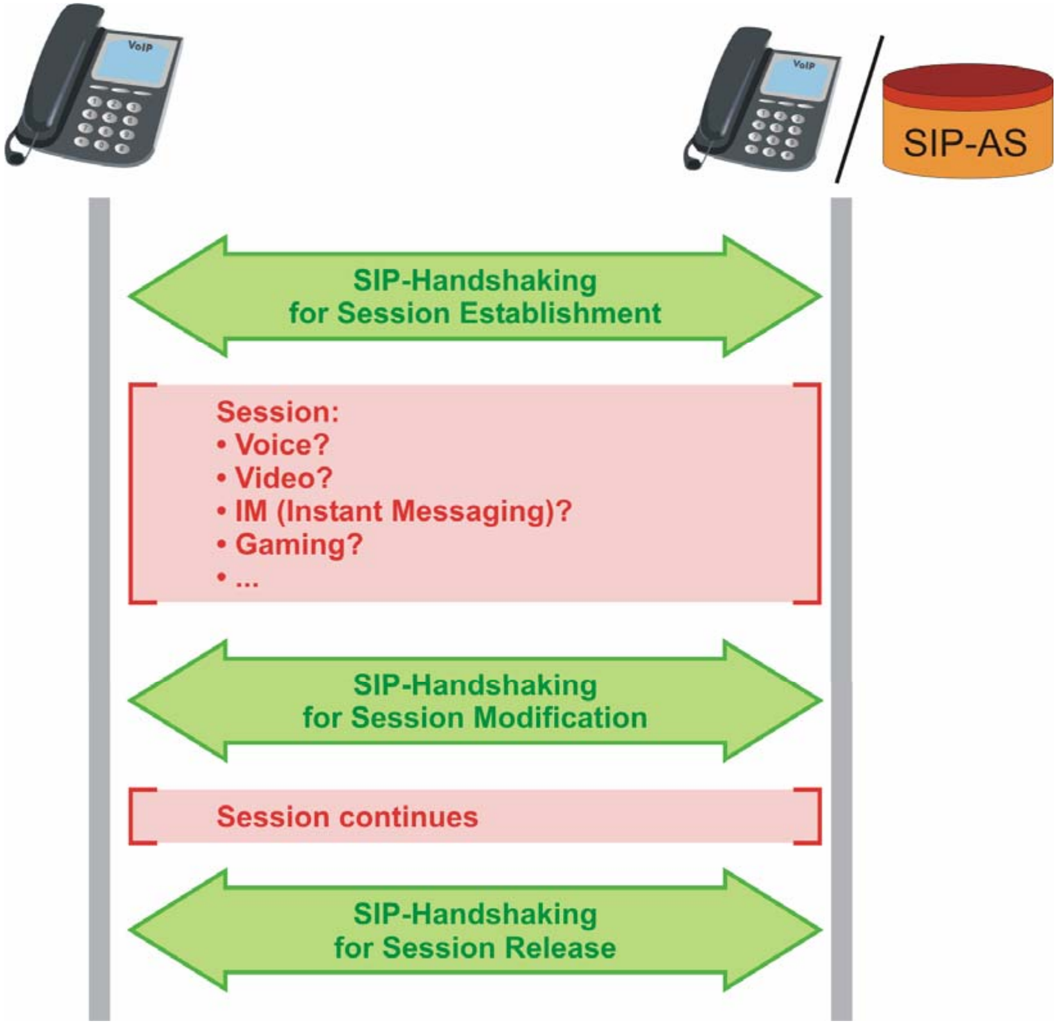
SBC (Session Border Controller), B2BUA (Back-to-Back User Agent)

Note that the terms "Session Border Controller" or "SBC" have no representation in IETF standards as such.

In practice, SBC's represent the combination of B2BUA's (which actually have been defined in RFC 3261) and media gateway like equipment that allows for media stream observation and even modification (e.g. change of codec type). Examples of SBC operation follow on the next side.
Most importantly, B2BUA's represent SIP-proxy servers that act like user agents. That is, B2BUA's can autonomously generate SIP-Requests and they can autonomously terminate a session (⇔ through a Request: BYE) which is something that a SIP-proxy cannot do.
When B2BUA's are also used for media transversal then they become SBC's.

The Session Initiation Protocol (SIP)

- **Scope of SIP**



The Session Initiation Protocol (SIP)

Scope of SIP
The figure illustrates the major tasks and functions of SIP which are:

Session Establishment
SIP-signaling messages are used to establish a session between two peers or between an originator and various other parties (e.g. conference call). In that respect it is important to understand the independence between the signaling protocol SIP and the session to be established. This independence is remarkable when comparing SIP with other "call control" protocols like the ISDN protocols that have been tailored to establish speech or fax calls between users.

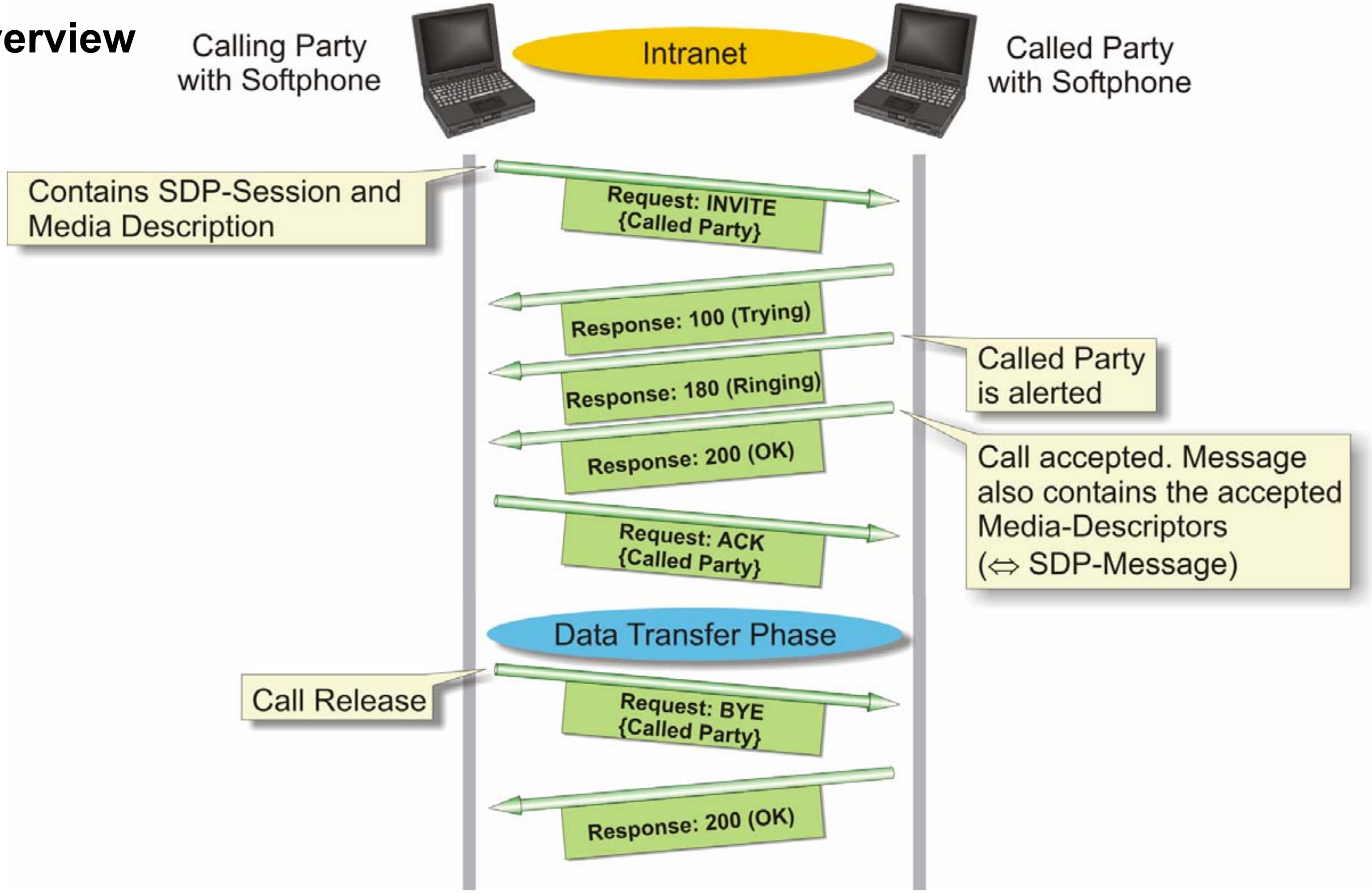
Clarification of the Term "Session"
SIP serves as a means to establish sessions; we understand this from the previous bullet. In the SIP-terminology a session is defined as "an exchange of data between an association of participants" [RFC 3261 (page 8)].
This abstract definition should be supported at this time through some practical examples: Sessions established through SIP include basic voice calls or video calls between two or more parties, real-time games between users or between a user and an application server where SIP is used in its genuine function to orchestrate the session setup, management and release. Yet another session example is instant messaging (IM). Obviously, this list is not exhaustive.

Session Modification
During a session it may become necessary or it is desired by either party to modify that session. Typical examples for session modification are the addition or reduction of a video component during a call or the addition or removal of participants.
Although SIP does not contribute anything to most sessions, it will jump in again for performing this session modification.

Session Release
Eventually, any session has to be released. SIP is invoked again to perform this action.

Simple Example of a SIP-Scenario: VoIP Call Setup with SIP

- **Overview**



Simple Example of a SIP-Scenario: VoIP Call Setup with SIP

Overview

The figure illustrates a very simple example for SIP-session establishment on our intranet. Both parties have a SIP-softphone installed and are connected to the intranet and the (private) IP-address of each party is known to each other party. In this example, we like to highlight the basic call establishment rules of SIP.

⇒ The Request: INVITE-message is sent to the called party. Most importantly, it contains the SDP-descriptors that describe this session and the media to be used from the perspective of the calling party. That means these SDP-descriptors tell the called party in case of a voice call, on which port number the calling party is prepared to receive information from the called party using which audio codec(s).

⇒ The Response: 100 (Trying)-message is quite redundant in this case where both parties are connected directly to each other. If a session setup ranks over various networks, each SIP-proxy server will respond to an INVITE-message with 100 (Trying), if the INVITE-message can be processed.

⇒ As soon as the called party is alerted (the softphone indicates incoming call to the user), the Response: 180 (Ringing)-message is sent back to the calling party.

⇒ When the called party accepts the call, a Response: 200 (OK)-message is sent to the calling user. This message also contains the SDP-description from the called party’s perspective. That means these SDP-descriptors tell the calling party in case of a voice call, on which port number the called party is prepared to receive information from the calling party using which audio codec(s).

⇒ The calling party acknowledges the reception of this final response by sending a Request: ACK-message to the called party.

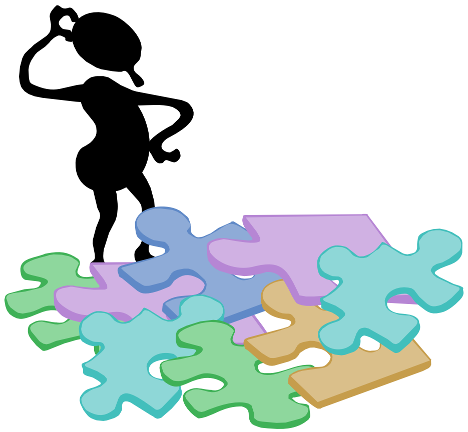
⇒ The call is active.

⇒ When either party intends to release the call a Request: BYE-message is sent to the peer. The reception of this message and the end of the call is indicated through a final Response: 200 (OK)-message.

Summary: Some SIP-Terminology

- **Message Types**
  Only two message types exist: Requests and Responses. Almost every Request must be responded by at least one Response.

- **SIP-Methods**
  The SIP-method defines a transaction. Many different method types have been defined of which the indicated INVITE-, ACK- and BYE-methods are only examples.



- **Response Types**
  There are provisional and final responses. Final responses terminate a transaction and they indicate whether a transaction was successful or not. Many different status codes exist to distinguish different transaction outcomes.

Summary: Some SIP-Terminology

Message Types

In general, SIP-Requests are used to initiate a transaction while SIP-Responses are used to indicate the possibly intermediate result of a transaction which was previously invoked by a related SIP-Request message. In our example, the initial message Request: INVITE receives the following three Response messages and the transaction ends.
Obviously, there are exceptions to the aforementioned rule: In the example we see one example: The Request: ACK-message does not initiate a transaction and it does not require a response as it is only there to confirm the dialog establishment which has been achieved when the Response: 200-OK is sent and received. Another example of an exception is CANCEL which does not initiate a transaction but which is used to cancel a previous Request: INVITE.

