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ANTARES

Communication Standard Technical Specification

DRAFT VERSION

(DRL N°: D018B)

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CHANGE RECORDS

ISSUE	DATE	§ CHANGE RECORDS	AUTHOR
Draft01	20/03/2012	First draft	Indra Team

Draft02	02/11/2012	Second draft (CS intermediate review)
		▪ Main changes / updates
		  ▪ Definitions, Symbols, bit numbering
		  ▪ System reference model architecture and interfaces
		  ▪ User, Control and Management Plane Protocol Stack
		  ▪ Network layer functions and QoS
		  ▪ Control functions: logon, handover, network synchro and ACM
		  ▪ Link layer: multiple access protocols and encapsulation
		  ▪ Physical layer specification: all
		  ▪ Management plane interfaces
		▪ New sections list
		  ▪ 14 Annex C for traceability of changed requirements.
		▪ Sections updated
		  ▪ 1.2, 2.2, 2.3, 4.1, 4.2, 5, 6, 7.1.1.2, 7.2.1, 7.2.2, 7.3.1, 8.4, 8.5, 8.6, 9.2, 12, 13, 14
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			Indra Team

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		FUN-0690 ▪ Corrected error in "Field Size" of Data Field Length (10 bits instead of 8) in Table 8-22 (D018-COM-FUN-1890) ▪ Restored requirement CSREQ-3225 deleted by error (D018-COM-FUN-2650) ▪ Section 4 overview section updated as per CSIDR ESA RID CMO-CS-002 (action A-CS-006) ▪ Removed RD-02, RD-03, RD-04 and RD-09 as per CSIDR ESA RID SCO-CS-011 (action A-CS-027) ▪ Annex A: Removed as per ESA RID PBU-IG-004 (action A-IG-002) and moved to D023. ▪ Annex C: Requirements change traceability from draft02 to draft01 corrected and updated. Traceability of draft03 to draft02 in DOORS module. ▪ Update Figure 2-1 and descriptions as per CSIDR ESA RID GA-CS-001 (action A-CS-012) ▪ Updated Figures 5-1 to Figure 5-5, as per CSIDR RID SCO-CS-010 (action A-CS-026). ▪ Updated Figure 5-5, as per CSIDR RID SCO-CS-009 (action A-CS-025). ▪ Updated Figure 4-1, as per CSIDR RID SCO-CS-008 (action A-CS-024). AGR is part of the GES. ▪ Updated section 5, as per CSIDR RID SCO-CS-007 (action A-CS-023). ▪ Updated section 4.1 and figure 4.1 regarding CSMa (now included in the NCC), as per CSIDR RID SCO-CS-006 (action A-CS-022). ▪ Updated section 5.3, as per TAS.I CSIDR RID GP-006.	
Draft04	21/01/2013	Fourth draft (version ready for publication) ▪ Format improved and typos solved ▪ Warning note at introduction	Indra Team

TABLE OF CONTENTS

1. INTRODUCTION

This document, named Communication Standard Technical Specification, has been issued in the scope of WP2 of the ANTARES project and integrates the work performed by the ANTARES WP2 partners.

The main objective of the ANTARES project is the definition of a new Air Traffic Services (ATS) and Airline Operational Control (AOC) satellite Communications Standard and an associated system implementation that allows seamless operation with terrestrial standards.

The new satellite-based Communication Standard, covered by this document, specifies the physical and link layers of the protocol stack, including the mechanisms for signalling between physical entities using the Communication Standard. The Communication Standard specification addresses the user, control and management planes of the standardised interfaces.

NOTE

The current version of this document is a **DRAFT version** that reflects work done so far within the ANTARES project. However, as a consequence of future CS consolidation and refinement activities, relevant revisions and updates can be expected, especially in the following areas:

- System architecture
- Network layer functions
- Control layer functions, as logon, handover, ACM.
- Multiple Access
- Management functions
- Signalling functions
- Multicast control procedures

The next two updates foreseen are:

1. End of design by April 2013
2. Final version after verification by March 2014

1.1 Scope

The present document reports the Communication Standard Technical Specification for the provision of ATS and AOC services through satellite-based communications. The present Technical Specification specifies the physical and link layer for the user, control and management planes.

1.2 Structure of the document

This document is structured as follows:

- Section 1 presents the introduction to the document
- Section 2 compiles the definition, symbols, acronyms and conventions used in the document

- Section 3 reports the applicable and reference documents
- Section 4 reports the satellite communication system overview, identifying the entities involved in the communication.
- Section 5 provides an overview of the user, control and management planes
- Section 6 provides the technical specifications for user, control and management plane external interfaces
- Section 7 addresses the technical specification for the frequency band, multiple access and system carriers definition, channels and other general requirements
- Section 8 reports the technical specification for the user plane
- Section 9 reports the technical specification for the control plane
- Section 10 provides the technical specification for the management plane
- Section 11 provides the descriptions of the signalling structures

In addition to these sections, the communication standard technical specification also contains the following annexes:

- Annex A provides a description of the aeronautical channel considered
- Annex B provides the parity bit accumulators for IRA LDPC codes
- Annex C summarizes the changes in requirements with respect to the previous version (Draft 01).

2. DEFINITIONS, SYMBOLS, ABBREVIATIONS AND CONVENTIONS

2.1 Definitions

2.1.1 Communication

- **Communication protocol:** A set of rules defining how network entities interact with each other, including both syntactic and semantic definitions.
- **Communication links:**
  - **Mobile link (or ATM link):** communication link between satellite and aircraft (uplink and downlink)
  - **Fixed link:** communication link between satellite and Ground Earth Station (uplink and downlink)
  - **Forward link:** communication link from the Ground Earth Station to aircraft, where:
    - **Uplink** is the communication link from ground to the satellite
    - **Downlink** is the communication link from satellite to aircraft
  - **Return link**: communication link from aircraft to Ground Earth Station where:
    - **Uplink** is the communication link from aircraft to the satellite
    - **Downlink** is the communication link from satellite to ground
- **Protocol stack**: a specific instance of a layered protocol that defines the communication protocol. The present communication standard supports several protocols in parallel, each one using its own terminology. The ISO-OSI reference protocol stack terminology is used for describing these protocols. In the following the description of the layers tailored for the present communication standard is provided:
  - **Physical layer (L1)**: The physical layer defines the Satellite Communication System waveform, including modulation and coding.
  - **Link layer (L2)**: The link layer defines the media access method (often referred to as MAC – Media Access Control) as well as framing, formatting and error control (often referred to as LLC – Link Layer Control).
  - **Network layer (L3)**: The network layer defines the format of end-to-end data packets, as well as routing of packets within the network. The following network layer protocols are supported: ISO 8208 packets (ATN/OSI) and IP (ATN/IPS).
  - **Transport layer (L4)**: The transport layer defines end-to-end functionalities such as reliable/unreliable data transport, flow and congestion control. The transport layer operates end-to-end, and is implemented only in the end systems. Therefore, it has no direct impact on the Satellite Communication system. However, the mechanisms of transport layer have to be carried, in form of overhead on network layer packets and additional packets.

    The following transport protocols are current or anticipated within the EATM environment:

- TP4 (ATN-OSI reliable transport protocol)
- TCP (ATN-IPS reliable transport protocol)
- UDP (ATN-IPS unreliable transport protocol)

TP4 and TCP generate significant numbers of transport layer acknowledgements.

- **Session layer (L5)**: Not applicable for this standard. Defined by SESARJU.
- **Presentation layer (L6)**: Not applicable for this standard. Defined by SESARJU.
- **Application layer (L7)**: The application layer defines additional mechanisms used by end user applications. It handles user data units in the form of application messages.

Additionally, definition of an additional layer located between layer 3 and layer 2 is useful:

- **Network adaptation layer (L2.5)**: this layer has been specifically defined for the CS and provides functions that are needed to properly adapt the network layer to the generic (i.e., network layer agnostic) CS link and control layer functions. While they require interpretation / knowledge of the specific network layer of the data unit to be transmitted (interpretation of headers, etc.), they do not cover traditional network layer functions as described for layer 3. It includes functions as IP header compression and support for mobility related events.

- The following definitions are also applicable to the present document (see also Figure 2-1):
  - **NSDU** (Network Service data Unit) **or Segment**: A NSDU is the data unit posted by the transport layer to L3. It is also named Segment.
  - **NPDU** (Network Protocol Data Unit) **or Packet:** A NPDU is the data unit resulting from adding network layer headers to the NSDU provided by L4. It is the basic data unit handled by the network layer and exchanged among L3 peers. It is also the data unit forwarded to the network adaptation layer.
  - **ALSAP** (Adaptation Layer Access point): The ALSAP is the point where L2.5 provides its services to L3.
  - **PNPDU** (Processed Network Protocol Data Unit): A PNPDU is the resulting data unit after the incoming NPDU data unit is processed by the L2.5 layer of the CS (in particular, by applying header compression protocols). In some cases (when header compression is disabled), it is equivalent to a NPDU. From a L2 point of view, it is equivalent to a LSDU.
  - **LSAP** (Link Service Access Point): The LSAP is the point where L2 provides the service to L2.5.
  - **LSDU** (Link Service Data Unit) **or Processed Packet:** A LSDU is the data unit posted by the network adaptation layer (L2.5) to L2 at the LSAP.
  - **LPDU** (Link Protocol Data Unit): A LPDU is the data unit resulting from adding L2 headers to LSDU or LSDU fragments (when fragmented).
  - **PSAP** (Physical Service Access Point): The PSAP is point where L1 provides the service to L2.

- **PSDU** (Physical Service Data Unit): A PSDU is the data unit posted by L2 to L1 at the PSAP. It is composed of 1 or more LPDUs. It is also referred to as frame throughout the document.
- **PPDU** (Physical Protocol Data Unit): A PPDU is a PSDU data unit which includes also L1 signalling headers (data descriptor), a CRC and, eventually, padding (in case the PSDU size is smaller than the PPDU payload). One PPDU always contains at most one PSDU.
- **PLFRAME** (Physical layer frame) **or Burst**: This is the data unit resulting from physical layer processes (coding, modulation, etc) as applied to one PPDU. It is also referred to as burst throughout the document.

Note: These terms have been adapted from the OSI layered model terminology.

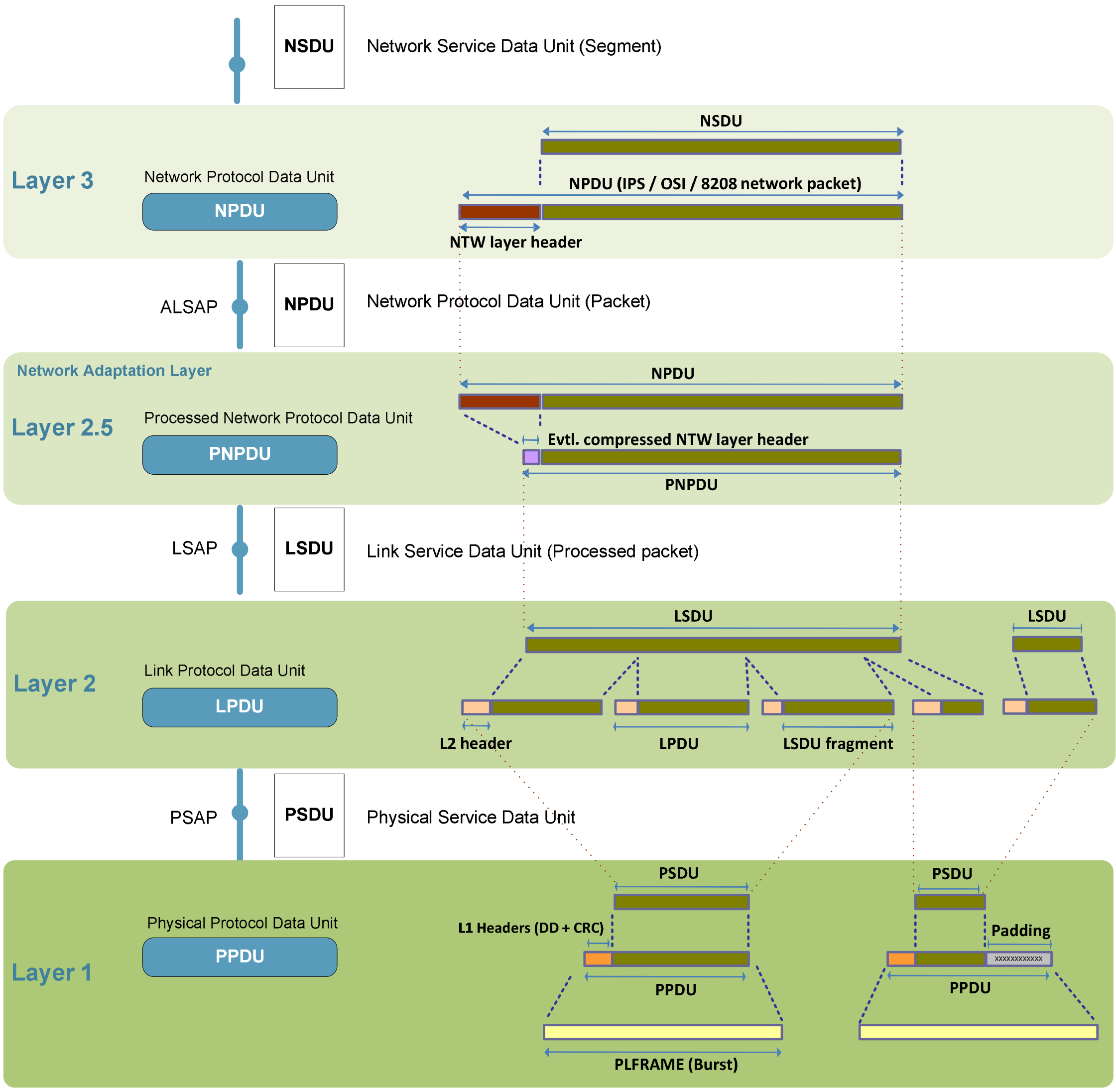


Figure 2-1: Introducing layer model terminology[1]

[1] Depicted headers are for illustration only. They refer to headers and trailers and may not be always located at the start of the data unit as shown in the figure. Please refer to the specific data format definitions included in the CS specification for the exact description of the data units.

- **QoS (Quality of Service):**
  - **Flow:** set of LPDUs belonging to an NPDU identified by a sequence number.
  - **CoS (Class of Service):** set of applications sharing similar QoS parameters, i.e. continuity (expired NSDUs rate), ET (expiration time) and TD95 (percentile 95 of transit delay) as defined in SYS-CSY-0080 at [AD-01].
- **Pt-to-pt** (point to point): A point to point channel is transmitted by one source and received by one destination.
- **Pt-to-mp** (point to multipoint): A point to multipoint channel is transmitted by one source and received by several receivers.
- **Mp-to-pt** (multipoint to point): A multipoint to point channel is transmitted by several source and received by one receiver.
- **Unicast**: the one-to-one transmission of data packets to one specified destination.
- **Multicast**: the one-to-many transmission of data packets to interested destinations.
- **Broadcast**: the one-to-all transmission of data packets to all possible destinations.
- **Physical layer link quality:**
  - **PER (Packet Error Rate):** In the Communication Standard, the term PER refers to the probability that a PPDU is received with errors. Therefore, the PER is computed as the number of erroneous PPDUs divided by the total number of received PPDUs.

2.1.2 Entities

- **Ground Earth Station (GES):** The network entity that provides the feeder link to the Space Segment. In the context of this document, a GES is defined as a logical entity that makes use of communication resources assigned to it in order to communicate with aircraft associated with it. A GES will typically user resources within a single beam of a single satellite, but this is not mandatory. A physical site may accommodate several logical GESs, and GESs may share Earth station infrastructure.
- **Network Control Centre (NCC):** The network entity that performs the control of the system resources and elements. It is expected that this entity covers neither the Satellite Control Centre nor the Satellite Operation Centre, but it includes the CSMa (Communication Spectrum Monitoring agent).
- **Network Management Centre (NMC):** The network entity that performs the management of the system resources and elements. It is expected that this entity covers neither the Satellite Control Centre nor the Satellite Operation Centre.
- **User Terminal (also called Airborne Earth Station - AES):** The avionics onboard the aircraft that implements the communication protocol and provides the interface to other on-board elements via an on-board network.

2.1.3 RAMS

- **Continuity**: Probability that a transaction will be completed having met specified performance. Possible anomalous behaviours include late transactions, lost messages or transactions that cannot be recovered within the expiration time, duplicate messages and uncorrected detected message errors.

- **Instantaneous availability:** It is the probability that a service (or system) will be operational (up and running) at any random time, t. This is very similar to the reliability function in that it gives a probability that a system will function at the given time, t. Unlike reliability, the instantaneous availability measure incorporates maintainability information.
- **Average Uptime Availability (or Mean Availability):** The mean availability is the proportion of time during a mission or time period that the system (or service) is available for use. It represents the mean value of the instantaneous availability function over the period (0, T].
- **Integrity:** Integrity is the acceptable rate of transactions that are completed with an undetected error. Undetected errors include undetected corruption of one or more messages within the transaction.
- **Expiration Time:** Maximum time between updates beyond which a service interruption is declared.
- **TD95:** 95-th percentile of the transit delay one-way latency.
- **Diversity**: The simultaneous use of two or more mutually independent and different systems to increase service availability. Diversity allows to improve the link availability and thus the overall system availability by providing (at least) two links thanks to redundant elements and allowing to switch from one link to the other one (or combine the two) by choosing the best configuration/link available at a certain time. This solution is mainly used as fade countermeasure technique and compensation of the channel, i.e. for events happening outside of the system. The overall availability for the two links (or paths) is better than the one for a single link (or path).
- **Redundancy**: Duplication of one element (of GES, NCC, satellite or UT) or equipment within an element (e.g. RF sub-system) or sub-equipment (e.g. modem) to provide back-up in case of failure. Typical cases to be considered are intended unavailability of equipment due to maintenance operations as well as failures due to design or lifetime of equipment. The objective is to compensate for unavailability of elements due to the system itself.

2.2 Symbols

Symbol	Definition
$C_{ch,a}$	Channelization code of Auxiliary Channel (RTN_ACH)
$C_{ch,d}$	Channelization code of Data Channel (RTN_DCH)
$C_{ch,SF,k}$	Channelization code identifier
$C_{FWD\_I\_SCR}$	In-phase component Physical Layer Complex Scrambling
$C_{FWD\_Q\_SCR}$	Quadrature component Physical Layer Complex Scrambling
$\boldsymbol{c}_{HAD}$	Hadamard Code Block
$c_{HAD\_0}, c_{HAD\_1}, \ldots, c_{HAD\_n}$	Hadamard Code bits
$\boldsymbol{c}_{ldpc}$	LDPC code word block
C_p	RTN_PREAMBLE channelization code
C_{Scram}	Complex Scrambling code
d(D)	Backward Recursive Systematic Convolutional Generator

Symbol	Definition
	polynomial
D_{FWD}	Number of rows of FWD Symbol Interleaver
f_N	Nyquist frequency
G	Hadamard generator matrix
G(D)	Transfer function of the 16-state constituent code for PCCC
G(X)	32-bit CRC generator polynomial
$\boldsymbol{h}$	FWD_DD information block
$h_0, h_1, ..., h_{23}$	FWD_DD Header information bits
h(D)	Generator polynomial of the binary pseudo-random sequence for the Base-band scrambling
I	In-phase component
$\boldsymbol{i}$	LDPC code information block
$i_0, i_1, ..., i_{K_{ldpc}-1}$	LDPC code information bits
$I_{FWD\_PLFRAME}$	In-phase component of a symbol of FWD_PLFRAME
$I_{FWD\_PLFRAME}$	In-phase component of FWD_PLFRAME
$I_{FWD\_S\_PLFRAME}$	In-phase component of FWD_S_PLFRAME
K_{ldpc}	Uncoded LDPC block Size / Number of bits of FWD_BB_FRAME
$\boldsymbol{l}$	FWD_FWD_BD block
$l_0, l_1, ..., l_{15}$	RTN_DD Header bits
$l_0, l_1, ..., l_m$	FWD_FWD_BD bits
m(k)	Base-band scrambling input sequence (FWD and RTN)
M(X)	Input stream to be processed by the systematic 32-bit CRC encoder
m_scr(k)	Base-band scrambling output sequence (scrambled sequence) (FWD and RTN)
M_{FWD}	Number of columns of FWD Bit Interleaver
M_{RTN}	Number of columns of FWD Bit Interleaver
$n_0(D)$	First Forward Recursive Systematic Convolutional Generator polynomial
$n_1(D)$	Second Forward Recursive Systematic Convolutional Generator polynomial
$n_2(D)$	Third Forward Recursive Systematic Convolutional Generator polynomial
N^{ACK}	Number of Acknowledgement
$N_{FEC\_FWD\_BD}$	Number of bits of FEC_FWD_BD
N_{FWD}	Number of rows of FWD Bit Interleaver
$N_{FWD\_BB\_DFL}$	Number of bytes of FWD_BB_DATAFIELD
N_{FWD_BD}	Number of bits of FWD_BD (FWD Burst Descriptor) header
N_{FWD_CRC}	Number of bits FWD_CRC_32 field
N_{FWD_DD}	Number of bytes of FWD_DD (FWD Data Descriptor) header
$N_{FWD\_I\_4XFECFRAME}$	Number of symbols (complex values) of FWD_I_4XFECFRAME
$N_{FWD\_I\_4XFECFRAME\_F}$	Numberof symbols of a fragment FWD_I_4XFECFRAME_F
$N_{FWD\_I\_XFRAME}$	Number of symbols per FWD_I_XFRAME
$N_{FWD\_I\_XFRAME\_F}$	Number of symbols in a fragment FWD_I_XFRAME_F
$N_{FWD\_I\_XFRAME\_FN}$	Number of symbols in the last fragment

Symbol	Definition
	FWD_I_XFRAME_FN
N_{FWD_PB}	Number of pilot symbols in a Pilot Block (PB)
$N_{FWD\_PLFRAME}$	Number of symbols of FWD_PLFRAME
N_{FWD_PPDU}	Number of bits of FWD_PPDU
$N_{FWD\_PREAMBLE}$	Number of FWD_PREAMBLE symbols
N_{FWD_PSDU}	Number of bytes of the incoming FWD_PSDU
$N_{FWD\_S\_PLFRAME}$	Number of symbols of FWD_S_PLFRAME
$N_{FWD\_S\_PPDU}$	Number of bits of Scrambled PPDU
$N_{FWD\_XFECFRAME}$	Number of symbols (complex values) of FWD_XFECFRAME
N_{ldpc}	Coded LDPC block Size / Number of bits of FWD_FECFRAME
$N_{PLHEADER}$	Number of symbols of PLHEADER
N_{RTN}	Number of rows of FWD Bit Interleaver
N_{RTN_ACH}	Number of symbols of Auxiliary Channel (BPSK mapped)
$N_{RTN\_AUXFRAME}$	Number of bits of the RTN_AUXFRAME
$N_{RTN\_BB\_DFL}$	Number of bytes of RTN_BB_DATAFIELD
$N_{RTN\_BBFRAME}$	Number of bits of RTN_BBFRAME
N_{RTN_CRC}	Number of bits FWD_CRC_32 field
N_{RTN_DCH}	Number of symbols of Data Channel (BPSK mapped)
N_{RTN_DD}	Number of bytes of RTN_DD (RTN Data Descriptor) header
$N_{RTN\_FECFRAME}$	Number of bits of FECFRAME / Coded TCC block size (including tail bits)
N_{RTN_PB}	Number of Pilot bits transmitted through the Auxiliary channel (RTN_ACH)
N_{RTN_PPDU}	Number of bits of RTN_PPDU
$N_{RTN\_PREAMBLE}$	Number of RTN_PREAMBLE symbols
N_{RTN_PSDU}	Number of bytes of the incoming RTN_PSDU
$\boldsymbol{p}$	LDPC code parity block
$p_0, p_1, \ldots, p_{Nldpc-Kldpc-1}$	LDPC code parity bits
P_{FWD}	Number of columns of FWD Symbol Interleaver
$\boldsymbol{PH}$	PLHEADER Block
$PH_0, PH_1, \ldots, PH_k$	PLHEADER symbols
Q	Quadrature component
$Q_{FWD\_PLFRAME}$	Quadrature component of a symbol of FWD_PLFRAME
$Q_{FWD\_PLFRAME}$	Quadrature component of FWD_PLFRAME
$Q_{FWD\_S\_PLFRAME}$	Quadrature component of FWD_S_PLFRAME
r	Code rate
R(X)	32-bit CRC (reminder of the division of the input data stream by the 32-bit CRC generator polynomial)
R_1	First (inner) ring Radius of APSK modulation
R_2	Second ring Radius of APSK modulation
$\boldsymbol{s}$	MODCOD_ID block
s_0, s_1, s_2, s_3	MODCOD_ID bits
T_s	Symbol period
$x(0), x(1), \ldots, x(N_{RTN\_S\_BBFRAME}-1)$	TCC (PCCC) code information bits
$y'_1(0), y'_1(1), \ldots, y'_1(N_{RTN\_S\_BBFRAME}-1)$	TCC (PCCC) parity bits of the second encoder (without tail

Symbol	Definition
	bits)
$y_1(0), y_1(1), ..., y_1(N_{RTN\_S\_BBFRAME}-1)$	TCC (PCCC) parity bits of the first encoder (without tail bits)
α	Roll-off factor
β_2	RTN_ACH Gain Factor
β_p	RTN_PREAMBLE Gain Factor
γ	Constellation radius ratio
η_{MOD}	Number of transmitted bits per constellation symbol
$\mu(k)$	Binary pseudo-random sequence for the Base-band scramling (FWD and RTN)

Table 2-1: Symbols

2.3 Acronym list

Acronym	Definition
16-APSK	16 Amplitude Phase Shift Keying
3GPP2	3rd Generation Partnership Project 2
8-PSK	8 Phase Shift Keying
A-CDMA	Asynchronous Code Division Multiple Access
ACK	Acknowledgement
ACM	Adaptive Coding and Modulation
AD	Applicable Document
AES	Aeronautical Earth Station
AF	Address Format
AGR or A/G-R	Air Ground Router
AMS(R)S	Aeronautical Mobile Satellite (en Route) Service
AOC	Airline Operational Control
APSK	Amplitude and Phase-Shift Keying
ARQ	Automatic Repeat reQuest
AS	Autonomous System
ATC	Air Traffic Control
ATM	Air Traffic Management, Asynchronous Transfer Mode
ATN	Aeronautical Telecommunication Network
ATN/IPS	ATN/ Internet Protocol Suite
ATN/OSI	ATN/ Open Systems Interconnection
ATS	Air Traffic Services
BB	Base Band
BCCH	Broadcast Control Channel
BER	Bit Error Rate

Acronym	Definition
BPSK	Binary Phase Shift Keying
BTCH	Broadcast/Multicast Traffic Channel
CBR	Constant Bit Rate
CC	Congestion Control
CDMA	Code Division Multiple Access
CLNP	Connectionless Network Protocol
CoS	Class of Service
CRC	Cyclic Redundancy Checksum
CS	Communication Standard
CSMa	Communications Spectrum Monitoring agents
DD	Data Descriptor
UTCH	Unicast Traffic Channel
ESP	Encapsulating Security Payload
ET	Expiration Time
FC	Fragment Counter
FCAPS	Fault, Configuration, Accounting, Performance and Security
FCH	Forward Channel
FEC	Forward Error Correction
FID	Flow ID
FIFO	First In First Out
FL	Forward Link
FLC	Forward Link Carrier
FSS	Fixed Satellite Service
FW	Forward
FWD	Forward
GEO	Geostationary Orbit
GES	Ground Earth Station
GGR or G/G-R	Ground-Ground Router
GMP	Group Management Protocol
GS	Ground Segment
GW	Gateway
HO	Handover
HPA	High-Power Amplifier
ICAO	International Civil Aviation Organization
ID	Identifier
IDRP	Inter-Domain Routing Protocol
IF	Interface
IP	Internet Protocol
IPS	Internet Protocol Suite

Acronym	Definition
IRA	Irregular Repeat and Accumulate
ISH	Intermediate System Hello
ITU	International Telecommunication Union
L1	Layer 1 – Physical layer
L2	Layer 2 – Link Layer
L3	Layer 3 – Network Layer
L4	Layer 4 – Transport Layer
LDPC	Low Density Parity Check
LPDU	Link Protocol Data Unit
LREF	Local Reference
LPDU	Link Protocol Data Unit
LSDU	Link Service Data Unit
MAC	Medium Access Control
MEO	Medium Earth Orbit
MF-TDMA	Multi Frequency Time Division Multiple Access
MIB	Management Information Base
MODCOD	MODulation and CODification
MSB	Most Significant Bit
NCC	Network Control Centre
NCR	Network Clock Reference
NMC	Network Management Centre
NSAP	Network Service Access Point
NTW	Network
OBP	On-board Processor
OSI	Open Systems Interconnection
OVSF	Orthogonal Variable Spreading Factor
PC	Packet Counter
PCCC	Parallel Concatenated Convolutional Code
PDU	Protocol Data Unit
PER	Packet Error Rate
PHB	Per-Hop-Behaviour
PID	Packet ID
PPDU	Physical Protocol Data Unit
PSAP	Physical Service Access Point
PSDU	Physical Service Data Unit
PSK	Phase-Shift Keying
PT	Payload Type
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying

Acronym	Definition
RA	Random Access
RACCH	Random Access Control Channel
RACH	Random Access Channel
RAMS	Reliability, Availability, Maintainability and Safety
RD	Reference Document
RF	Radio Frequency
RFU	Reserved for Future Use
RHCP	Right-Hand Circular Polarisation
RL	Return Link
RLC	Return Link Carrier
ROHC	RObust Header Compression
RTN	Return
RTP	Real-Time Transport Protocol
RTT	Round-Trip Time
SCC	Satellite Control Centre
SDU	Service Data Unit
SF	Spreading Factor
SNDCF	Sub-Network Dependent Convergence Functions
SNIR	Signal to Noise plus Interference Ratio
SOC	Satellite Operation Centre
SPS	Space Segment
SRRC	Square Root Raised Cosine
SSA	Spread Spectrum Aloha
SSP	Satellite Service Provider
S-WAN	Satellite Wide Area Network
TBC	To Be Confirmed
TBD	To Be Defined
TCC	Turbo Convolutional Code
TCP	Transmission Control Protocol
TD95	Transit Delay 95-th percentile
TDMA	Time Division Multiple Access
T-WAN	Terrestrial Wide Area Network
UCCH	Unicast Control CHannel
UDP	User Datagram Protocol
UT	User Terminal
WAN	Wide Area Network

2.4 Specification numbering

The communication standard specifications are identified by a unique alphanumeric code with the following format:

CSREQ-NNNN

where:

- CSREQ is common for all the specifications
- NNNN stands for the specification number

2.5 Verb tense

In the present document, the following definitions apply:

- “Shall”: the specifications formulated as “shall” are mandatory specifications and must be implemented.
- “May”: The requirements formulated as “may” express a permissible practise or action.
- “Will”: The requirements formulated as “will” denotes a provision or an intention in connection with this requirement.

3. APPLICABLE AND REFERENCE DOCUMENTS

3.1 Applicable documents

ID	Document Number	Title	Issue	Date
[AD-01]	Iris-B-OS-RSD-0002-ESA	Iris Phase 2.1 System Requirements Document	1.4	06/09/2010

Table 3-1: Applicable documents

3.2 Reference documents

ID	Document Number	Title	Issue	Date
[RD-01]	RFC 2578	Structure of Management Information Version 2 (SMIv2)		04/1999
[RD-02]	Doc 9896-AN/469	Manual for the ATN using IPS Standards and Protocols 1st edition		
[RD-03]	RFC 5795	The RObust Header Compression (ROHC) Framework		03/2010
[RD-04]	RFC 3095	RObust Header Compression (ROHC) : Framework and four profiles : RTP, UDP, ESP, and uncompressed		07/2001
[RD-05]	RFC 3843	RObust Header Compression (ROHC): A Compression Profile for IP		06/2004
[RD-06]	ICAO Doc 9705/AN956	ATN Standards and Recommended Practices (SARPs). Manual of Technical Provisions for the ATN.		
[RD-07]		ITU Radio Regulations, Edition 2008		2008

Table 3-2: Reference documents

4. COMMUNICATION STANDARD OVERVIEW

This document is a proposal in view of an ICAO worldwide approved standard. The CS is aimed to be applicable to all aircraft under IFR (including rotorcrafts), distributed and/or centralized GS infrastructures and GEO, HEO and MEO satellite constellations.

