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# GSM PROTOCOL STACK

# CCD

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1. Initial version

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## 1.2 Abbreviations

AGCH Access Grant Channel
BCCH Broadcast Control Channel
BS Base Station
BSIC Base Station Identification Code
CBCH Cell Broadcast Channel
CBQ Cell Bar Qualify
CC Call Control
CCCH Common Control Channel
CCD Condat Coder Decoder
CKSN Ciphering Key Sequence Number
C/R Command / Response
C1 Path Loss Criterion
C2 Reselection Criterion
DCCH Dedicated Control Channel
DISC Disconnect Frame
DL Data Link Layer
DM Disconnected Mode Frame
EA Extension Bit Address Field
EL Extension Bit Length Field
EMMI Electrical Man Machine Interface
F Final Bit
FACCH Fast Associated Control Channel
FHO Forced Handover
GP Guard Period
GSM Global System for Mobile Communication
HPLMN Home Public Land Mobile Network
I Information Frame
IMEI International Mobile Equipment Identity
IMSI International Mobile Subscriber Identity
Kc Authentication Key
L Length Indicator
LAI Location Area Information
LPD Link Protocol Discriminator
M More Data Bit
MCC Mobile Country Code
MM Mobility Management
MMI Man Machine Interface
MNC Mobile Network Code
MS Mobile Station
NCC National Colour Code
NECI New Establishment Causes included
N(R) Receive Number
N(S) Send Number
OTD Observed Time Difference
P Poll Bit
PCH Paging Channel
PDU Protocol Description Unit
P/F Poll / Final Bit
PL Physical Layer
PLMN Public Land Mobile Network
RACH Random Access Channel
REJ Reject Frame
RNR Receive Not Ready Frame
RR Radio Resource Management
RR Receive Ready Frame
RTD Real Time Difference

SABM Set Asynchronous Balanced Mode
SACCH Slow Associated Control Channel
SAP Service Access Point
SAPI Service Access Point Identifier
SDCCH Slow Dedicated Control Channel
SIM Subscriber Identity Module
SMS Short Message Service
SMSCB Short Message Service Cell Broadcast
SS Supplementary Services
TCH Traffic Channel
TCH/F Traffic Channel Full Rate
TCH/H Traffic Channel Half Rate
TDMA Time Division Multiple Access
TMSI Temporary Mobile Subscriber Identity
UA Unnumbered Acknowledgement Frame
UI Unnumbered Information Frame
VPLMN Visiting Public Land Mobile Network
V(A) Acknowledgement State Variable
V(R) Receive State Variable
V(S) Send State Variable

## 1.3 Terms

| | |
|---|---|
| Entity: | Program which executes the functions of a layer |
| Message: | A message is a data unit which is transferred between the entities of the same layer (peer-to-peer) of the mobile and infrastructure side. Message is used as a synonym to protocol data unit (PDU). A message may contain several information elements. |
| Primitive: | A primitive is a data unit which is transferred between layers on one component (mobile station or infrastructure). The primitive has an operation code which identifies the primitive and its parameters. |
| Service Access Point: | A Service Access Point is a data interface between two layers on one component (mobile station or infrastructure). |

# 2 Overview

The Protocol Stacks are used to define the functionality of the GSM protocols for interfaces. The GSM specifications are normative when used to describe the functionality of interfaces, but the stacks and the subdivision of protocol layers does not imply or restrict any implementation.

The base of the Protocol Stack rests on the physical layer.

The Data Link Layer (DL) is used to handle an acknowledged connection between mobile and base station. The LAPDm protocol is used.

Radio Resource (RR) manages the resources of the air-interface. That means configuration of physical layer, cell selection and cell reselection, data transfer, RR-Connection handling.

Mobility Management (MM) handles registration aspects for the mobile station. It detects changes of location areas and updates a mobile station in the new location area.

Call Control (CC) provides the call functionality. This includes call establishment, call maintenance procedures like Hold, Retrieve or Modify, and call disconnection.