SIP-Methods

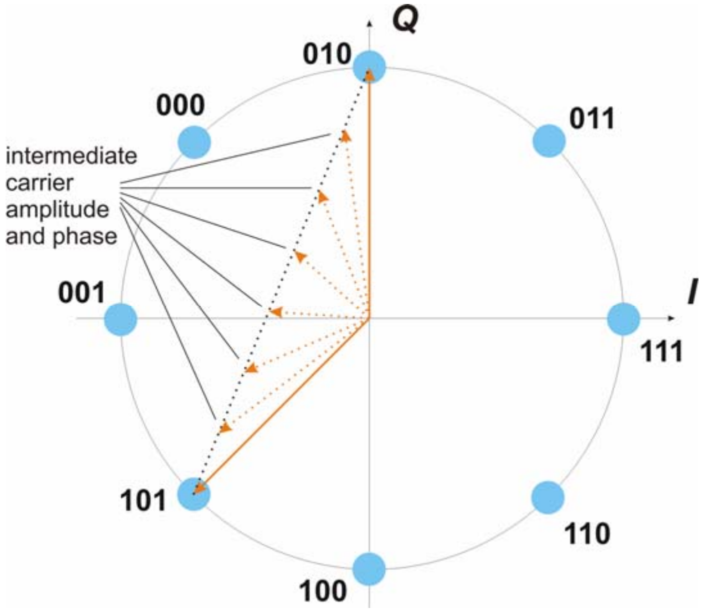
The “real” message type in SIP is the “method-type”. It is the method type that indicates what the target of a transaction is. In that respect, the illustrated INVITE-method is the most important method type as it is the only method type to establish sessions between peers. The example also includes the BYE-method which is used to initiate the release of an established session. Many more method types exist which will be presented later.

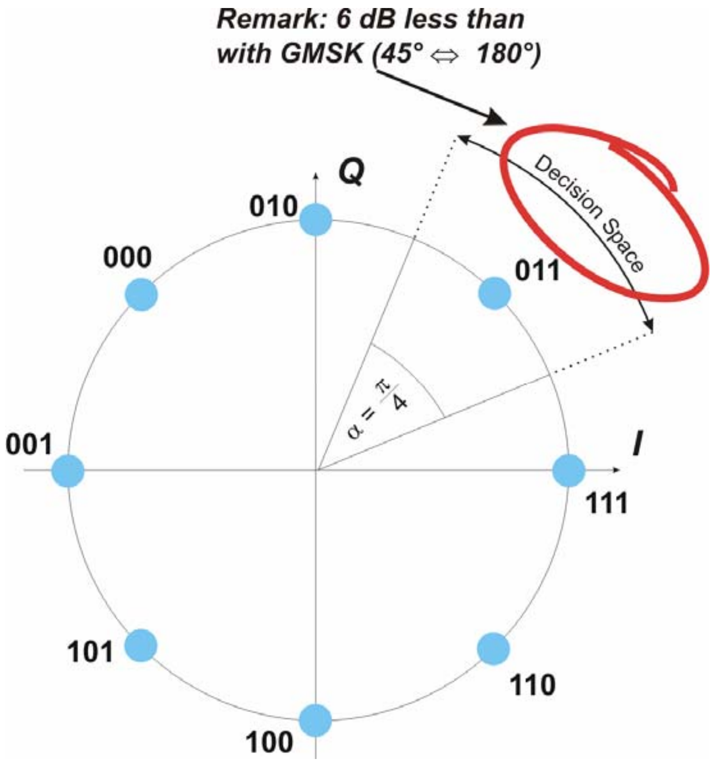
Response Types

With the exception of the aforementioned method type ACK, every SIP-Request message needs to be responded to with at least one response message which is called the “final response” message. Final response messages are those with a status code between 200 and 699. In that respect, there is a primary distinction between successful transaction results (⇔ status code = 2XX) and unsuccessful transaction results (⇔ status code = 3XX – 6XX). Further distinction of unsuccessful responses is possible through the 3, 4, 5 and 6 at the front of the status codes which indicate whether a transaction needed to be terminated unsuccessfully because of server error, client error or global errors. More details will be provided later.

8-PSK Modulation

- **8-PSK in the I/Q-Plane**





8-PSK Modulation

Introduction

With the advent of EDGE, a second modulation scheme is supported in GSM. This new modulation scheme is "3π/8 Offset 8-PSK", a special offset variant of plain 8-PSK modulation. Before a detailed consideration of 3π/8 Offset 8-PSK, we need to explain the specifics of 8-PSK:

⇒ Unlike GMSK, plain 8-PSK is no differential modulation scheme. The position of the modulated symbols and the respective bits is fixed as illustrated in the two figures.

⇒ Unlike GMSK, 8-PSK distinguishes among 8 different symbols. Therefore, 3 bit can be conveyed within a single symbol when using 8-PSK. Provided that the same symbol rate is used, 8-PSK provides three times the throughput of GMSK.

In GSM, 3π/8 Offset 8-PSK and GMSK use the same symbol rate of 1/T = 1625 / 6 kilo symbols/s. With 3 bit per symbol, 3π/8 Offset 8-PSK provides for a gross bit rate of 1625 / 6 x 3 kbit/s = 812.5 kbit/s.

⇒ The decision space in 8-PSK is much smaller than in GMSK as illustrated in the right figure (⇔ 8-PSK = π/4 / GMSK = π). This makes 8-PSK modulation more vulnerable to interference than GMSK (⇔ the C/I-requirement is higher using the same data rate and FEC).

- Another disadvantage of plain 8-PSK modulation is the inherent amplitude modulation. Symbol changes always occur directly and not along the circle between any two symbols (⇔ left figure).
- To be more precise: When using 8-PSK with a symbol duration of T = 6/1625 µs and a maximum phase shift of 180° (⇔ π), it is no longer possible to move the signal vector along the circle. The required frequency shift would be $\Delta f = \Delta\varphi / (2\pi \times T) = \pm \pi / (2\pi \times 3.692\ \mu s) = \pm 135.43$ kHz. This would exceed the available frequency spectrum of ± 100 kHz = 200 kHz.
- As a consequence of the direct shifts the amplitude of the carrier frequency changes. In the extreme case a phase change of 180° (⇔ π) causes the carrier amplitude to reverse its direction which in turn results in an increased bandwidth demand.

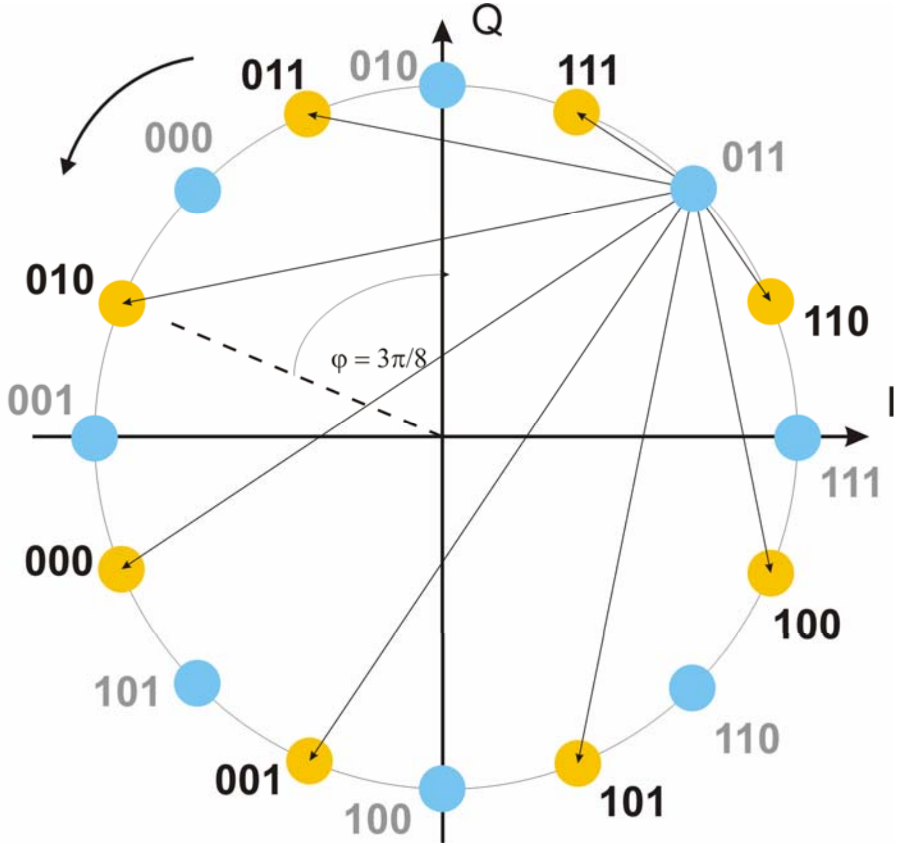
Gray Encoding

The figure illustrates 8-PSK modulation, using Gray-Encoding. With Gray-Encoding, any two adjacent symbols differ only by a single bit. Therefore, output errors can be minimized in case of an erroneous demodulation of the adjacent symbol. Gray-Encoding is also used in GSM.

[3GTS 05.04 (3)]

3π/8 Offset 8-PSK

3π/8 Offset 8-PSK Modulation
No Zero Passing



3π/8 Offset 8-PSK

As the name suggests, 3π/8 Offset 8-PSK is an offset variant of plain 8-PSK-modulation. Between any two symbols, the symbol circle shifts by an offset angle of 3π/8. As an example, the figure illustrates one symbol change from the blue-colored symbol state which is in-phase with plain 8-PSK to the orange-colored symbol state which is shifted by 3π/8 compared to the previous symbol state.
The advantage over plain 8-PSK becomes immediately apparent when looking at the possible symbol changes for (011):

There can be no "Zero"-crossings in 3π/8 Offset 8-PSK. The amplitude modulation is limited to –15 dB.

Obviously, 3π/8 Offset 8-PSK also provides three times the throughput rate of GMSK-modulation, if the symbol rate is identical. The disadvantage of 3π/8 Offset 8-PSK compared to plain 8-PSK is:

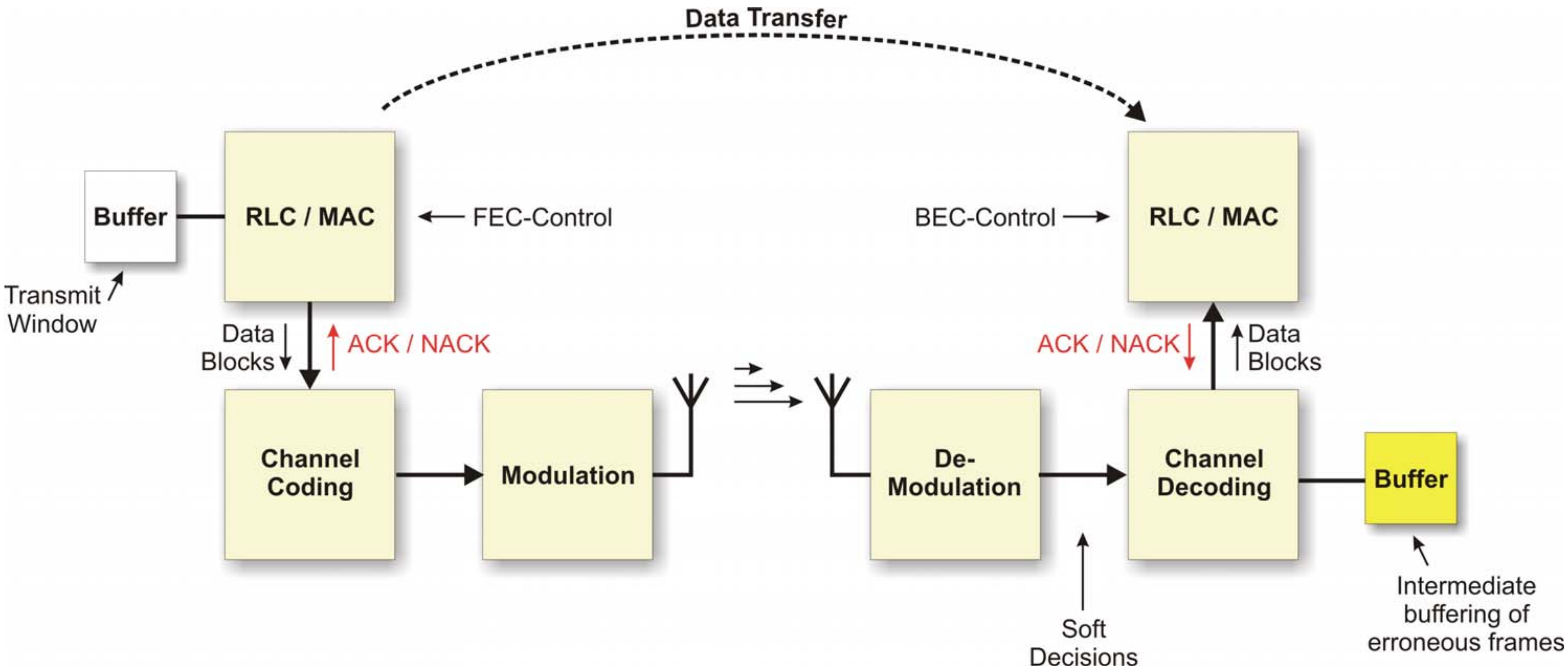
In 3π/8 Offset 8-PSK the phase of the received signal is unknown to the receiver and needs to be determined prior to demodulation which requires additional effort (⇔ is achieved in GSM through the alignment of the received symbols with the TSC).

Note: Even when using 3π/8 Offset 8-PSK and therefore limiting the maximum phase shift $\Delta\varphi$ to 7/8 π it is still not possible to move the signal vector along the circle. The required frequency shift would be $\Delta f = \Delta\varphi / (2\pi \times T) = \pm 7/8\,\pi / (2\pi \times 3.692\ \mu s) = \pm 118.5$ kHz. Like in plain 8-PSK, this would exceed the available frequency spectrum of ± 100 kHz = 200 kHz.