4.1 System reference model

The following figure illustrates the system reference model.

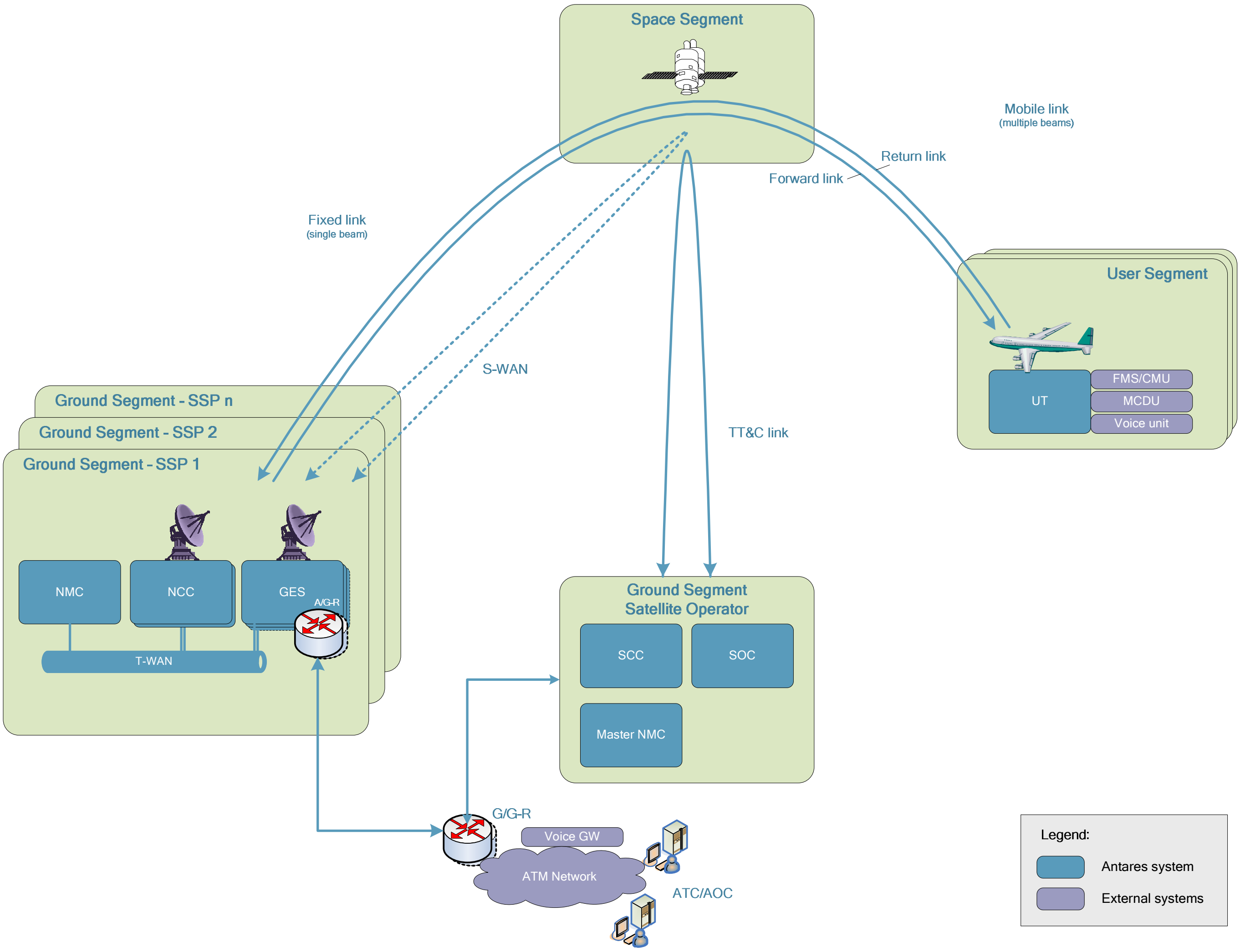


Figure 4-1: System reference model

This figure identifies the physical system components of the satellite communication network as well as the interfaces with the ATM network and the end users (ATC and AOC). The system reference architecture represents the most general system scenario where different Satellite Service Providers (SSPs) participate in the ATM service provision. In this general system configuration each SSP accesses the satellite communication resources by means of multiple stations providing the Tx/Rx communication capabilities. Depending on the particular operational requirements coming from the service providers, a simplified ground segment topology could be envisaged which is characterised by only one SSP accessing the satellite link via a single station. This scenario may be considered as sub-case of the most general one described above.

The satellite communication system reference architecture used for the development of the communication standard is composed of the three following segments:

- **The Space Segment (SPS)**. The SPS is composed of several satellites carrying dedicated ATM payloads operating in the AMS(R)S frequency band (portion of L-band spectrum reserved for aeronautical safety services) in the mobile link, whilst C, Ku or Ka frequency band is mainly used for the fixed link, being Ku band the most likely one.

  The on-board ATM payloads are transparent, which means that they are not equipped with On-Board Processing (OBP) capabilities. In the mobile link, the SPS is a multi-beam system, while for the fixed link, a single beam is considered as reference architecture. For the system reference architecture, hot redundant GEO satellites are considered which may be either co-located in the same orbital position or orbitally separated.

- **The Ground Segment (GS)**. The GS is mainly composed of three types of network entities:

  - **Network Control Centre (NCC)**: the NCC is the network entity responsible for controlling the satellite network. In the system reference architecture, one backup NCC located at a different site for satellite link availability purposes for each active NCC is foreseen.
  - **Ground Earth Station (GES)**: The GES is the network entity that provides the feeder link to the Space segment. The GES makes use of the communication resources assigned to it in order to communicate with its associated aircraft, providing voice and data traffic services. The GES also provides an interface with the terrestrial ATM networks.
  - **Network Management Centre (NMC)**: the NMC is the network entity in charge of managing the overall satellite communication network (system resources, system elements, etc) in a centralised way. Management functions performed by the NMC are considered to be not critical since the system is designed for surviving to a failure of the management sub-system during a limited time.

  Within the NCC, Communication Spectrum Monitoring agents (CSMa) are in charge of monitoring the forward link (all forward carriers, if needed) and uploading the status of the satellite in order to quickly manage GS switchovers. It shall be deployed in every spot beam.

  With regard to control functions, it is noted that the communication standard is flexible to support SSP GS implementations with different degrees of responsibility distribution between the NCC and GES.

  In the system reference architecture, multiple GESs are envisaged to adapt the satellite communication system to an operation concept where different administrative and political entities (communication service providers, etc) want to own and operate their facilities with a certain degree of autonomy. In the system reference architecture it is considered that any GES has connectivity to any mobile beam; that is, a GES can manage UTs located in any mobile beam.

In case of multiple Satellite Service Providers (SSPs), envisaged in the most general system architecture configuration, there can be an additional entity of the satellite operator, the **Master NMC**, in charge of allocating resources among the different SSP in a rather static way.

- **The User Segment**. The User Segment is composed of the mobile User Terminals (UTs) (or Aeronautical Earth Stations (AES)), which are the avionics equipment in charge of implementing the communication protocol and providing interface to the other on-board elements via the on-board network. The dimensioning and design of the UT is carried out taking into account several constraints impacting on the final achievable performance. In this respect, constraints on installation (e.g. possible configurations and location of the UT antenna, no need for external active cooling), on regulation, on cost etc. are considered which influence the final UT performance (e.g. HPA power, antenna radiation pattern etc.).

Although not considered for CS aspects, the GS will include the **SCC/SOC** stations in charge of controlling and monitoring the satellites.

The GS Elements (NMC, NCC and GES) are interconnected through a Wide Area Network (WAN) supporting the Ground-to-Ground signalling communications, as depicted in the figure. Two different WAN typologies are considered in the system reference architecture:

- **Terrestrial-WAN (T-WAN)**: T-WAN is a terrestrial network used to transport the signalling among the GS Elements.
- **Satellite-WAN (S-WAN)**: S-WAN, also called Feeder-to-Feeder link, is based on interconnecting the GS Elements through satellite links operating in the FSS (Fixed Satellite Service). The S-WAN is used to support the signalling information exchange between the GS Elements.

The WANs are intended to transport control and management signalling among distant GS elements. The management signalling is expected to be carried over the Terrestrial WAN (T-WAN), as the NMC is not expected to be equipped with a satellite station.

For the control signalling exchanged among GS elements, several solutions are identified:

i. No control signalling is exchanged between GS elements and specific mechanism based on AES – GS extra signalling is envisaged.

ii. A highly available WAN (T-WAN + S-WAN) is deployed to connect the GS elements that rely on such WAN for critical information.

iii. A T-WAN or a S-WAN without any special availability requirements is deployed. Then the GS – AES protocol implements extra signalling as in the first solution.

The selection of the most appropriate solution from the above ones is a decision left to the SSP, as it depends on its operational strategy and constraints.

4.2 Interfaces covered by the Communication Standard

In order to assure interoperability, the CS defines the air interface of the aircraft from the physical and link layers up to the network layer, both for user and control planes. Additionally, it defines two (logical) interfaces for management, one at the aircraft side and another at GS level. It should be noted that management plane information is not transmitted over the air interface.

Interfaces are shown in Figure 4-2, using dashed lines.

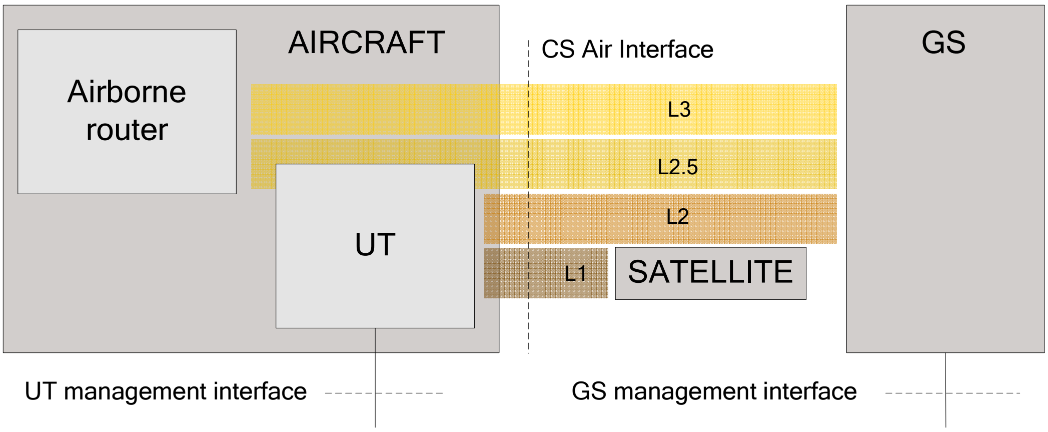


Figure 4-2: Interfaces defined in the CS

The term airborne router refers to the element within the aircraft which supports network layer related functionality associated to the satellite link interface, whereas the term UT refers to the element which supports at least the CS physical and link layer functions. Layer 2.5 functionality, which provides network layer adaptation functionality, can be provided either by the airborne router, by the UT or by both elements, depending on implementation and also on legacy considerations (in particular, for ATN/OSI support). In any case, the CS has been defined with the intention to not restrict implementation decisions whenever possible as long as this target is compatible with the objective to assure proper interoperability.

5. USER, CONTROL AND MANAGEMENT PLANE PROTOCOL STACK OVERVIEW

The following sections illustrate user, control and management plane protocol stacks associated to the CS. It shows a representative distribution of protocol layers in the aircraft and GS elements, but it should be noted that other options could be also fully compliant with the CS.

Elements that are specified fully by the CS are represented in orange, whereas elements which are mainly specified by other standardization bodies are shown in blue.

5.1 User plane protocol stack overview

The following diagram shows a representative user plane protocol stack for the ATN/IPS case.

In this reference case, the airborne router acts as a mere pass-through (i.e., it is transparent from a network layer point of view), as network layer functionality at the aircraft side is implemented by the FMS, which acts as mobile node. Additionally, for this particular reference case, layer 2.5 functionality is fully implemented by the UT.

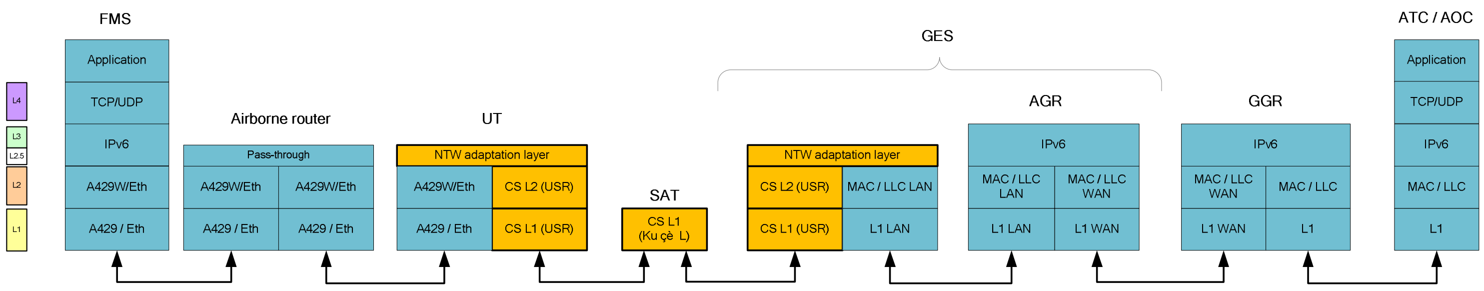


Figure 5-1: Communication standard user plane protocol stack reference (end-to-end) – ATN/IPS

The following diagram shows the expected user plane protocol stack for the ATN/OSI case.

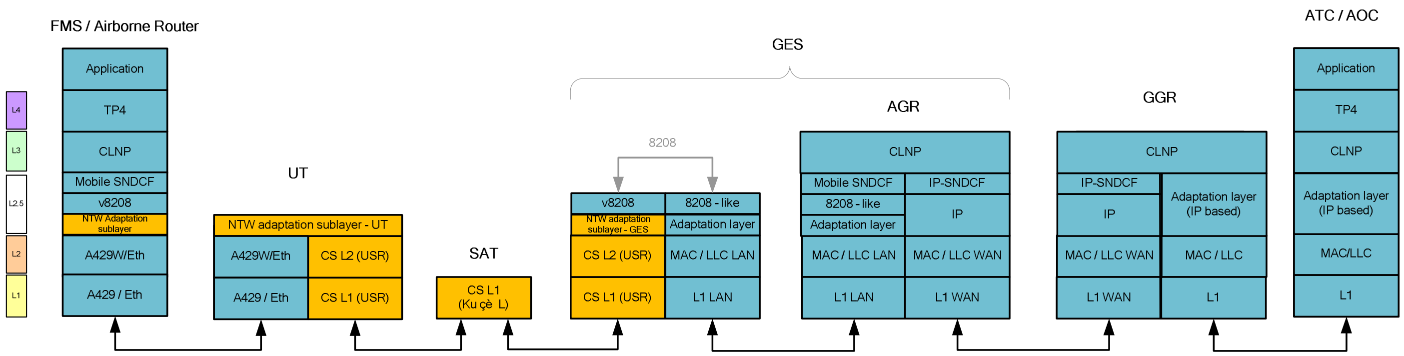


Figure 5-2: Communication standard user plane protocol stack reference (end-to-end) – ATN/OSI

5.2 Control plane protocol stack overview

The following diagrams show the control plane protocol stack for ATN/IPS and ATN/OSI. It includes control functions up to the network layer.

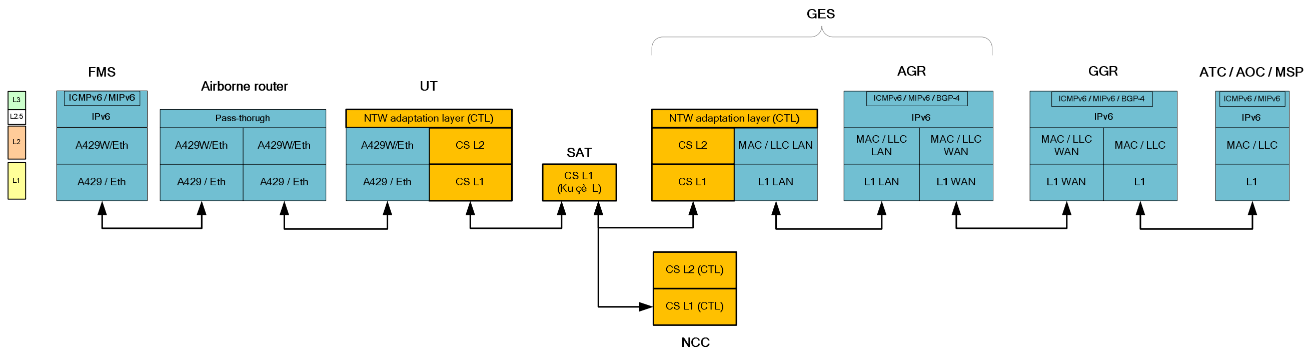


Figure 5-3: Communication standard control plane protocol stack reference – ATN/IPS

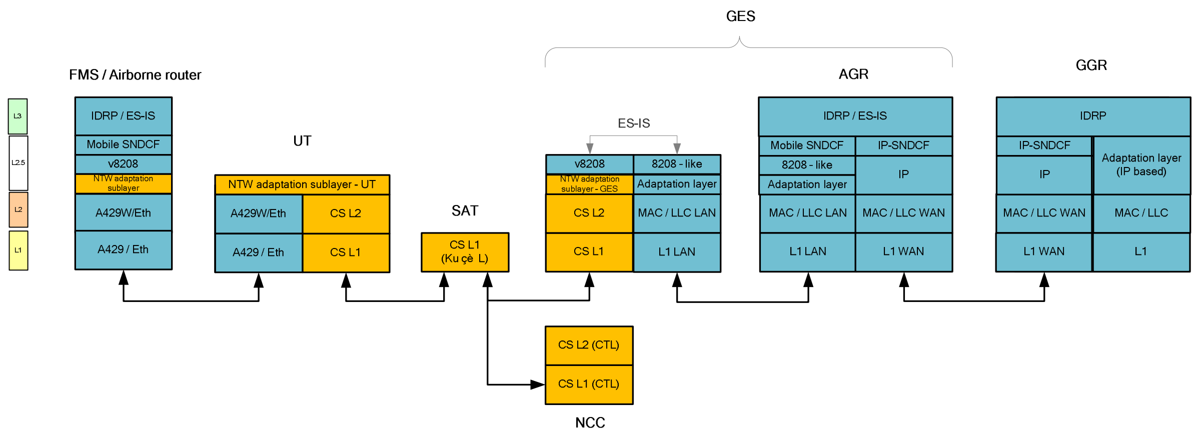


Figure 5-4: Communication standard control plane protocol stack reference – ATN/OSI

5.3 Management plane protocol stack overview

The following diagram shows a possible management plane protocol stack. It should be noted that management plane data is not transmitted over the air interface.

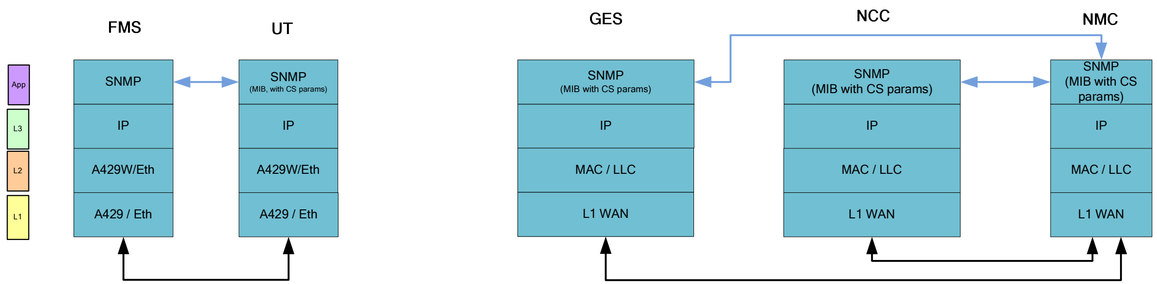


Figure 5-5: Communication standard management plane protocol stack reference

6. USER, CONTROL AND MANAGEMENT PLANE EXTERNAL INTERFACES

6.1 General Interface Requirements

D018-COM-ITF-0020

All management elements definition shall be compatible with SMIv2 [RD-01] defined structures.

6.2 UT Management Interface

D018-COM-ITF-0030

At least the following monitored parameters shall be accessible (read-only) from the User Terminal about its UT Satellite Interface: (TBC)

Parameter	Description	Type
Aircraft ICAO address	Allows access to the aircraft 24-bit ICAO address used in CS procedures.	Octet String
L2 addresses	Provides access to the layer 2 address(es) for the User Terminal.	Octet String
L3 addresses	Provides access to the layer 3 address(es) configured on the air interface.	Octet String
Traffic Log	Indicates the location of the traffic log files on the local file system for retrieval.	Octet String
Tx bytes	Provides the number of bytes transmitted on the interface since system startup.	Counter
Rx bytes	Provides the number of bytes received on the interface since system startup.	Counter
Rx Power	Indicates the received signal power level (0.1 dBm units).	Integer
SNIR	Indicates the received Signal-to-(Noise+Interference) Ratio (0.1 dB units).	Integer
BER	Indicates the current Bit Error rate on the air interface (1E-9 units).	Integer
PER	Indicates the current Packet Error rate on the air interface (1E-9 units).	Integer
ModCod evolution	Provides the history of the ModCod used by the user terminal.	Octet String
Status	Indicates the status of the communication link. This is a binary status and can either be “up” (1) or “down” (0).	Octet
Logon Status	Indicates the logon status of the user terminal. This can either be success in case the user terminal logon was successful or error otherwise. In case of error, an error code used to further diagnose the problem will be provided.	Octet String
Current GES Address	Indicates the address of the GES to which the User Terminal is currently assigned and to which data packets are to be addressed.	Octet String
Current Tx carrier information	Provides access to the details on the current carrier(s) that is in use for transmitting traffic.	Octet String
Current Rx carrier information	Provides access to the details on the current carrier(s) that is in use for receiving traffic.	Octet String
Current SNIR	Indicates the currently published SNIR when ACM is in use (0.1 dB units).	Integer
Current ARQ retransmissions	Provides the total number of retransmissions performed by the ARQ mechanisms when it is in use.	Counter
Random Access collision rate	Indicates the current rate of collisions for the random access channel.	Integer
Current Random Access backoff	Provides access to the current transmission back-off parameter (tx_backoff) for the random access mechanism (10 ms units).	Integer
Current Random Access persistency	Provides access to the current persistency parameter for the random access mechanism (1E-2 units).	Integer
Current Random Access timeout	Provides access to the current retransmission timeout parameter for the random access mechanism (10 ms units).	Integer
Current Data Rate	Provides access to the data rate of the carrier(s) the User Terminal is currently using.	Octet String
Fault History	Lists the fault IDs of all the faults that have been recorded since system startup indicating for each fault, the timestamp at which it has occurred.	Octet String
Current Fault Status	Provides access to the current fault status for the User Terminal. Additionally, in presence of a failed state, information regarding the current fault is also provided.	Octet String

Table 6-1: UT monitored parameters

D018-COM-ITF-0040

At least the following configurable parameters shall be accessible (read-write) from the User Terminal about its UT Satellite Interface: (TBC)

Parameter	Description	Type
System information	Provides the information about the systems to which the User Terminal should try to logon. This includes the details necessary to acquire the initial System Information tables with signalling messages/carrier(s) for the system.	Octet String
ATN/OSI addresses and preferred SSP	Allows access to the ATN/OSI configuration parameters such as addressing and preferred SSP. NULL if only ATN/IPS is supported.	Octet String
System Logon credentials	Provides the credentials needed for logging on to the system.	Octet String

Table 6-2: UT configurable parameters

6.3 GS Management Interface

D018-COM-ITF-0050

In order to allow inter-system handover, at least the following parameters shall be available* for other inter-operable systems complying with the CS: (TBC)

(*) The configuration of these parameters is usually a manual process done by the network operator inside their configuration procedures for network management from the NMC.

Parameter	Description	Type
SSP identifier	Identifies the Satellite Service provider.	Octet String
Initial system details	Includes the details necessary to acquire the initial System Information tables with signalling messages/carrier(s) for the system.	Octet String
Frequency bands	List of frequency bands used by the system	Octet String
Coverage area	System coverage area description	Octet String

Table 6-3: External system parameters

7. GENERAL REQUIREMENTS

7.1 Frequency band, multiple access and system carriers definition

7.1.1 Forward link

7.1.1.1 Mobile link frequency band specifications

D018-COM-FUN-0060

The System shall operate the mobile link at frequencies identified by ITU for Aeronautical Mobile-Satellite (Route) Service (AMS(R)S), in agreement to in agreement to Article 1, Section III, 1.33 of ITU Radio Regulations [RD-7] and allocated worldwide:

- 1545 to 1555 MHz for the mobile downlink (from satellite to User Terminal)

D018-COM-FUN-0070

The mobile link polarisation shall be right hand circular (RHCP) for uplink and downlink.

7.1.1.2 Forward link multiple access

D018-COM-FUN-0080

The forward link access shall be based on a MF-TDMA scheme.

D018-COM-FUN-0090

The resource segmentation structure of the forward link shall be defined as follows:

- Time-slot: a time duration in which a burst is allocated. It is specified by duration, carrier frequency and carrier rate or bandwidth.
- Frame: defined as a sequence of time-slots at the same carrier rate.

7.1.1.3 Forward link system carriers definition and burst types

D018-COM-FUN-0100

The Forward Link shall be supported by one type of carrier: Forward Link Carrier (FLC).

D018-COM-FUN-0110

The Forward Link Carrier (FLC) shall provide the frequency and time reference of the system.

D018-COM-FUN-0120

The Forward Link Carrier shall be shared by the GS elements in MF-TDMA mode.

D018-COM-FUN-0130

The Forward Link Carrier shall transmit multiplexed both user traffic and network signalling (broadcast or unicast).

D018-COM-FUN-0140

The Forward Link Carrier shall transmit multiplexed the following physical channels or burst types (refer to section 7.2.2 for their definition):

- Forward Channel (FCH)

D018-COM-FUN-0150

The Forward Link Carrier shall support the following baud rates:

- 160 kbauds

D018-COM-FUN-0160

The guard band of the forward carriers (FLC) shall be:

- 600 Hz for GEO constellations
- 500 Hz for MEO constellations
- 3.6 kHz for HEO constellations

7.1.2 Return link

7.1.2.1 Mobile link frequency band specifications

D018-COM-FUN-0170

The System shall operate the mobile link at frequencies identified by ITU for Aeronautical Mobile-Satellite (Route) Service (AMS(R)S), in agreement to in agreement to Article 1, Section III, 1.33 of ITU Radio Regulations [RD-7] and allocated worldwide:

- 1646.5 to 1656.5 MHz for the mobile uplink (from User Terminal to satellite).

7.1.2.2 Return link multiple access

D018-COM-FUN-0180

The return link access shall be based on an A-CDMA (Asynchronous-CDMA) scheme.

7.1.2.3 Return link system carriers definition and burst types

D018-COM-FUN-0190

The Return Link shall be supported by the following type of carriers:

- Return Link Carrier (RLC).

D018-COM-FUN-0200

The Return Link Carrier shall be shared by the UTs in Random Access mode to transmit either signalling or user traffic information.

D018-COM-FUN-0210

The Return Link Carrier shall transmit the following physical channels or bursts types (refer to section 7.2.2 for their definition):

- Random Access Channel (RACH).

D018-COM-FUN-0220

The Return Link Carrier shall support the following chip rates:

- 160 kchips/s

D018-COM-FUN-0230

The guard band of the return carriers shall be 8 kHz.

7.2 Logical and physical channels

7.2.1 Definition of logical channels

The following logical channels, covered in the requirements that follow, are defined:

	FWD	RTN
Traffic channels		
Broadcast/Multicast Traffic Channel (BTCH)	✓	-
Unicast Traffic Channel (UTCH)	✓	✓
Control channels		
Broadcast Control Channel (BCCH)	✓	-
Unicast Control Channel (UCCH)	✓	✓

Table 7-1: Logical channels

D018-COM-FUN-0240

The BTCH shall be a point-to-multipoint logical channel for the transmission of user plane data to all or a sub-group of UTs within one or more beams.

D018-COM-FUN-0250

The BTCH shall be supported on the Forward Link only.

D018-COM-FUN-0260

The UTCH shall be a point-to-point bi-directional logical channel unicast to the transmission of user plane data (LSDUs) between the GS and a specific UT.

D018-COM-FUN-0270

The BCCH shall be a point-to-multipoint logical channel used to forward general system control information that shall be announced to all or a sub-group of UTs within one or more beams.

D018-COM-FUN-0280

The BCCH shall be supported on the Forward Link only.

D018-COM-FUN-0290

The UCCH shall be a point-to-point bi-directional logical channel used to exchange control messages with a specific UT.

7.2.2 *Definition of physical channels*

The following physical channels, covered in the requirements that follow, are defined:

Channel	FWD	RTN
Forward Channel (FCH)	✓	-
Random Access Channel (RACH)	-	✓

Table 7-2: Physical channels

D018-COM-FUN-0300

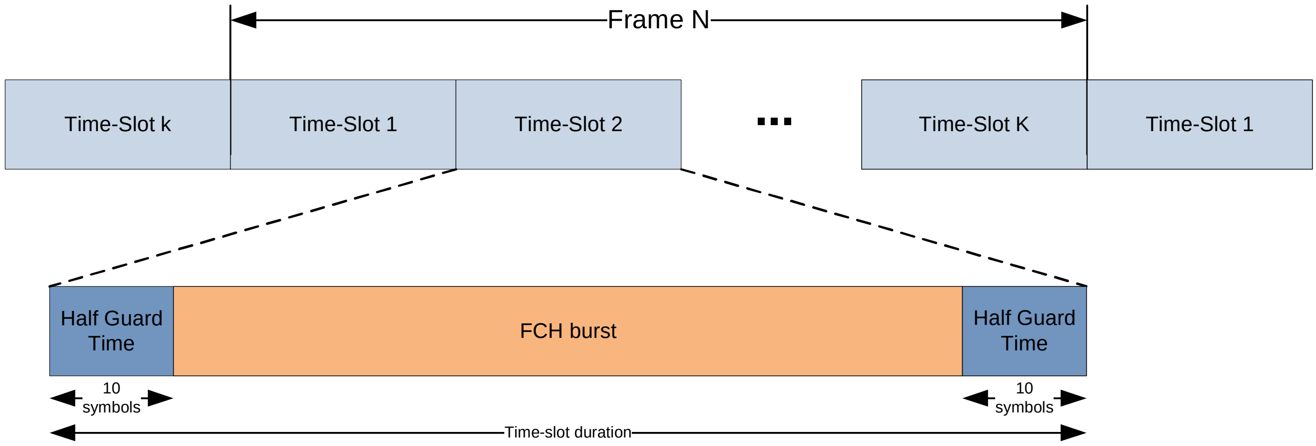
The FCH shall be used either for transmitting control or data information.

D018-COM-FUN-0310

The FCH shall be supported on the Forward Link only.

D018-COM-FUN-0320

The FCH burst shall be surrounded by guard time which allows for power switch-off transients and system timing errors. The guard time of the FCH shall be 20 symbols. Half the guard time shall be inserted at the beginning of the time-slot, half the guard time shall be inserted at the end of the time-slot, as it is shown in the following figure.



D018-COM-FUN-0330

The RACH shall be a used to transfer either control and/or user traffic information.

D018-COM-FUN-0340

The RACH shall be a contention-based physical channel whose transmission is based on a Spread Spectrum Aloha (SSA) approach.

D018-COM-FUN-0350

The RACH shall be supported on the Return Link only.