Supplementary Services (SS) handles all call independent supplementary services like call forwarding or call barring.

Short Message Services (SMS) is used for sending and receiving point-to-point short messages. Additionally the reception of cell broadcast short messages is included.

The man machine interface (MMI) is the interface to the user. Normally it is connected with a keypad as input device and a display as output device.

Between the several entities data interfaces are defined. These data interfaces are called Service Access Points (SAPs), indicating that an upper layer uses the services of a lower layer.

The GSM specification do not set out any implementation of the Protocol Stack. The following diagrams show the implementation described in all these documents for the mobile station. All entities except the Man Machine Interface and Physical Layer are implemented as part of the Protocol Stack.

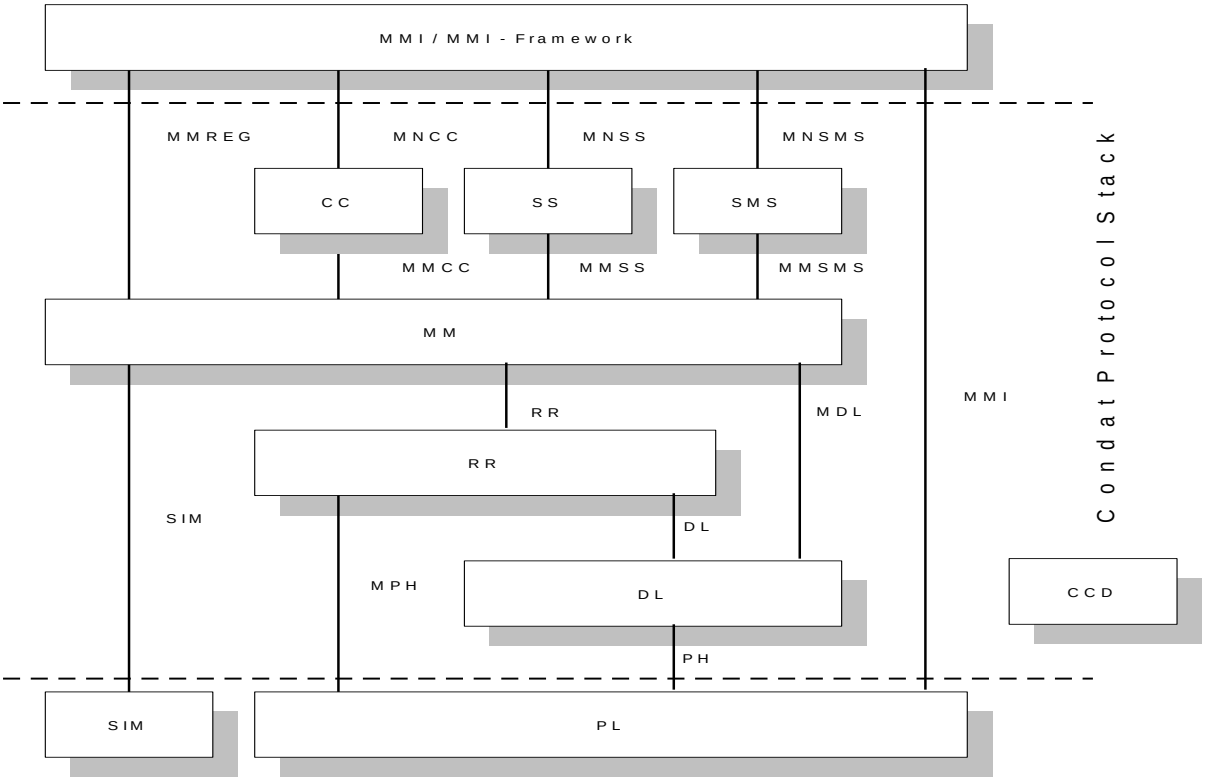


Figure 1: Mobile-station protocol architecture

This document is the technical documentation for the Condat Coder/Decoder (CCD).