[3GTS 05.04 (3)]

Incremental Redundancy

- **Principles**



Incremental Redundancy

Principles

Please recall the data processing chain that we introduced at the beginning of this chapter. This new figure re-uses the same data processing chain but adds another data buffer at the receiving side. This buffer is required to deploy incremental redundancy.

When incremental redundancy shall be used, the receiver needs to buffer erroneous frames to be able to combine them with the upcoming retransmission(s) of the same frame. This buffer is memory that is required in the layer 1 most likely within the base station. The buffer size depends on the implementation and the number of timeslots that have been allocated.

Even when incremental redundancy is used, the BEC-control remains a function of the RLC/MAC-control layer which is part of layer 2.

When incremental redundancy is used, data blocks cannot be split.

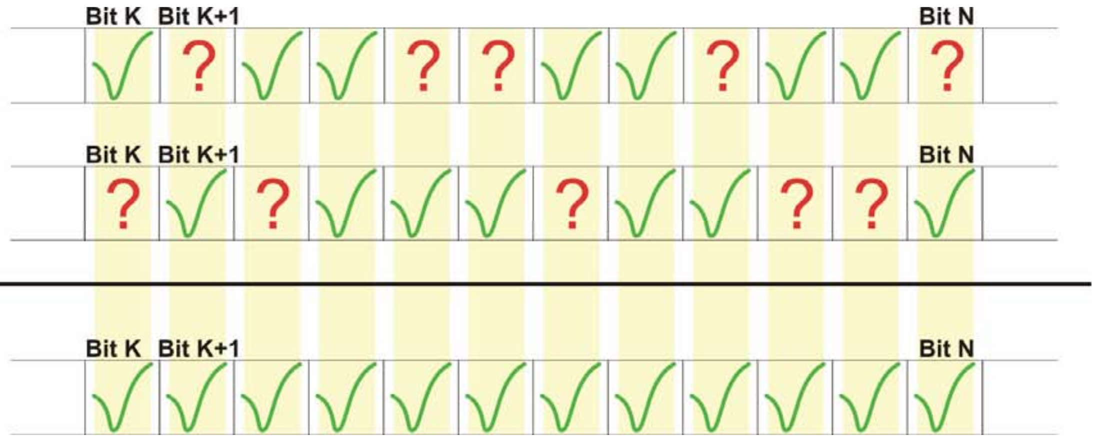
[3GTS 03.64]

Operation in the Receiver

1. Instance / State after Decoding:

2. Instance / State after Decoding:

Combination of both Instances:



Operation in the Receiver

The figure illustrates how incremental redundancy operates:

⇒ After reception of the initial transmission of a given data frame, there are some bit positions which remain unknown to the decoder. Recalling our considerations of demodulation, these bits are in the “red or yellow areas”, they do not deliver “strong” values. Accordingly, the receiver will ask for a retransmission but since incremental redundancy shall be used, the entire data block needs to be buffered.

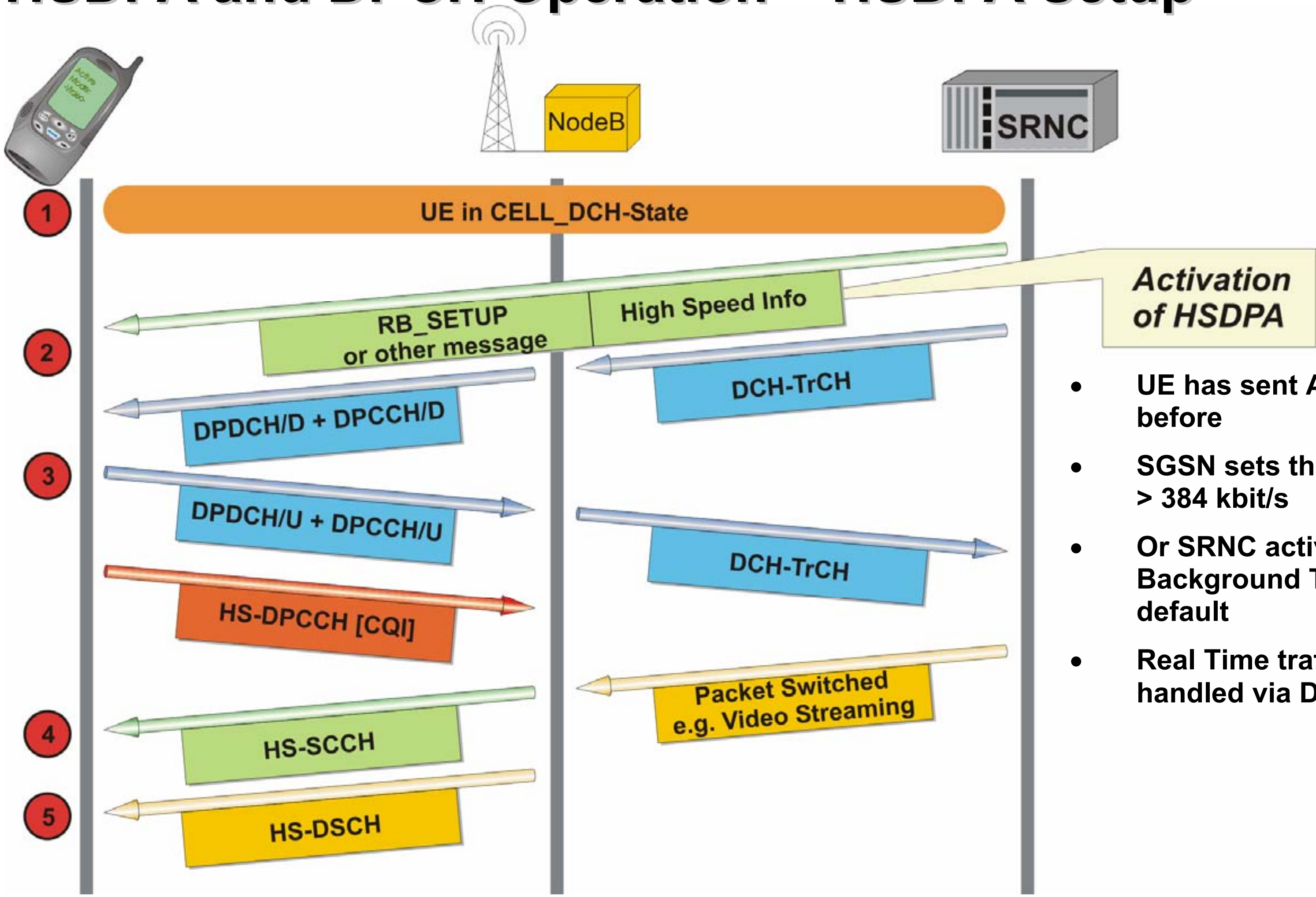
⇒ The retransmission of the same data block will occur with another puncturing scheme. In our example, this second transmission neither provides all “strong” values. Still, combining the two instances the decoder is able to select only strong bit positions and to provide an entirely correct result to the next higher layer.

Note:

- It is implementation dependent whether the decoder buffers all instances of a data block until a correct result is available or whether all previous instances are combined to only one result which is then combined with the next retransmission.
- Even “strong” bit values can be wrong which can only be detected through a parity bit check at the end of the decoding process.
- The GERAN recommendations require a very impressive performance of the incremental redundancy implementation: 3GTS 51.010 (Rel. 5) defines the test case TC 14.18.7 which requires that even with –96 dBm and using MCS-9 the throughput rate shall be at least 20 kbit/s. Considering the maximum throughput rate of MCS-9 (⇔ 59.2 kbit/s), this requires that in average only two retransmissions are allowed.

[3GTS 03.64 / 3GTS 04.60 / 3GTS 51.010 (14.18.7)]

HSDPA and DPCH Operation – HSDPA Setup



- UE has sent ACT_PDP_CONTEXT_REQ before
- SGSN sets the MaxBitrate to > 384 kbit/s
- Or SRNC activates for Interactive and Background Traffic Class HSDPA by default
- Real Time traffic e.g. voice call must be handled via DCH/DPCH

HSDPA and DPCH Operation – HSDPA Setup

HSDPA Setup via DPCH

The resource allocation of HSDPA requires the previous setup of a DCCH mapped on DCH. The DCH transport channel runs on a Rel. '99 DPCH. This means, in order to setup and maintain HSDPA operation, there is always a DL DPCH and UL DPCH needed. Upon RRC connection request sent by UE, the SRNC may request the UE's HSDPA capabilities. The HSDPA related configuration supported in a cell is signaled to the UE via a DCCH mapped onto a DCH which is carried by DPDCH+DPCCH. By decoding the so called "High Speed Information" on the DCCH the UE obtains is informed about the physical layer configuration for HSDPA in the Cell. This physical layer configuration allows the UE to decode the HS-SCCH which informs the UE about available user data on the shared transport channel HS-DSCH.

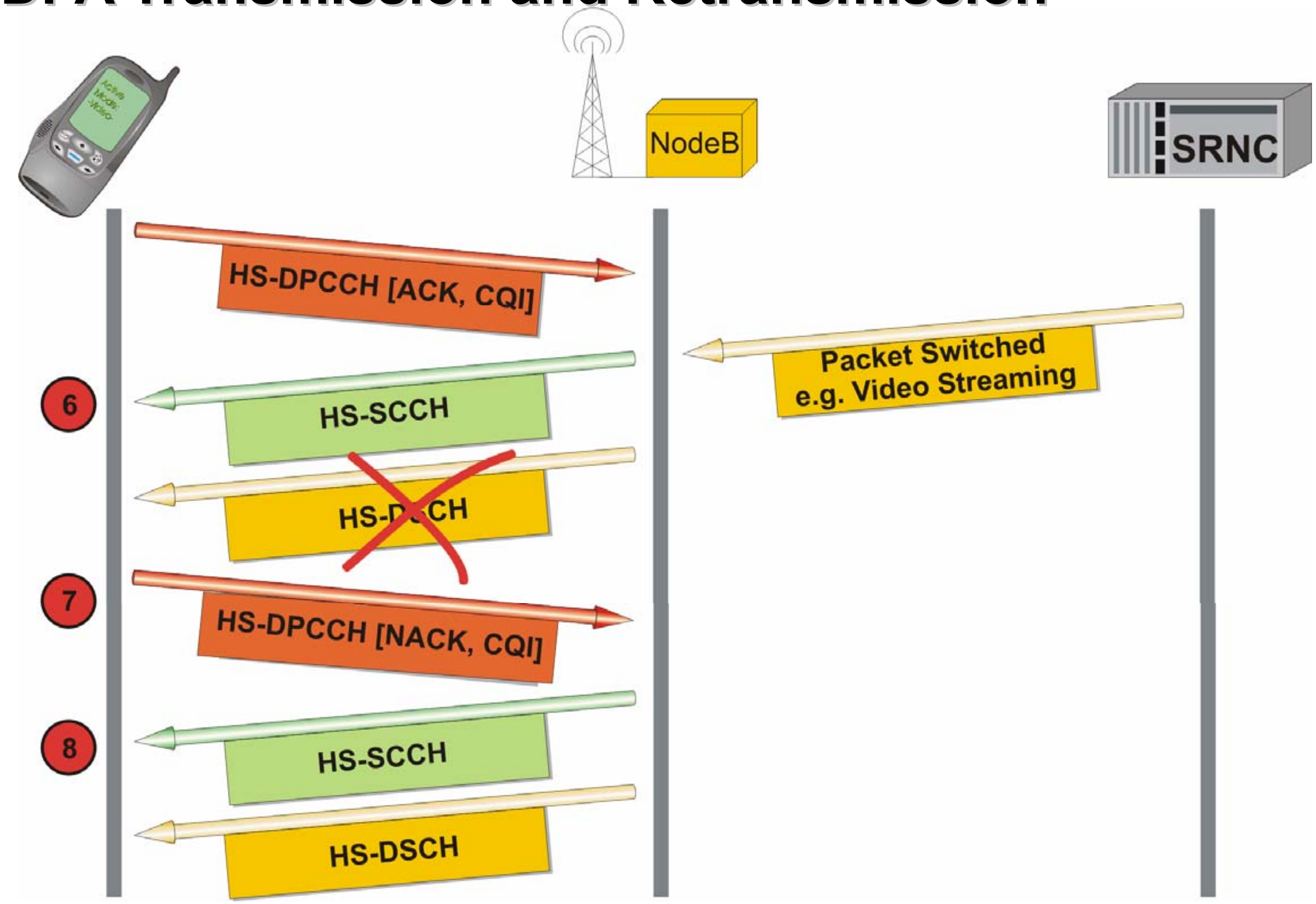
Note there are no parameters broadcast on BCCH about a cell's HSDPA capability.