7.2.3 Mapping between logical and physical channels

D018-COM-FUN-0360

The mapping between logical channels and physical channels shall be as defined in the following figure:

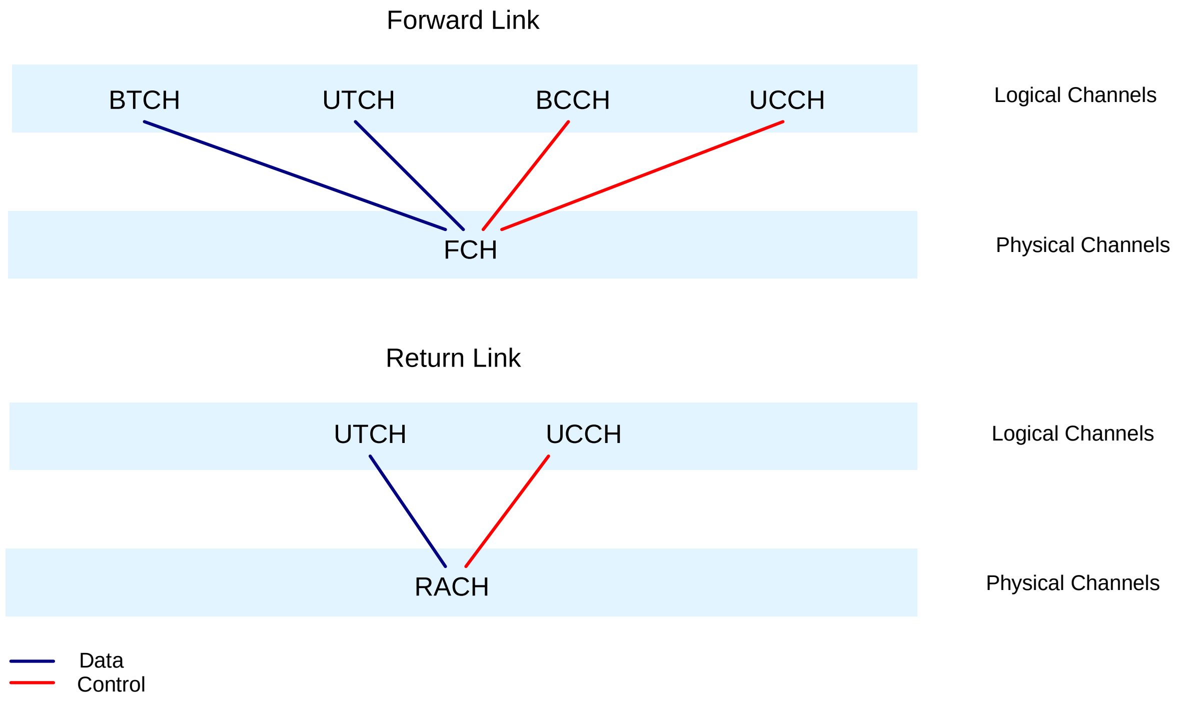


Figure 7-1: Mapping between logical and physical channels

7.2.4 Link layer process sequencing

D018-COM-FUN-0370

The order of link layer transmission processes shall be as follows:

- Mapping to physical channel(s)
- Queuing / buffering, until the LSDU is scheduled for transmission
- Encapsulation, including associated functions:
    - o ARQ header insertion (if applicable)
- MAC procedures associated to random access

D018-COM-FUN-0380

The order of link layer reception processes shall be as follows:

- Link layer filtering
- Reception buffering and re-sequencing, associated to ARQ (if applicable)
- Assembly of LSDU

7.3 Bit order

The following specifications are applicable to user, control and management plane.

7.3.1 Bit numbering

D018-COM-FUN-0390

In an n-bit data field, the interpretation of the bit numbering shall be the following:

- The term "bit n-1" refers to the least significant bit of a multi-bit field
- The most significant bit of a n-bit unsigned field shall be designated as "bit 0"
- For signed fields, "bit 0" shall refer to the sign bit and "bit 1" to the most significant bit

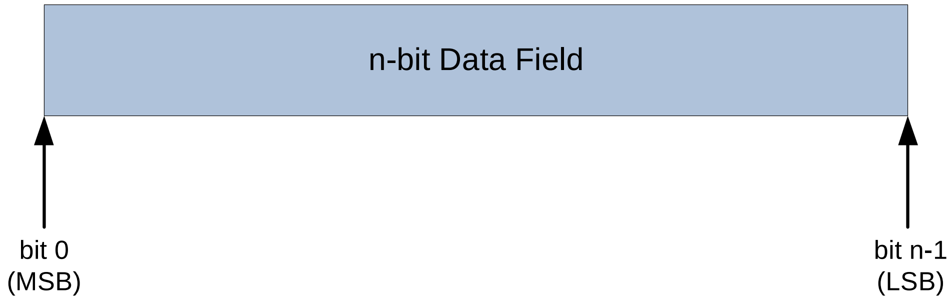


Figure 7-2: Bit numbering

7.3.2 Transmission order

The following rules for the transmission order shall be considered in the implementation of the communication standard.

D018-COM-FUN-0400

Unsigned values shall be transmitted starting the most significant bit and ending with the less significant.

D018-COM-FUN-0410

Signed values shall be transmitted starting with the sign bit, followed by the most significant bit and ending with the least significant bit.

D018-COM-FUN-0420

Bytes shall be processed MSB first (big endian).

8. USER PLANE SPECIFICATION

8.1 User plane description

The User plane covers the aspects related to the transmission of user data. Refer to section 5.1 for details on the user plane.

8.2 Addressing scheme

8.2.1 Unicast addressing

D018-COM-FUN-0430

The UT shall be identified by a 16-bit L2 address assigned during the logon process. This address should be associated to its 24-bit ICAO address in the ground segment element responsible for the logon procedure while the UT is logged on the system.

D018-COM-FUN-0440

The L2 ranges for UT addressing shall be (in hexadecimal notation):

- from 0x0000 to 0x007F: Multicast addresses
- from 0x0080 to 0x00FF: Reserved addresses
- from 0x0100 to 0xFFFE: Unicast addresses
- 0xFFFF: Broadcast address

D018-COM-FUN-0450

Each GS element shall be assigned a unique 8-bit L2 address used for all communications in which L2 addressing is required.

D018-COM-FUN-0460

The L2 ranges for GS element addressing shall be (in hexadecimal notation):

- from 0x00 to 0x7F: Reserved addresses
- from 0x80 to 0xFE: Unicast addresses
- 0xFF: Reserved address

8.2.2 Multicast addressing

D018-COM-FUN-0470

The L2 broadcast address shall be 0xFFFF in hexadecimal notation.

D018-COM-FUN-0480

The L2 range for multicast addresses shall be from 0x0000 to 0x007F in hexadecimal notation. A mapping between L2 and L3 multicast groups shall be performed by the GS element responsible for multicast subscriptions management.

8.3 Security

[REQUIREMENTS DELETED]

8.4 Network layer support

8.4.1 ATN/IPS

D018-COM-FUN-0500

The CS shall support the IPv6 network layer protocol as specified by ICAO in [RD-02].

8.4.1.1 Mapping between link layer and network layer addresses

D018-COM-FUN-0520

In the UT, the UT L2 destination address associated to a certain CoA or link-local IPv6 address shall be obtained from the first NPDU coming from this L2 address to be transmitted over the air interface.

Note: This requirement addresses a scenario with the UT providing an IPv6 interface to multiple mobile nodes. It is feasible as the traffic flow is always air-initiated (i.e., the first NPDU having the CoA or LLA as L3 source address is always sent by the aircraft).

D018-COM-FUN-0530

The CS shall include the source link layer address option in the Router Advertisement messages (as defined in RFC4861), which are sent by the GS.

D018-COM-FUN-0540

[Placeholder - Multicast address mapping]

8.4.2 ATN/OSI

D018-COM-FUN-0550

The CS shall support the OSI network layer as defined in ATN/OSI SARPS [RD-06] for air-ground (mobile) subnetworks.

8.4.2.1 Mapping between link layer and network layer addresses

In ATN/OSI, mapping between 8208 and CLNP network layer addresses is provided through the use of ISH / IDRP protocols, as specified in [RD-06].

D018-COM-FUN-0560

In the GS, all transmitted 8208 packets associated to a certain virtual circuit shall be forwarded over the same CS logical channel where the 8208 CALL-REQUEST was received.

D018-COM-FUN-0570

In the aircraft, all transmitted 8208 packets associated to a certain virtual circuit shall be forwarded over the same CS logical channel where the 8208 CALL-REQUEST was sent.

8.5 Network layer adaptation functions

8.5.1 ATN/IPS

8.5.1.1 QoS

D018-COM-FUN-0580

For the FWD link data and signalling transmissions scheduling it shall be possible to get the next QoS information from NSDUs to transmit content, in order to be able to apply required application based prioritization QoS mechanisms for the NSDUs and derived data units at lower layers:

- NSDU associated application
- Application layer message size in bytes
- NSDU TD95
- NSDU ET

D018-COM-FUN-0581

For the RTN link data and signalling transmissions mapping to bursts and prioritization it shall be possible to get the next QoS information from NSDUs to transmit content, in order to be able to apply required application based prioritization QoS mechanisms for the NSDUs and derived data units at lower layers:

- NSDU associated application
- Application layer message size in bytes
- NSDU TD95
- NSDU ET

D018-COM-FUN-0590

UT and GES shall keep a register of the next QoS measurements per application, in order to measure its compliance with required application QoS:

- TD95 of NSDU latencies
- Number of NSDU successfully transmitted vs. arrived (continuity estimation)

8.5.1.2 Compression

8.5.1.2.1 Header Compression

D018-COM-FUN-0600

The UT shall implement RObust Header Compression framework (ROHC) as specified in [RD-03]. (TBC)

D018-COM-FUN-0610

The GS shall implement RObust Header Compression framework (ROHC) as specified in [RD-03].

D018-COM-FUN-0620

If ROHC is supported, at least the following profiles shall be supported:

- UDP profile (defined in [RD-04]) and
- IP-Only profile (defined in [RD-05]).

Note: Benefits regarding the support of other profiles are under evaluation and still TBC.

D018-COM-FUN-0630

The following ROHC configuration parameters shall be set as indicated:

- MAX_CID = TBD
- LARGE_CIDS = TBD
- MRRU = 0 (ROHC packet segmentation is disabled)

D018-COM-FUN-0640

The following ROHC configuration parameters shall be set as indicated, for unicast ROHC channels:

- Confidence value = TBD
- Refresh timer = TBD
- Mode = TBD

D018-COM-FUN-0650

The following ROHC configuration parameters shall be set as indicated, for multicast ROHC channels:

- Confidence value = TBD
- Refresh timer = TBD
- Mode = TBD

8.5.2 ATN/OSI

8.5.2.1 SARPs network layer adaptation functions

D018-COM-FUN-0660

The CS shall support the Mobile SNDCF, as defined in [RD-06].

D018-COM-FUN-0670

The CS shall support the v8208 SNAcP, as defined in [RD-06].

D018-COM-FUN-0680

Upon reception of a LOGON ACCEPT - TRAFFIC message, a new v8208 virtual circuit shall be established by the aircraft over the newly established link, including as destination SNAP address one of the 8208-AGR-Addresses which are part of the LOGON ACCEPT - TRAFFIC message.

D018-COM-FUN-0690

Upon reception of a HANDOVER ACK message of types 1, 3 or 7, a new v8208 virtual circuit shall be established by the aircraft over the newly established link, including as destination SNAP address one of the 8208-AGR-Addresses which are part of the HANDOVER ACK message.

8.5.2.2 QoS

D018-COM-FUN-0700

QoS mapping for ATN/OSI shall be Normal Priority - Normal Rate.

8.5.2.3 Compression

8.5.2.3.1 Header compression

D018-COM-FUN-0710

LREF header compression shall be implemented between the airborne router and A/G-Rs, as specified in the ICAO ATN SARPS [RD-06].

8.6 User plane forward link specification

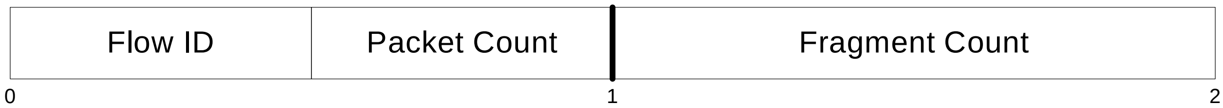
8.6.1 Link layer specification

8.6.1.1 ARQ protocol

8.6.1.1.1 ARQ header format

D018-COM-FUN-0720

The ARQ header format shall include the following fields:



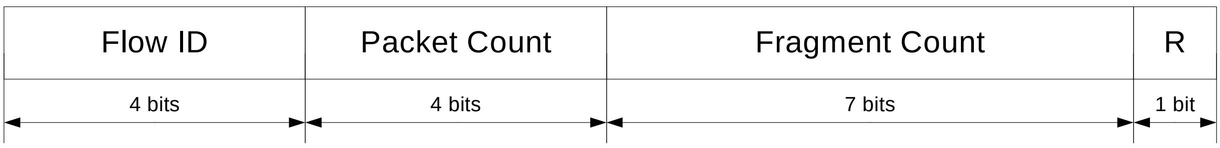
where

Field	Length	Description
Flow identifier field	4 bits	This field differentiates between different flows.
Packet Count field	4 bits	This field is a counter of packets associated to a flow. It is incremented for each packet sent toward a specific destination, using an independent counter for each flow.
Fragment Count field	0 or 7 bits	This field identifies individual fragments (LPDUs) of a NPDU. This field is only required for LPDUs of fragmented NPDUs.

Table 8-1 ARQ header fields encapsulation fields

D018-COM-FUN-0730

The ARQ ACK packet shall include the following fields:



where

Field	Length	Description
Flow identifier field	4 bits	This field shall be a copy of the Flow Identifier of the ACK'ed LDPU.
Packet Count field	4 bits	This field shall be a copy of the Packet Counter of the ACK'ed LDPU.
Fragment Count field	7 bits	When available, this field shall be a copy of the Fragment Counter of the ACK'ed LDPU. Otherwise, it shall be set to 0.
RFU	1 bit	Reserved for future use. Shall be set to 0.

Table 8-2: ARQ ACK information

This information is encapsulated in a RL link layer frame as indicated in §8.7.1.3, without using ARQ and including MAC address. The RL link layer header for ACK packets shall contain the MAC SRC address for the ACK receiver to identify the ARQ context (see D018-COM-FUN-0750).

8.6.1.1.2 ARQ procedure

D018-COM-FUN-0740

The ARQ procedure shall comply with the characteristics stated hereafter:

- The ARQ protocol only provides support to unicast user data traffic
- The ARQ protocol univocally resolve to which NPDU a L2 fragment or ACK belongs to using:
  - o Terminal MAC Address (2 bytes received after logon)
  - o GES MAC Address (optional in case of a single GES per beam)
  - o The Flow Identifier and Packet Counter from the ARQ header (D018-COM-FUN-0720)
- The transmitter shall be able to activate/deactivate the ARQ support in a per NPDU basis
- Only positive ACKs (to unicast user data traffic fragments) can be generated.
- Only ACKs to LPDUs satisfying any of the conditions shown below:

$$\forall\, FragmentCount \in [0, M), \quad \begin{cases} mod\left(\frac{FragmentCount + 1}{N^{ACK}}\right) = 0, or \\ FragmentCount = M - 1 \end{cases}$$

where,

- M is the total number of LPDUs in which a NPDU is fragmented. The ARQ algorithm relies in the ability of the FL encapsulation to identify the last L2 fragment of a NPDU.

- N^{ACK} is the number of LPDUs in an ARQ block, value set by logon signalling.

- Reception of an ACK packet automatically acknowledges all transmitted LPDUs with a Fragment Count equal or smaller to the Fragment Count indicated by the ACK packet
- The ARQ algorithm shall be able to retransmit a L2 data unit without re-fragmenting it
- Retransmissions are driven by timeouts at transmitter side specified in D018-COM-FUN-0750

8.6.1.1.2.1 ARQ procedure at transmitter end

D018-COM-FUN-0750

The ARQ procedure in the transmitter shall follow the SDL diagram shown below. The ARQ Parameters present in this diagram are:

- The "ARQ Context" concept refers to the requirement to univocally resolve to which NPDU a LPDU or ACK belongs to
- An "ARQ Block" concept refers to the set of LPDUs associated to an ARQ ACK
- "ReTx_Timer", timer associated to LPDU retransmissions based on the non reception of ACKs
- "ET_timer", timer associated to the expiration of the maximum NSDU transmission time

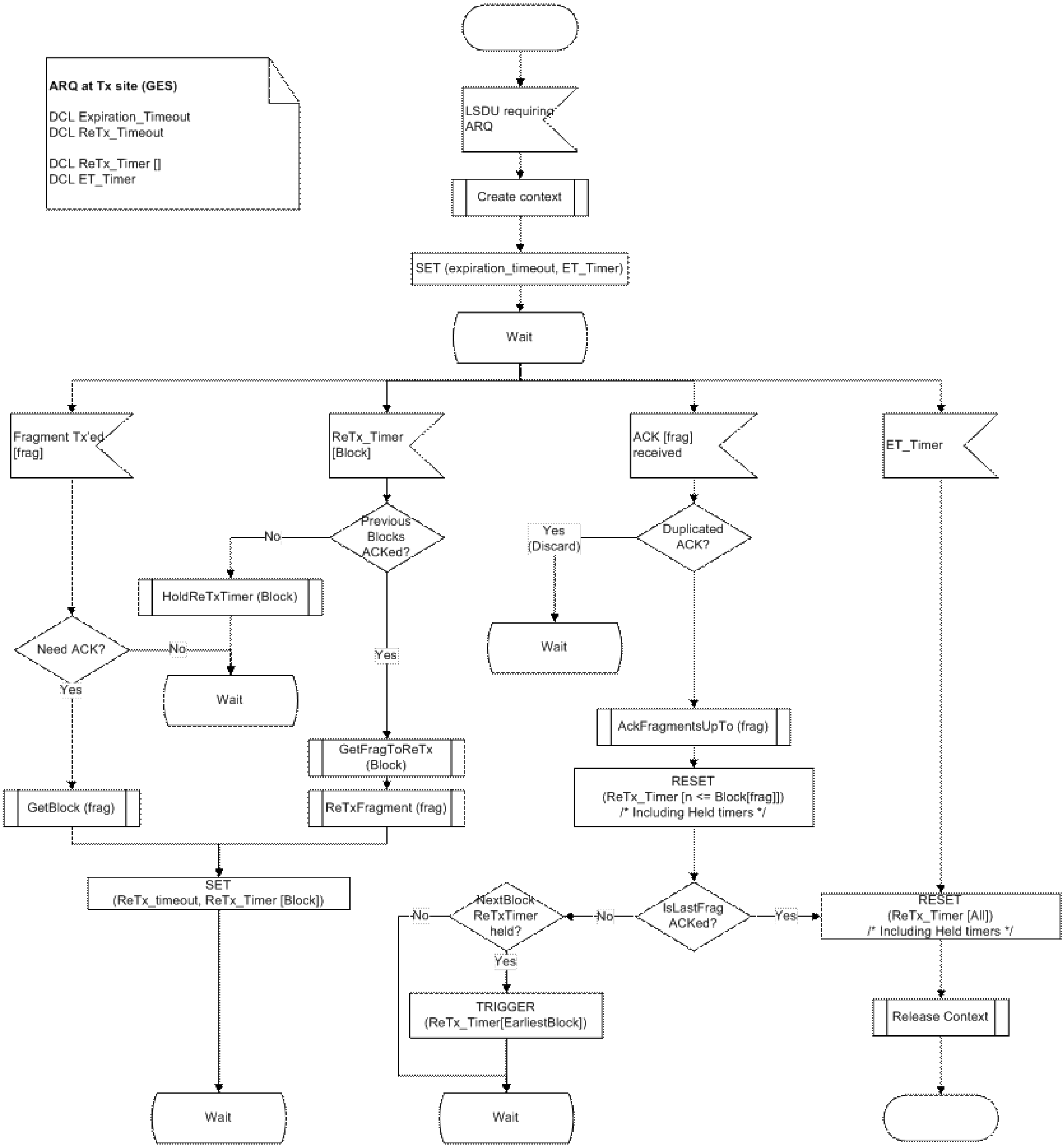


Figure 8-1: SDL Diagram for ARQ protocol specification at transmitter end

8.6.1.1.2.2 ARQ procedure at receiver end

D018-COM-FUN-0760

The ARQ procedure in the receiver shall follow the SDL diagram shown below. The ARQ Parameters present in this diagram are:

- "Activity_timer", a watchdog timer in the receiver used to release ARQ Contexts based on the context activity (reception of fragments associated to it)

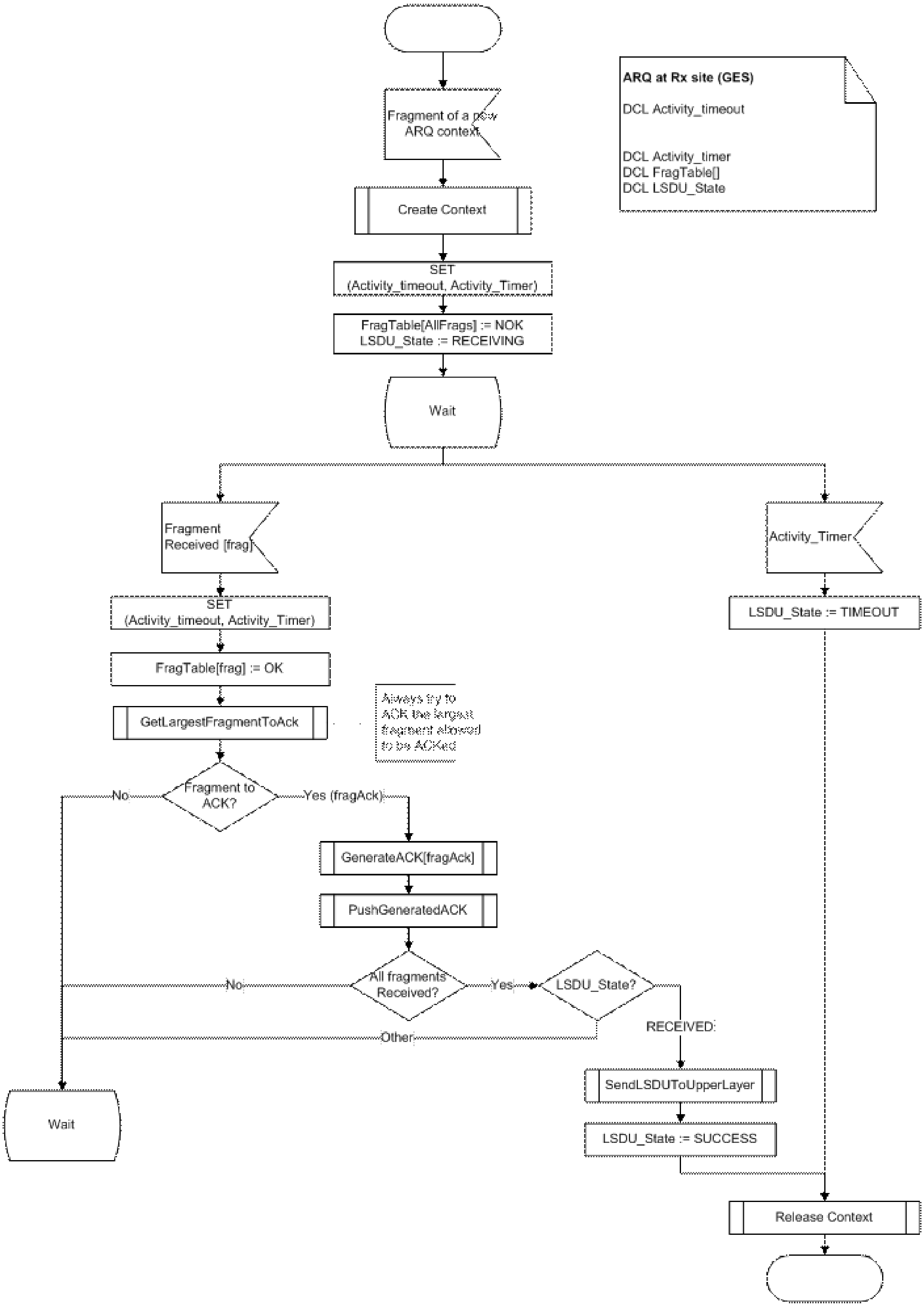


Figure 8-2: SDL Diagram for ARQ protocol specification at receiver end

8.6.1.2 Encapsulation

D018-COM-FUN-0780

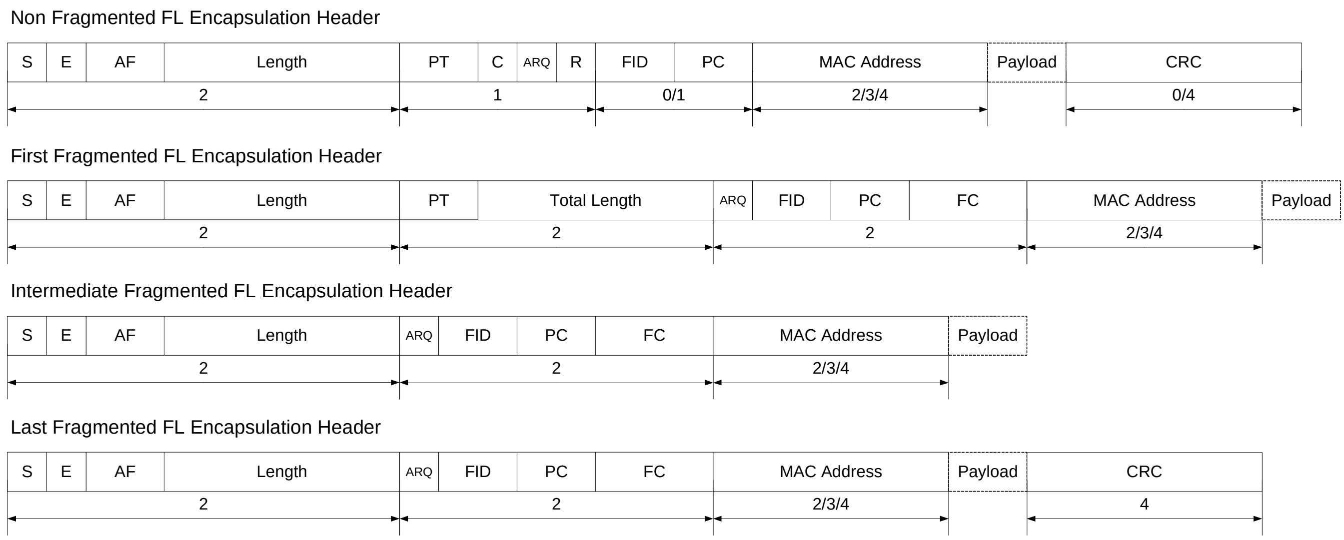
The forward link encapsulation scheme shall limit the size of the L2 data units (LPDU), including payload and headers, to the payload size of the most robust FL MODCOD for data services using the ARQ protocol.

D018-COM-FUN-0820

The forward link encapsulation scheme requires that a PPDU payload always starts with the encapsulation header of the first LDPU. Therefore, LDPU fragmentation between PPDU payloads is not allowed.

D018-COM-FUN-0830

The forward link encapsulation scheme used shall comply with the following:



where

Field	Length	Description
S and **E** flags: Start and End bits	1 bit each	These fields indicate if the packet is non-fragmented (11), if it is the first fragment (10), the last fragment (01) or an intermediate fragment (00) of a fragmented packet.
AF field: Address Format	2 bits	This field indicates the address format that will be contained in the encapsulation header. It can take the following values: **00**: No address field/label re-use **01**: 2 bytes address field: UT destination address **10**: 3 bytes address field: 2 bytes destination UT address + 1 byte source GS element address **11**: 4 bytes address field: 3 bytes destination UT ICAO address + 1 byte source GS element address

Field	Length	Description
Length field	12 bits	This field indicates the length of the L2 payload size for the current fragment (for fragmented packet) or the total length of the payload for non-fragmented packet. This length enables physical payload sizes up to 4099 bytes.
Total Length field	13 bits	This field indicates the total length of the L3 payload when fragmented. This length enables L3 packet sizes up to 8192 bytes.
PT field: Payload Type	3 bits	This field indicates the type of the contained payload that can be ATN/IPS, ATN/OSI, Signalling, compressed data, etc.
C flag: CRC Presence	1 bits	This field indicates if a 4 bytes CRC field is present as a trailer in the current packet (when un-fragmented).
ARQ flag	1 bits	This field indicates whether the ARQ support is required (1) for the LSDU transmission, or not (0). For un-fragmented LSDUs, the transmitter shall add the FID (4 bits) and PC (4 bits) fields to the encapsulation header whenever this flag is set to ‘1’.
R field: Reserved	3 bits	This field is reserved for future use. Shall be set to 0.
Source/Dest Address field	optional field of 2, 3 or 4 bytes	This field is optional and contains the source and destination addresses as indicated by the Address Format (AF) field.
FID field: Flow ID	0 / 4 bits	This information is used by the ARQ process and/or by the re-assembly process for fragmented LSDUs. It shall comply with the Flow Identifier field of the ARQ header defined in §8.6.1.1.1. The presence of this field is mandatory for LPDUs associated to fragmented LSDUs. Otherwise, its presence depends on the value of the ARQ flag.
PC field: Packet Count	0 / 4 bits	This field identifies the packet currently sent. It is incremented for each packet sent toward a specific destination, using an independent counter for each flow ID. This field is used by ARQ process and/or by re-assembly process when the packet is fragmented. It shall comply with the Packet Counter field of the ARQ header defined in §8.6.1.1.1. The presence of this field in the encapsulation header is mandatory for LPDUs associated to fragmented LSDUs. Otherwise, its presence depends on the value of the ARQ flag.
FC field: Fragment Count	0 / 7 bits	This field is used as a counter for the fragments composing a packet. This field is used by ARQ process and/or by re-assembly process when the packet is fragmented. It shall comply with the Packet Counter field of the ARQ header defined in §8.6.1.1.1. The presence of this field in the encapsulation header is mandatory and restricted to LPDUs associated to fragmented LSDUs.
CRC-32 field	4 bytes	When indicated by the C field, a 4 bytes trailer is added after the payload when un-fragmented. It is mandatory at the end of the last fragment when fragmented.

Table 8-3: Forward link encapsulation fields

8.6.1.3 Security

Refer to 8.3.

8.6.2 Physical layer specification

The following section specifies the physical layer of the user plane FWD link.