# 3 Structure

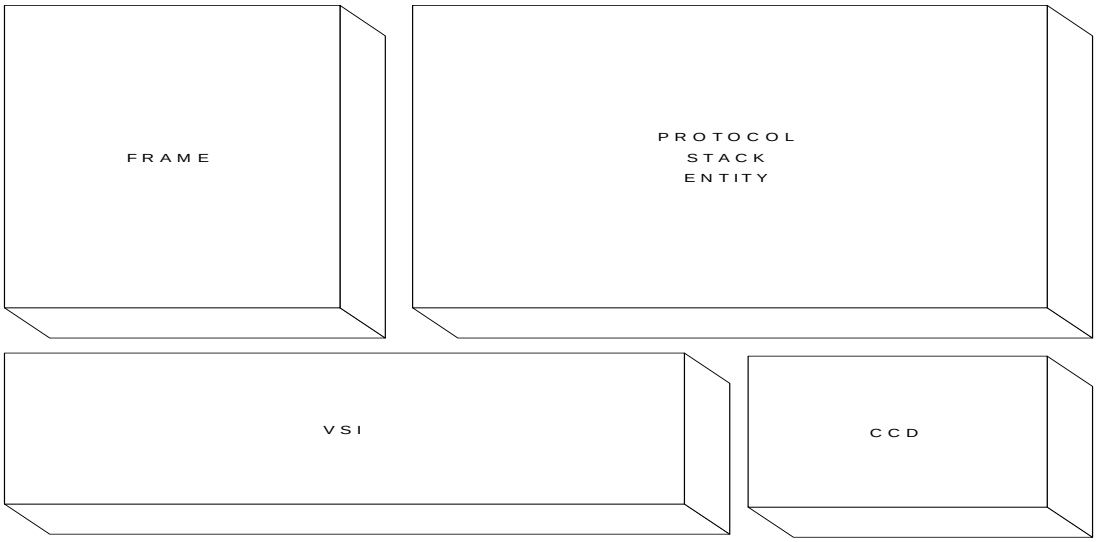


Figure 3: Structure of Protocol Stack Entity

Each protocol stack entity has the same structure and is build by the following modules

- Frame
- Protocol Stack Entity
- Virtual System Interface and
- Condat Coder Decoder

**Frame**
The frame carries out the work depending on the operating system, like startup or shutdown of a entity. This module is implemented by the customer and linked to the protocol stack entity. The interface between both is the protocol stack entity interface (PEI).

**Protocol Stack Entity**
The protocol stack entities are implemented without any dependencies on the underlying operating system. And they contain the protocol stack functionality as described into the ETSI Recommendations. They are sub-divided in the three modules protocol stack entity interface, custom specific functions and finite state machine.
The protocol stack interface module defines the interface to the frame. Custom specific functions are used to configure the protocol stack at run-time with custom specific data from a non-erasable memory for example. The finite state machine modules implement the protocol stack logic.

**Virtual System Interface**
The protocol stack entities requires operation system functionality like communication and timer. The requirements are low and independent from the operating system, so the system interface is virtual from the view of protocol stack entities. The module virtual system interface implements this interface. This implementation is carried out by pre-processor definitions or by function calls.

**Condat Coder Decoder**
GSM message at the air-interface are bit streams. The most efficient method to handle this GSM messages into a protocol stack entity is to convert this bit streams into corresponding C-Structures.

This is done by the module Condat Coder Decoder. It makes sense to integrate this module as a server into the target system because this module is needed by more than one entity.