The basic HSDPA setup is explained below:

1. Before moving in CELL_DCH state the UE is told by the RNC to reveal its HSDPA capabilities and category e.g. via RRC Connection Setup message.
2. Once the RNC has obtained the UE's HSDPA capabilities, the subsequent RRC configuration messages (e.g. Radio Bearer Setup) contain the high speed information telling the UE about the HSDPA configuration in the cell. High speed information contains e.g. the UE identity (⇔ called H-RNTI) which is implicitly encoded on HS-SCCH to identify the very UE getting HS-DSCH resources allocated, the scrambling code to be applied for HS-PDSCH and HS-SCCH and the HS-SCCH channelization code-set. This is necessary to inform the UE about the decoding of the HS-SCCH which contains specific information about the HS-PDSCH's format carrying the HS-DSCH. From this moment on the UE is in a so called HSDPA "standby mode" ready to decode HS-SCCH's. Note: The UE might be told to monitor up to four HS-SCCH's.
3. A DPCH must always exist before a UE is able to operate in HSDPA as it carries the DCCH. The DPCH handles the real-time services, e.g. AMR 12.2 voice channel and the RRC signaling via SRB's. On SRB's the necessary RRC signaling messages are exchanged e.g. to reconfigure the physical link for HSDPA or prepare for HS-DSCH cell change. Please remember that HSDPA is not (yet) intended for services with real-time QoS requirements.
4. If there are packet data to be transferred to the UE in downlink, the NodeB will relay the necessary information for decoding the HS-DSCH to the UE on HS-SCCH's. The UE must be capable of decoding up to four HS-SCCH in parallel. This is a so called HS-SCCH-set. From the HS-SCCH's the UE obtains information how to decode the subsequent HS-PDSCH's and finally obtains the user data from the HS-DSCH.
5. If the UE detects consistent control information intended for it, the UE shall start receiving the HS-PDSCH's. Consistent control information means e.g. that the UE decodes its H-RNTI in one of the assigned HS-SCCH's of the HS-SCCH code-set.

[3GTS 25.302 (8.2), 3GTS 25.331 (8.6.3.1b, 8.6.6.32, 10.3.6.23a, 10.3.6.36a)]

HSDPA Transmission and Retransmission



HSDPA Transmission and Retransmission

6. Whenever there are packet data to be transmitted to a certain UE, the HS-SCCH indicates to the respective UE that the successive HS-DSCH transport channel contains user data destined for it. If the decoding of the HS-DSCH transport block fails because of CRC error, it is going to report a NACK in the corresponding uplink HS-DPCCH channel.
7. The UE shall transmit acknowledgement information received from the MAC-hs-entity to inform the NodeB whether the HS-DSCH subframe was decoded correctly or incorrectly.
8. If the HS-DSCH was received incorrectly and this result is reported by the UE on uplink HS-DPCCH, the NodeB schedules retransmissions in case of RLC-AM. The MAC-hs in NodeB informs the UE with the next possible HS-SCCH whether a retransmission or a new transmission of HS-DSCH transport block will be performed.

Note, while the UE is in HSDPA standby or receiving data, it may send CQI reports about the downlink reception quality to the serving NodeB.

Physical Channel Combinations supported with HSDPA on the same FDD Frequency

	Physical Channel Combination	Transport Channel Combination	Mandatory or dependent on UE radio access capabilities	Comment
Uplink	DPCCH + one or more DPDCH's + HS-DPCCH	One or more DCH's coded into a single CCTrCH	Depending on UE radio access capabilities	The maximum number of DCH's and the maximum bit rate are dependent on UE radio access capabilities. This combination is required in case HS-DSCH(s) are configured.
Downlink	DPCCH + one or more DPDCH + one or more HS-SCCH's + zero, one or more HS-PDSCH's	One HS-DSCH coded into a single CCTrCH + one or more DCH coded into a single CCTrCH	Depending on UE radio access capabilities	The maximum number of DCH's and the maximum channel bit rate are dependent on UE radio access capabilities
	PCCPCH (neighbour cell) + DPCCH + one or more DPDCH + one or more HS-SCCH's + zero, one or more HS-PDSCH's	BCH (neighbour cell) + one or more DCH's + one HS-DSCH	Depending on UE radio access capabilities	This combination is required by a UE in CELL_DCH state to be able to read the SFN of a neighbouring cell and support "SFN-CFN observed time difference" and "SFN-SFN observed time difference" measurements while HS-DSCH(s) are configured.

[3GTS 25.302 (8.1, 8.2), 3GTS 25.331 (8.6.3.1b, 8.6.6.32, 10.3.6.23a, 10.3.6.36a)]

The Business Case of IEEE 802.16

Degree of Mobility: --- → +++

IEEE 802.16-2001

- **"Last Mile" Market for Enterprises in metropolitan areas**
  Interconnection of Offices at different sites within a metropolitan area
- **Long range cable alternative for interconnecting remote sites / villages to a backbone network**
  For both, data lines and telephone lines (E1, T1)

IEEE 802.16-2004

- **WLAN-market (IEEE 802.11, Hiperlan/2)**
  Quote: "WIMAX, the Super-WLAN"
- **DSL-Alternative / Part 1**
  Targeted at residential users in *rural* areas of developed countries.
- **DSL-Alternative / Part 2**
  Targeted at residential users in *urban* areas of developed countries.
- **DSL-Alternative / Part 3**
  Targeted at residential users in all areas of developing countries.

IEEE 802.16-2005

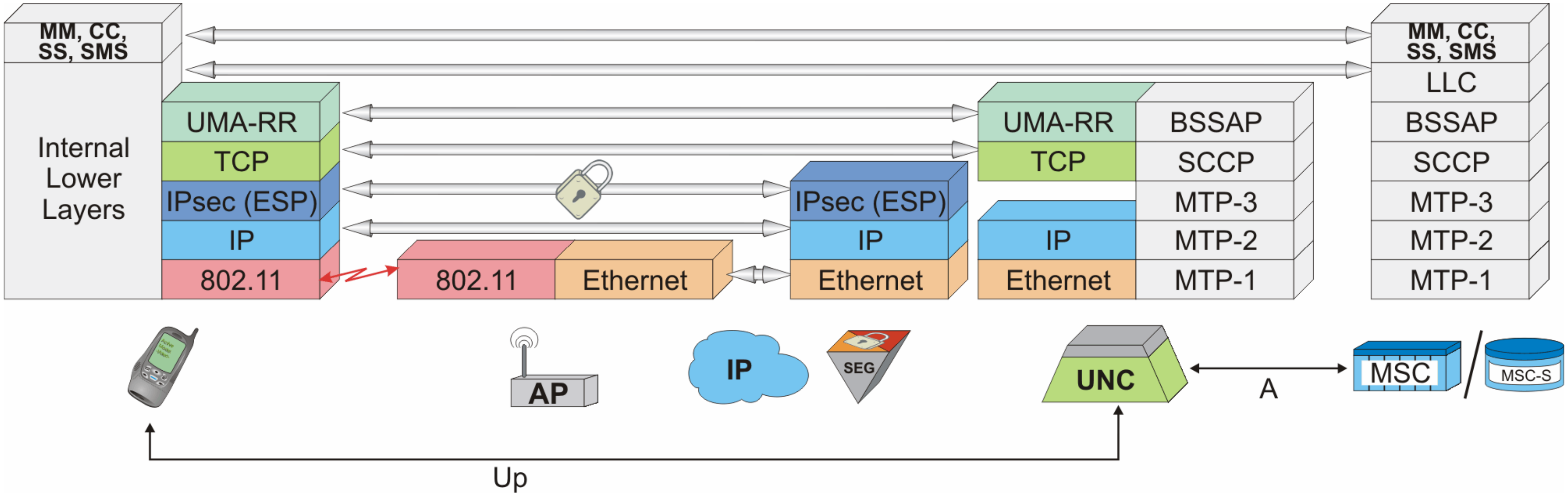
- **Cellular market**
  IEEE 802.16e as 4G radio access network.

The Business Case of IEEE 802.16

- **"Last Mile" Market for Enterprises in urban areas**
  This was the genuine target market of IEEE 802.16 when work started in 1999. The technology is described in IEEE 802.16-2001 and works on frequency ranges 10-66 GHz.
- **Long range cable alternative for interconnecting remote sites / villages to a backbone network**
  The same hardware can be used as in the previous case.
- **WLAN-market (IEEE 802.11, Hiperlan/2)**
  IIEEE 802.16 offers more range than WLAN and is therefore cheaper to implement for the operator and more reliable and easier to use from the perspective of the consumer. Provided that INTEL equips its new chipsets IEEE 802.16 compliant, there is a good chance for IEEE 802.16 to be successful in this marketplace.
- **DSL-Alternative / Part 1**
  Many potential DSL-customers in rural and remote areas or in villages of developed countries are currently not served with DSL because the necessary investments in the cable infrastructure would not pay off for the network operators. This is another market for IEEE 802.16.
- **DSL-Alternative / Part 2**
  Despite the fact that DSL is usually available in urban areas of developed countries, there is a good chance for IEEE 802.16 to become successful in this niche of the market, too. The reasons are of regulatory and historic nature: The old 2-wire cable infrastructure in the cities that DSL is based upon is usually owned by the PTT's which charge more or less large interconnection fees to alternative network operators who want to use these cables. The PTT's also charge these fees to their own customers to discourage the use of DSL-lines as bearers for free-of-charge VoIP. It is obvious that this market is tailored for IEEE 802.16 to achieve two targets: Bypass the PTT and be able to attack them on their genuine market: Telephony.
- **DSL-Alternative / Part 3**
  Nobody in developing countries like India, China or Russia is enthusiastic to invest billions of dollars into a cable infrastructure. Obviously, this is an ideal market for WMAN-systems like IEEE 802.16, if at least enough money is there to invest into this infrastructure….
- **Cellular market**
  Please see the next page which is dedicated to this opportunity.

Protocol Stacks

- Circuit-Switched Domain / Control Plane



Protocol Stacks

Circuit-Switched Domain / Control Plane

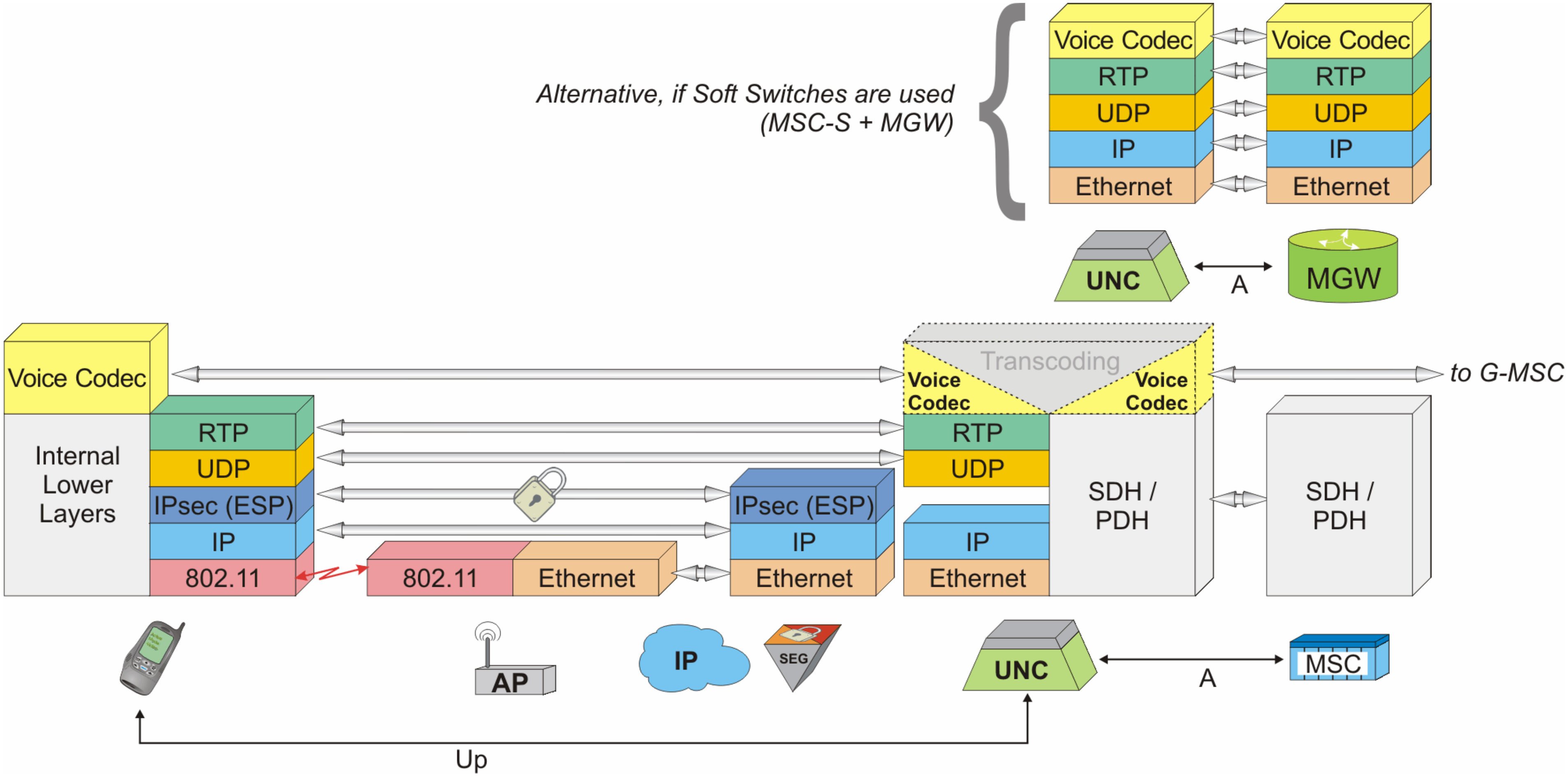
⇒ The figure illustrates the control plane protocol stack of the circuit-switched domain. It is noticeable that only UMA-related parts of the protocol stack are colored while all other parts are in light grey.