8.6.2.1 Burst types

D018-COM-FUN-0840

The User plane FWD link shall support the following burst types:

- FCH burst

D018-COM-FUN-0850

The FCH burst shall support the following MODCODs:

- QPSK 1/4, 1/3, 1/2, 2/3
- 8-PSK 1/2, 2/3
- 16-APSK 2/3

8.6.2.2 Burst waveform generation

D018-COM-FUN-0860

The burst waveform generation shall be applied to the FWD_PSDU and shall be composed of a sequence of functional modules as represented in Figure 8 3. The functional modules shall be:

- Physical Layer Adaptation
- CRC insertion
- Base Band scrambling
- FEC Encoding, which includes the inner encoding and the bit interleaver
- Bit Mapping into Constellation
- Symbol Interleaving
- Physical Layer Signalling Generation and Insertion
- Physical Layer Framing
- Physical Layer Scrambling
- Base-band Pulse Shaping and Quadrature Modulation

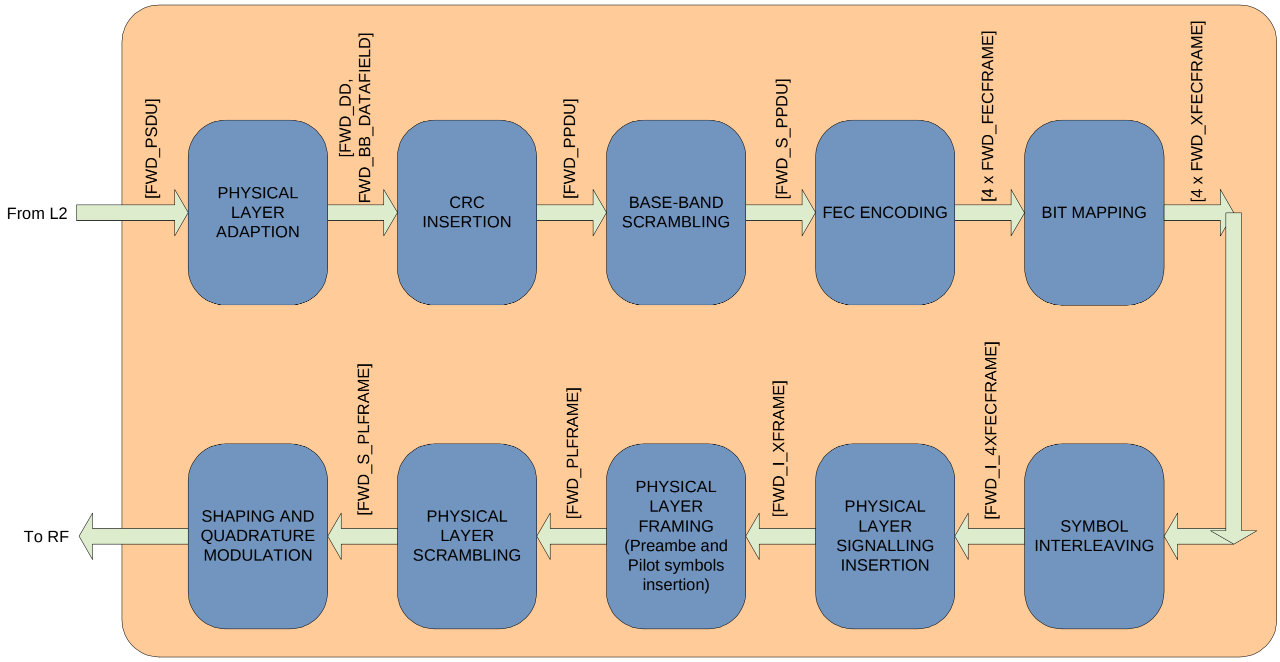


Figure 8-3: FCH burst waveform generation

D018-COM-FUN-0870

FCH bursts shall follow the burst format presented in the next figure:

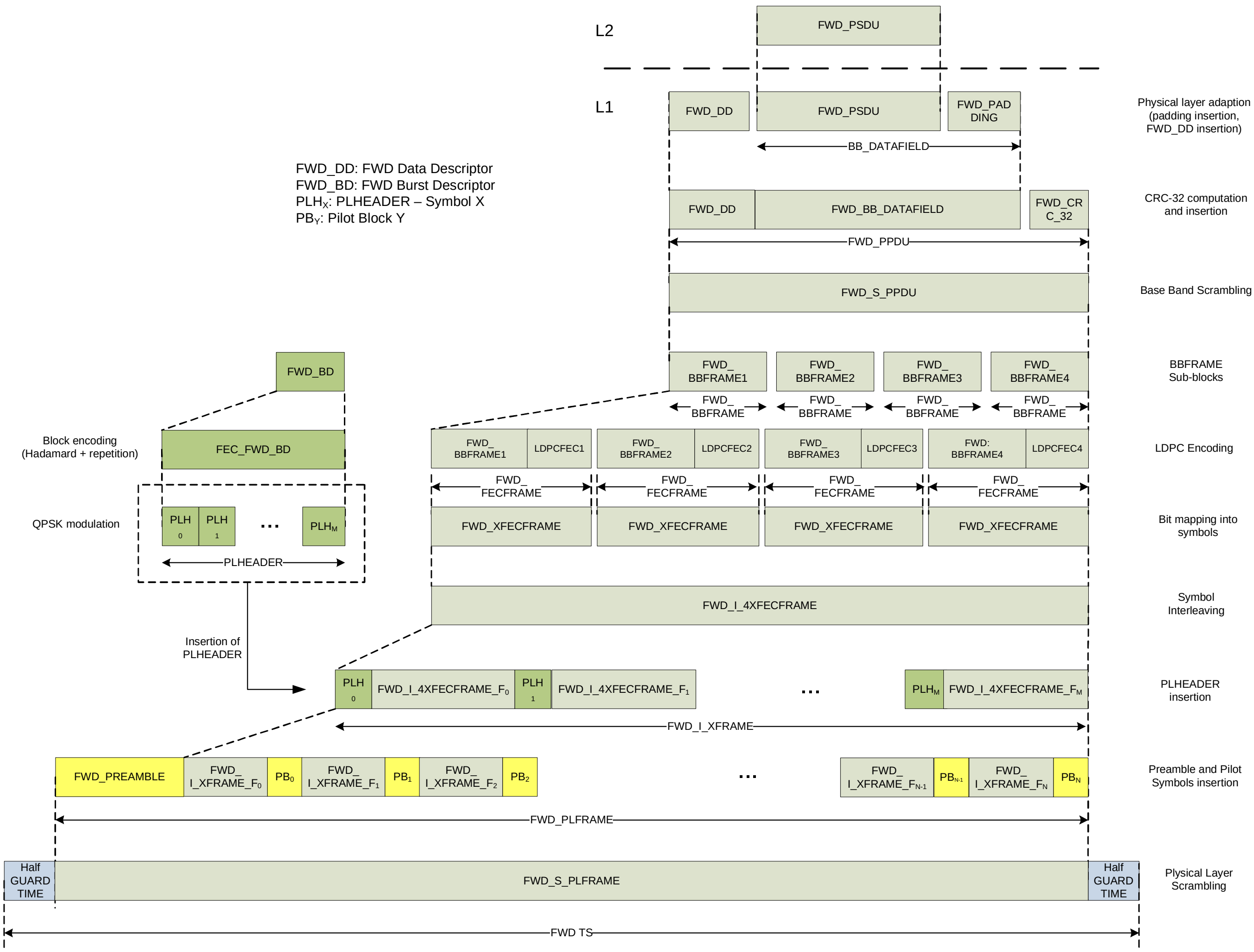


Figure 8-4: FCH burst format structure

8.6.2.3 Physical Layer Adaptation

D018-COM-FUN-0880

The Physical Layer Adaptation module shall perform:

- Interface with Layer 2
- Padding insertion
- FWD_DD (FWD Data Descriptor) insertion

D018-COM-FUN-0890

The input stream of the Physical Layer Adaptation module shall be a FWD_PSDU and the output stream shall be a FWD_DD Header followed by a FWD_BB_DATAFIELD, as detailed in Figure 8 5.

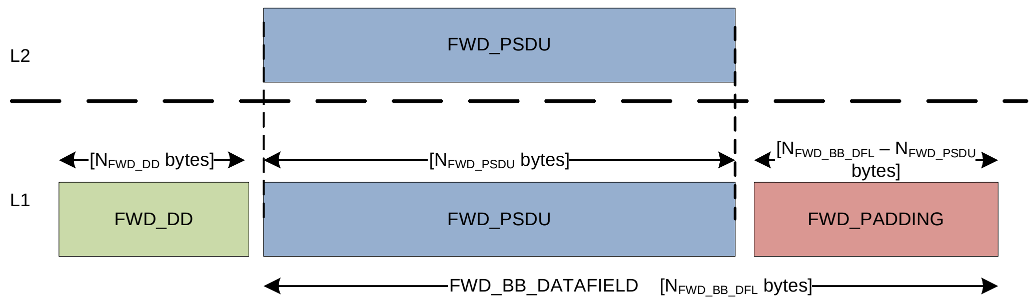


Figure 8-5: Data format at the output of the Physical Layer Adaptation module

D018-COM-FUN-0900

A single FWD_PSDU shall be mapped onto a single FCH burst.

8.6.2.3.1 Interface with Layer 2

D018-COM-ITF-0910

The Physical Layer Adaptation module shall map FWD_PSDU of up to 4 types of layer 2 encapsulation protocols:

- FL Encapsulation, as defined in D018-COM-FUN-0830
- Protocol 1 (RFU)
- Protocol 2 (RFU)
- Protocol 3 (RFU)

D018-COM-ITF-0920

The FWD_PSDU size (in bytes) shall be variable in the range. The maximum PSDU size (Max. NFWD_PSDU) depending on the selected MODCOD shall be as detailed in the next table:

Mode	Max. N_{FWD_PSDU} [Maximum PSDU size (bytes)]
QPSK 1/4	761
QPSK 1/3	1017
QPSK 1/2	1529
QPSK 2/3	2041
8-PSK 1/2	2297
8-PSK 2/3	3065
16-APSK 2/3	4089

Table 8-4: Maximum FWD_PSDU size (bytes)

8.6.2.3.2 Padding insertion

D018-COM-FUN-0930

(NFWD_BB_DFL - NFWD_PSDU) bytes shall be appended after the FWD_PSDU according to Figure 8 5. The contents of the padding bytes shall be "0x00".

8.6.2.3.3 FWD_DD (FWD Data Descriptor) insertion

D018-COM-FUN-1000

A fixed length header (FWD_DD) of NFWD_DD= 3 bytes ($h = (h_0, \ldots, h_{23})$) shall be inserted in front of the FWD_BB_DATAFIELD according to Figure 8 5.

The FWD_DD header shall contain the following fields:

Bits	Field	Field size	Description
h_0-h_1	L2DP	2 bits	It indicates the L2 Data Protocol (L2DP) used in the FWD_PSDU
h_2	GS	1 bit	It indicates the GS Source (NCC or GES)
h_3	SYNC	1 bit	It indicates whether the burst is synchronous with respect to. the NCC.
h_4-h_7	Reserved for future use	4 bits	--
h_8-h_{23}	DLF	16 bits	It contains the FWD_PSDU length (Data Length Field - DFL) in bytes. Range [0-65535].

Table 8-5: FWD_DD header fields

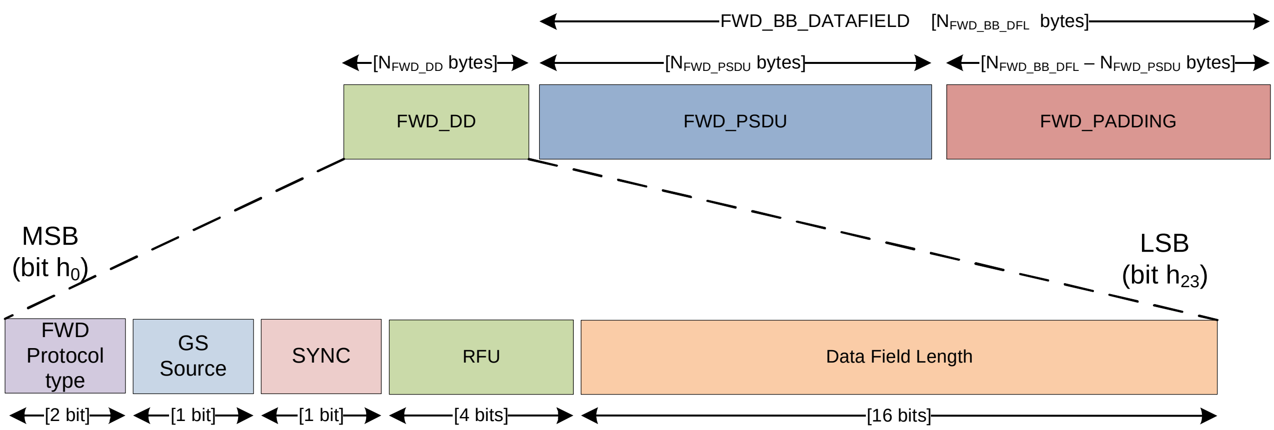


Figure 8-6: FWD_DD Header fields

D018-COM-FUN-1010

The L2DP field shall indicate which L2 entity (encapsulation protocol) is the client of the burst. It is a 2-bit field coded as detailed in the next table:

bit h_0- bit h_1	Description
00	FL Encapsulation
01	RFU
10	RFU
11	RFU

Table 8-6: RTN Link Protocol Type field mapping

D018-COM-FUN-1020

The GS field shall indicate which Ground Segment (NCC or GES) entity has transmitted the burst. GS field is a 1-bit field coded as detailed in Table 8-7.

bit h_2	Description
0	NCC
1	GES

Table 8-7: GS field mapping

D018-COM-FUN-1030

The SYNC field shall indicate whether the burst is synchronous with respect the NCC transmissions. SYNC field is a 1-bit field coded as detailed in Table 8-8.

bit h_3	Description
0	Burst “not synchronous” w.r.t. NCC transmissions
1	Burst “synchronous” w.r.t. NCC transmissions

Table 8-8: SYNC field mapping

The criterion to determine whether a burst is synchronous with respect the NCC transmissions shall be the following:

- If the burst is transmitted by the NCC, SYNC flag will always be set to "1"
- If the burst is transmitted by a GES, the SYNC flag will be set to "1" when the GES is in the synchronisation maintenance stage.

Note: the information whether the burst is synchronous or not w.r.t. the NCC transmissions shall be used by the UT in order to decide whether the burst can be used to compute the Doppler pre-compensation or not.

8.6.2.4 CRC insertion

D018-COM-FUN-1040

The FWD CRC insertion module shall compute the CRC parity bits in order to detect erroneous packets in the receiver side and to provide a packet quality indicator.

D018-COM-FUN-1050

The input stream of the CRC Insertion module shall be a FWD_DD header followed by a FWD_BB_DATAFIELD and the output stream shall be a FWD_PPDU, as illustrated in the Figure 8-7.

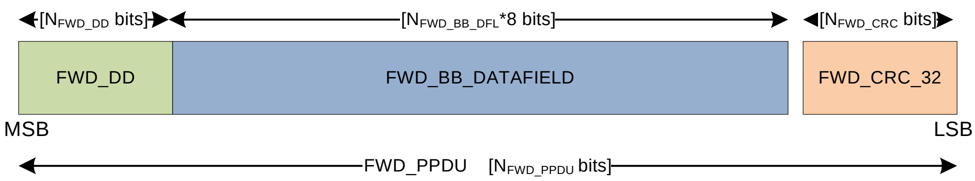


Figure 8-7: Data format at the output of the FWD CRC Insertion module

D018-COM-FUN-1060

The contents of the FWD_CRC_32 field shall be result of processing

- the FWD_DD field and
- the FWD_BB_DATAFIELD field

by a systematic 32-bit CRC encoder and shall be appended after the FWD_BB_DATAFIELD, as illustrated in Figure 8-7.

D018-COM-FUN-1070

The CRC parity bits (FWD_CRC_32 field) shall be computed as the remainder of the division of the input stream (FWD_DD and FWD_BB_DATAFIELD) by the generator polynomial

$$G(X) = X^{32} + X^{26} + X^{23} + X^{22} + X^{16} + X^{12} + X^{11} + X^{10} + X^{8} + X^{7} + X^{5} + X^{4} + X^{2} + X + 1$$

$$CRC = R(X) = [X^{32} \cdot M(X)] mod(G(X))$$

where,

- all the arithmetic is in modulo 2
- M(X) is the input stream to be processed by the systematic 32-bit CRC encoder expressed as a polynomial with binary coefficients:

$$M(X) = m_{n-1}X^{n-1} + \cdots + m_1X^1 + m_0$$

D018-COM-FUN-1080

The contents of the FWD_CRC_32 field shall be equal to the value computed by the following procedures and the shift register structure shown in the next figure:

1. The shift register cells shall be initialized to 1.

2. All the switches shall be set in the A position.

3. The shift register is clocked a number of times equal to the number of input bits (FWD_DD + FWD_BB_DATAFIELD). The MSB of the FWD_DD shall be the first bit to be inserted in the shift register.

4. Once the last input bit has been inserted in the shift register (LSB of FWD_BB_DATAFIELD), the switches shall be set to position B, forcing that the inputs to the shift register are 0.

5. The shift register shall be clocked an additional number of times equal to the number of CRC parity bits (i.e. 32). The 32 additional bits shall be the CRC parity bits (FWD_CRC_32 field).

6. The CRC parity bits shall be transmitted in the order of generation (MSB first).

All the addition operations shall be performed in GF(2)

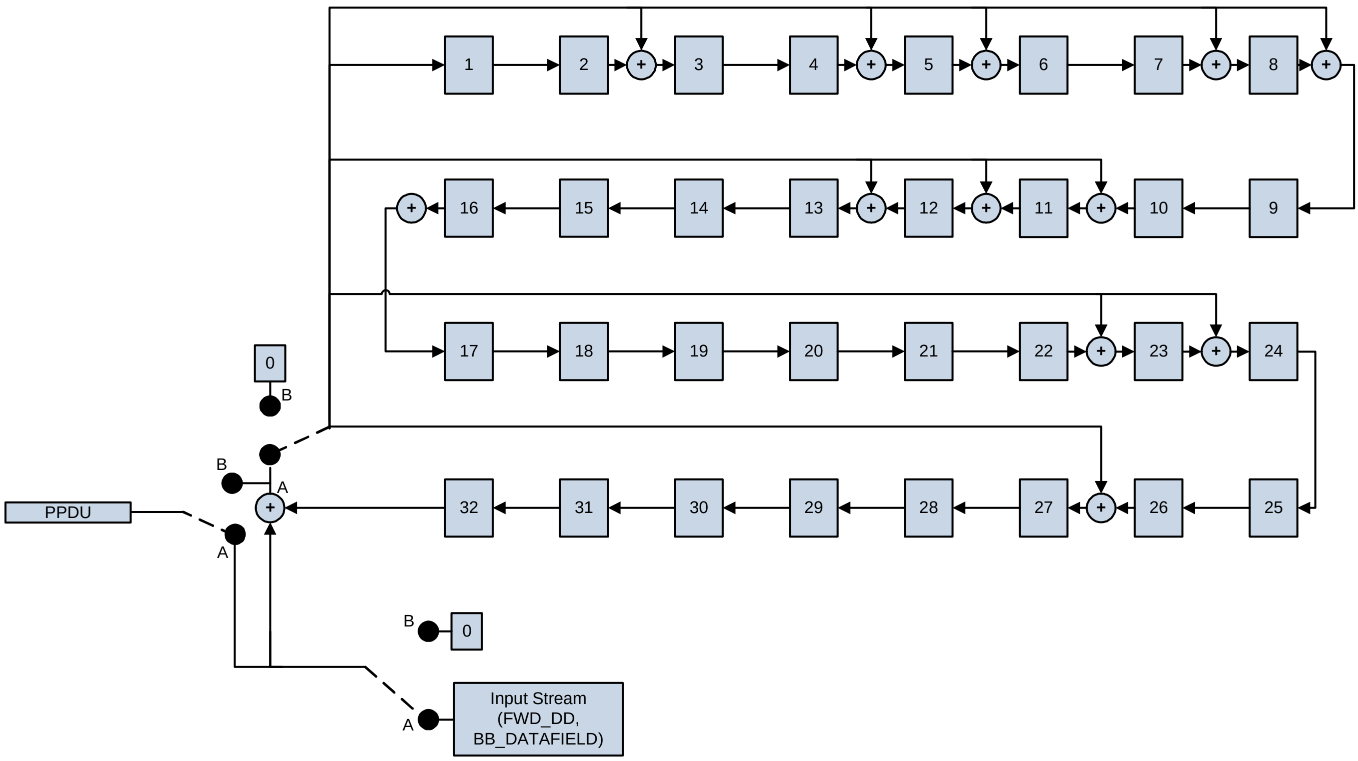


Figure 8-8: FWD_CRC_32 computation

8.6.2.5 Base-Band scrambling

D018-COM-FUN-1090

The Base-band scrambling module shall add a binary pseudo-noise sequence to the input data stream in order to randomise the binary transitions in the output data stream.

D018-COM-FUN-1100

The input stream of the Base-band scrambling module shall be a FWD_PPDU and the output stream shall be a FWD_S_PPDU (FWD Scrambled PPDU).

Note: the length of the input and output data stream (FWD_PPDU and FWD_S_PPDU) is the same, as the Base-band scrambling does not add redundancy, i.e., N_{FWD_PPDU} *bits =* $N_{FWD\_S\_PPDU}$ *bits*

D018-COM-FUN-1110

The complete FWD_PPDU shall be randomized using the Base-band scrambling. The binary pseudo-noise sequence shall be synchronous with the FWD_PPDU, starting with the MSB of the FWD_PPDU.

D018-COM-FUN-1120

The binary pseudo-random sequence (scrambling sequence) shall be generated by a linear feedback shift register with connection polynomial

$$h(D) = 1 + D^{14} + D^{15}$$

D018-COM-FUN-1130

The FWD_S_PPDU shall be generated by adding in modulo 2 the pseudo-random sequence with the connection polynomial specified in D018-COM-FUN-1120 to the input data stream (FWD_PPDU), as it is shown in Figure 8 9. The procedure to generate the FWD_S_PPDU from a FWD_PPDU shall be the following:

1. At the start of every FWD_PPDU, the contents of the shift register cells shall be initialised with the following sequence (1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0), as indicated in Figure 8-9.

2. The first value of the pseudo-noise sequence is $\mu(0) = 0$, being the modulo-2 sum of the two last elements in the shift register after initialization. For each input bit of the FWD_PPDU frame, the shift register shall be clocked once to generate the next element of the pseudo-noise sequence.

3. After each clocking of the shift register, the output bit of the FWD_S_PPDU frame is computed according to the rule:

$$m\_scr(k) = [m(k) + \mu(k)]mod2$$

where k represents the k^{th} clocking of the shift register.

The shift register shall be clocked a number of time equal to the number of inputs bits of FWD_PPDU frame (N_{FWD_PPDU}). The MSB of the FWD_PPDU shall be randomised first.

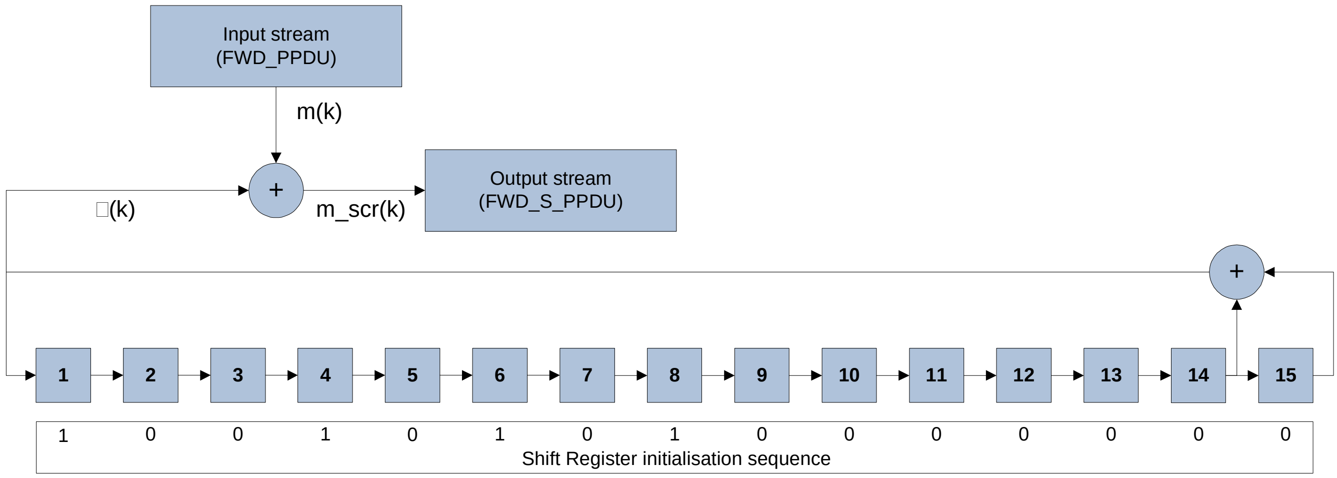


Figure 8-9: Base-band scrambler block diagram

8.6.2.6 FEC Encoding

D018-COM-FUN-1140

The FEC Encoding module shall perform the following functions:

- Inner channel coding (IRA LDPC)
- Bit interleaving

D018-COM-FUN-1150

The input stream of the FEC encoding module shall be a FWD_S_PPDU and the output stream shall be 4 FWD_FECFRAME, as illustrated in the following figure.

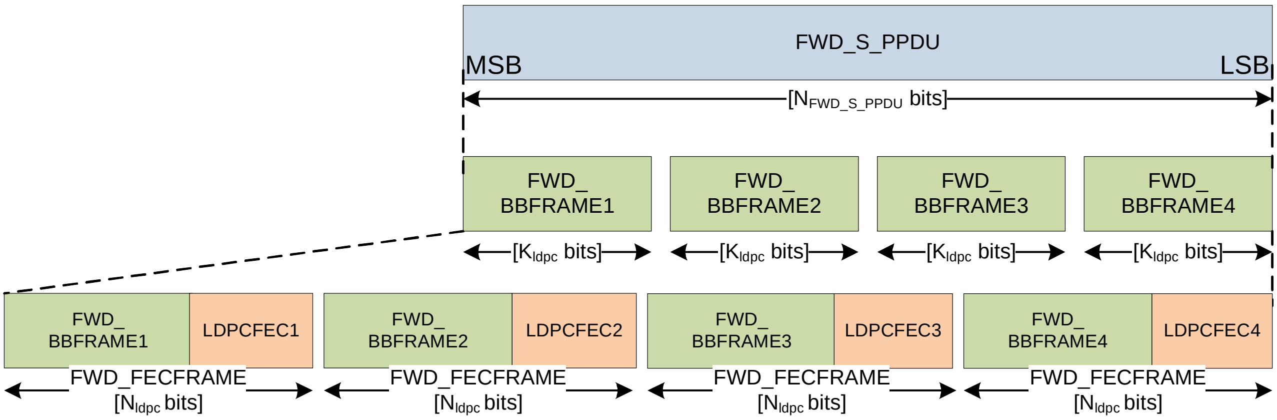


Figure 8-10: Output stream of the FEC Encoding before the bit interleaving

D018-COM-FUN-1160

The FWD_S_PPDU ($N_{FWD\_S\_PPDU}$ bits) shall be divided in 4 FWD_BBFRAME of K_{ldpc} bits each starting from the MSB (i.e. FWD_BBFRAME1 contains the MSB of FWD_S_PPDU). K_{ldpc}

depends on the supported MODCOD types (Mode). The coding parameters are provided in the following table.

MODCOD Id	MODCOD	$N_{FWD\_S\_PPDU}$ (bits)	K_{ldpc} (bits)	N_{ldpc} (bits)
MODCOD0	QPSK 1/4	6144 bits	1536 bits	6144 bits
MODCOD1	QPSK 1/3	8192 bits	2048 bits	6144 bits
MODCOD2	QPSK 1/2	12288 bits	3072 bits	6144 bits
MODCOD3	QPSK 2/3	16384 bits	4096 bits	6144 bits
MODCOD4	8-PSK 1/2	18432 bits	4608 bits	9216 bits
MODCOD5	8-PSK 2/3	24576 bits	6144 bits	9216 bits
MODCOD6	16-APSK 2/3	32768 bits	8192 bits	12288 bits

Table 8-9: FWD_BBFRAME (K_{ldpc}) and FWD_FECFRAME (N_{ldpc}) block size

D018-COM-FUN-1170

The 4 FWD_BBFRAME belonging to the same FWD_S_PPDU shall be encoded with the same MODCOD.

8.6.2.6.1 Inner Encoding (LDPC)

D018-COM-FUN-1180

Each $FWD\_BBFRAME_i$ (K_{ldpc} bits) shall be encoded using IRA LDPC codes to generate a $FWD\_FECFRAME_i$ (N_{ldpc} bits).

D018-COM-FUN-1190

LDPC parity (LDPCFEC) bits shall be appended after the FWD_BBFRAME, as illustrated in Figure 8-11:

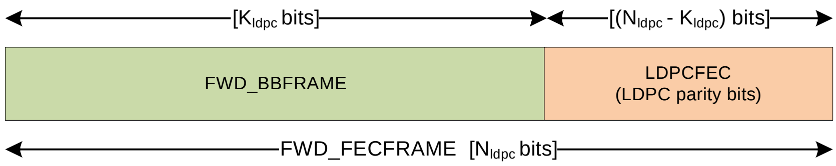


Figure 8-11: Format of data after FEC encoder (LDPC)

D018-COM-FUN-1200

The LDPC encoder shall systematically encode a FWD_BBFRAME block of size K_{ldpc}, $\boldsymbol{i} = (i_0, i_1, i_2, i_3, \ldots, i_{kldpc-3}, i_{kldpc-2}, i_{kldpc-1})$ onto a codeword (FWD_FECFRAME) of size N_{ldpc}, $\boldsymbol{c}_{ldpc} = (i_0, i_1, i_2, \ldots, i_{kldpc-2}, i_{kldpc-1}, p_0, p_1, \ldots, p_{nldpc-kldpc-2}, p_{nldpc-kldpc-1})$.

The procedure to determine the N_{ldpc} - K_{ldpc} parity bits $\boldsymbol{p} = (p_0, p_1, \ldots, p_{nldpc-kldpc-2}, p_{nldpc-kldpc-1})$ shall be as follows:

1. Initialise $p_0 = p_1 = ... = p_{nldpc\text{-}kldpc\text{-}2} = p_{nldpc\text{-}kldpc\text{-}1} = 0$

2. Accumulate the first information bit i_0 at parity bit addresses specified in the first row of Table 13-1 through Table 13-7 in section 13. For example, for code rate = 1/2 and Kldpc = 3072 bits (Table 13-2), (*Note: All additions are in GF(2)*)

$p_{1001} = p_{1001} \oplus i_0$

$p_{1397} = p_{1397} \oplus i_0$

$p_{1561} = p_{1561} \oplus i_0$

$p_{2604} = p_{2604} \oplus i_0$

$p_{2768} = p_{2768} \oplus i_0$

3. For the next c-1 information bits (FWD_BBFRAME bits) i_m, $m=1, 2, ..., c-1$ accumulate i_m at parity bit addresses $\{x + (m \, mod c) \cdot q\} mod(N_{ldpc} - K_{ldpc})$

where x denotes the address of the parity bit of the accumulator corresponding to the first bit i_0. C and q values are specified in the following table.

Block Size (K_{ldpc}), code rate (r)	ModCod Id	q/c values
K_{ldpc} = 1536 bits; r=1/4	0	36/128
K_{ldpc} = 2048 bits; r= 1/3	1	32/128
K_{ldpc} = 3072 bits; r=1/2	2	24/128
K_{ldpc} = 4096 bits; r=2/3	3	16/128
K_{ldpc} = 4608 bits; r=1/2	4	36/128
K_{ldpc} = 6144 bits; r=2/3	5	24/128
K_{ldpc} = 8192 bits; r=2/3	6	16/256

Table 8-10: q/c values

Continuing with the example (code rate = 1/2 and Kldpc = 3072 bits), $c = 128$ and $q = 24$. So for the information bit i_1, the following operations are performed:

$p_{1025} = p_{1025} \oplus i_1$

$p_{1421} = p_{1421} \oplus i_1$

$p_{1585} = p_{1585} \oplus i_1$

$p_{2628} = p_{2628} \oplus i_1$

$p_{2792} = p_{2792} \oplus i_1$

4. For the $(c+1)^{th}$ information bit i_c, the addresses of the parity bit accumulators are given in the second row of Table 13-1 through Table 13-6. In a similar manner the addresses of the parity bit

accumulators for the following c-1 information bits i_m, m=c+1, ..., 2c-1 are obtained using the formula $\{x + (m\ mod c) \cdot q\} mod(N_{ldpc} - K_{ldpc})$ where x denotes the address of the parity bit accumulator corresponding to the information bit i_c, i.e. the entries in the second row of Table 13-1 through Table 13-7.

5. In a similar manner, for every group of c new information bits, a new row from Table 13-1 through Table 13-7 is used to find the addresses of the parity bit accumulators.

6. After all of the information bits are exhausted, the final parity bits are obtained as follows,

a. sequentially perform the following operations starting with i = 1

$$p_i = p_i \oplus p_{i-1}, \quad i = 1, 2, \ldots, N_{ldpc} - K_{ldpc} - 1$$

b. final content of p_i, i = 0, 1, N_{ldpc}-K_{ldpc} -1 is equal to the parity bit p_i.

8.6.2.6.2 Bit interleaving (for 8-PSK and 16-APSK only)

D018-COM-FUN-1210

The output of the LDPC encoder and puncturing (FWD_FECFRAME) shall be bit interleaved using a block interleaver (row/column) with the parameters defined in the following table:

Modcod Id	MODCOD	N_{FWD} (Rows)	M_{FWD} (Columns)
MODCOD 0	QPSK 1/4	N.A.	N.A.
MODCOD 1	QPSK 1/3	N.A.	N.A.
MODCOD 2	QPSK 1/2	N.A.	N.A.
MODCOD 3	QPSK 2/3	N.A.	N.A.
MODCOD 4	8-PSK 1/2	3072	3
MODCOD 5	8-PSK 2/3	3072	3
MODCOD 6	16-APSK 2/3	3072	4
Note: – N stands for the number of rows – M stands for the number of columns			

Table 8-11: Bit interleaver parameters

D018-COM-FUN-1220

The bit interleaver depth shall be 1 FWD_FECFRAME (1 Code Word)

D018-COM-FUN-1230

On the transmitter side, the encoded bits shall be serially written into the interleaver column-wise and shall be serially read out row-wise according to Figure 8-12. MSB of FWD_FECFRAME shall be written and read out first.