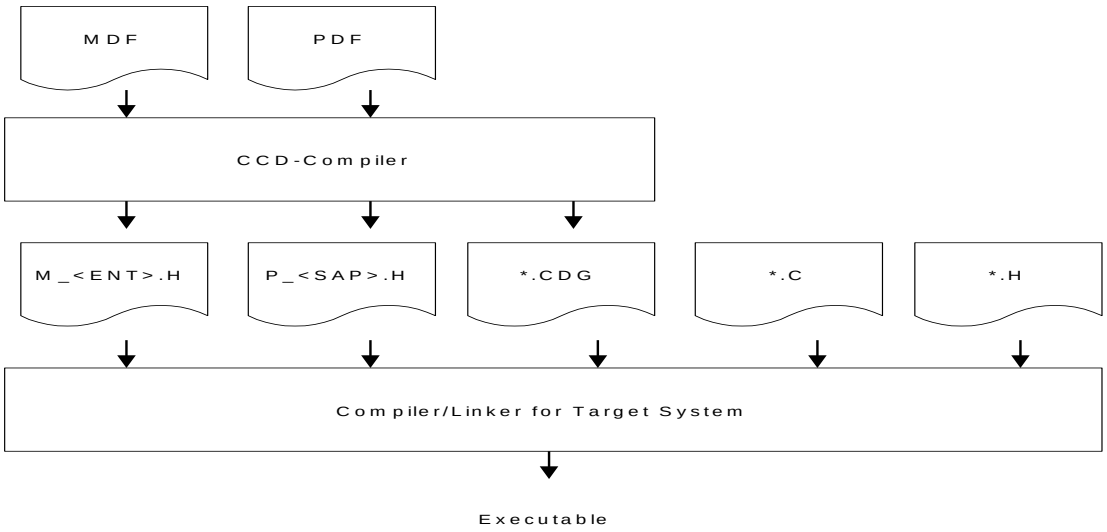


Figure 4: Generating a Protocol Stack Entity

Generating a protocol stack entity is carried out in two steps:

- Generating primitives and message structures
- Compiling / linking for target system

The message definition files (MDF) and primitive definition files (PDF) contain a description for all messages and primitives independent from a target system. The CCD-Compiler generates target dependent header files and tables. Parameters of the CCD-Compiler are Alignment and Byte-ordering of the target system.
The generated header files and the delivered header and source files are compiled and linked for the target system to obtain a executable for the target system.

# 4 Modules

The protocol stack component CCD for the mobile station is divided in the following modules:

- bitfun.c
- ccd.c
- cdc_std.c
- cdc_gsm.c
-

**bitfun.c**
This module contains functions for the bit oriented access to the message stream. The machine dependent conversation between the numeric model of the network and the numeric model of the used processor in the mobile station is performed by this module too.
**ccd.c**
This module defines the kernel of the CCD. It contains the global main functions for encoding and decoding of messages and does the CCD-table selection for the messages. The kernel contains an UPN arithmetic engine for evaluating conditions and manipulating bit positions.
**cdc_std.c**
Contains the standard codecs for encoding and decoding basic numeric and structured elements. The functions are common for each protocol standard.
**cdc_gsm.c**
Contains the GSM specific codec for encoding and decoding the types GSM1-5 (TVL) wich are defined in the 4.08 message specification. The GSM codec is implemented as a „plugin“ module for the CCD.

# 5 Header

The modules include several header files. Header files which are changeable by the user are marked (*). These header files are used to integrate the protocol stack entities in a specific target system.

- bitfun.h
- ccdtable.h
- ccdapi.h (*)
- ccd.h
- gsm.h
- stddefs.h
- custom.h
- vsi.h (*)
- calc.cdg
- ccdmtab.cdg
- mconst.cdg
- pconst.cdg
- mcomp.cdg
- melem.cdg
- mmtx.cdg
- mvar.cdg
- spare.cdg