⇒ Most importantly, there is a new protocol UMA-RR that takes on the tasks and functions known from GSM-Radio Resource Management. This new protocol resides on top of a TCP-connection which needs to be established between mobile station and UNC.

⇒ In turn, this TCP-connection sits on top of an IPsec-tunnel which has been established between mobile station and security gateway.

⇒ As the mobile station's protocol stack indicates, the mobile station uses the WLAN-NIC solemnly to providing a transparent IP-bearer between itself and the UNC. This relationship will become more obvious when we take a look at the packet-switched protocol stacks.

Circuit-Switched Domain / User Plane



Circuit-Switched Domain / User Plane

⇒ The figure illustrates the user plane protocol stack of the circuit-switched domain. It is noticeable that only UMA-related parts of the protocol stack are colored while all other parts are in light grey.

⇒ Different to the control plane, the circuit-switched user plane uses UDP between mobile station and UNC. The standard GSM-voice codecs may be used on top of UDP.

▪ List of Acronyms v2.1

Term	Explanation
16-QAM	16 symbols Quadrature Amplitude Modulation (⇔ 3GTS 25.213)
2B1Q	Two Binary One Quaternary (⇔ Line Coding used on the ISDN U-Interface)
3G ...	3rd Generation ...
3GPP	Third Generation Partnership Project (Collaboration between different standardization organizations (e.g. ARIB, ETSI) to define advanced mobile communications standards, responsible for UMTS)
3GPP2	Third Generation Partnership Project 2 (similar to 3GPP, but consisting of ANSI, TIA and EIA-41, responsible for cdma2000, EvDO and EVDV)
8-PSK	8 Symbol Phase Shift Keying
AA	Anonymous Access
AAA	Authentication, Authorization and Accounting
AAL-2	ATM Adaptation Layer 2 (for real-time services) (⇔ ITU-T I.363.2)
AAL-5	ATM-Adaptation Layer 5 (non-real time) (⇔ ITU-T I.363.5)
AAS	Adaptive Antenna Systems
A-Bit	Acknowledgement Request Bit (⇔ used in LLC-protocol ⇔ Logical Link Control)
ABM	Asynchronous Balanced Mode
ABNF	Augmented Backus Naur Form (⇔ RFC 2234)
ACC	Access Control Class (⇔ 3GTS 22.011)
ACCH	Associated Control Channel (GSM / can be an SACCH or an FACCH)
ACK	Acknowledgement (⇔ 3GTS 25.214)
ACS	Active Codec Set
ADM	Asynchronous Disconnected Mode
ADPCM	Adaptive Differential Pulse Code Modulation
AES	Advanced Encryption Standard / Cipher Key Lengths: 128 bit, 192 bit or 256 bit; AES is based on the Rijndael algorithm which is named after its two developers Joan Daemen and Vincent Rijmen
AESA	ATM End System Address
AG	Absolute Grant (⇔ 3GTS 25.309)
AGCH	Access Grant Channel (GSM)
AH	Authentication Header (⇔ RFC 2402)
AI	Acquisition Indicator
AICH	Acquisition Indicator Channel (UMTS Physical Channel)
AK	Authentication Key (⇔ IEEE 802.16)
AK	Anonymity Key (⇔ 3GTS 33.102)
AKA	Authentication and key agreement (⇔ 3GTS 33.102)
ALCAP	Access Link Control Application Part (⇔ ITU-T Q.2630.1 / Q.2630.2)
ALG	Application Layer Gaetway
AM	Acknowledged Mode operation (⇔ e.g. in UMTS-RLC)
AM	Amplitude Modulation
AMC	Adaptive Modulation and Coding (⇔ 3GTS 25.858)
AMD	Acknowledged Mode Data (⇔UMTS RLC PDU-type)

AMF	Authentication management field (⇔ 3GTS 33.102)
AMI	Alternate Mark Inversion (⇔ Line Coding)
AMPS	Advanced Mobile Phone System
AMR	Adaptive Multirate Encoding (⇔ 3GTS 26.090)
ANSI	American National Standards Institute
AP	Access Point (⇔ IEEE 802.11, 802.16)
AP	Access Preamble
AP-AICH	CPCH Access Preamble Acquisition Indicator Channel (⇔ UMTS Physical Channel)
API	Access Preamble Acquisition Indicator
APN	Access Point Name (⇔ Reference to a GGSN)
APP	A Posteriori Probability (⇔ Turbo Decoding)
ARFCN	Absolute Radio Frequency Channel Number
ARIB	Association of Radio Industries and Businesses (Japanese)
ARP	Address Resolution Protocol (⇔ RFC 826)
ARPU	Average Return Per User
ARQ	Automatic Repeat Request
AS	Application Server
AS	Access Stratum (⇔ UMTS)
ASC	Access Service Class
ASCI	Advanced Speech Call Items (⇔ GSM-R)
ASCII	American Standard Code for Information Interchange (⇔ ANSI X3.4-1986)
ASIC	Application Specific Integrated Circuit
AS-ILCM	Application Server - Incoming Leg Control Model
ASN.1	Abstract Syntax Notation 1 (⇔ ITU-T X.680 / X.681)
AS-OLCM	Application Server - Outgoing Leg Control Model
ATCA	Advanced Telecommunications Computing Architecture
AT-Command	Attention-Command
ATM	Asynchronous Transfer Mode (⇔ ITU-T I.361)
AuC	Authentication Center
AUTN	Authentication Token (⇔ 3GTS 33.102)
AV	Authentication Vector (⇔ 3GTS 33.102)
B2BUA	Back-to-Back User Agent (⇔ SIP term / RFC 3261, RFC 3725)
B8ZS	Bipolar with Eight-Zero Substitution (⇔ Line Code used at the T1-Rate (1.544 Mbit/s))
BB	Base Band module
BC	Broadcast
BCC	Base Station Color Code
BCCH	Broadcast Control Channel (UMTS Logical Cannel)
BCCH	Broadcast Control Channel (⇔ GSM Logical Channel)
BCH	Broadcast Channel (UMTS Transport Channel)
BCTP	Bearer Control Tunneling Protocol (⇔ ITU-T Q.1990)
BEC	Backward Error Correction
BEG	BEGin Message (⇔ TCAP)
BER	Bit Error Rate
BFI	Bad Frame Indication
BG	Border Gateway
BGCF	Breakout Gateway Control Function

BIB	Backward Indicator Bit
BICC	Bearer Independent Call Control (⇔ ITU-T Q.1902.1 – Q.1902.6)
BLER	Block Error Rate
BMC	Broadcast / Multicast Control (⇔ 3GTS 25.324)
BM-IWF	Broadcast Multicast Interworking Function
BNF	Backus Naur Form (⇔ RFC 2234)
BQA	Bluetooth Qualification Administer
BQB	Bluetooth Qualification Body
BQRB	Bluetooth Qualification Review Board
BQTF	Bluetooth Qualification Test Facility
BRAN	Broadband Radio Access Network
BS	Base Station (⇔ IEEE 802.16)
BS_CV_MAX	Maximum Countdown Value to be used by the mobile station (⇔ Countdown Procedure)
BS_EIRP	Base Station Effective Isotropic Radiated Power
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 (⇔ 3GTS 48.008)
BTAB	Bluetooth Technical Advisory Board
BTS	Base Transceiver Station
BVCI	BSSGP Virtual Connection Identifier
C/I	Carrier-to-Interference Ratio (⇔ like SNR)
C/R-Bit	Command / Response Bit
C/T-Field	logical **C**hannel **/ T**ransport channel identification **Field**
CAI	Channel Assignment Indicator
CAP	CAMEL Application Part (⇔ CCS7)
CBC	Cipher Block Chaining (⇔ DES-Operation Mode)
CBC	Cell Broadcast Center
CBCH	Cell Broadcast Channel (GSM)
CC	Call Control
CCC	CPCH Control Command
CCCH	Common Control Channel (UMTS Logical Channel)
CCCH	Common Control Channel (GSM Logical Channel)
CCH	Control Channel
CCITT	Comité Consultatif International Télégraphique et Téléphonique (International Telegraph and Telephone Consultative Committee)
CCM	Common Channel Management (Protocol Part on the GSM Abis-Interface / 3GTS 48.058)
CCM-Mode	Counter with CBC-MAC (⇔ RFC 3610) Combined Authentication and Encryption with AES-Algorithm
CCN	Cell Change Notification (related to Network Assisted Cell Change / 3GTS 44.060)
CCPCH	Common Control Physical Channel (see also P-CCPCH and S-CCPCH)
CCS7	Common Channel Signaling System No. 7 (⇔ ITU-T Q-series of specifications, in particular Q.700 – Q.703)

CCTrCH	Coded Composite Transport Channel (UMTS)
CCU	Channel Codec Unit
CD/CA-ICH	Collision Detection / Channel Assignment Indicator Channel (UMTS Physical Channel)
CDI	Collision Detection Indicator
CDMA	Code Division Multiple Access
CDR	Call Detail Record
CEPT	Conférence Européenne des Postes et Télécommunications
CESoP	Circuit Emulation Services over Packet
CFN	Connection Frame Number
CG	Charging Gateway
CGF	Charging Gateway Function
CGI	Cell Global Identification
CHAP	Challenge Handshake Authentication Protocol (⇔ RFC 1334)
CIC	Circuit Identity Code (⇔ ISUP)
CIC	Call Instance Code (⇔ BICC)
CID	Channel Identity (⇔ ATM)
CIDR	Classless Inter-Domain Routing (⇔ RFC 1519)
CIF	Common Intermediate Format (352 x 240 pixels / ⇔ ITU-T H261 / H263)
CINR	Carrier to Interference and Noise Ratio
CIO	Cell Individual Offset (⇔ 3GTS 25.331)
CK	Ciphering Key (⇔ 3GTS 33.102)
CKSN	Ciphering Key Sequence Number
CMC	Codec Mode Command
CMI	Codec Mode Indication
CMR	Codec Mode Request
CMTS	Cable Modem Termination System
CN	Core Network
COFDM	Coded Orthogonal Frequency Division Multiplexing
CON	CONtinue Message (⇔ TCAP)
COPS	Common Open Policy Service Protocol (⇔ RFC 2748)
CPCH	Common Packet Channel (UMTS Transport Channel)⇔ FDD only
CPCS	Common Part Convergence Sublayer
CPICH	Common Pilot Channel (UMTS Physical Channel / see also P-CPICH and S-CPICH)
CPS	Coding and Puncturing Scheme
CPU	Central Processing Unit
CQI	Channel Quality Indicator (⇔ 3GTS 25.214)
CRNC	Controlling RNC
CS	Coding Scheme
C-SAP	Control Service Access Point
CSCF	Call Session Control Function (⇔ SIP)
CSD	Circuit Switched Data
CSICH	CPCH Status Indicator Channel (UMTS Physical Channel)
CSMA-CA	Carrier-Sense Multiple Access – Collision Avoidance
CSPDN	Circuit Switched Public Data Network
CS-X	Coding Scheme (1 – 4)
CTCH	Common Traffic Channel (Logical) ⇔ PTM

CTFC	Calculated Transport Format Combination (⇔ 3GTS 25.331)
CV	Countdown Value
CW	Code Word
cwnd	Congestion window
DARP	Downlink Advanced Receiver Performance (⇔ 3GPP's adaptation of SAIC / 3GTS 45.015, 3GTS 24.008)
dBm	The unit dBm measures a power. The conversion of a power value from Watt [W] to dBm is done in the following way: $X\,[dBm] = 10 \times \log_{10}(X\,[W] / 0.001\,[W])$
DBP	Diameter Base Protocol (⇔ RFC 3588)
DCCH	Dedicated Control Channel (UMTS Logical Channel)
DCH	Dedicated Channel (Transport)
DCM	Dedicated Channel Management (Protocol Part on the GSM Abis-Interface / 3GTS 48.058)
DCS	Digital Communication System
DDDS	Dynamic Delegation Discovery System (⇔ RFC 3401 – RFC 3404)
DDI	Data Description Indicator (⇔ 3GTS 25.309, 25.331)
DES	Data Encryption Standard
DHCP	Dynamic Host Configuration Protocol (⇔ RFC 2131)
DIA	Diameter Protocol (⇔ RFC 3588, RFC 3589)
Digit	4 bit
DL	Downlink
DLR	Destination Local Reference (⇔ SCCP term)
DNS	Domain Name System
DOCSIS	Data Over Cable Service Interface Specification (⇔ defined by CableLabs)
DOCSIS	Data Over Cable Service Interface Specification
DPC	Destination Point Code
DPCCH	Dedicated Physical Control Channel (UMTS Physical Channel)
DPCH	Dedicated Physical Channel (UMTS / Term to combine DPDCH and DPCCH)
DPDCH	Dedicated Physical Data Channel (UMTS Physical Channel)
DRNC	Drift Radio Network Controller
DRX	Discontinuous Reception
DS-CDMA	Direct Sequence Code Division Multiple Access
DSCH	Downlink Shared Channel (UMTS Transport Channel)
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DSN	Digital Switching Network
DSS1	Digital Subscriber Signaling System No.1 (⇔ also referred to as LAPD-signaling / ITU-T Q.931)
DTAP	Direct Transfer Application Part
DTCH	Dedicated Traffic Channel (UMTS Logical Channel)
DTM	Dual Transfer Mode (⇔ 3GTS 43.055)
DTX	Discontinuous Transmission
DVB-H	Digital Video Broadcasting – Handheld
DVB-T	Digital Video Broadcasting – Terrestrial
E-AGCH	E-DCH Absolute Grant Channel (⇔ 3GTS 25.211)