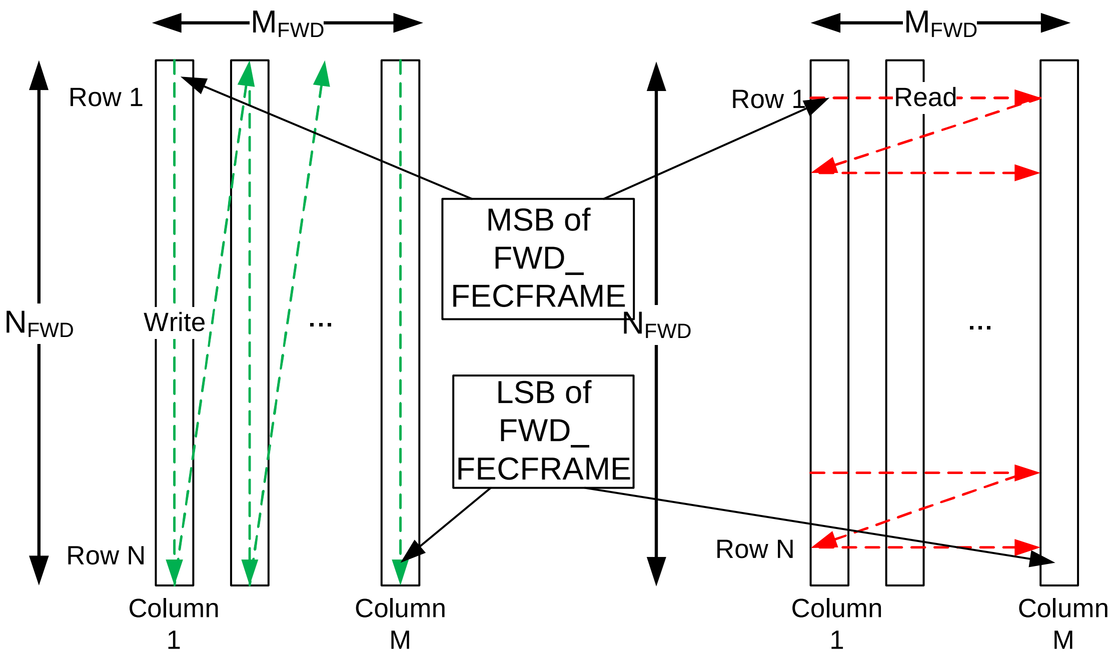


Figure 8-12: Bit interleaving scheme (Tx side)

D018-COM-FUN-1240

On the receiver side, the encoded bits shall be serially written in row-wise and shall be serially read in column-wise. MSB of FWD_FECFRAME shall be written and read out first.

8.6.2.7 Bit mapping into constellation

D018-COM-FUN-1250

The Bit Mapping module shall perform the mapping of the incoming bits into symbols (complex values) according to the specified constellation order.

D018-COM-FUN-1260

The input stream of the bit mapping module shall be a FWD_FECFRAME and the output stream shall be a FWD_XFECFRAME (FWD compleX FECFRAME)

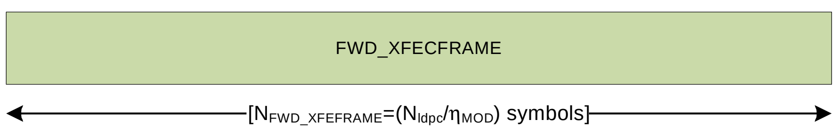


Figure 8-13: Data format at the output of the Bit mapping module

D018-COM-FUN-1270

Each FWD_FECFRAME shall be serial-to-parallel converted. Three parallelism levels shall be supported (parallelism level = η_{MOD})

- η_{MOD}=2 for QPSK
- η_{MOD}=3 for 8-PSK
- η_{MOD}=4 for 16-APSK

Then, each parallel sequence shall be mapped into constellation, generating a complex (I,Q) sequence (FWD_XFECFRAME) according to the modulation efficiency (η_{MOD}) as described in section 8.6.2.7.1 for η_{MOD}=2, section 8.6.2.7.2 for η_{MOD}=3 and section 8.6.2.7.3 for η_{MOD}=4.

D018-COM-FUN-1280

The number of symbols after the bit mapping shall be constant, as detailed in the following table

Modcod Id	MODCOD	N_{ldpc} (bits) FWD_FECFRAME size	Mod. efficiency (η_{MOD})	$N_{FWD\_XFECFRAME}$ (symbols) FWD_XFECFRAME size
MODCOD0	QPSK 1/4	6144 bits	2	3072 symbols
MODCOD 1	QPSK 1/3	6144 bits	2	3072 symbols
MODCOD 2	QPSK 1/2	6144 bits	2	3072 symbols
MODCOD 3	QPSK 2/3	6144 bits	2	3072 symbols
MODCOD 4	8-PSK 1/2	9216 bits	3	3072 symbols
MODCOD 5	8-PSK 2/3	9216 bits	3	3072 symbols
MODCOD 6	16-APSK 2/3	12288 bits	4	3072 symbols

Table 8-12: Bit mapping parameters

D018-COM-FUN-1290

The FWD_FECFRAMEs belonging to the same FWD_S_PPDU (4 FWD_FECFRAME) shall be modulated (bit-mapped) using the same modulation format.

8.6.2.7.1 Bit mapping into QPSK constellation

D018-COM-FUN-1300

The bit mapping into QPSK constellation shall be compliant with Figure 8-14. Two FWD_FECFRAME bits shall be mapped to a QPSK symbol.

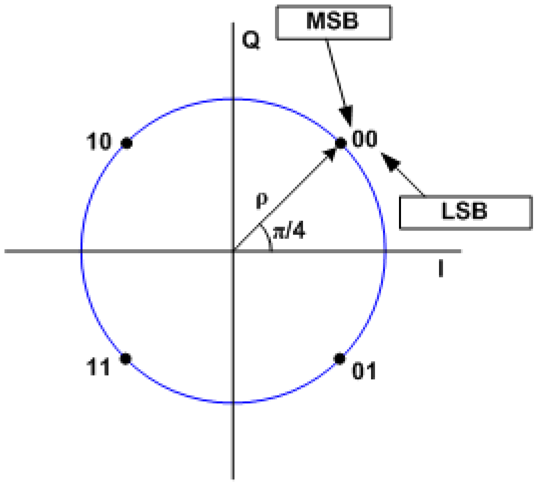


Figure 8-14: Bit mapping into QPSK modulation

Note: the symbols energy is ρ²

8.6.2.7.2 Bit mapping into 8-PSK constellation

D018-COM-FUN-1310

The bit mapping into the 8-PSK constellation shall be compliant with Figure 8-15. Three FWD_FECFRAME bits shall be mapped to a 8-PSK symbol.

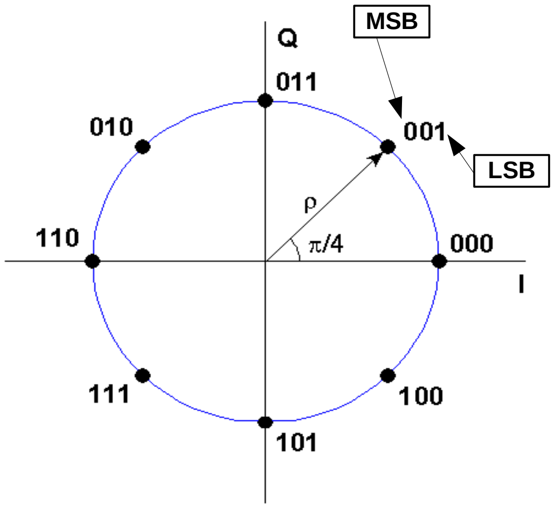


Figure 8-15: Bit mapping into 8-PSK modulation

Note: the symbols energy is ρ²

8.6.2.7.3 Bit mapping into 16-PSK constellation

D018-COM-FUN-1320

The 16-APSK modulation constellation shall be composed of two concentric rings of uniformly spaced 4 and 12-PSK points respectively in the inner ring of radius R1 and the outer ring of radius R2 (See Figure 8-16).

D018-COM-FUN-1330

The bit mapping of the 16-PSK constellation shall be compliant with Figure 8-16. Four FWD_FECFRAME bits shall be mapped to a 16-APSK symbol.

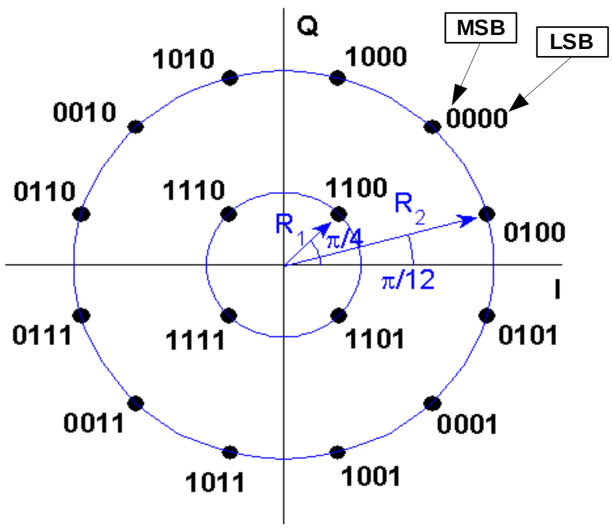


Figure 8-16: Bit mapping into 16-APSK modulation

Note: the average symbols energy is $(4R_1^2+12R_2^2)/16$

D018-COM-FUN-1340

The ratio of the outer circle radius to the inner circle radius shall comply with the next table:

Code rate	Modulation/coding spectral efficiency	γ
2/3	2.66	3.15

Table 8-13: Optimum constellation radius ratio for 16-APSK

Note: the ratio between the outer and inner circle depends on the code rate.

8.6.2.8 Symbol interleaving

D018-COM-FUN-1350

The Symbol Interleaving module shall interleave the symbols of 4 FWD_XFECFRAMES in order to exploit the time diversity.

D018-COM-FUN-1360

The input stream of the Symbol Interleaving module shall be 4 FWD_XFECFRAME (FWD_XFECFRAMEi, i=1, ..4) and the output shall be a FWD_I_4XFECFRAME.

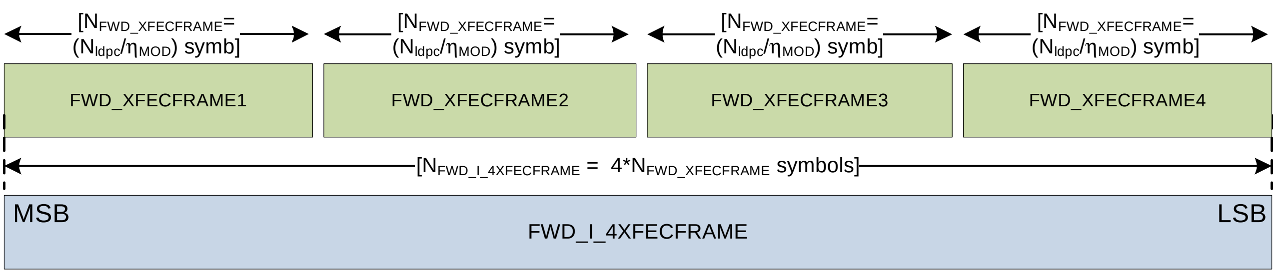


Figure 8-17: Data format at the output of the Symbol Interleaving module

D018-COM-FUN-1370

4 FWD_XFECFRAMES shall be symbol interleaved using a block interleaver (row/column) with the parameters defined in the following table:

Modcod Id	MODCOD	D_{FWD} (Number of rows)	P_{FWD} (Number of colums)	$N_{FWD\_I\_4XFECFRAME}$ (symbols)
MODCOD 0	QPSK 1/4	192	64	12288 symbols
MODCOD 1	QPSK 1/3	192	64	12288 symbols
MODCOD 2	QPSK 1/2	192	64	12288 symbols
MODCOD 3	QPSK 2/3	192	64	12288 symbols
MODCOD 4	8-PSK 1/2	192	64	12288 symbols
MODCOD 5	8-PSK 2/3	192	64	12288 symbols
MODCOD 6	16-APSK 2/3	192	64	12288 symbols
Note: – D_{FWD} stands for the number of rows – P_{FWD} stands for the number of columns				

Table 8-14: Symbol interleaver parameters

D018-COM-FUN-1380

On the transmitter side, the symbols shall be serially written in column-wise (starting from the MSB of FWD_XFECFRAME1 and ending with the LSB of FWD_XFECFRAME4) and shall be serially read out row-wise according to the following figure.

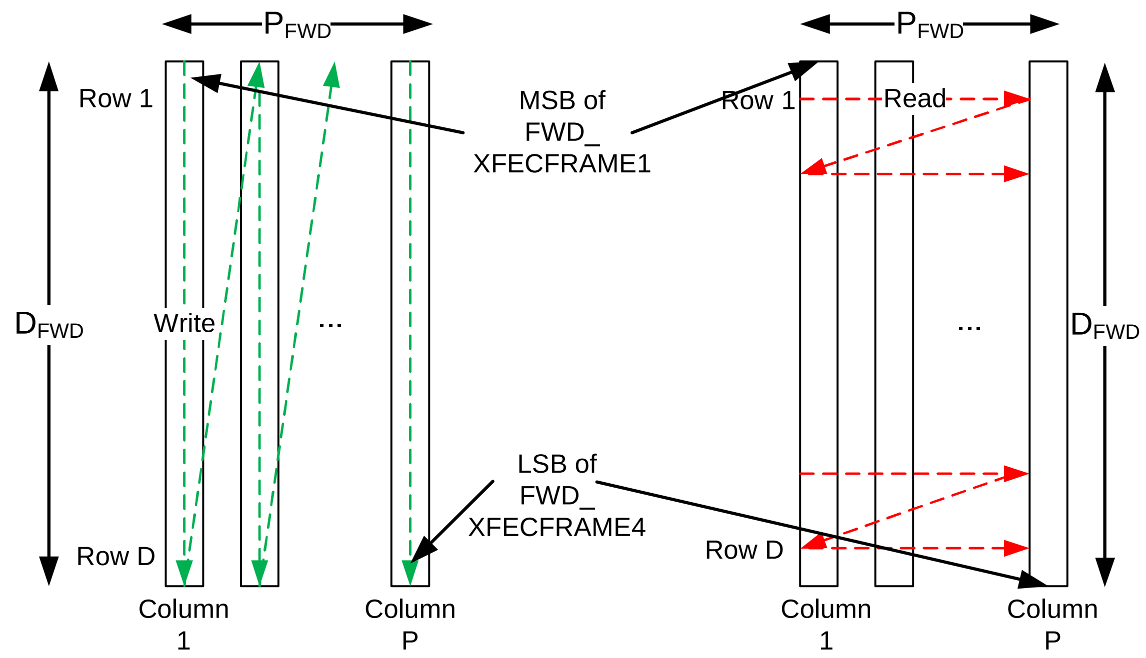


Figure 8-18: Symbol interleaving scheme

D018-COM-FUN-1390

On the receiver side, the symbols shall be serially written in row-wise and shall be serially read out column-wise.

8.6.2.9 Physical Layer Signalling Generation and Insertion

D018-COM-FUN-1400

The input stream of the Physical layer Signalling Generation and Insertion shall be a FWD_I_4XFECFRAME and the output stream shall be a FWD_I_XFRAME.

8.6.2.9.1 Physical Layer Signalling Generation

D018-COM-FUN-1410

The FWD_BD (FWD Burst Descriptor) field shall break into:

- The MODCOD_ID field (4 bits)

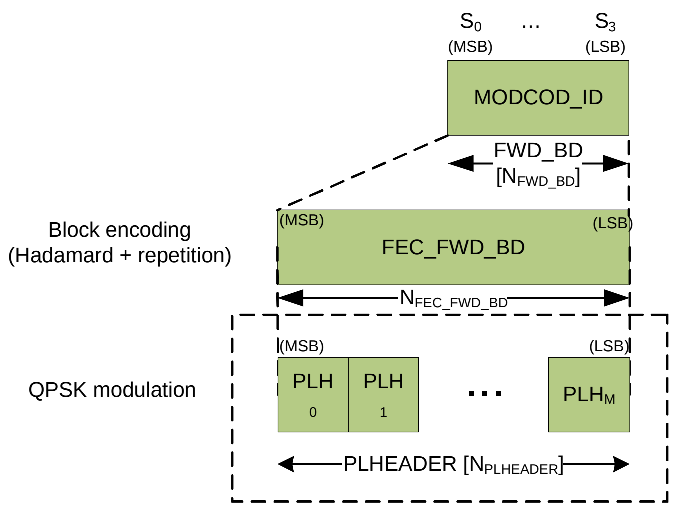


Figure 8-19: Construction and insertion of FWD_BD header

D018-COM-FUN-1420

The MODCOD_ID field shall indicate which MODCOD has been used for transmitting the FWD_I_4XFECFRAME. The MODCOD_ID shall be coded on N_{FWD_BD} = 4 bits s = (s_0, s_1, s_2, s_3) according to the following table:

Mode	MODCOD_ID			
	bit s_0	bit s_1	bit s_2	bit s_3
QPSK 1/4	0	0	0	0
QPSK 1/3	0	0	0	1
QPSK 1/2	0	0	1	0
QPSK 2/3	0	0	1	1
8-PSK 1/2	0	1	0	0
8-PSK 2/3	0	1	0	1
16-APSK 2/3	0	1	1	0

Table 8-15: MODCOD coding

Note: The other possible combinations of (s_0, s_1, s_2, s_3) are Reserved for Future Use (RFU)

D018-COM-FUN-1430

The FEC_FWD_BD field shall be constructed using the Hadamard code (8, 4, 4) concatenated with code repetition (16 times). The procedure to generate FEC_FWD_BD shall be as follows:

1. The FWD_BD field s = (s_0, s_1, s_2, s_3) shall be first encoded using the Hadamard code of length 8 (8, 4, 4) with the following generator matrix:

$$G = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \end{pmatrix}$$

The produced 8-bit code-word (c_{HAD}) shall be given by

$$\boldsymbol{c_{HAD}} = (s_0, s_1, s_2, s_3)G = (c_{HAD\_0}, c_{HAD\_1}, c_{HAD\_2}, c_{HAD\_3}, c_{HAD\_4}, c_{HAD\_5}, c_{HAD\_6}, c_{HAD\_7})$$

where the matrix multiplication is performed in GF(2). The input string (s) and the output string (c) are horizontal vectors.

2. The 8-bit code-word c_{HAD} is repeated 16 times to get the FEC_FWD_BD bit pattern ($N_{FEC\_FWD\_BD}$ bits)

$$\boldsymbol{l} = (l_0, l_1, l_2, \ldots, l_{125}, l_{126}, l_{127}), \quad with \quad l_m = c_{HAD\_m(mod8)}$$

D018-COM-FUN-1440

FEC_FWD_BD, represented by the binary sequence l = (l_0, l_1, ..., l_{127}) shall be modulated into $N_{PLHEADER}$ = 64 QPSK symbols **PLH =** (PLH_1, PLH_2, ..., PLH_{64}). Bit mapping into QPSK modulation shall be done according to D018-COM-FUN-1300.

Note: the output PLH_i is a compex symbol ($PLH_i = I_i + jQ_i$)

8.6.2.9.2 Physical Layer Signalling Insertion

D018-COM-FUN-1450

The 64 QPSK PLHEADER symbols shall be uniformly spread through the FWD_I_4XFECFRAME according to the following rule:

1. The FWD_I_4XFECFRAME shall be divided in 64 fragments of NFWD_I_4XFECFRAME_F = 192 symbols, named FWD_I_4XFECFRAME_Fk (k=0, ..., M; with M=63)

2. At the beginning of each fragment (FWD_I_4XFECFRAME_Fk), it shall be inserted 1 PLHEADER symbol (PLHk) starting with the MSB, as it is represented in the following figure.

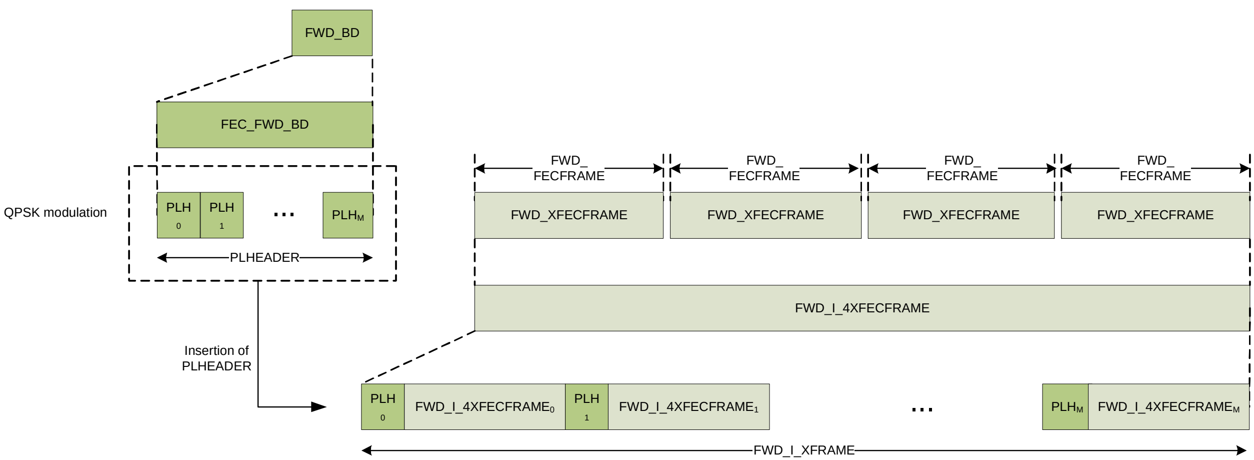


Figure 8-20: PLHEADER insertion

The output stream (FWD_I_XFRAME) shall be $N_{FWD\_I\_XFRAME}$ = 12352-symbols length

8.6.2.10 Physical Layer Framing

D018-COM-FUN-1460

The Physical Layer Framing module shall perform the following process:

- PB (Pilot Block) insertion.
- FWD_PREAMBLE insertion.

D018-COM-FUN-1470

The input stream of the Physical Layer Framing sub-system shall be a FWD_I_XFRAME and the output a FWD_PLFRAME.

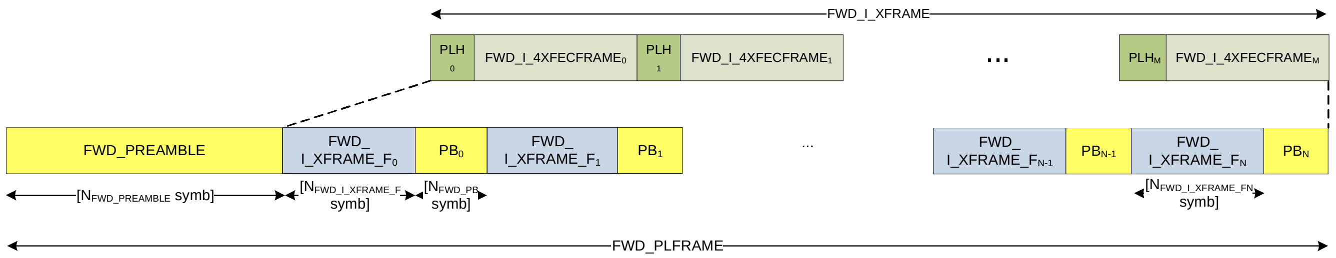


Figure 8-21: Data format at the output of the Physical layer framing module

8.6.2.10.1 PB (Pilot Blocks) insertion

D018-COM-FUN-1480

A Pilot Block (PB) shall be composed of N_{FWD_PB} = 24 symbols. Each pilot symbol shall be an un-modulated symbol with equal In-phase (I) and Quadrature (Q) components:

$$I_j = Q_j = \frac{\rho}{\sqrt{2}}, \qquad j = 0, \dots, N_{FWD\_PB} - 1$$

D018-COM-FUN-1490

PB shall be uniformly inserted within the FWD_I_XFRAME according to the following procedure:

1. The FWD_I_XFRAME shall be divided in constant-length fragments of $N_{FWD\_I\_XFRAME\_F}$ = 224 symbols each, called FWD_I_XFRAME_F$_i$ (see Figure 8-21), resulting in:

- 55 fragments of $N_{FWD\_I\_XFRAME\_F}$ = 224 symbols (FWD_I_XFRAME_F$_0$, ..., FWD_I_XFRAME_F$_{54}$)
- 1 last fragment of $N_{FWD\_I\_XFRAME\_FN}$ = 32 symbols (FWD_I_XFRAME_F$_{56}$)

2. A PB is appended after each FWD_I_XFRAME_F$_i$, as it is illustrated in Figure 8-21

8.6.2.10.2 PREAMBLE insertion

D018-COM-FUN-1500

The FWD_PREAMBLE shall consists of a $N_{FWD\_PREAMBLE}$ = 100 symbols. Each preamble symbol shall be an un-modulated symbol with equal In-phase (I) and Quadrature (Q) components:

$$I_k = Q_k = \frac{\rho}{\sqrt{2}}, \quad k = 0, \ldots, N_{FWD\_PREAMBLE} - 1$$

D018-COM-FUN-1510

The FWD_PREAMBLE shall be inserted before the first fragment of FWD_I_XFRAME ($FWD\_I\_XFRAME\_F_0$), as illustrated in Figure 8-21.

8.6.2.11 Physical Layer Scrambling

D018-COM-FUN-1520

The input stream of the Physical Layer Scrambling module shall be a FWD_PLFRAME and the output stream shall be a FWD_S_PLFRAME (FWD Scrambled PLFRAME).

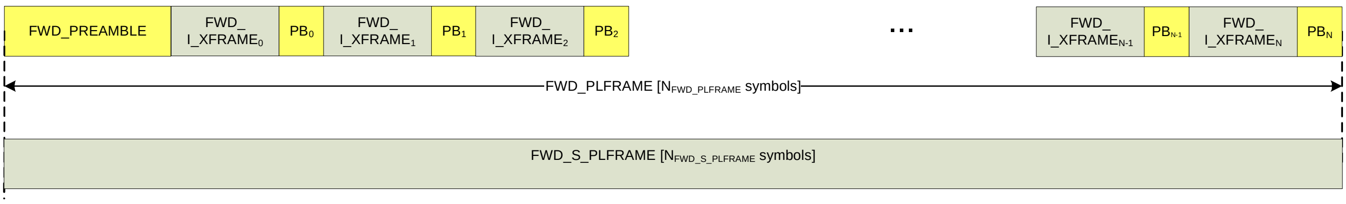


Figure 8-22: Physical layer scrambling

Note: the length of the input and output data stream (FWD_PLFRAME and FWD_S_PLFRAME) shall be the same, as the Physical Layer scrambling does not add redundancy, i.e., $N_{FWD\_PLFRAME}$ symbols = $N_{FWD\_S\_PLFRAME}$ symbols.

D018-COM-FUN-1530

The FWD_PLFRAME shall be randomised for energy dispersal by multiplying the In-phase ($I_{FWD\_PLFRAME}$) and Quadrature ($Q_{FWD\_PLFRAME}$) samples by a complex randomization sequence ($C_{FWD\_I\_SCR}$+j$C_{FWD_Q_SCR}$):

$$I_{FWD\_S\_PLFRAME} = \left(I_{FWD\_PLFRAME} \cdot C_{FWD\_I\_SCR} - Q_{FWD\_PLFRAME} \cdot C_{FWD\_Q\_SCR}\right)$$

$$I_{FWD\_S\_PLFRAME} = \left(I_{FWD\_PLFRAME} \cdot C_{FWD\_I\_SCR} - Q_{FWD\_PLFRAME} \cdot C_{FWD\_Q\_SCR}\right)$$

The complex randomization sequence is defined in D018-COM-FUN-1550.

Note: The whole FWD_PLFRAME is randomized; this includes the FWD_PREAMBLE, the PB and the FWD_I_XFRAME fragments.

D018-COM-FUN-1540

The randomisation sequence ($C_{FWD\_I\_SCR}$+j$C_{FWD_Q_SCR}$) shall be reinitialised at each FWD_PLFRAME.

D018-COM-FUN-1550

The complex scrambling sequence shall be constructed by combining 2 real m-sequences, x and y (generated by means of 2 generator polynomials of degree 18), into a complex sequence, as follows.

1. The sequence x is constructed using the primitive polynomial $h(x) = 1 + x^7 + x^{18}$

2. The sequence y is constructed using the primitive polynomial $g(y) = 1 + y^5 + y^7 + y^{10} + y^{18}$

3. The sequence depending on the chosen scrambling code number n is denoted z_n in the sequel and x(i), y(i) and z_n(i) denote the ith symbol of the sequence x, y and z_n respectively. Then, the m-sequences x and y are constructed as:

a. Initial conditions:

- x is constructed with $x(0) = 1, x(1) = x(2) = \ldots = x(16) = x(17) = 0$

- y is constructed with $y(0) = y(1) = \ldots = y(16) = y(17) = 1$

b. Recursive definition of subsequent symbols

- $x(i + 18) = [x(i + 7) + x(i)]mod2, \quad i = 0, \ldots, 2^{18} - 20$

- $y(i + 18) = [y(i + 10) + y(i + 7) + y(i + 5) + y(i)]mod2, \quad i = 0, \ldots, 2^{18} - 20$

c. The nth Gold code sequence z_n, n=0,1,2, ..., 2^{18}-2, is defined as

$$z_n(i) = [x((i + n)mod(2^{18} - 1)) + y(i)]mod(2), i = 0, \ldots, 2^{18} - 2$$

d. These binary sequences shall be converted to integer valued sequences R_n (R_n assuming values 0, 1, 2 and 3) by the following transformation.

$$R_n(i) = 2 \cdot z_n((i + 131072)mod(2^{18} - 1)) + z_n(i), \quad i = 0, 1, \ldots, 13795$$

e. Finally, the nth complex scrambling sequence C_I(i)+jC_Q(i) is defined as:

$$C_{FWD\_I\_SCR}(i) + jC_{FWD\_Q\_SCR}(i) = exp\left(jR_n(i) \cdot \frac{\pi}{2}\right)$$

R_n	$exp\left(jR_n(i) \cdot \frac{\pi}{2}\right)$	$I_{FWD\_S\_PLFRAME}$	$Q_{FWD\_S\_PLFRAME}$
0	1	I	Q
1	j	-Q	I
2	-1	-I	-Q
3	-j	Q	-I

Table 8-16: Physical layer complex scrambling sequence

The Physical Layer complex scrambling sequence shall be generated with n=0. The following figure shows the block diagram for pseudo-randomization sequence generation for n=0.

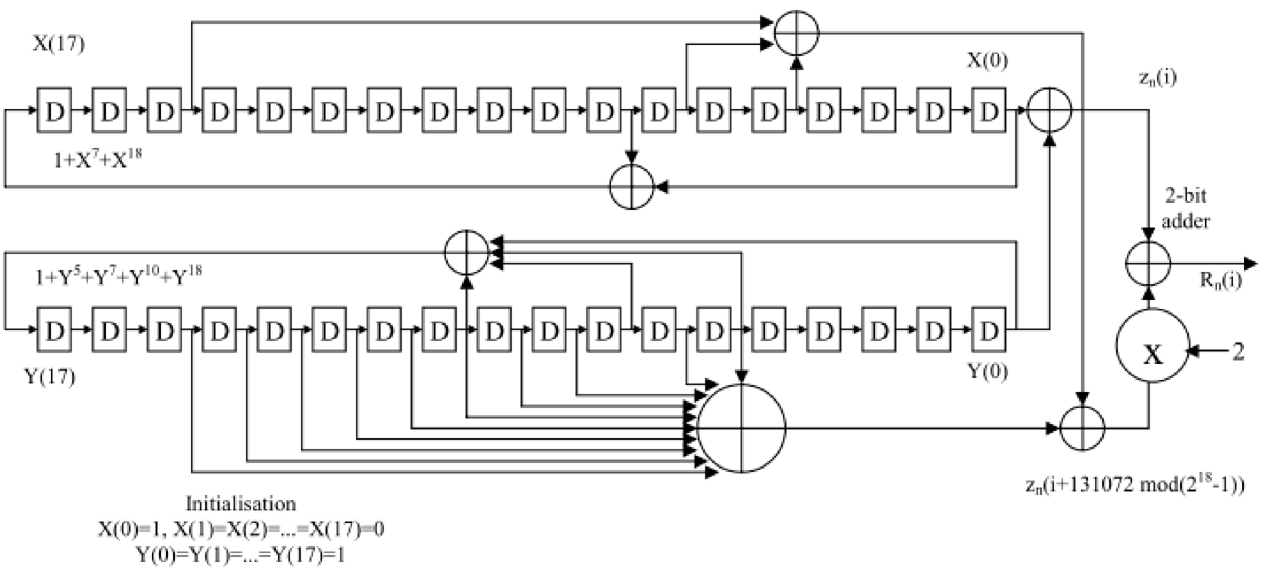


Figure 8-23: Configuration of Physical Layer Scrambling code generator for n=0

8.6.2.12 Base-band pulse shaping and quadrature modulation

D018-COM-FUN-1560

After the physical layer scrambling, the FWD_S_PLFRAME shall be shaped and quadrature modulated.