**bitfun.h**
contains the prototypes for the bit access functions.
**ccdtable.h**
contains the definitions of the structures of the CCD-tables
**ccdapi.h (*)**
The header defines the prototypes and some constants for the Condat Coder Decoder (CCD).
**ccd.h**
contains the prototypes for elemtary functions that can be used by any codec function. The definitions of the ERROR values are defined here.
**gsm.h**
The header contains global definitions for all protocol stack entities. Depending on the definitions in custom.h many options and traces are defines in this header.
**stddefs.h**
The header contains several standard definitions used by the protocol stack entities.
**custom.h**
The header defines global constants for the integration of the protocol stack entity into a specific target system. The user may define the identifier of the communication resource, the supported traces, the communication method (by copying primitives or by exchanging references of primitives) , the custom specific primitive header and some more.
**vsi.h**
Prototypes for the virtual system interface are defined in this header. Some parameter and the return types of these function are changeable by the user for integration in a specific target system.
**calc.cdg**
This header is generated by the CCD compiler. It defines all UPN calculation steps.
**ccdmtab.cdg**
This header is generated by the CCD compiler. It defines the data area for all CCD tables.
**mconst.cdg**
This header is generated by the CCD compiler. It includes all message identifier and some constants needed by the entities.
**pconst.cdg**
This header is generated by the CCD compiler. It includes all primtive identifier and some constants needed by the entities.
**mcomp.cdg**
This header is generated by the CCD compiler. It defines the structured elements of all messages.
**melem.cdg**
This header is generated by the CCD compiler. It defines the contents of structured and basic elements.
**mmtx.cdg**
This header is generated by the CCD compiler. It defines the main table for selection of the message codec rules.
**mvar.cdg**
This header is generated by the CCD compiler. It defines the coding rules for all basic elements.
**spare.cdg**
This header is generated by the CCD compiler. It defines the coding rules for all spare definitions.

# 6 Configuration

The protocol stack software is independent from a specific target system. The step from the independent protocol stack software to a target system is carried out by configuration and by custom specific functions. CCD can be configured with static configurations. Static configuration is carried out by setting constants or types in some header files before compiling the sources. The following header files are changeable by the user:

- ccdapi.h
- custom.h
- pei.h
- vsi.h

Some configurations are valid for all protocol stack entities (defined in ccdapi.h, custom.h, pei.h and vsi.h). They are described in the Users guide.
The CCD specific configuration must be performed by defining symbols at compile time. This can be done with the -D option by most of the known compilers.

**M_INTEL/M_MOTOROLA**
The symbol defines the memory model for the representation of numeric values of the used processor type. M_INTEL defines the little-endian machines like INTEL/ARM7 - M_MOTOROLA defines the big-endian machines like MOTOROLA/PowerPC. One and only one of the options must be defined.

**DEBUG_CCD and CCD_TRACEFILE**
If this symbol is defined the CCD generates debug information while coding and decoding. This is done via the vsi_o_trace function. If the symbol CCD_TRACEFILE is set to an string that defines a valid filename the trace will be done in a file instead with vsi_o_trace. This file makes only sense if CCD is used in a OS environment that supports files.

**CCDTABLES_EXTERN**
If this symbol is defined the CCD expect that the CCDTABLES (defined in ccdmtable.h) are defined extern and the start addresses are defined at the link time.
**SHARED_CCD**
To use the CCD in a multithread environment this symbol must be defined. In this case the CCD requests a semaphore from the FRAME to avoid a multiple call of CCD-Functions.
**SHARED_VSI**
This symbol must be set if the CCD is used in a multithread environment and the DEBUG_CCD is defined.
**CCD_SYMBOLS**
If it is necessary to have access to the names of the messages, primitives and the Information elements with their variables this symbol must be defined. For this case the CCD-tables must be generated without symbols by CCDGEN before compiling any CCD source.
**CCD_PLUGIN_GSM**
To use the GSM specific „plugin“ it is necessary to define this symbol.

# 7 Resources

## 7.1 Semaphores

One semaphore is requested at initialisation time to protect the CCD to be called twice before a complete message is coded or decoded.

# Appendices

## A. Acronyms

**DS-WCDMA** Direct Sequence/Spread Wideband Code Division Multiple Access

## B. Glossary

**International Mobile Telecommunication 2000 (IMT-2000/ITU-2000)** Formerly referred to as FPLMTS (Future Public Land-Mobile Telephone System), this is the ITU's specification/family of standards for 3G. This initiative provides a global infrastructure through both satellite and terrestrial systems, for fixed and mobile phone users. The family of standards is a framework comprising a mix/blend of systems providing global roaming. <URL: http://www.imt-2000.org/>