EAP	Extensible Authentication Protocol (⇔ RFC 3748)
EAPOL	EAP encapsulation Over Lan or wlan (⇔ IEEE 802.1X)
Ec/No	Received energy per chip / power density in the band
ECSD	Enhanced Circuit Switched Data (⇔ HSCSD + EDGE)
E-DCH	Enhanced Uplink Dedicated Transport Channel (⇔ 3GTS 25.211, 25.309)
EDGE	Enhanced Data Rates for Global Evolution
E-DPCCH	E-DCH Dedicated Physical Control Channel(⇔3GTS 25.211)
E-DPDCH	E-DCH Dedicated Physical Data Channel(⇔ 3GTS 25.211)
EDR	Enhanced Data Rate (⇔ more speed with Bluetooth 2.0 (⇔ 2.0 – 3.0 Mbit/s)
EFR	Enhanced Full Rate speech codec
EGPRS	Enhanced General Packet Radio Service
E-GSM	Extended GSM (GSM 900 in the Extended Band)
E-HICH	E-DCH HARQ Acknowledgement Indicator Channel (⇔ 3GTS 25.211)
EIA	Electronic Industries Alliance (US-organization to support US industry)
EIR	Equipment Identity Register
EIRENE	European Integrated Railway Radio Enhanced Network (⇔ GSM-R)
eMLPP	enhanced Multi-Level Precedence and Pre-emption (⇔ 3GTS 23.067)
END	END Message (⇔ TCAP)
ENUM	E.164-telephone number to URI (Uniform Resource Identifier) translation (⇔ RFC 3761)
E-RGCH	E-DCH Relative Grant Channel (⇔ 3GTS 25.211)
E-RNTI	E-DCH Radio Network Temporary Identifier (⇔ 3GTS 25.401)
ESN	Electronic Serial Number (North American Market)
ESP	Encapsulating Security Payload (⇔ RFC 2406)
E-TFC	E-DCH Transport Format Combination (⇔ 3GTS 25.309)
Ethernet	Layer 2 Protocol for IP (⇔ IEEE 802.3)
ETSI	European Telecommunications Standard Institute
EV-DO	Evolution Data Only or Evolution Data Optimized (⇔ cdma2000)
EV-DV	Evolution Data/Voice (⇔ cdma2000)
EVM	Error Vector Magnitude
FA	Foreign Agent (⇔ Mobile IP / RFC 3344)
FACCH	Fast Associated Control Channel (GSM)
FACH	Forward Access Channel (UMTS Transport Channel)
FBI	Feedback Information ⇔ UMTS
FBI	Final Block Indicator
FCC	Federal Communications Commission
FCCH	Frequency Correction Channel (GSM)
FCS	Frame Check Sequence (CRC-Check)
FDD	Frequency Division Duplex
FDDI	Fiber Distributed Data Interconnect (optical Layer 2)
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FER	Frame Error Rate
FFH	Fast Frequency Hopping

FFT	Fast Fourier Transformation
FH-CDMA	Frequency Hopping Code Division Multiple Access
FIB	Forward Indicator Bit
FIPS	Federal Information Processing Standard
FISU	Fill In Signal Unit
FMC	Fixed Mobile Convergence
FN	Frame Number
FPB	First Partial Bitmap
FQDN	Fully Qualified Domain Name Fully qualified domain names consist of a host ***and*** a domain name whereas the domain name needs to include a top-level domain (e.g. “de” or “org”). Examples: “www.inacon.de” and “PC10.inacon.com” are fully qualified domain names. ⇒ “www” and “PC10” represent the host, ⇒ “inacon” is the second-level domain, ⇒ “de” and “com” are the top level domain.
FR	Fullrate or Frame Relay
FRMR	Frame Reject
FSN	Forward Sequence Number
FTP	File Transfer Protocol (⇔RFC 959)
GCC	Generic Call Control
GCF	General Certification Forum
GEA	GPRS Encryption Algorithm
GERAN	GSM EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GIF	Graphics Interchange Format
GK	Gatekeeper
GMM	GPRS Mobility Management
G-MSC	Gateway MSC
GMSC-S	Gateway MSC Server
GMSK	Gaussian Minimum Shift Keying
G-PDU	T-PDU + GTP-Header
GPRS	General Packet Radio Service
GPRS-CSI	GPRS CAMEL Subscription Information
GPRS-SSF	GPRS Service Switching Function (⇔ CAMEL)
GPS	Global Positioning System
GRA	GERAN Registration Area
GSM	Global System for Mobile Communication
GSM-R	GSM for Railways
GSN	GPRS Support Node
GTP	GPRS Tunneling Protocol (⇔ 3GTS 29.060)
GTP-C	GTP Control Plane
GTP-U	GTP User Plane
GTT	Global Text Telephony (⇔ 3GTS 23.226)
GTTP	GPRS Transparent Transport Protocol (⇔ 3GTS 44.018)
HA	Home Agent (⇔ Mobile IP / RFC 3344)
HARQ	Hybrid ARQ (⇔ 3GTS 25.212)
HCS	Hierarchical Cell Structure
HDB3	High Density Bipolar Three (⇔ Line Coding used for E1 (PCM 30))
HDLC	High level Data Link Control

HFC-Network	Hybrid Fiber- / Coaxial-cable
HIPERLAN/2	High Performance Radio Local Area Network type 2
HLR	Home Location Register
HMAC	Keyed Hashing for Message Authentication (⇔ RFC 2104)
H-PLMN	Home PLMN
HR	Halfrate
H-RNTI	HS-DSCH Radio Network Transaction Identifier (⇔ 3GTS 25.331, 25.433)
HSCSD	High Speed Circuit Switched Data
HSDPA	High Speed Downlink Packet Access (⇔ 3GTS 25.301, 25.308, 25.401, 3GTR 25.848)
HS-DPCCH	High Speed Dedicated Physical Control Channel (⇔ 3GTS 25.211)
HS-DSCH	High Speed Downlink Shared Transport Channel (⇔ 3GTS 25.211, 25.212, 25.308)
HS-PDSCH	High Speed Physical Downlink Shared Channel (⇔ 3GTS 25.211)
HSS	Home Subscriber Server (⇔ 3GTS 23.002). HSS replaces the HLR with 3GPP Rel. 5
HS-SCCH	High Speed Shared Control Channel (⇔ 3GTS 25.211, 25.214)
HSUPA	High Speed Uplink Packet Access (⇔ 3GTS 25.301, 25.309, 25.401, 3GTR 25.896)
HTTP	HyperText Transfer Protocol (⇔ RFC 2616)
HUMAN	High-speed Unlicensed Metropolitan Area Network
I+S	Information + Supervisory
IAM	Initial Address Message (ISUP ⇔ ISDN User Part)
IANA	Internet Assigned Numbers Authority
ICANN	Internet Corporation for Assigned Names and Numbers
ICH	Indicator Channel (UMTS Physical Channel / see also PICH, AICH, CD/CA-ICH)
ICH	Indicator Channel
ICM	Initial Codec Mode
ICMP	Internet Control Message Protocol (⇔ RFC 792)
ICS	Implementation Conformance Statement
I-CSCF	Interrogating Call Session Control Function (⇔ SIP)
IE	Information Element
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force (www.ietf.org)
IFFT	Inverse Fast Fourier Transformation
IHOSS	Internet Hosted Octet Stream Service
IK	Integrity Key (⇔ 3GTS 33.102)
IKE	Internet Key Exchange (⇔ RFC 2409)
IKMP	Internet Key Management Protocol
iLBC	Internet Low Bitrate Codec (⇔ RFC 3951 / RFC 3952)
ILCM	Incoming Leg Control Model
IMEI	International Mobile Equipment Identity
IMPI	IM Private Identity; the private user identity of an IMS-subscriber, formatted as an NAI (⇔ 3GTS 33.203)
IMPI	IP Multimedia Private Identity
IMPU	IM Public User identity; the public user identity of an IMS-subscriber, formatted as SIP-URI or TEL-URL (⇔ 3GTS 33.203)

IMPU	IP Multimedia Public Identity
IMS	Internet Protocol Multimedia Core Network Subsystem (⇔ Rel. 5 onwards)
IMS-AG	IMS-Access Gateway
IMSI	International Mobile Subscriber Identity
IMS-SSF	IP Multimedia Subsystem – Service Switching Function
IMT-2000	International Mobile Telecommunications for the year 2000
INAP	Intelligent Network Application Part (⇔ CCS7)
IOV-I / IOV-UI	Input Offset Variable for I+S and UI-Frames (⇔ for ciphering in GPRS)
IP	Internet Protocol (⇔ RFC 791)
IPBCP	IP Bearer Control Protocol (⇔ ITU-T Q.1970)
IP-CAN	Internet Protocol - Connectivity Access Network (e.g. DSL, TV-Cable, WIMAX, UMTS)
IPCP	Internet Protocol Control Protocol (⇔ RFC 1332)
IPsec	Internet Protocol / secure (⇔ RFC 2401)
IPv4	Internet Protocol (version 4)
IPv6	Internet Protocol (version 6)
IR	Incremental Redundancy (⇔ ARQ II)
ISAKMP	Internet Security Association and Key Management Protocol (⇔ RFC 2408)
ISC	IP multimedia subsystem Service Control-Interface
ISCP	Interference Signal Code Power (⇔ 3GTS 25.215 / 3GTS 25.102)
ISDN	Integrated Services Digital Network
I-SIM	IMS capable SIM
ISO	International Standardization Organization
ISP	Internet Service Provider
ISPC	International Signaling Point Code (⇔ ITU-T Q.708)
ISUP	ISDN User Part (⇔ ITU-T Q.761 – Q.765)
ITU-T	International Telecommunication Union – Telecommunication Sector
Iub-FP	Iub-Frame Protocol (⇔ 3GTS 25.427 / 25.435)
Iu-FP	Iu-Frame Protocol (⇔ 3GTS 25.415)
Iur-FP	Iur-Frame Protocol (⇔ 3GTS 25.424, 3GTS 25.425, 25.426, 25.435)
JPEG	Joint Picture Expert Group
kbps	kilo-bits per second
KEK	Key Encryption Key (⇔ IEEE 802.16)
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L2TP	Layer 2 Tunneling Protocol (⇔ RFC 2661)
L3	Layer 3 (network layer)
LA	Location Area
LAC	Location Area Code
LAI	Location Area Identification (LAI = MCC + MNC + LAC)
LAPB	Link Access Procedure Balanced
LAPD	Link Access Protocol for the ISDN D-Channel
LBS	Location Based Service
LCP	Link Control Protocol (⇔ PPP)
LCS	LoCation Service
LI	Length Indicator

LLC	Logical Link Control-Protocol
LMDS	Local Multipoint Distribution Services
LOS	Line Of Sight
LPD	Link Protocol Discriminator
LSB	Least Significant Bit
LSSU	Link Status Signal Unit
LTE	Long Term Evolution (of UMTS)
M3UA	MTP-3 User Adaptation Layer (⇔ RFC 3332 / 3GPP 29.202 (Annex A))
MAC	Medium Access Control (UMTS ⇔ 3GTS 25.321)
MAC	Medium Access Control ((E)GPRS ⇔ 3GTS 04.60 / 3GTS 44.060)
MAC	Message Authentication Code (⇔ 3GTS 33.102)
MAC-e	MAC-E-DCH (⇔ 3GTS 25.321)
MAC-es	MAC-E-DCH SRNC (⇔ 3GTS 25.321)
MAC-hs	MAC-High Speed (⇔ 3GTS 25.321)
MAN	Metropolitan Area Network
MAP	Mobile Application Part
MASF	Minimum Available Spreading Factor
Max [X, Y]	The value shall be the maximum of X or Y, which ever is bigger
MBMS	Multimedia Broadcast / Multicast Service (⇔ 3GTS 23.246, 3GTS 43.846)
MBWA	Mobile Broadband Wireless Access (⇔ IEEE 802.20 Specification of physical and medium access control layers of an air interface for interoperable mobile broadband wireless access systems, operating in licensed bands below 3.5 GHz, optimized for IP-data transport, with peak data rates per user in excess of 1 Mbps. It supports various vehicular mobility classes up to 250 Km/h in a MAN environment and targets spectral efficiencies, sustained user data rates and numbers of active users that are all significantly higher than achieved by existing mobile systems)
MBZ	Must Be Zero
MCC	Mobile Country Code
Mcps	Mega Chip Per Second
MCS-X	Modulation and Coding Scheme (1 – 9) and for HSDPA / HSUPA
MCU	Multipoint Control Unit (⇔ H.323 equipment)
MD-X	Message Digest Algorithm (MD-2, 4, 5 are defined) (MD-5 ⇔ RFC 1321)
ME	Mobile Equipment (ME + SIM = MS)
MEGACO	Media Gateway Control Protocol (⇔ ITU-T H.248 incl. Annex F – H and IETF RFC 3015)
MExE	Mobile Station Application Execution Environment
MGC	Media Gateway Controller
MGCF	Media Gateway Control Function
MGCP	Media Gateway Control Protocol (⇔ RFC 2705)
MGW	Media Gateway
MIDI	Musical Instrument Digital Interface
MIH	Media Independent Handover (⇔ IEEE 802.21)
MIME	Multipurpose Internet Mail Extensions