D018-COM-FUN-1570

I and Q signals shall be shaped using a Square Root Raised Cosine with a roll-off factor α=0.2.

D018-COM-FUN-1580

The baseband SRRC filter shall have a theoretical function defined by the following expression.

$$H(f)=1 \qquad \text{for } |f|<f_N(1-\alpha)$$

$$H(f)=\left\{\frac{1}{2}+\frac{1}{2}\sin\frac{\pi}{2f_N}\left[\frac{f_N-|f|}{\alpha}\right]\right\}^{1/2} \qquad \text{for } f_N(1-\alpha)$$

$$H(f)=0 \text{ for } |f|>f_N(1+\alpha),$$

where f_N = R_s/2 is the Nyquist frequency and α is the roll-off factor.

D018-COM-FUN-1590

The quadrature modulation shall be performed by multiplying the In-phase component (I) by $\cos(2\pi f_0 t)$ and the Quadrature component (Q) by $-\sin(2\pi f_0 t)$. I and Q signals shall be added to conform the modulation output.

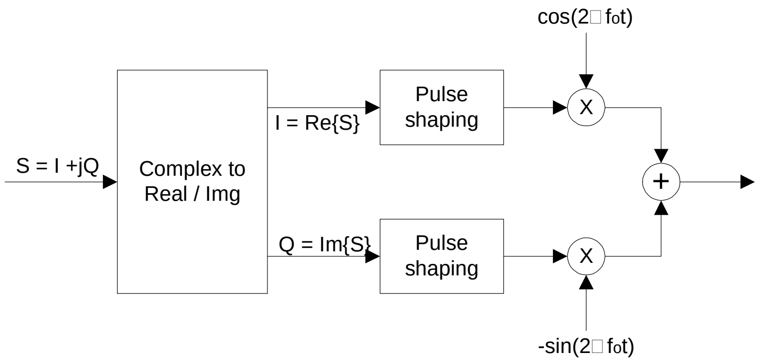


Figure 8-24: Forward link modulation

8.6.2.13 Physical layer error performance

8.7 User plane return link specification

8.7.1 Link layer specification

8.7.1.1 Random access

D018-COM-FUN-1610

The CS shall support the ALOHA state machine depicted below for RTN link random access. It includes the following steps:

- Every time a transmission is going to happen, a random delay (back-off delay), following an exponential distribution (pdf = $\lambda \exp(-\lambda x)$), is applied. The mean value of this delay, defined as $1/\lambda = 2^{n-1} \cdot$ tx_backoff, increases with the number of transmissions 'n' (n = 1 for the fisrt transmission). tx_backoff is a configuration parameter associated to congestion control, as it is defined in D018-COM-FUN-3410.
- After the application of the transmission back-off delay, a persistency check is performed. With a probability equal to the persistency parameter, the transmission is actually performed. Otherwise a new delay is applied, using the procedure described in the previous bullet. This operation is repeated until the LPDU is transmitted or a time-out is exceeded. In this latter case

the LPDU is dropped without being transmitted. Persistency is a configuration parameter associated to congestion control, as it is defined in D018-COM-FUN-3410.

- After every (effective) transmission a timer is started and if it exceeds the time-out, a retransmission is attempted. Re-transmission timeout is a configuration parameter associated to congestion control and ARQ, as it is defined in D018-COM-FUN-3410.

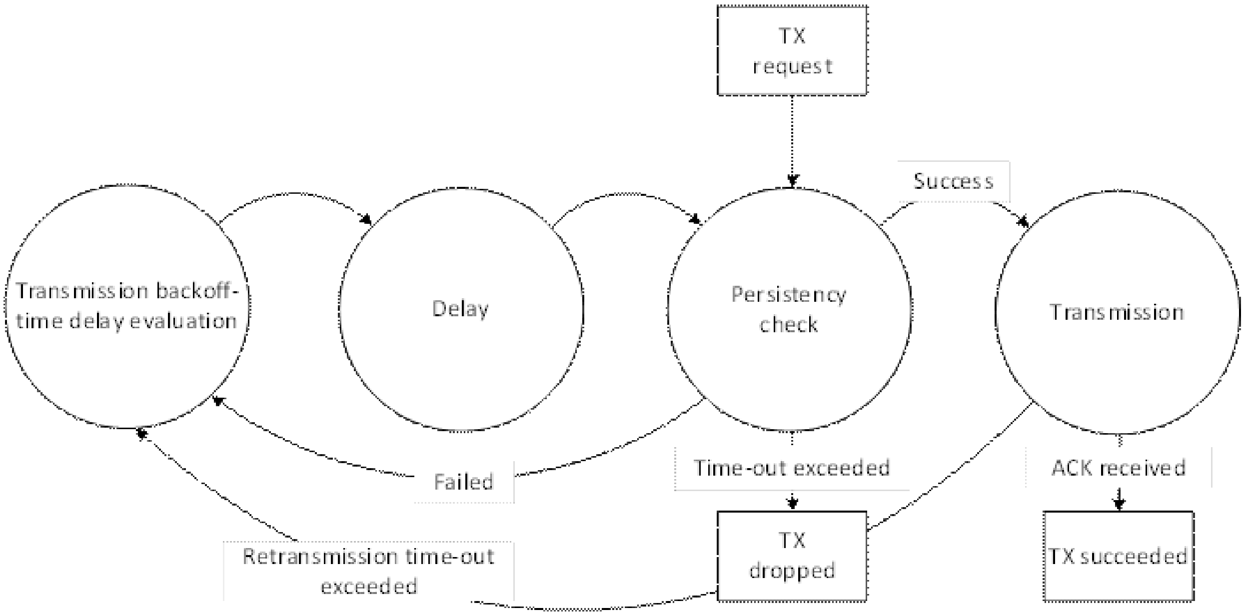


Figure 8-25: ALOHA State Machine

D018-COM-FUN-1620

For each physical transmitter, several ALOHA state machines (ALOHA MAC Stack) as they are defined in D018-COM-FUN-1610 shall run in parallel.

Each of them shall work independently, computing its own set of back-off delay, persistency check and re-transmission timer, scheduling pending data in LPDU input queues for transmission once the state machine becomes idle (i.e., previous transmission has either succeeded or failed).

D018-COM-FUN-1640

Upon expiration timeout in an ALOHA state machine, all LDPUs associated to the same NSDU shall be dropped. Therefore, the expiration time shall be set in a per NSDU basis.

D018-COM-FUN-1650

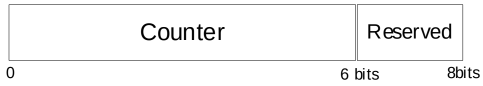
The ARQ field of the RL Encapsulation header, as it is defined in D018-COM-FUN-1780, along with the UT's MAC address shall be used for the in-order reassembly of the received NPDU's fragments.

8.7.1.2 ARQ protocol

8.7.1.2.1 ARQ header and ACK format

D018-COM-FUN-1660

The ARQ header shall include the following fields: (TBC)



where

Field	Length	Description
Counter	6 bits	This field provides a sequence number for PSDU identification.
Reserved	2 bits	TBD

Table 8-18: ARQ header fields

D018-COM-FUN-1670

ARQ ACK format as specified per D018-COM-FUN-0730.

8.7.1.2.2 ARQ procedure

D018-COM-FUN-1680

An ARQ mechanism shall be integrated with each ALOHA state machine.

D018-COM-FUN-1690

ARQ for a single ALOHA state machine shall be based on cumulative ACK strategy, with timeouts triggering retransmissions.

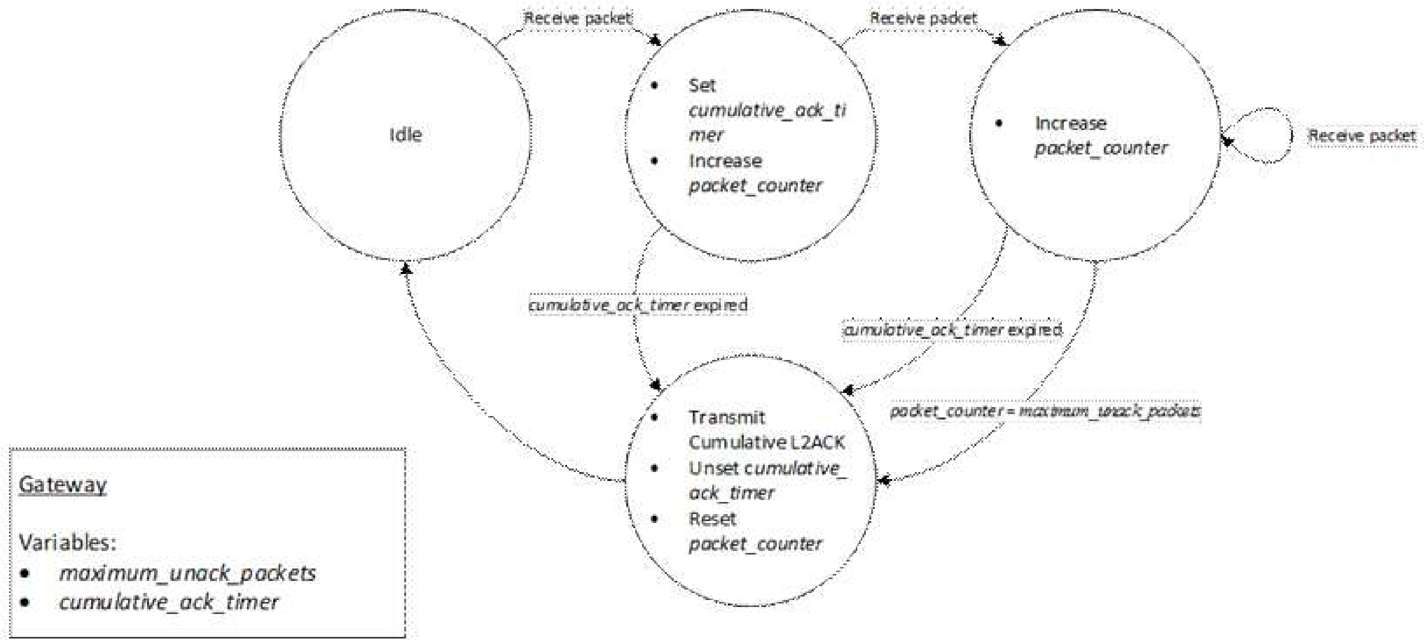


Figure 8-27: ARQ block diagram at receiver end

Note: Refer to Figure 8-25 for the ARQ block diagram at transmitter end.

D018-COM-FUN-1700

One ARQ header management entity shall be active per CoS category and shall be common for the ALOHA state machine bank associated to the category.

D018-COM-FUN-1710

Retransmission timer shall be started when the PSDU is forwarded to the physical layer.

D018-COM-FUN-1720

Retransmission timer shall be set to PSDU frame transmission time plus RTT plus a configurable processing time plus a configurable margin.

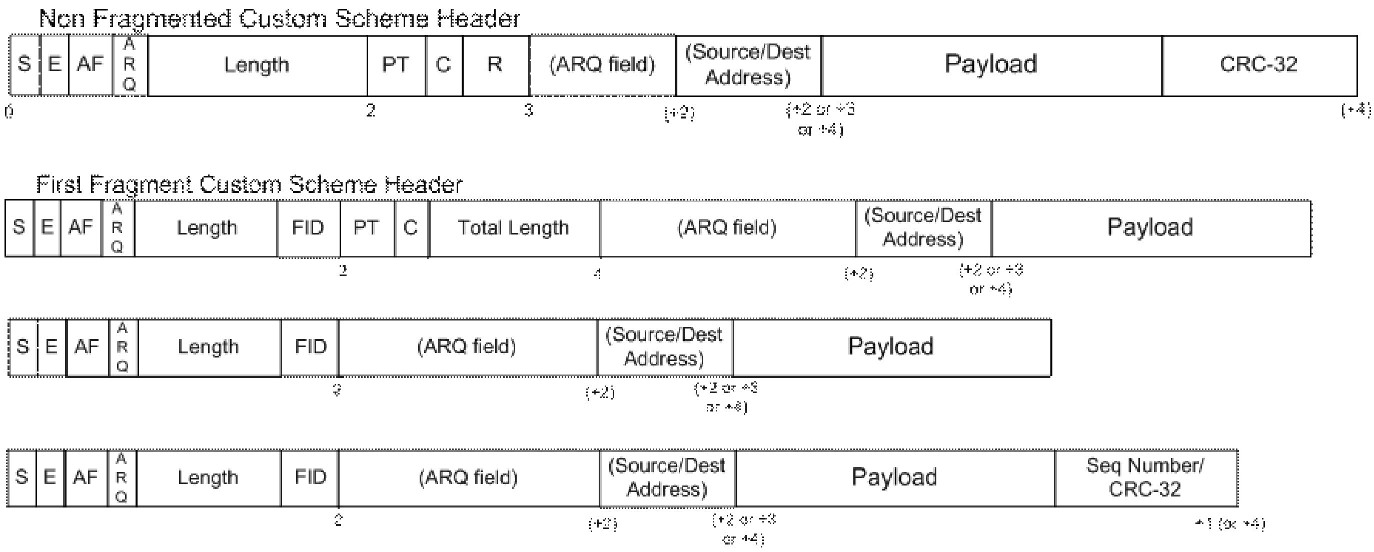
8.7.1.3 Encapsulation

D018-COM-FUN-1770

The return link encapsulation scheme requires that a PPDU payload always starts with the encapsulation header of the first LDPU. Therefore, LDPU fragmentation between PPDU payloads is not allowed.

D018-COM-FUN-1780

The return link encapsulation scheme used shall comply with the following (TBC):



where

Field	Length	Description
S and **E** flags: Start and End bits	1 bit each	These fields indicate if the packet is non-fragmented (11), if it is the first fragment (10), the last fragment (01) or an intermediate fragment (00) of a fragmented packet.
AF field: Address Format	2 bits	This field indicates the address format that will be contained in the encapsulation header. It can take the following values: **00**: No address field/label re-use **01**: 2 bytes address field: UT source address **10**: 3 bytes address field: 2 bytes source UT address + 1 byte destination GS element address **11**: 4 bytes address field: 3 bytes source UT ICAO address + 1 byte destination GS element address
ARQ flag	1 bits	This field indicates whether the ARQ process is used, implying an additional 2 bytes field for un-fragmented packet, and for every fragment when fragmented.
Length field	11 bits not fragmented/ 8 bits fragmented	This field indicates the length of the L2 payload size for the current fragment (for fragmented packet) or the total length of the payload for non-fragmented packet. This length enables physical payload sizes up to 259 bytes (this length is sufficient in regards to the considered physical burst size over the return link, which is below 200 bytes).
PT field: Payload Type	3 bits	This field indicates the type of the contained payload that can be ATN/IPS, ATN/OSI, Signalling, compressed data, etc.
C flag: CRC Presence	1 bits	This field indicates if a 4 bytes CRC field is present as a trailer in the current packet (when un-fragmented).
R field: Reserved	4 bits	This field is reserved for future use.
ARQ field: ARQ Information	2 bytes	This optional field contains the information required for the ARQ process when the ARQ bit is set to 1. It shall comply with §8.7.1.1. When fragmented, the ARQ mechanism reuses the Flow ID field already present in the encapsulation header. Thus only the Packet Count and the fragment count fields are present within this ARQ field. When non fragmented, the three fields of the ARQ are required (FID, PC and FC).
Source/Dest Address field	optional field of 2, 3 or 4 bytes	This field is optional and contains the source and destination addresses as indicated by the Address Format (AF) field.
FID field: Flow ID	3 bits	This field identifies the Class of Service (or the flow) of the current packet (it permits to differentiate interleaving of various CoS or MODCODs). This field is used by re-assembly process when the packet is fragmented and by ARQ process when activated.
Total Length field	12 bits	This field indicates the total length of the L3 payload when fragmented. This length enables L3 packet sizes up to 4096 bytes.
Seq Number/CRC-32 field	1 or 4 bytes	When indicated by the C bit or by system design, a 4 bytes trailer is added after the payload when un-fragmented or at the end of the last fragment when fragmented. When fragmented, if this option is set by system design, a 1-byte sequence number is added and used by re-assembly process to identify the fragment having the same PID in case of fragment loss.

Table 8-19: Return link encapsulation fields

8.7.1.4 Security

Refer to 8.3.

8.7.2 Physical layer specification

8.7.2.1 Burst types

D018-COM-FUN-1790

On the return link the following burst types shall be implemented:

- RACH burst (Random Access Channel)

8.7.2.2 Burst waveform generator

D018-COM-FUN-1800

The burst waveform generation shall be applied to the RTN_PSDU and shall be composed of a sequence of functional modules as represented in Figure 8-28. The functional blocks shall be:

- Physical Layer Adaptation
- CRC Insertion
- Base-band Scrambling
- FEC Encoding, which includes the inner encoding and the bit interleaver
- Auxiliary channel generation
- Bit Mapping into Constellation
- Spreading
- Preamble generation
- Preamble spreading
- Physical Layer Framing
- Base-band Pulse Shaping and Quadrature Modulation

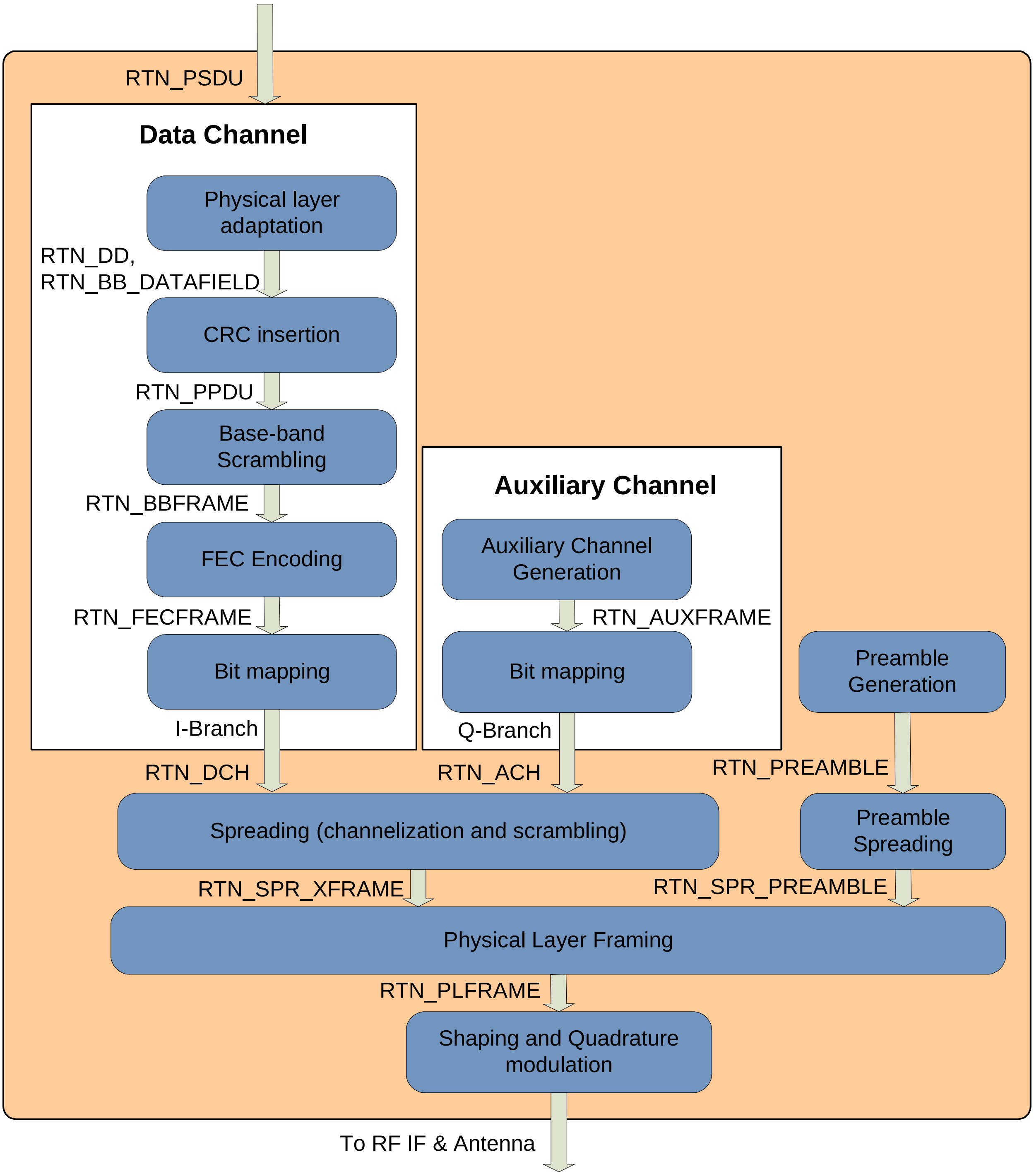


Figure 8-28: Return link burst waveform generation

D018-COM-FUN-1810

The RTN Link bursts shall follow the frame format presented in the following figure:

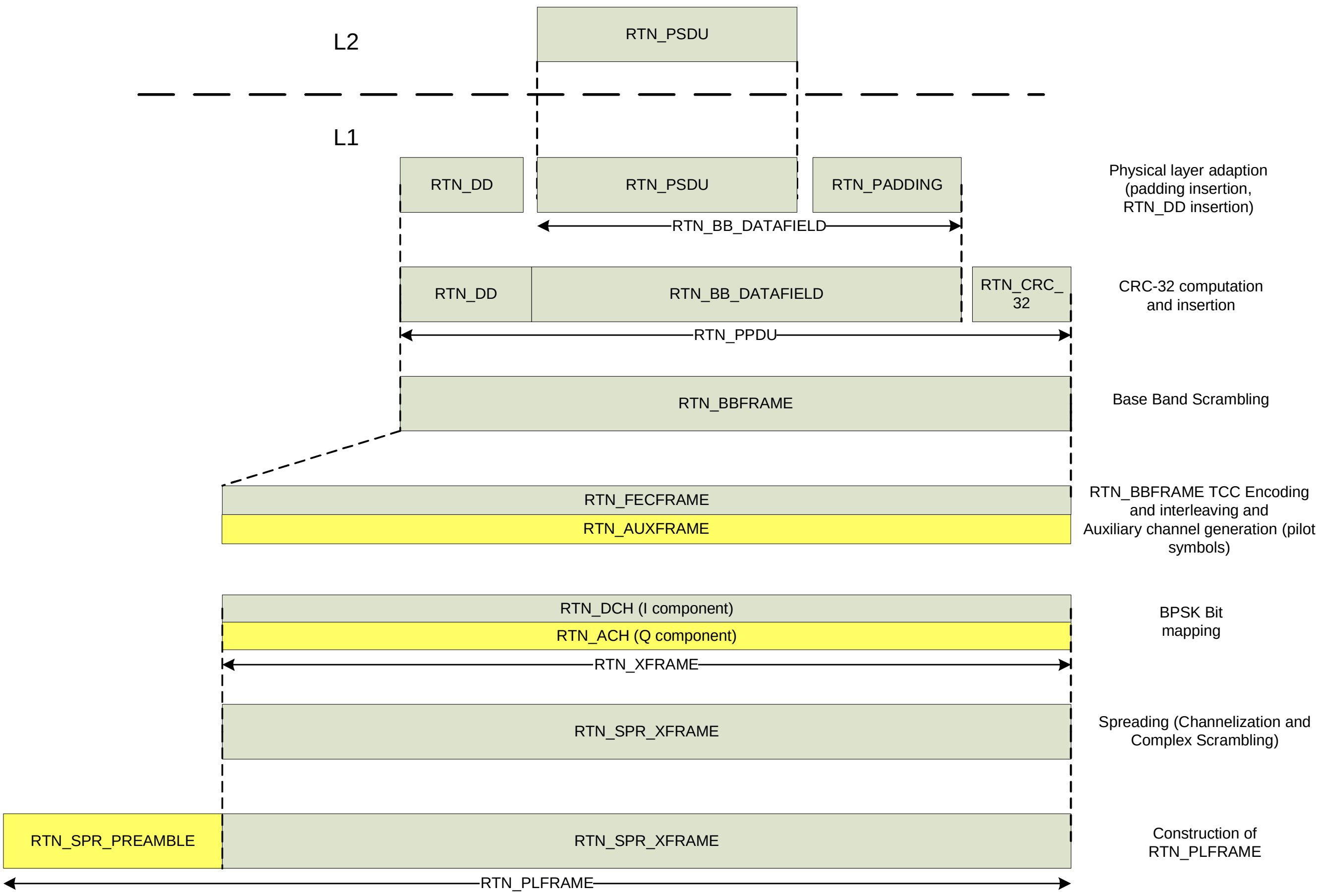


Figure 8-29: RTN Link burst frame structure

D018-COM-FUN-1820

The RACH burst shall support the following configurations.

RACH Configuration ID	Chip rate (kchip/s)	SF length	Mod	Code rate	Data Word Size (bits) - RTN_PPDU
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	160	16	BPSK	1/3	512
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	160	4	BPSK	1/3	2048
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	160	16	BPSK	1/3	288
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	160	4	BPSK	1/3	288

Table 8-20: Allowed RACH burst configurations

Note: these configurations correspond to the Data Channel

8.7.2.3 Physical Layer Adaptation

D018-COM-FUN-1830

The Physical Layer Adaptation module shall perform:

- Interface with Layer 2
- Padding insertion
- RTN_DD (RTN Data Descriptor) insertion

D018-COM-FUN-1840

The input stream of the Physical Layer Adaptation module shall be a RTN_PSDU and the output stream shall be a RTN_DD Header followed by a RTN_BB_DATAFIELD, as detailed in Figure 8-30.

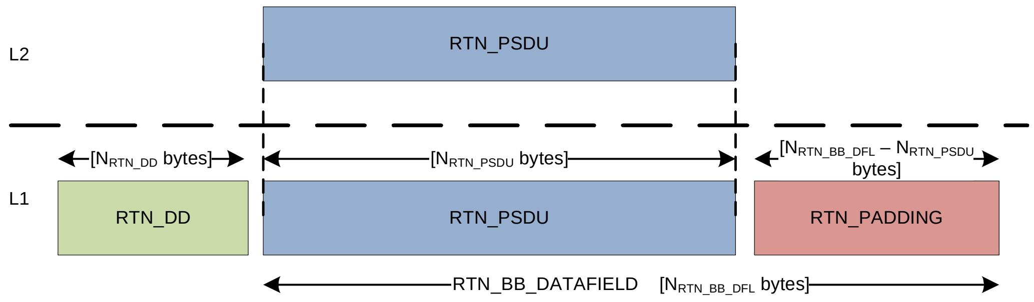


Figure 8-30: Data format at the output of the RTN Physical Layer Adaptation module

D018-COM-FUN-1850

A single RTN PSDU shall be mapped onto a single burst.

8.7.2.3.1 Interface with Layer 2

D018-COM-ITF-1860

The Physical Layer Adaptation module shall map RTN_PSDU of up to 4 types of layer 2 entities (or protocols):

- RL Encapsulation, as defined in D018-COM-FUN-1780
- Protocol 2 (RFU)
- Protocol 3 (RFU)
- Protocol 4 (RFU)

D018-COM-ITF-1870

The RTN_PSDU size (in bytes) shall be variable in the range depending on the selected RACH configuration. The maximum RTN_PSDU size (Max. NRTN_PSDU) shall be as follows:

RACH Configuration ID	**Max. N_{RTN_PSDU} [Maximum RTN_PSDU size (bytes)]**
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	58 bytes
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	250 bytes
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	30 bytes
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	30 bytes

Table 8-21: Maximum PSDU size

8.7.2.3.2 Padding insertion

D018-COM-FUN-1880

($N_{RTN\_BB\_DFL}$ - N_{RTN_PSDU}) bytes shall be appended after the RTN_PSDU according to Figure 8-31. The contents of the padding bytes shall be "0x00".

8.7.2.3.3 RTN_DD (RTN Data Descriptor) insertion

D018-COM-FUN-1890

A fixed length header (RTN_DD) of N_{RTN_DD}= 2 bytes (bits I_0-I_{15}) shall be inserted in front of the RTN_BB_DATAFIELD according to Figure 8-31.The RTN_DD header shall contain the following fields:

Bits	**Field**	**Field size**	**Description**
I_0-I_1	L2 Protocol Type	2 bits	It indicates the L2 protocol used in the RTN_PSDU
I_2-I_{11}	Data Field length	10 bits	It contains the RTN_PSDU size
I_{12}-I_{15}	Reserved field	4 bits	Reserved for future use

Table 8-22: RTN_DD header fields

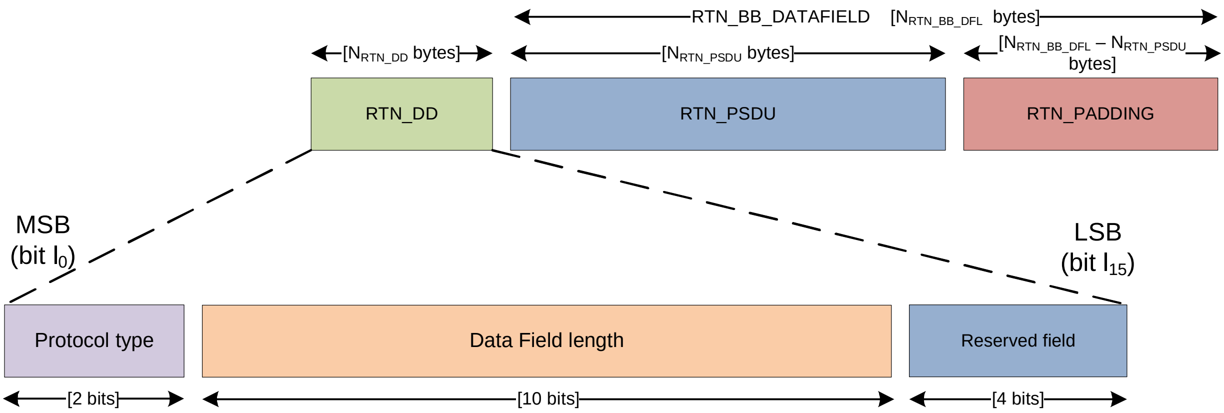


Figure 8-31: RTN_DD Header fields

D018-COM-FUN-1900

The Protocol Type shall indicate which L2 entity is the client of the burst. It is a 2-bit field coded as follows:

I_0 I_1 (RTN Protocol Type)	Description
00	RL Encapsulation
01	RFU
10	RFU
11	RFU

Table 8-23: RTN Link Protocol Type field mapping

8.7.2.4 CRC insertion

D018-COM-FUN-1910

The RTN CRC Insertion module shall compute the CRC parity bits in order to detect erroneous packets in the receiver side and to provide a packet quality indicator.

D018-COM-FUN-1920

The input stream of the RTN CRC Insertion module shall be a RTN_DD header followed by a RTN_BB_DATAFIELD and the output stream shall be a RTN_PPDU, as illustrated in Figure 8-32.

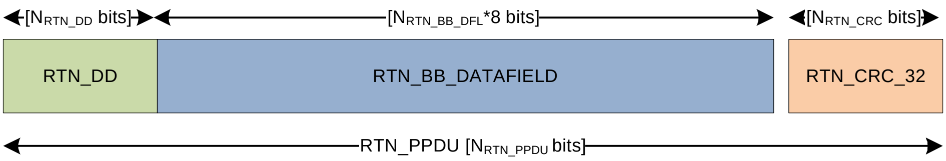


Figure 8-32: Data format at the output of the RTN CRC Insertion module

D018-COM-FUN-1930

The RTN_CRC_32 shall be computed over:

- The RTN_DD header
- The RTN_BB_DATAFIELD

by a systematic 32-bit CRC encoder and shall be appended after the RTN_BB_DATAFIELD, as illustrated in Figure 8-32.

D018-COM-FUN-1940

The content of the RTN_CRC_32 field shall be computed as it is described in D018-COM-FUN-1070 and D018-COM-FUN-1080.