MIMO	Multiple In, Multiple Out
MIN	Mobile Identity Number (North American Market)
Min [X, Y]	The value shall be the minimum of X or Y, which ever is smaller
MINA	Mobile Internet Network Architecture
MLP	MAC Logical Channel Priority
MLPP	Multi-Level Precedence and Pre-emption (⇔ ITU-T Q.85 / Clause 3)
MM	Mobility Management
MMCC	Multimedia Call Control
MMD	IP Multimedia Domain (⇔ name of the IMS in 3GPP2)
MMDS	Multipoint Microwave Distribution System or Multi-channel Multi-point Distribution System
MMS	Multimedia Messaging Service (⇔ 3GTS 22.140, 3GTS 23.140]
MNC	Mobile Network Code
MNRG	Mobile Not Reachable for GPRS flag
MOC	Mobile Originating Call
MPCC	Multiparty Call Control
MPEG	Motion Picture Expert Group
MPLS	Multi Protocol Label Switchung
MRC	Maximum Ratio Combining
MRFC	Multimedia Resource Function Controller
MRFP	Multimedia Resource Function Processor
MRU	Maximum Receive Unit (⇔ PPP)
MRW	Move Receiving Window
MS	Mobile Station

MS	Mobile Subscriber Station (⇔ IEEE 802.16e)
MSB	Most Significant Bit
MSC	Mobile Services Switching Center
MSC-S	MSC-Server
MS-ISDN	Mobile Subscriber – International Service Directory Number
MSRP	Message Session Relay Protocol (⇔ draft-ietf-simple-message-sessions-XX)
MSS	Maximum Segment Size (⇔ TCP)
MSU	Message Signal Unit
MT	Mobile Terminal or Mobile Terminating
MTC	Mobile Terminating Call
MTP	Message Transfer Part (⇔ ITU-T Q.701 – Q.709)
MTP-3b	Message Transfer Part level 3 / broadband (⇔ ITU-T Q.2210)
MTU	Maximum Transmit Unit (⇔ IP)
NACC	Network Assisted Cell Change (⇔ 3GTS 44.060)
NACK	Negative Acknowledgement (⇔ 3GTS 25.308, 25.309))
NAI	Network Access Identifier (⇔ RFC 2486)
NAPT	Network Address Port Translation (⇔ RFC 3022)
NAPTR	Naming Authority Pointer (⇔ RFC 2915)
NAS	Non-Access-Stratum (⇔ UMTS)
NASS	Network Attachment SubSystem (⇔ part of the TISPAN NGN-architecture)
NAT	Network Address Translation (⇔ RFC 1631)
NBAP	NodeB Application Part (⇔ 3GTS 25.433)
NBNS	NetBios Name Service

NC	Neighbor Cell
NCC	Network Color Code
NCP	Network Control Protocol (⇔ PPP)
NGN	Next Generation Networks
NI	Network Indicator
NIC	Network Interface Card
NLOS	Non Line Of Sight
NMT	Nordic Mobile Telephone (analog cellular standard, mainly used in Scandinavia)
NPB	Next Partial Bitmap
N-PDU	Network-Protocol Data Unit (⇔ IP-Packet, X.25-Frame)
NS	Network Service
NSAPI	Network Service Access Point Identifier
N-SAW	N-Channel Stop and Wait (⇔ 3GTS 25.309, 3GTR 25.848)
NSE	Network Service Entity
NSPC	National Signaling Point Code
NSS	Network Switching Subsystem
NS-VC	Network Service – Virtual Connection
NS-VCG	Network Service – Virtual Connection Group
NS-VL	Network Service – Virtual Link
NT	Network Termination
O&M	Operation and Maintenance
Octet	8 bit
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OLCM	Outgoing Leg Control Model
OMA	Open Mobile Alliance (⇔ http://www.openmobilealliance.org/)
OMAC	One-Key CBC-MAC (⇔ NIST standard: SP 800-38B and http://csrc.nist.gov/CryptoToolkit/modes/proposedmodes/)
OMC	Operation and Maintenance Center
OoBTC	Out of Band Transcoder Control (⇔ 3GTS 23.153)
OPC	Originating Point Code
OPWA	One Pass With Advertising (⇔ Term in RSVP)
OSA	Open Service Access
OSA-SCS	Open Service Access – Service Capability Server
OSCP	Online Certificate Status Protocol (⇔ RFC 2560)
OSI	Open System Interconnection
OSP	Octet Stream Protocol
OTDOA	Observed Time Difference Of Arrival
OVSF	Orthogonal Variable Spreading Factor
P/F-Bit	Polling/Final - Bit
PABX	Private Automatic Branch Exchange
PACCH	Packet Associated Control Channel ((E)GPRS)
PACS	Personal Access Communication System
PAD	Packet Assembly Disassembly
PAGCH	Packet Access Grant Channel ((E)GPRS)
PAP	Password Authentication Protocol (⇔ RFC 1334)

PBCCH	Packet Broadcast Control Channel ((E)GPRS)
PCCCH	Packet Common Control Channel ((E)GPRS)
PCCH	Paging Control Channel (UMTS Logical Channel)
P-CCPCH	Primary Common Control Physical Channel (UMTS / used as bearer for the BCH TrCH)
PCH	Paging Channel (UMTS / Transport Channel)
PCH	Paging Channel (GSM / Logical Channel)
PCI	Peripheral Component Interconnect (computer bus standard to interconnect peripherals to the CPU)
PCM	Pulse Code Modulation
PCN	Personal Communication Network
PCPCH	Physical Common Packet Channel (UMTS Physical Channel)
P-CPICH	Primary Common Pilot Channel (UMTS Physical Channel)
PCS	Personal Communication System
P-CSCF	Proxy Call Session Control Function (⇔ SIP)
PCU	Packet Control Unit
PD	Protocol Discriminator
PDCH	Packet Data Channel ((E)GPRS)
PDCP	Packet Data Convergence Protocol (⇔ 3GTS 25.323)
PDF	Policy Decision Function (⇔ Part of the IP Multimedia Subsystem)
PDG	Packet Data Gateway
PDG	Packet Data Gateway
PDH	Plesiochronous Digital Hierarchy
PDN	Packet Data Network
PDP	Packet Data Protocol
PDS	Packet Data Subsystem (⇔ 3GPP2)
PDSCH	Physical Downlink Shared Channel (UMTS Physical Channel)
PDSN	Packet Data Support Node (⇔ the SGSN in 3GPP2)
PDTCH	Packet Data Traffic Channel ((E)GPRS)
PDU	Protocol Data Unit or Packet Data Unit
PEAP	Protected Extensible Authentication Protocol
PEP	Policy Enforcement Point (⇔ 3GTS 23.209)
PER	Packed Encoding Rules (⇔ ITU-T X.691)
PES	PSTN/ISDN Emulation Subsystem (⇔ part of the TISPAN NGN-architecture)
PFC	Packet Flow Context
PFI	Packet Flow Identifier
PHS	Payload Header Suppression (⇔ IEEE 802.16)
PHY	Physical Layer
PICH	Page Indicator Channel (UMTS Physical Channel)
PICMG	PCI (⇔ Peripheral Component Interconnect) Industrial Computer Manufacturers Group (http://www.picmg.org/)
PKCS	Public Key Cryptography Standard
PLC	Power Line Communications
PLMN	Public Land Mobile Network
PMM	Packet Mobility Management
PN	Pseudo Noise
PNCH	Packet Notification Channel ((E)GPRS)

PoC	Push to talk over Cellular (⇔ 3GTR 29.979 and various OMA-specifications)
PoE	Power over Ethernet
POP	Post Office Protocol (⇔ RFC 1939)
POTS	Plain Old Telephone Service
PPCH	Packet Paging Channel ((E)GPRS)
PPP	Point-to-Point Protocol (⇔ RFC 1661)
PRA	PCPCH Resource Availability
PRACH	Physical Random Access Channel ⇔ UMTS
PRACH	Packet Random Access Channel ((E)GPRS)
PRD	Bluetooth Qualification Program Reference Document
PRI	Primary rate access ISDN-user interface for PABX's (23 or 30 B-channels plus one D-Channel)
PS	Physical Slot (⇔ IEEE 802.16)
PS	Puncturing Scheme
PSC	Primary Synchronization Code or Primary Scrambling Code (both used in UMTS)
P-SCH	Primary Synchronization Channel (physical)
PSD	Power Spectral Density (⇔ 3GTS 25.215 / 3GTS 25.102)
PSK	Phase Shift Keying
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network
PT	Protocol Type (⇔ GTP or GTP')
PTCCH	Packet Timing Advance Control Channel ((E)GPRS)
PTCCH/D	Packet Timing Advance Control Channel / Downlink Direction ((E)GPRS)
PTCCH/U	Packet Timing Advance Control Channel / Uplink Direction ((E)GPRS)
PTM	Point to Multipoint
P-TMSI	Packet TMSI
PTP	Point to Point
PVC	Permanent Virtual Circuit
QCIF	Quarter Common Intermediate Format (176 x 144 pixels ⇔ ITU-T H261 / H263)
QE	Quality Estimate
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying (⇔ 3GTS 25.213)
QSIG	Q-interface signaling protocol
RA	Routing Area
RAB	Radio Access Bearer
RAC	Routing Area Code
RACH	Random Access Channel (UMTS Transport Channel)
RACH	Random Access Channel (GSM)
RACS	Resource and Admission Control Subsystem (⇔ part of the TISPAN NGN-architecture)
RADIUS	Remote Authentication Dial In User Service (⇔ RFC 2865)
RAI	Routing Area Identification
RANAP	Radio Access Network Application Part (⇔ 3GTS 25.413)
RAND	Random Number
RAT	Radio Access Technology (e.g. GERAN, UTRAN, …)
RATSCCH	Robust AMR Traffic Synchronized Control CHannel
RB	Receive Block Bitmap (⇔ EGPRS)

RB	Radio Bearer
RBB	Receive Block Bitmap (⇔ GPRS)
REJ	Reject
RF	Radio Frequency
RFC	Request for Comments (⇔ Internet Standards)
RFID	Radio Frequency Identification
RG	Relative Grant (⇔ 3GTS 25.309)
R-GSM	Railways-GSM
RL	Radio Link
RLC	Radio Link Control (UMTS ⇔ 3GTS 25.322)
RLC	Radio Link Control ((E)GPRS / 3GTS 04.60 / 3GTS 44.060)
RLM	Radio Link Management (Protocol Part on the GSM Abis-Interface / 3GTS 48.058)
RLP	Radio Link Protocol (⇔ 3GTS 24.022)
RLS	Radio Link Set (⇔ 3GTS 25.309, 25.433)
RNC	Radio Network Controller
RNL	Radio Network Layer
RNR	Receive Not Ready
RNS	Radio Network Subsystem
RNSAP	Radio Network Subsystem Application Part (⇔ 3GTS 25.423)
RNSN	Radio Network Serving Node
RNTI	Radio Network Temporary Identifier
RPLMN	Registered PLMN
RPR	Resilient Packet Ring (⇔ IEEE 802.17)
RR	Radio Resource Management
RR	Receive Ready (LAPD/LLC/RLP-Frame Type)
RRBP	Relative Reserved Block Period
RRC	Radio Resource Control (⇔ 3GTS 25.331)
RRC-Filter	Root Raised Cosine Filter
RSA	Ron **R**ivest, Adi **S**hamir and Leonard **A**dleman-algorithm (Public Key Encryption / PKCS #1)
RSADP	RSA-Decryption Primitive (⇔ RFC 3447 (5.1.2) or PKCS #1 (5.1.2); PKCS = Public Key Cryptography Standard]
RSAEP	RSA-Encryption Primitive (⇔ RFC 3447 (5.1.1) or PKCS #1 (5.1.1); PKCS = Public Key Cryptography Standard]
RSAES-OAEP	RSA Encryption Scheme - Optimal Asymmetric Encryption Padding (⇔ PKCS #1 / RFC 3447)
RSC	Recursive Systematic Convolutional Coder(⇔ Turbo Coding, 25.212)
RSCP	Received Signal Code Power (⇔ 3GTS 25.215)
RSN	Retransmission Sequence Number (⇔ 3GTS 25.309)
RSSI	Received Signal Strength Indicator
RSVP	Resource Reservation Protocol (⇔ RFC 2205)
RTG	Receive transmit Transition Gap (⇔ IEEE 802.16 (3.45)) the time between an uplink subframe and the subsequent downlink subframe in a TDD-system
RTO	Retransmission Time Out
RTP	Real-time Transport Protocol (⇔ RFC 3550)
RTSP	Real Time Streaming Protocol (⇔ RFC 2326)
RTT	RoundTrip Time (⇔ RFC 793)