8.7.2.5 *Base-band scrambling*

D018-COM-FUN-1950

The Base-band scrambling module shall add a binary pseudo-noise sequence to the input data stream in order to randomise the binary transitions in the output stream.

D018-COM-FUN-1960

The input stream of the Base-band scrambling module shall be a RTN_PPDU and the output stream shall be a RTN_BBFRAME.

Note: the length of the input and output data stream (RTN_PPDU and RTN_BBFRAME) is the same, as the Base-band scrambling does not add redundancy

D018-COM-FUN-1970

The complete RTN_PPDU shall be randomized using the Base-band scrambling. The binary pseudo-noise sequence shall be synchronous with the RTN_PPDU, starting with the MSB of the RTN_PPDU.

D018-COM-FUN-1980

The binary pseudo-random sequence (scrambling sequence) shall be generated by a linear shift register with connection polynomial

$$h(D) = 1 + D^{14} + D^{15}$$

D018-COM-FUN-1990

The RTB_BBFRAME shall be generated by adding in modulo 2 the pseudo-random sequence with the connection polynomial specified in D018-COM-FUN-1980 to the input data stream (RTN_PPDU), as it is shown in Figure 8-33. The procedure to generate the RTN_BBFRAME from a RTN_PPDU shall be the following:

1. At the start of every RTN_PPDU, the contents of the shift register cells shall be initialised with the following sequence (1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0), as indicated in Figure 8-33: Base-band scrambler block diagram.

2. The first value of the pseudo-noise sequence is µ(0) = 0, being the modulo-2 sum of the two last elements in the shift register after initialization. For each input bit of the RTN_PPDU frame, the shift register shall be clocked once to generate the next element of the pseudo-noise sequence.

3. After each clocking of the shift register, the output bit of the RTN_BBFRAME frame is computed according to the rule:

$$m\_scr(k) = [m(k) + \mu(k)]mod2$$

where k represents the k^{th} clocking of the shift register.

The shift register shall be clocked a number of times equal to the number of inputs bits of RTN_PPDU frame (NRTN_PPDU). The MSB of the RTN_PPDU shall be randomised first.

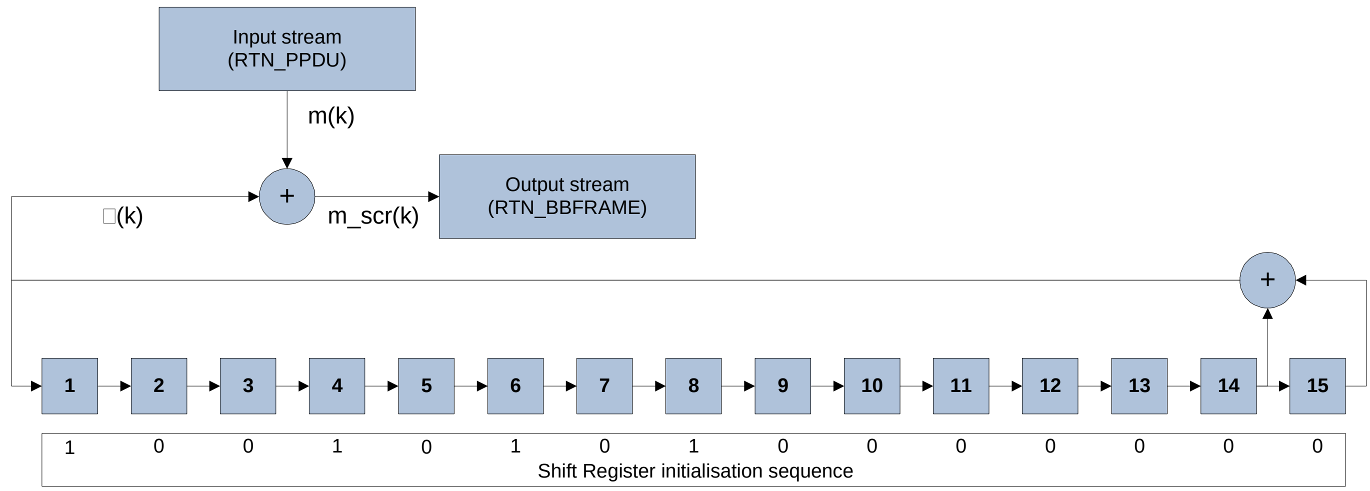


Figure 8-33: Base-band scrambler block diagram

8.7.2.6 FEC encoding

D018-COM-FUN-2000

The FEC Encoding module shall perform the following functions:

- Inner channel coding (TCC)
- Bit interleaving

D018-COM-FUN-2010

The input stream of the FEC encoding module shall be a RTN_BBFRAME and the output stream shall be a RTN_FECFRAME, as illustrated in the following figure.

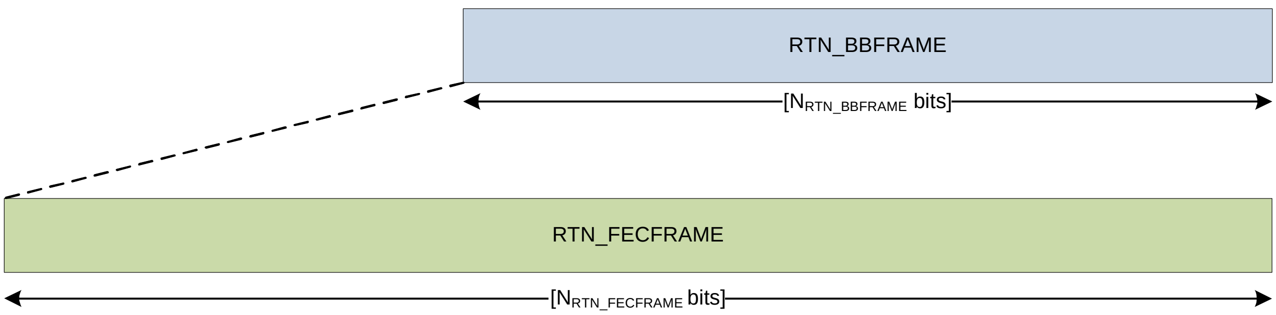


Figure 8-34: Output stream of the FEC Encoding

D018-COM-FUN-2020

The RTN_BBFRAME shall be encoded with 1/3 code rate using the inner coding described in section 8.6.2.6.1.

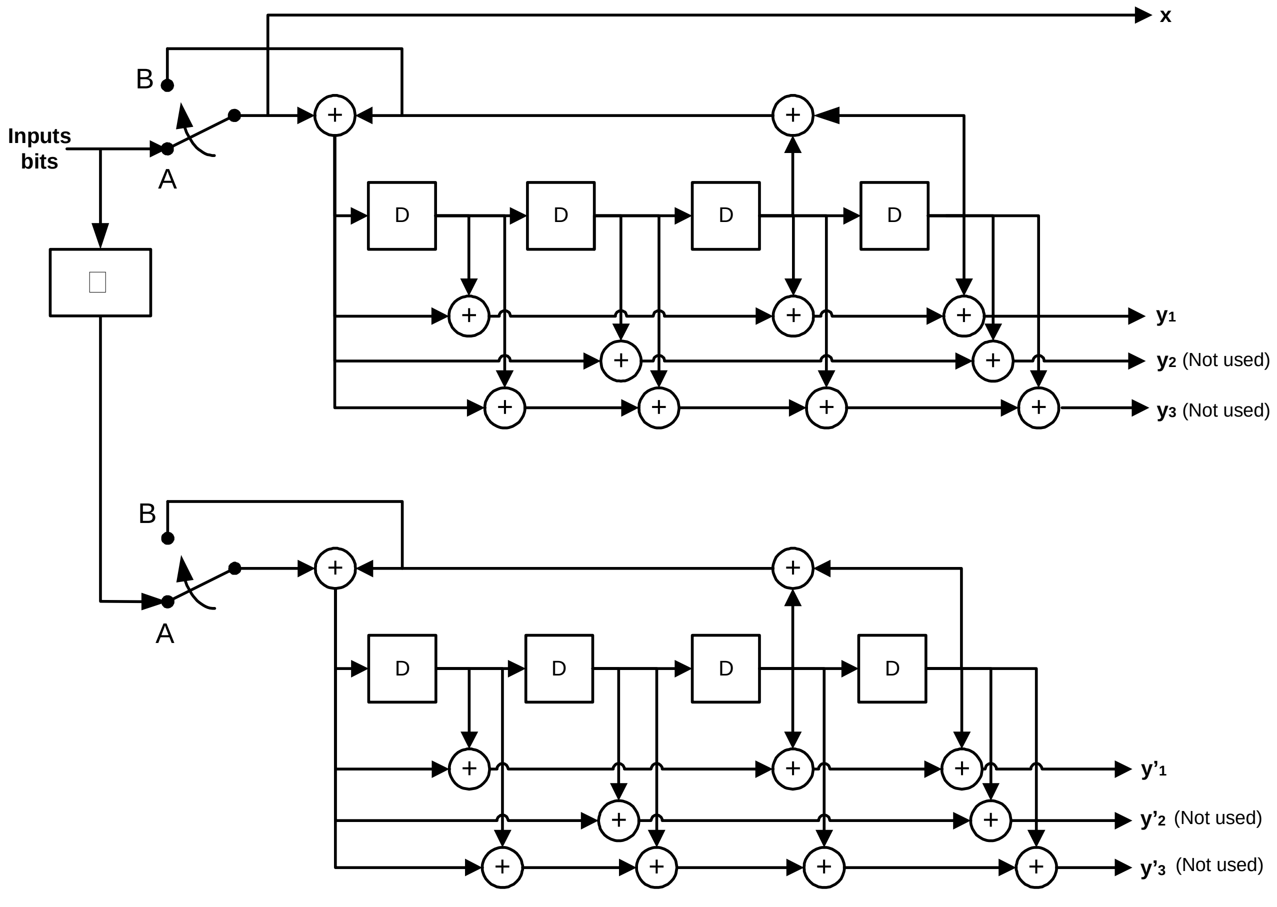
8.7.2.6.1 Inner encoding (TCC)

D018-COM-FUN-2030

The Forward Error correction scheme on the return link shall be Turbo Convolutional Codes.

D018-COM-FUN-2040

The Turbo code architecture shall be a Parallel Concatenated Convolutional Code (PCCC) with two identical 16-state binary, recursive and systematic convolutional encoders and a Turbo code internal interleaver, as it is depicted in the following figure.



(Note: y_2, y_3, y'_2, and y'_3 are not used for the code rate 1/3)

Figure 8-35: PCCC 16-states binary architecture

The Turbo encoder output shall be computed according to the following procedure (code rate 1/3):

1. Both 16-state constituent encoders shall be initialised with 0 in all the shift registers before coding a block (initial state)

2. All switches shall be set in the A position

3. The encoded data shall be generated by clocking the constituent encoders $N_{RTN\_BBFRAME}$ times. MSB of RTN_BBFRAME shall be inserted first in the TCC encoder. The constituent encoder outputs for each bit period k (k< $N_{RTN\_BBFRAME}$) shall be the output sequence (k represents the):

$$x(k), y_1(k), y'_1(k)$$

4. Once the last input bit has been inserted in the constituent encoders (LSB of RTN_BBFRAME), the switches shall be set to position B

5. Then the tail (trellis termination) bits are generated by clocking 4 times the constituent encoders. The tail bits shall be appended after the encoded information block. The tail bits are transmitted in the same order as in step 3 and shall be:

$x(N_{RTN\_BBFRAME})$, $y1(N_{RTN\_BBFRAME})$, $y'_1(N_{RTN\_BBFRAME})$, ..., $x(N_{RTN\_BBFRAME+3})$, $y_1(N_{RTN\_BBFRAME+3})$, $y'_1(N_{RTN\_BBFRAME+3})$

6. The transmitted sequence shall be:

$x(0)$, $y_1(0)$, $y'_1(0)$, $x(1)$, $y_1(1)$, $y'_1(1)$, ..., $x(N_{RTN\_BBFRAME-1})$, $y_1(N_{RTN\_BBFRAME-1})$, $y'_1(N_{RTN\_BBFRAME-1})$, $x(N_{RTN\_BBFRAME})$, $y_1(N_{RTN\_BBFRAME})$, $y'1(N_{RTN\_BBFRAME})$, ..., $x(N_{RTN\_BBFRAME+3})$, $y_1(N_{RTN\_BBFRAME+3})$, $y'1(N_{RTN\_BBFRAME+3})$

D018-COM-FUN-2050

The transfer function of the 16-state constituent code for shall be:

$$G(D)=\left[1 \quad \frac{n_0(D)}{d(D)} \quad \frac{n_1(D)}{d(D)} \quad \frac{n_2(D)}{d(D)}\right]$$

where

$$d(D)=1+D^3+D^4$$

$$n_0(D)=1+D+D^3+D^4$$

$$n_1(D)=1+D^2+D^4$$

$$n_2(D)=1+D+D^2+D^3+D^4$$

(Note: for code rate 1/3 only d(D) and $n_0(D)$ are required)

D018-COM-FUN-2060

The internal turbo interleaver shall be implemented as detailed in the algorithm provided below.

The turbo interleaver functionality shall be such that the input bits are readdressed following a certain mapping sequence, in position i of which the new address of input bit i can be read. This mapping sequence is generated following the process defined in the 3GPP2 standard and described below.

An (n+5)-bit counter, initialised to 0 and where n is the smallest integer such that $N_{turbo} <= 2^{n+5}$

(N_{turbo} is input bit sequence length), is used as input to the algorithm detailed in Figure 8-36, in such a way that the output is the new address for each i generated by the counter.

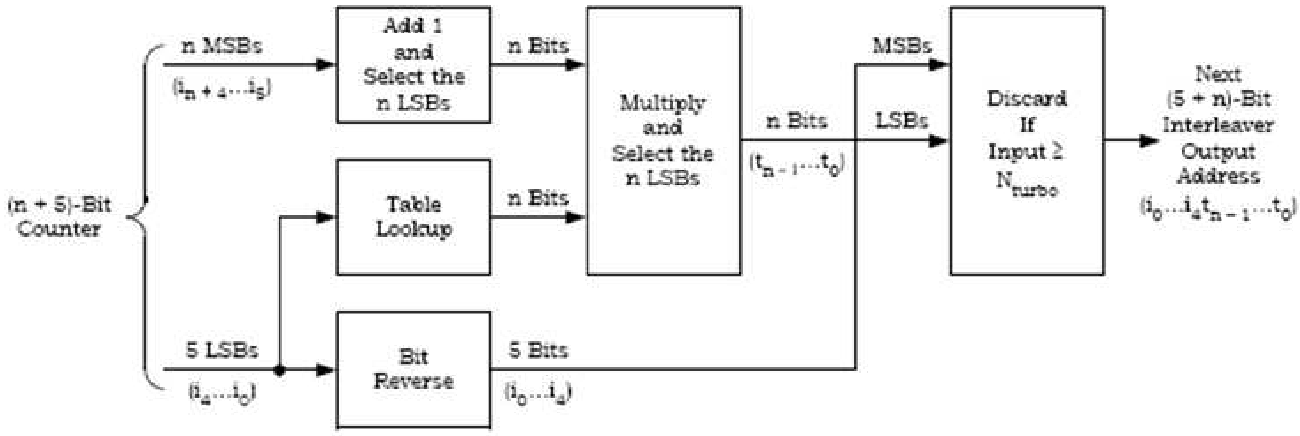


Figure 8-36: Turbo interleaver output address calculation algorithm.

The lookup table included in algorithm is depicted in the following table.

Table index	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
0	1	5	27	3	15	3	13	1
1	1	15	3	27	127	1	335	349
2	3	5	1	15	89	2	87	303
3	5	15	15	13	1	83	15	721
4	1	1	13	29	31	19	15	973
5	5	9	17	5	15	179	1	703
6	1	9	23	1	61	19	333	761
7	5	15	13	31	47	99	11	327
8	3	13	9	3	127	23	13	453
9	5	15	3	9	17	1	1	95
10	3	7	15	15	119	3	121	241
11	5	11	3	31	15	13	155	187
12	3	15	13	17	57	13	1	497
13	5	3	1	5	123	3	175	909
14	5	15	13	39	95	17	421	769
15	1	5	29	1	5	1	5	349
16	3	13	21	19	85	63	509	71
17	5	15	19	27	17	131	215	557
18	3	9	1	15	55	17	47	197
19	5	3	3	13	57	131	425	499
20	3	1	29	45	15	211	295	409
21	5	3	17	5	41	173	229	259
22	5	15	25	33	93	231	427	335
23	5	1	29	15	87	171	83	253
24	1	13	9	13	63	23	409	677
25	5	1	13	9	15	147	387	717
26	1	9	23	15	13	243	193	313
27	5	15	13	31	15	213	57	757
28	3	11	13	17	81	189	501	189
29	5	3	1	5	57	51	313	15
30	5	15	13	15	31	15	489	75
31	3	5	13	33	69	67	391	163

Table 8 24: Turbo interleaver lookup table definition

D018-COM-FUN-2070

The TCC coding shall support the following RACH block sizes reported in the following table

RACH Configuration ID	Code rate	RTN_BBFRAME (bits)	Tail bits	RTN_FECFRAME (bits)
RACH_CR_{160}_SF_{16}_DB_{512}	1/3	512 bits	12 bits	1548 bits
RACH_CR_{160}_SF_{4}_DB_{2048}	1/3	2048 bits	12 bits	6156 bits
RACH_CR_{160}_SF_{16}_DB_{288}	1/3	288 bits	12 bits	876 bits
RACH_CR_{160}_SF_{4}_DB_{288}	1/3	288 bits	12 bits	876 bits

Table 8-25: RACH TCC coding parameters

8.7.2.6.2 Bit interleaving

D018-COM-FUN-2080

The output of the TCC encoder shall be bit interleaved using a block interleaver (row/column) with the parameters defined in the following table

RACH Configuration ID	RTN_FECFRAME size (bits)	Bit interleaver specification	
		N_{RTN}	M_{RTN}
RACH_CR_{160}_SF_{16}_DB_{512}	1548	36	43
RACH_CR_{160}_SF_{4}_DB_{2048}	6156	36	171
RACH_CR_{160}_SF_{16}_DB_{288}	876	12	73
RACH_CR_{160}_SF_{4}_DB_{288}	876	12	73
Note: – N stands for the number of rows – M stands for the number of columns			

Table 8-26: RACH burst bit interleaver parameters

D018-COM-FUN-2090

The bit interleaver depth shall be 1 RTN_FECFRAME (1 Code Word)

D018-COM-FUN-2100

On the transmitter side, the encoded bits shall be serially written in column-wise and shall be serially read out row-wise. MSB of RTN_FECFRAME shall be written and read out first.

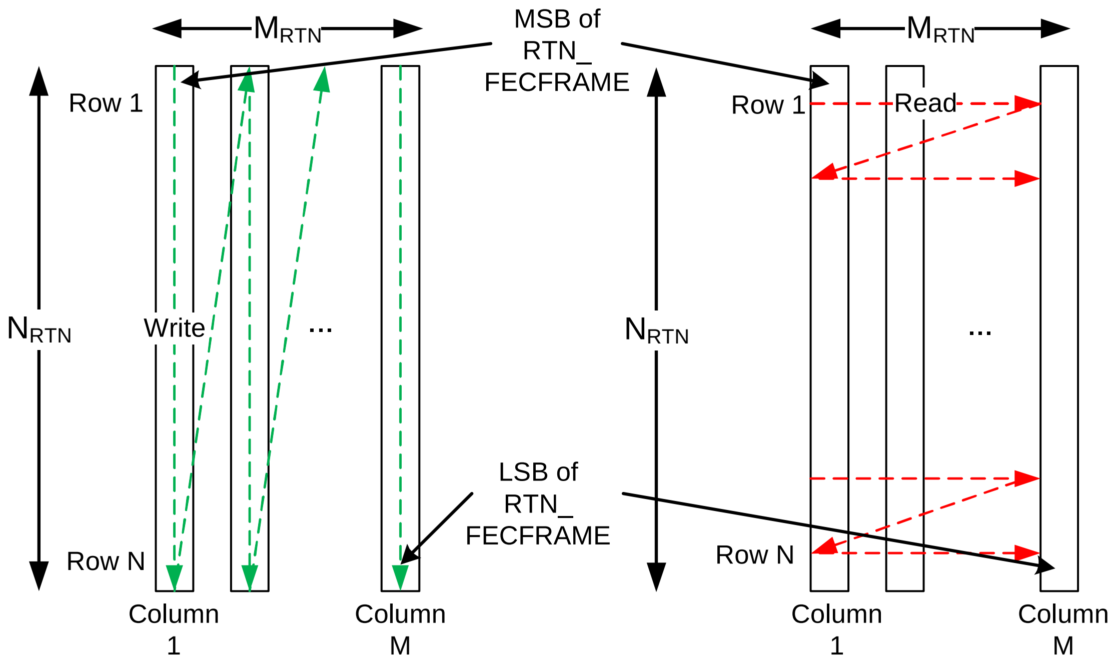


Figure 8-37: Bit interleaving scheme

D018-COM-FUN-2110

On the receiver side, the encoded bits shall be serially written in row-wise and shall be serially read out column-wise. MSB of RTN_FECFRAME shall be written and read out first.

8.7.2.7 Auxiliary channel generation

D018-COM-FUN-2120

The Auxiliary Channel Generation module shall generate the Pilot sequence to support the channel estimation for coherent detection.

D018-COM-FUN-2130

The output stream of the Auxiliary Channel Generation shall be RTN_AUXFRAME. The RTN_AUXFRAME shall consist of a known pilot sequence of N_{RTN_PB} bits.

D018-COM-FUN-2140

The number of pilot bits (N_{RTN_PB}) of the Auxiliary channel shall depend on the RTN burst configuration and shall be as reported in Table 8-27.

RACH Configuration ID	N_{RTN_PB} (bits)
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	1548 bits
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	6156 bits
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	876 bits
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	876 bits

Table 8-27: Number of Pilot bits (NRTN_PB) of the Auxiliary Channel for each RTN burst configuration

D018-COM-FUN-2150

The contents of the Auxiliary channel (RTN_AUXFRAME) shall be generated using a binary m-sequence x.

The binary m-sequence x shall be generated by means of a generator polynomial of degree 15.

The x sequence is constructed using the primitive (over GF(2)) polynomial $x^{15} + x + 1$.

Let x(i) denote the i-th bit of the sequence.

The m-sequence x is constructed as:

- Initial conditions: x(14,...,0) = [1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0]
- Recursive definition of subsequent bits: x(i+15) = x(i+1) + x(i) modulo 2, i=0,...,N_{RTN_PB}-15.

The binary sequence generation is depicted in Figure 8-38.

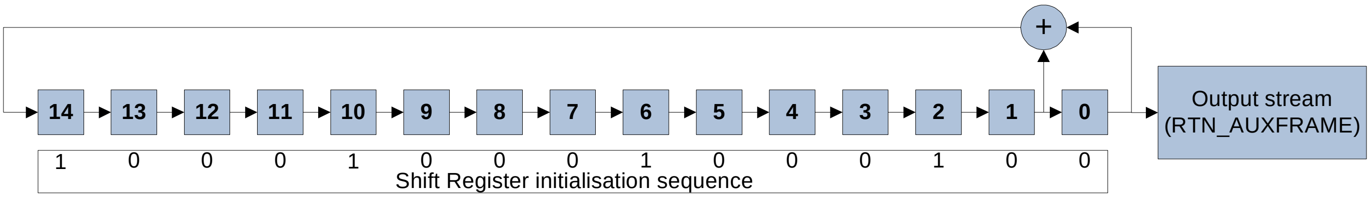


Figure 8-38: Auxiliary channel pilot sequence generator

8.7.2.8 Bit mapping into constellation

D018-COM-FUN-2160

The bit mapping module shall perform the mapping of the incoming bits into symbols according to the specified constellation order.

D018-COM-FUN-2170

The input stream of the Bit mapping module shall be a RTN_FECFRAME and a RTN_AUXFRAME and the output stream shall be a RTN_DCH (Return Data Channel) and a RTN_ACH (Auxiliary Channel) respectively.

Both inputs (RTN_FECFRAME and RTN_AUXFRAME) are bit mapped independently.

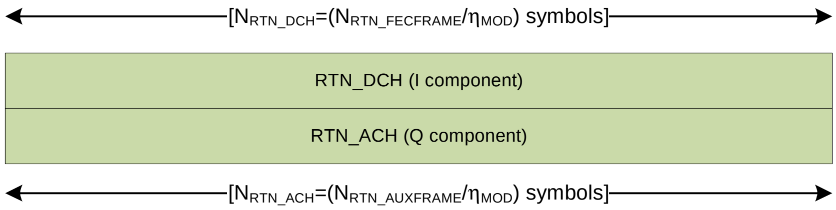


Figure 8-39: Data format at the output of the Bit mapping module

D018-COM-FUN-2180

The RTN_FECFRAME and the RTN_AUXFRAME shall be bit mapped independently into BPSK modulation (η_{MOD}=1) according to the D018-COM-FUN-2190.

D018-COM-FUN-2190

The bit mapping into the BPSK constellation shall be compliant with Figure 8-40.

One bit of the RTN_FECFRAME shall be mapped to a 1 BPSK symbol. One bit of the RTN_AUXFRAME shall be mapped to a 1 BPSK symbol.

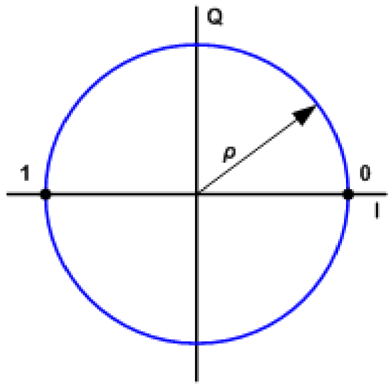


Figure 8-40: Bit mapping into BPSK modulation

8.7.2.9 Spreading

D018-COM-FUN-2200

The Spreading module shall perform

- the channelization of both channels (Data and Auxiliary channel)
- the complex scrambling

D018-COM-FUN-2210

The input stream of the Spreading module shall be a RTN_DCH (I component) and a RTN_ACH (Q component) and the output stream a RTN_SPR_XFRAME.

D018-COM-FUN-2220

The spreading of RTN_DCH and RTN_ACH shall be applied as illustrated in the following figure and shall consist of two operations:

1. The channelization operation, which transforms every symbol into a number of chips, increasing the bandwidth of the signal ($C_{ch,d}$ and $C_{ch,a}$ channelization codes).

2. The scrambling operation, where a complex scrambling code is applied to the spread signal (C_{Scram} scrambling code)

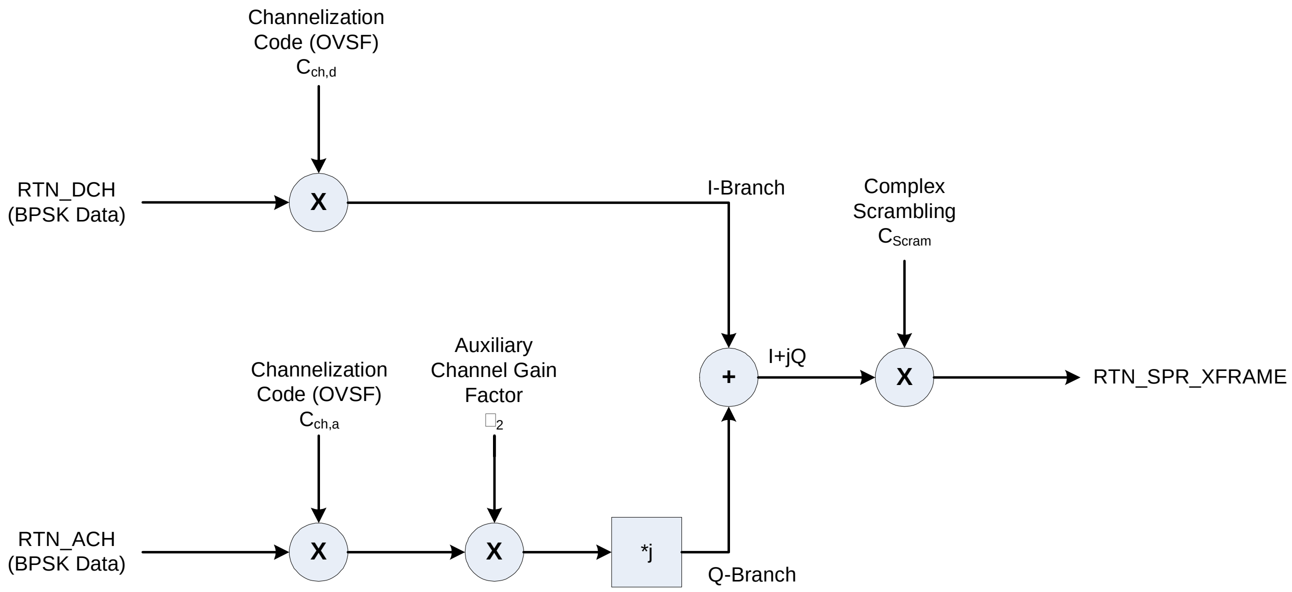


Figure 8-41: Spreading operation

D018-COM-FUN-2230

The RTN_DCH shall be spread to the chip rate by the channelization code $C_{ch,d}$ and the RTN_ACH shall be spread to the chip rate by the channelization code $C_{ch,a}$. The channelization codes used shall be OVSF codes following the specification described in section 8.7.2.9.1.

D018-COM-FUN-2240

After the channelization, the Auxiliary part (RTN_ACH) shall be weighted by the gain factor $\beta_2 = \sqrt{0.1}$.

D018-COM-FUN-2250

The stream of the real-valued chips on the I-branch (RTN_DCH) and Q-branch (RTN_ACH) shall be treated as a complex-valued stream of chips, being the RTN_DCH (I component) the real part and the RTN_ACH (Q component) the imaginary part.

D018-COM-FUN-2260

The complex-valued stream (I+jQ) shall be scrambled by the complex valued scrambling code C_{scram}, (complex product). The scrambling code is specified in section 8.7.2.9.2.

8.7.2.9.1 Channelization

D018-COM-FUN-2270

The channelization codes ($C_{ch,d}$, $C_{ch,a}$) shall be Orthogonal Variable Spreading Factor (OVSF) codes. The channelization codes shall be used to distinguish the RTN_DCH and the RTN_ACH.

D018-COM-FUN-2280

The OVSF codes shall be generated using the code tree of Figure 8-42.

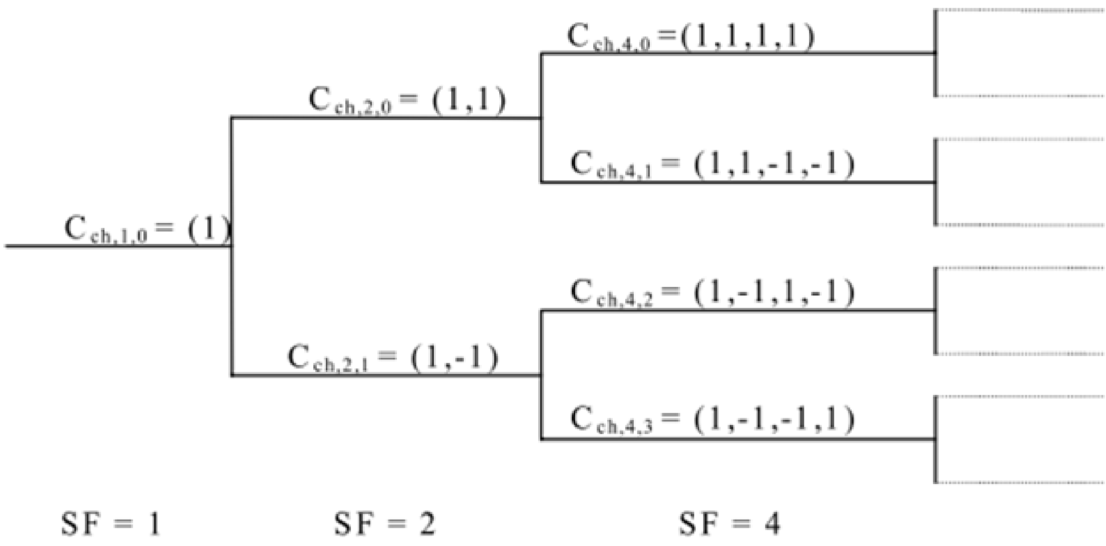


Figure-8-42: Code-tree for generation of Orthogonal Variable Spreading Factor (OVSF) codes

Channelization codes are uniquely described as $C_{ch,SF,k}$, where SF is the spreading factor of the code and k is the code number, 0<=k<=SF-1.The generation method for the channelization code is defined as:

[redacted]

[redacted]

[redacted]

D018-COM-FUN-2290

The RTN_DCH shall be spread by the following channelization codes ($C_{ch,d}$), depending on the Burst Configuration ID, as reported in Table 8-28. Channelization codes ($C_{ch,d}$) shall be uniquely identified by the code number k_d for each Burst Configuration.