RTWP	Received Total Wideband Power
RV	Redundancy and Constellation Version (⇔ 3GTS 25.212)
RX	Receive
SA	Service Area
SAAL-NNI	Signaling ATM Adaptation Layer – Network Node Interface
SAB	Service Area Broadcast
SABM(E)	Set Asynchronous Balanced Mode (Extended for Modulo 128 operation) (LAPD/LLC/RLP-Frame Type)
SABP	Service Area Broadcast Protocol (⇔ 3GTS 25.419)
SACCH	Slow Associated Control Channel (GSM)
SACCH/MD	SACCH Multislot Downlink (related control channel of TCH/FD / GSM)
SAI	Service Area Identifier
SAIC	Single Antenna Interference Cancellation
SANC	Signaling Area Network Code (⇔ ITU-T Q.708)
SAP	Service Access Point
SAPI	Service Access Point Identifier
SAR	Segmentation And Reassembly (ATM-sublayer)
SBC	Session Border Controller (⇔ SIP term, usually a B2BUA with NAT-function and media gateway)
SC	Serving Cell
SCCP	Signaling Connection Control Part (⇔ ITU-T Q.711 – Q.714)
S-CCPCH	Secondary Common Control Physical Channel (used as bearer for the FACH and PCH TrCH's / UMTS Physical Channel)
SCH	Synchronization Channel (UMTS Physical Channel / see also P-SCH and S-SCH)
SCH	Synchronization Channel (GSM)
S-CPICH	Secondary Common Pilot Channel (UMTS Physical Channel)
SCR	Source Controlled Rate
S-CSCF	Serving Call Session Control Function (⇔ SIP)
SCTP	Stream Control Transmission Protocol (⇔ RFC 2960)
SDCCH	Stand Alone Dedicated Control Channel
SDH	Synchronous Digital Hierarchy
SDMA	Space Division Multiple Access
SDP	Session Description Protocol (⇔ RFC 2327, RFC 3266, RFC 3264)
SDU	Service Data Unit (⇔ the payload of a PDU)
SF	Spreading Factor
SFH	Slow Frequency Hopping
SFN	System Frame Number
SG	Security Gateway (IPsec / ⇔ RFC 2401)
SGSN	Serving GPRS Support Node
SGW	Signaling Gateway (SS7 ⇔ IP)
SHA	Secure Hash Algorithm
SHCCH	Shared Channel Control Channel (UMTS Logical Channel / ⇔ TDD only)
SI	Service Indicator
SIB	System Information Block
SID	Silence Insertion Descriptor
SID	Size InDex (⇔ 3GPP 25.321)
SIF	Signaling Information Field

SIG	Special Interest Group (⇔ e.g. Bluetooth)
SIM	Subscriber Identity Module
SIO	Service Information Octet
SIP	Session Initiation Protocol (⇔ RFC 3261)
SIP-AS	SIP-Application Server
SIP-B	SIP for Businesses (⇔ abbreviation for a set of PABX-specific SIP-extensions)
SIP-I	SIP with encapsulated ISUP (⇔ ITU-T Q.1912.5)
SIP-T	SIP for Telephones (⇔ RFC 3372)
SIR	Signal to Interference Ratio
SLC	Signaling Link Code
SLF	Subscriber Locator Function
SLR	Source Local Reference
SLS	Signaling Link Selection
SLTA	Signaling Link Test Acknowledge
SLTM	Signaling Link Test Message
SM	Session Management (⇔ 3GTS 23.060, 3GTS 24.008)
SME	Small and Medium size Enterprises (Type of Business)
SMS	Short Message Service (⇔ 3GTS 24.011, 3GTS 23.040)
SM-SC	Short Message Service Center
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 (⇔ RFC 2821)
SN	Sequence Number
SND	Sequence Number Downlink (⇔ GTP)
SNDCP	Subnetwork Dependent Convergence Protocol
SNM	Signaling Network Management Protocol (⇔ ITU-T Q.704 (3))
SNN	SNDCP N-PDU Number Flag
SN-PDU	Segmented N-PDU (SN-PDU is the payload of SNDCP)
SNR	Signal to Noise Ratio
SNTM	Signaling Network Test & Maintenance (⇔ ITU-T Q.707)
SNU	Sequence Number Uplink (⇔ GTP)
SOAP	Simple Object Access Protocol (⇔ http://www.w3.org/TR/2000/NOTE-SOAP-20000508)
SOHO	Small Office Home Office (Type of Business)
SPC	Signaling Point Code
SPI	Security Parameter Index (⇔ RFC 2401)
SQCIF	Semi Quarter Common Intermediate Format (128 x 96 pixels ⇔ ITU-T H261 / H263)
SQN	Sequence number (used in UMTS-security architecture / 3GTS 33.102)
SRB	Signaling Radio Bearer
SRES	Signed Response
SRNC	Serving Radio Network Controller
SRNS	Serving Radio Network Subsystem
SRTP	Secure RTP (⇔ RFC 3711)
SRTT	Smoothed RoundTrip Time (⇔ RFC 793)

SRV	Service Location (⇔ RFC 2782)
SS	Subscriber Station (⇔ IEEE 802.16)
SSC	Secondary Synchronization Code
SSCF	Service Specific Co-ordination Function
SSCF/NNI	Service Specific Coordination Function – Network Node Interface Protocol (⇔ ITU-T Q.2140)
SSCF/UNI	Service Specific Coordination Function – User Network Interface Protocol (⇔ ITU-T Q.2130)
S-SCH	Secondary Synchronization Channel (physical)
SSCOP	Service Specific Connection Oriented Protocol (⇔ ITU-T Q.2110)
SSCOPMCE	Service Specific Connection Oriented Protocol in a Multi-link or Connectionless Environment (⇔ ITU-T Q.2111)
SSCS	Service Specific Convergence Sublayer
SSDT	Site Selection Diversity Transmission
SSID	Service Set Identifier (⇔ IEEE 802.11)
SSN	Start Sequence Number (⇔ related to ARQ-Bitmap in GPRS / EGPRS)
SSN	Send Sequence Number (⇔ GSM MM and CC-Protocols)
SSRTG	Subscriber Station Receive to transmit Transition Gap (⇔ IEEE 802.16 (3.53)) Time that the SS needs to switch from receive to transmit.
SSSAR	Service Specific Segmentation And Reassembly (⇔ ITU-T I.366.1)
ssthresh	Slow start threshold (⇔ RFC 2001)
SSTTG	Subscriber Station Transmit to receive Transition Gap (⇔ IEEE 802.16 (3.54)) Time that the SS needs to switch from transmit to receive.
STC	Signaling Transport Converter on MTP-3 and MTP-3b (⇔ ITU-T Q.2150.1) / Signaling Transport Converter on SSCOP and SSCOPMCE (⇔ ITU-T Q.2150.2)
STTD	Space Time block coding based Transmission Diversity
STUN	**S**imple **T**raversal of **U**DP through **N**etwork Address Translators (⇔ RFC 3489)
SUERM	Signal Unit Error Rate Monitor (⇔ ITU-T Q.703 (10))
SUFI	Super Field (RLC-Protocol)
SVC	Switched Virtual Circuit
SWAP	Shared Wireless Access Protocol (⇔ Home RF)
TA	Terminal Adapter (⇔ ISDN)
TA	Timing Advance
TACS	Total Access Communication System
TAF	Terminal Adopter Function (⇔ 3GTS 27.001)
TAI	Timing Advance Index
TB	Transport Block
TBF	Temporary Block Flow
TBS	Transport Block Set
TCAP	Transaction Capabilities Application Part (⇔ Q.771 – Q.773)
TCH	Traffic Channel
TCH/FD	Traffic Channel / Fullrate Downlink
TCH-AFS	Traffic CHannel Adaptive Full rate Speech
TCH-AHS	Traffic Channel Adaptive Half rate Speech
TCP	Transmission Control Protocol
TCTF	Target Channel Type Field

TCTV	Transport Channel Traffic Volume
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TE	Terminal Equipment
TEID	Tunnel Endpoint Identifier (⇔ GTP / 3GTS 29.060)
TEK	Traffic Encryption Key (⇔ IEEE 802.16)
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport Format Combination Identifier
TFCS	Transport Format Combination Set
TFI	Transport Format Indication (⇔ UMTS)
TFI	Temporary Flow Identity (⇔ (E)GPRS)
TFO	Tandem Free Operation (⇔ 3GTS 22.053)
TFRC	Transport Format and Resource Combination (⇔ 3GTS 25.308)
TFRI	Transport Format and Resource Indicator (<=> 3GTS 25.308, 25.321)
TFS	Transport Format Set
TFTP	Trivial File Transfer Protocol (⇔ RFC 1350)
TGD	Transmission Gap start Distance (⇔ 3GTS 25.215)
TGL	Transmission Gap Length (⇔ 3GTS 25.215)
TGPRC	Transmission Gap Pattern Repetition Count (⇔ 3GTS 25.215)
TGSN	Transmission Gap Starting Slot Number (⇔ 3GTS 25.215)
TH-CDMA	Time Hopping Code Division Multiple Access
THIG	Topology Hiding Inter Network Gateway
TI	Transaction Identifier
TIA	Telecommunications Industry Association
TID	Tunnel Identifier
TIPHON	Telecommunications and Internet Protocol Harmonization Over Networks (⇔ ETSI Project)
TISPAN	Telecoms & Internet converged Services & Protocols for Advanced Networks (⇔ ETSI Working Group to define IMS for fixed broadband access networks)
TLLI	Temporary Logical Link Identifier
TLS	Transport Layer Security (⇔ RFC 2246 / RFC 3546 / formerly known as SSL or Secure Socket Layer)
TLV	Tag / Length / Value Notation
TM	Transparent Mode operation (⇔ UMTS-RLC)
TM	Transmission Modules
TMD	Transparent Mode Data (⇔UMTS RLC PDU-type)
TMN	Telecommunication Management Network
TMSI	Temporary Mobile Subscriber Identity
TNL	Transport Network Layer (⇔ 3GTS 25.401)
ToIP	Text over IP
TPC	Transmit Power Command
T-PDU	Payload of a G-PDU which can be user data, i.e. possibly segmented IP-frames, or GTP signaling information (⇔ GTP)
TQI	Temporary Queuing Identifier
TRAU	Transcoder and Rate Adaption Unit
TrCH	Transport Channel (UMTS)
TrFO	Transcoder Free Operation
TrGw	Transition Gateway (IPv4 ⇔ IPv6)

TRX	Transmitter / Receiver
TS	Timeslot
TSC	Training Sequence Code
TSN	Transmission Sequence Number (⇔ 3GTS 25.321)
TSTD	Time Switched Transmit Diversity
TTA	Telecommunications Technology Association (South Korean standards organization)
TTG	Tunnel Termination Gateway
TTG	Transmit receive Transition Gap (⇔ IEEE 802.16 (3.63)) the time between a downlink subframe and the subsequent uplink subframe in a TDD-system
TTI	Transmission Time Interval
TTL	Time To Live (⇔ IP-Header / RFC 791)
TX	Transmit
UA	User Agent (⇔ SIP-Term / RFC 3261)
UA	Unnumbered Acknowledgement (LAPD/LLC/RLP-Frame Type)
UAC	User Agent Client (⇔ SIP-Term / RFC 3261)
UARFCN	UMTS Absolute Radio Frequency Channel Number
UART	Universal Asynchronous Receiver and Transmitter
UAS	User Agent Server (⇔ SIP-Term / RFC 3261)
UDP	User Datagram Protocol (⇔ RFC 768)
UE	User Equipment
UEA	UMTS Encryption Algorithm (⇔ 3GTS 33.102)
UI	Unnumbered Information (⇔ LAPD) / Unconfirmed Information (⇔ LLC) / Frame Type
UIA	UMTS Integrity Algorithm (⇔ 3GTS 33.102)
UICC	Universal Integrated Circuit Card (⇔ 3GTS 22.101 / Bearer card of SIM / USIM)
UL	Uplink
UM	Unacknowledged Mode operation (⇔ UMTS-RLC)
UMA	Unlicensed Mobile Access (⇔ 3GTS 43.318)
UMAN	Unlicensed Mobile Access Network
UMD	Unacknowledged Mode Data (⇔UMTS RLC PDU-type)
UMS	User Mobility Server (⇔ HSS = HLR + UMS)
UMTS	Universal Mobile Telecommunication System
UNC	UMA Network Controller
UNC-SGW	UMA Network Controller Security Gateway
URA	UTRAN Registration Area
URI	Uniform Resource Identifier
URL	Uniform Resource Locator (⇔ RFC 1738)
USAT	USIM Application Toolkit
USB	Universal Serial Bus
USCH	Uplink Shared Channel (UMTS Transport Channel ⇔ TDD only
USF	Uplink State Flag
USIM	Universal Subscriber Identity Module (⇔ 3GTS 31.102)
UTF-8	Unicode Transformation Format-X (Is an X-bit) lossless encoding of Unicode characters)
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
UUI	User to User Information
UUS	User-User-Signaling (⇔ 3GTS 23.087)

UWB	Ultra-Wide Band (⇔ IEEE 802.15.3)
UWC	Universal Wireless Convergence (Merge IS-136 with GSM)
VAD	Voice Activity Detector
VBS	Voice Broadcast Service (⇔ GSM-R)
VC	Virtual Circuit
VCI	Virtual Circuit Identifier (⇔ ATM)
VGCS	Voice Group Call Service (⇔ GSM-R)
VHE	Virtual Home Environment (⇔ 3GTS 22.121, 3GTS 23.127)
VLR	Visitor Location Register
VPI	Virtual Path Identifier (⇔ ATM)
V-PLMN	Visited PLMN
VPN	Virtual Private Network
WAG	WLAN Access Gateway
WAP	Wireless Application Protocol
WCDMA	Wide-band Code Division Multiple Access
WIMAX	Worldwide Interoperability for Microwave Access (⇔ IEEE 802.16)
WINS	Windows Internet Name Service

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