Configuration ID	Channelization code length	Channelization code allocation ($C_{ch,d}$)
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	16 chips	$C_{ch,16,kd}$, 0=*kd*=15
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	4 chips	$C_{ch,4,kd}$, 0=*kd*=3
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	16 chips	$C_{ch,16,kd}$, 0=*kd*=15
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	4 chips	$C_{ch,4,kd}$, 0=*kd*=3

Table 8-28: Channelization code allocation for $C_{ch,d}$

D018-COM-FUN-2300

The RTN_ACH shall be spread by the following channelization codes ($C_{ch,a}$), depending on the Burst Configuration ID, as reported in Table 8 28. Channelization codes ($C_{ch,a}$) shall be uniquely identified by the code number k_a for each Burst Configuration.

Configuration ID	Channelization code length	Channelization code allocation ($C_{ch,a}$)
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	16 chips	$C_{ch,16,ka}$, 0=*ka*=15
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	4 chips	$C_{ch,4,ka}$, 0=*ka*=3
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	16 chips	$C_{ch,16,ka}$, 0=*ka*=15
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	4 chips	$C_{ch,4,ka}$, 0=*ka*=3

Table 8-29: Channelization code allocation for $C_{ch,a}$

Note: the RTN_ACH shall always use the same SF as the RTN_DCH.

8.7.2.9.2 Complex Scrambling

D018-COM-FUN-2310

The scrambling code C_{scram} shall be a complex-valued sequence.

D018-COM-FUN-2320

The scrambling code C_{scram} shall be generated from two real-valued sequences $C_{1,n}$ and $C_{2,n}$., as defined in D018-COM-FUN-2330.

A scrambling code is uniquely identified by a 24-bit number n, which identifies the real-valued sequences $C_{1,n}$ and $C_{2,n}$.

D018-COM-FUN-2330

The real-valued sequences $C_{1,n}$ and $C_{2,n}$ are constructed from position wise modulo 2 sum of segments of two binary m-sequences generated by means of a generator polynomial of degree 25. Let x and y be the two m-sequences respectively. The x sequence is constructed using the primitive (over GF(2)) polynomial $x^{25} + x^3 + 1$. The y sequence is constructed using the polynomial $x^{25} + x^3 + x^2 + x + 1$. The resulting sequences thus constitute segments of a set of Gold sequences.

The sequence $C_{2,n}$ is a 16 777 232 chip shifted version of the sequence $C_{1,n}$.

Let n_{23} ... n_0 be the 24 bit binary representation of the scrambling sequence number n with n_0 being the least significant bit. The x sequence depends on the chosen scrambling sequence number n and is denoted x_n in the sequel. Furthermore, let $x_n(i)$ and y(i) denote the i-th bit of the sequence x_n and y, respectively.

The m-sequences x_n and y are constructed as:

- Initial conditions:

  $x_n(0) = n_0$, $x_n(1)=n_1$, ..., $x_n(23)=n_{23}$, $x_n(24)=1$;

  y(0) = y(1) = ... = y(23) = y(24) = 1.

- Recursive definition of subsequent bits:

  $x_n(i+25) = x_n(i+3) + x_n(i)$ modulo 2, $i=0,...,2^{25}-27$;

  y(i+25) = y(i+3) + y(i+2) + y(i+1) + y(i) modulo 2, $i=0,...,2^{25}-27$.

Define the binary Gold sequence z_n by:

$z_n(i) = x_n(i) + y(i)$ modulo 2, $i=0,1,2,...,2^{25}-2$

The real valued Gold sequence Z_n is defined by:

$$Z_n(i) = \begin{cases} +1 \; if \; z_n(i) = 0 \\ -1 \; if \; z_n(i) = 1 \end{cases} \quad for \; i = 0,1,\dots,2^{25}-2$$

Now, the real-valued sequences $C_{1,n}$ and $C_{2,n}$ are defined as follows:

$$C_{1,n}(i) = Z_n(i), \quad i = 0,1,2,\dots,2^{25}-2 \;\; and$$

$$C_{2,n}(i) = Z_n\big((i + 16\,777\,232) \; modulo \; (2^{25}-1)\big), i = 0,1,2,\dots,2^{25}-2.$$

Code construction for $C_{1,n}$ and $C_{2,n}$ is shown in Figure 8-43.

Finally, the complex-valued scrambling sequence C_{scram}, is defined as:

$$C_{scram}(i) = \frac{1}{\sqrt{2}} \cdot C_{1,n}(i) \cdot \left[1 + j \cdot (-1)^i \cdot C_{2,n}(2 \cdot \lfloor i/2 \rfloor)\right], \;\; i = 0,1,\dots,2^{25}-2$$

where $\lfloor . \rfloor$ denotes rounding to nearest lower integer.

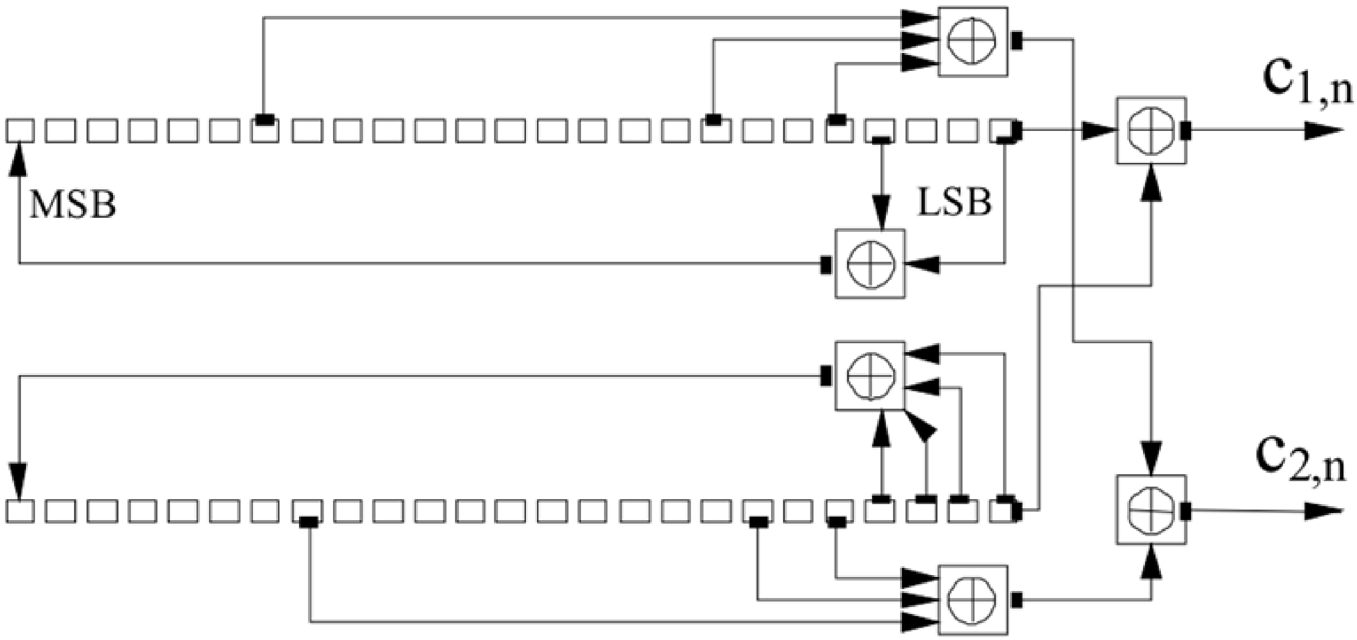


Figure 8-43: Configuration of complex scrambling generator.

D018-COM-FUN-2340

The scrambling sequence shall be truncated to the data channel size in chips. The size of the scrambling sequence shall be:

RACH Configuration ID	Scrambling code length (chips)
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	24,768
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	24,624
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	14,016
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	3,504

Table 8-30: Scrambling code length

8.7.2.10 Preamble generation

D018-COM-FUN-2350

The RTN_PREAMBLE shall consist of $N_{RTN\_PREAMBLE}$ known complex symbols. The preamble length shall be as reported in Table 8 31.

RACH Configuration ID	$N_{RTN\_PREAMBLE}$ (symbols)
RACH_CR$_{160}$_SF$_{16}$_DB$_{512}$	128 symbols
RACH_CR$_{160}$_SF$_{4}$_DB$_{2048}$	128 symbols
RACH_CR$_{160}$_SF$_{16}$_DB$_{288}$	128 symbols
RACH_CR$_{160}$_SF$_{4}$_DB$_{288}$	128 symbols

Table 8-31: RACH Preamble length (in symbols)

D018-COM-FUN-2360

The complex-valued preamble sequence RTN_PREAMBLE shall be generated from a real-valued Gold sequence Z_n., being the sequence RTN_PREAMBLE uniquely identified by the 9-bit index n, which identifies the Gold sequence.

The complex-valued preamble sequence shall be constructed from position wise modulo 2 sum of $N_{RTN\_PREAMBLE}$ chip segments of the Gold code Z_n.

Two binary m-sequences generated by means of a generator polynomial of degree 9 shall be used to construct a binary Gold code z. Let x and y be the two m-sequences respectively. The x sequence is constructed using the primitive (over GF(2)) polynomial $x^9 + x^4 + 1$. The y sequence is constructed using the polynomial $x^9 + x^4 + x^3 + x + 1$.

The Gold sequence z is actually a function of the chosen sequence index n and is thus denoted z_n in the sequel. Furthermore, let x(i), y(i) and $z_n(i)$ denote the i-th symbol of the sequence x, y and z_n respectively.

The m-sequences x and y are constructed as:

- Initial conditions:

  x(0) = 1, x(1) = x(2) =, ...,= x(7) = x(8) = 0;

  y(0) = y(1) = ... = y(7) = y(8) = 1.

- Recursive definition of subsequent bits:

  $x(i+9) = x(i+4) + x(i)$ modulo 2, $i=0,...,2^9-2$;

  $y(i+9) = y(i+4) + y(i+3) + y(i+1) + y(i)$ modulo 2, $i=0,...,2^9-2$.

x and y sequences construction is depicted in Figure 8-44.

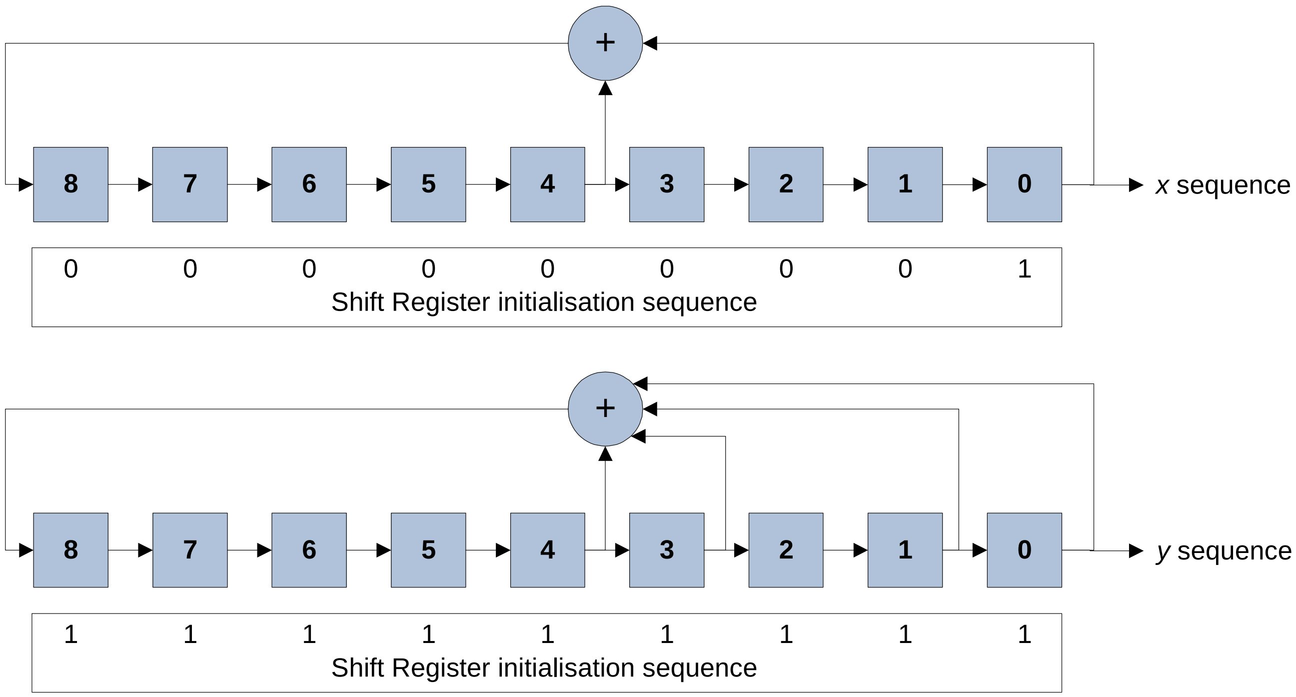


Figure 8-44: m-sequence generation for preamble construction

Define the binary Gold sequence z_n by:

$z_n(i)$ = x((i+n) modulo 2^9-2) + y(i) modulo 2, i=0,1,2,...,2^9-2

The real valued Gold sequence Z_n is defined by:

$$Z_n(i) = \begin{cases} +1 \ if \ z_n(i) = 0 \\ -1 \ if \ z_n(i) = 1 \end{cases} \quad for \ i = 0,1,\ldots,2^9 - 2$$

Finally, the complex-valued preamble sequence RTN_PREAMBLE shall be defined as:

$$RTN\_PREAMBLE(i) = \frac{1}{\sqrt{2}} \cdot [Z_n(i) + j \cdot Z_n(i + 256)], \quad i = 0, 1, \ldots, N_{RTN\_PREAMBLE} - 1$$

8.7.2.11 Preamble spreading

D018-COM-FUN-2370

The input stream of the Preamble Spreading module shall be a RTN_PREAMBLE and the output stream a RTN_SPR_PREAMBLE.

D018-COM-FUN-2380

The spreading of RTN_PREAMBLE shall be applied as illustrated in the following figure and shall consist of one operation:

1. The channelization operation, which transforms every preamble complex symbol into a number of complex chips, increasing the bandwidth of the signal (C_p channelization code).

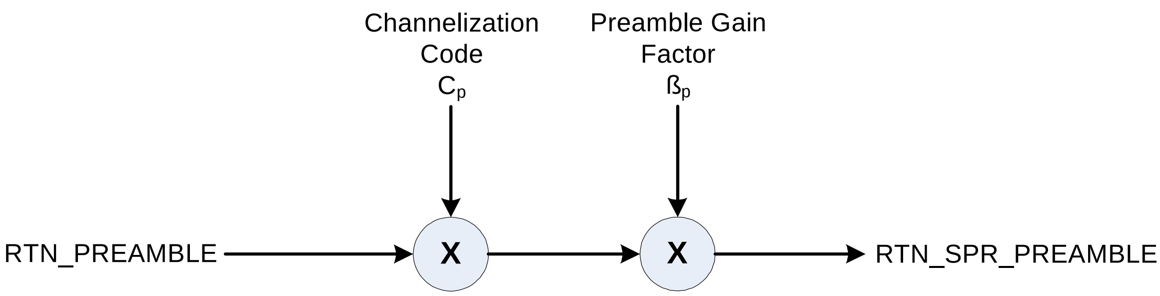


Figure 8-45: Preamble spreading operation

D018-COM-FUN-2390

The RTN_PREAMBLE shall be spread to the chip rate by the channelization code Cp The channelization codes used shall be:

RACH Configuration ID	**Channelization code length**	**Preamble channelization code allocation** (C_p)
RACH_CR_{160}_SF_{16}_DB_{512}	16	[1, j, j, 1, j, -1, -1, j, j, 1, -1, -j, 1, -j, j, -1]·exp(jπ/4)
RACH_CR_{160}_SF_4_DB_{2048}	4	[1, -j, j, -1]·exp(jπ/4)
RACH_CR_{160}_SF_{16}_DB_{288}	16	[1, j, j, 1, j, -1, -1, j, j, 1, -1, -j, 1, -j, j, -1]·exp(jπ/4)
RACH_CR_{160}_SF_4_DB_{288}	4	[1, -j, j, -1]·exp(jπ/4)

Table 8-32: Preamble channelization code allocation

Note: the RTN_PREAMBLE shall always use the same SF as the RTN_DCH and RTN_ACH.

D018-COM-FUN-2400

After preamble channelization, the preamble shall be weighted by the gain factor

$$\beta_p = \rho\sqrt{1+\beta_2^2}$$

so that the average power of RTN_SPR_PREAMBLE is the same as the RTN_SPR_XFRAME, i.e. $\rho^2(1+\beta_2^2)$.

8.7.2.12 Physical layer framing

D018-COM-FUN-2410

The Physical Layer Framing module shall perform the RTN_SPR_PREAMBLE insertion.

D018-COM-FUN-2420

The input stream of the Physical Layer Framing module shall be a RTN_SPR_XFRAME and a RTN_SPR_PREAMBLE and the output a RTN_PLFRAME, as detailed in Figure 8-46.

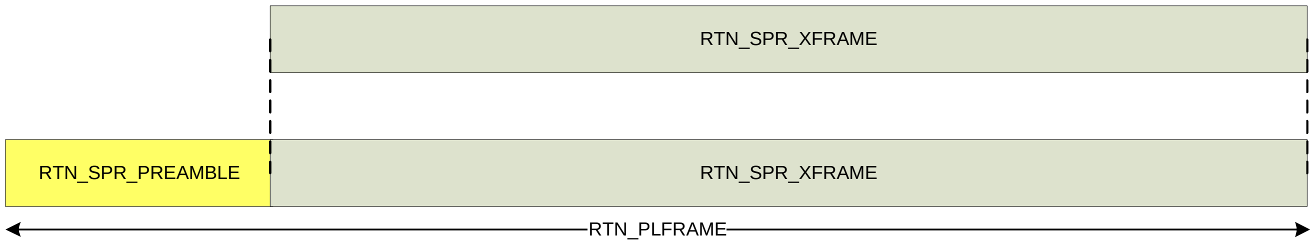


Figure 8-46: Physical layer framing

8.7.2.13 Base-band pulse shaping and quadrature modulation

D018-COM-FUN-2430

I and Q signals shall be shaped using a Square Root Raised Cosine with a roll-off factor α=0.2.

D018-COM-FUN-2440

The baseband SRRC filter shall have a theoretical function defined by the following expression.

$$H(f) = 1 \qquad \text{for } |f| < f_N(1-\alpha)$$

$$H(f) = \left\{ \frac{1}{2} + \frac{1}{2}\sin\frac{\pi}{2f_N}\left[\frac{f_N - |f|}{\alpha}\right]\right\}^{1/2} \qquad \text{for } f_N(1-\alpha)$$

$$H(f) = 0 \text{ for } |f| > f_N(1+\alpha),$$

where $f_N = R_s/2$ is the Nyquist frequency and α is the roll-off factor.

D018-COM-FUN-2450

The quadrature modulation shall be performed by multiplying the In-phase component (I) by cos($2\pi f_0$t) and the quadrature component (Q) by -sin($2\pi f_0$t). The resulting I and Q components shall be added to conform the modulator output signal.

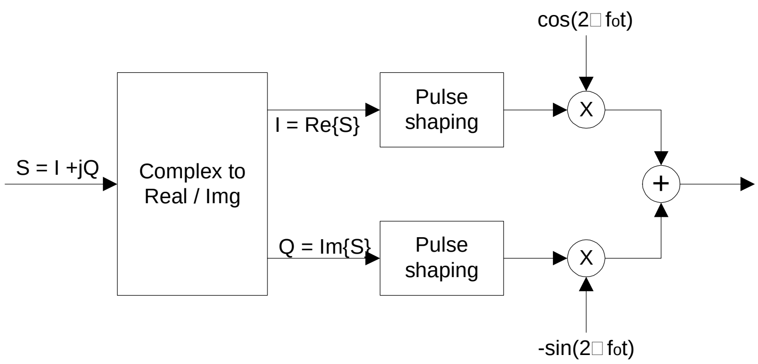


Figure 8-47: Return link modulation

8.7.2.14 Physical layer error performances

[REQUIREMENTS DELETED]

8.7.3 Splitting traffic profiles

D018-COM-FUN-2470

The messages shall be mapped to the RACH burst Configurations based on message service requirements as detailed in Table 8-34.

RACH Configuration ID	Service	Splitting policy
$RACH\_CR_{160}\_SF_{16}\_DB_{512}$	Data/Signalling	All except the data messages transmitted through $RACH\_CR_{160}\_SF_{4}\_DB_{2048}$
$RACH\_CR_{160}\_SF_{4}\_DB_{2048}$	Data/Signalling	TD95 = 2.4 & Message size = 1000 bytes (TBC)
$RACH\_CR_{160}\_SF_{16}\_DB_{288}$	ACK	Message size <= 36 bytes, TL_ACK and L2 ARQ ACK
$RACH\_CR_{160}\_SF_{4}\_DB_{288}$	Voice	--

Table 8-34: Mapping between services and RACH bursts Configuration

Note: This requirement will also address mapping of L2 signalling messages to RACH burst configurations.

9. CONTROL PLANE SPECIFICATION

9.1 Control plane description

The Control plane deals with real-time control functionality that is required in order for the communication system to function including:

- terminal registration
- handover
- multicast control
- synchronisation
- ACM
- radio resource management
- redundancy
- security control

Refer to section 5.2 for details on the control plane.

9.2 Control procedures

Signalling messages mentioned in the following sections are specified in detail in section 11.

9.2.1 General

D018-COM-FUN-2480

With respect to the protocols defined for all control procedures, in case the expected response signalling message is not received by the other party, the sender shall support TBD retransmissions after a TBD timeout.

D018-COM-FUN-2490

With respect to the protocols defined for all control procedures, use of link layer ARQ shall be disabled for the transmitted signalling messages.

9.2.2 Terminal registration procedure (log-on/off)

9.2.2.1 Terminal logon-on procedure

D018-COM-FUN-2500

A UT shall support the following set of a pre-configured parameters (basic configuration settings), for each system on which logon might be performed:

- System ID
- Version number - basic configuration settings
- Scanning priority
- System FWD link carrier types:
    - For each type (global beam / regional beam):
        - ♦ FWD carrier type ID
        - ♦ Roll-off
- For each beam in the system:
    - Logon FWD carrier frequency
    - FWD carrier type ID

D018-COM-FUN-2510

A UT may support the following additional set of pre-configured parameters (additional configuration settings), for each system on which logon might be performed:

- System ID
- Version number - additional configuration settings
- Additional system FWD link carrier types:
    - For each type (global beam / regional beam):
        - ♦ FWD carrier type ID
        - ♦ Roll-off
- System RTN link :
    - Roll-off
    - For each RACH ID supported by the system:
        - ♦ RACH ID
        - ♦ DCH channelization code (8 bits)
        - ♦ ACH channelization code (8 bits)
        - ♦ Preamble / Complex scrambling sequence options. For each option:
            - Preamble / Complex scrambling ID (8 bits)
            - Preamble sequence generator (9 bits)
            - Complex scrambling sequence generator (24 bits)
- For each FWD carrier in the system:
    - FWD carrier ID

- FWD carrier frequency
- FWD carrier type ID

- For each RTN frequency band in the system:
    - RTN frequency band ID
    - RTN frequency band central frequency
    - List of supported RACH IDs

D018-COM-FUN-2520

Basic configurations settings shall be updated by management procedures only.

D018-COM-FUN-2530

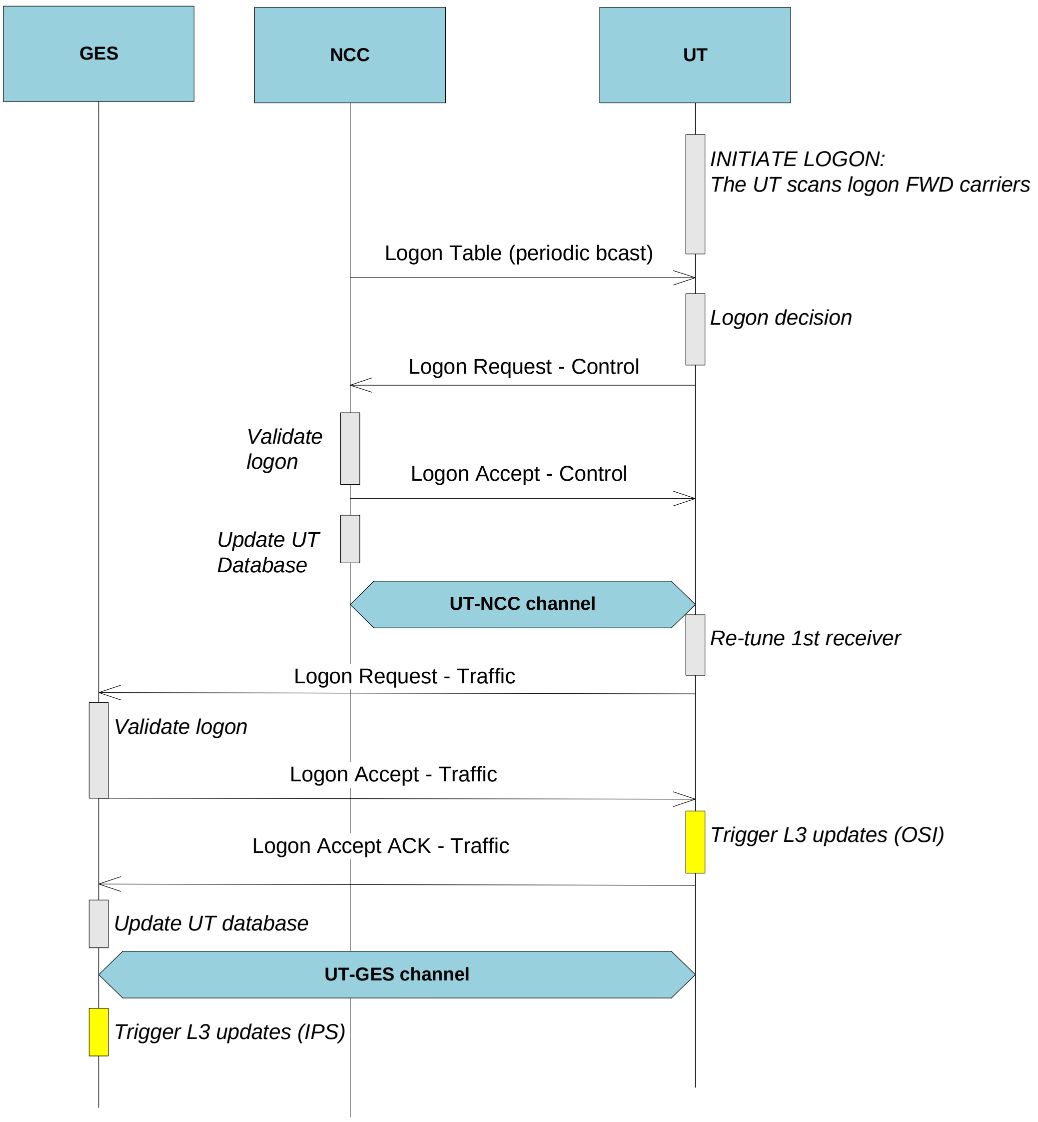
Additional configurations settings shall be updated by management procedures only.

D018-COM-FUN-2540

The LOGON TABLE shall include optional parameters in case service shall be provided also to UTs which only have the basic configuration parameters.

D018-COM-FUN-2550

The following procedure shall be followed by UT and GSE for the nominal logon process:



The following steps shall be performed:

1. If a logon FWD carrier is detected, the UT shall wait for the reception of the LOGON TABLE message, which is periodically broadcasted by the NCC.

2. If the UT decides to perform a logon procedure, it shall send a LOGON REQUEST - CONTROL message, using the RTN link access configuration parameters indicated in the LOGON TABLE.

3. If the logon request is accepted by the NCC, the NCC shall decide the target GES and GES FWD carrier. The NCC shall answer with a LOGON ACCEPT - CONTROL message.

4. Using the FWD/RTN link parameters indicated in the LOGON ACCEPT - CONTROL message, the UT shall re-tune its 1st receiver and send a LOGON REQUEST - TRAFFIC message to the GES.

5. If the GES decides to accept the logon request, it shall answer with a LOGON ACCEPT - TRAFFIC message.

6. The UT confirms the reception of this message by sending a LOGON ACCEPT ACK message.

D018-COM-FUN-2560

The LOGON ACCEPT - CONTROL message shall contain optional configuration parameters if the UT signals through the LOGON REQUEST - CONTROL message that it does not have an additional configuration set for the system.

9.2.2.2 Terminal log-off procedure

D018-COM-FUN-2580

The UT shall be able to initiate a log-off procedure.

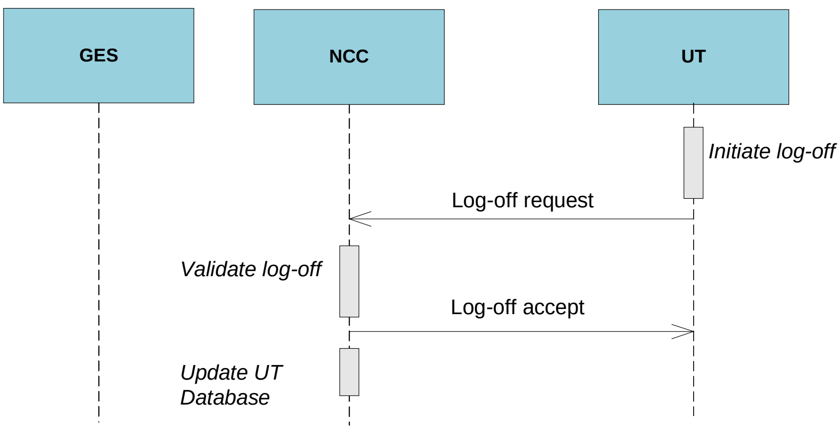
D018-COM-FUN-2590

The GS shall be able to trigger the log-off of a UT (TBC). The UT shall log-off at the request of the GS.

Note: This requirement needs feedback from the safety case.

D018-COM-FUN-2600

The following procedure shall be followed by UT and GSE for the nominal air-initiated log-off process:



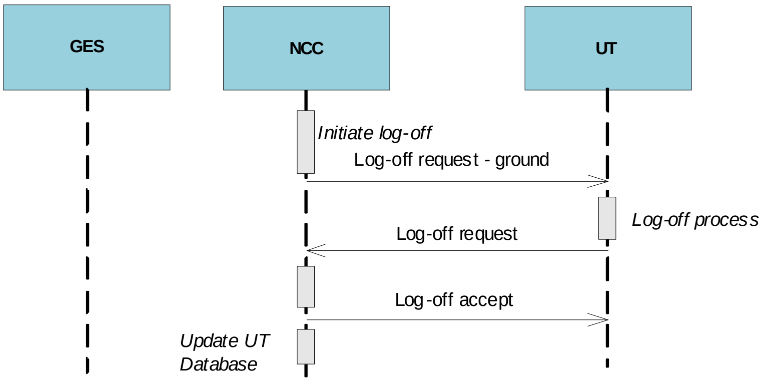
The following steps shall be performed:

1. The UT shall send a LOG-OFF REQUEST to the NCC.

2. The NCC shall answer with a LOG-OFF ACCEPT message.

D018-COM-FUN-2610

The following procedure shall be followed by UT and GSE for the nominal ground-initiated log-off process:



The following steps shall be performed:

1. The NCC shall send a LOG-OFF REQUEST - GROUND message to the UT.
2. The UT shall answer with a LOG-OFF REQUEST message.
3. The NCC shall send a LOG-OFF ACCEPT message.

9.2.3 Handover procedures

9.2.3.1 General aspects

9.2.3.2 Handover sequence

9.2.3.2.1 Handover detection

D018-COM-FUN-2630

The handover detection process in the UT shall be able to rely only on signal measurements.

D018-COM-FUN-2640

The UT shall constantly monitor the link quality of at least 3 neighbour/alternative channels (from same or different beams, satellites or SSPs) and compare the measurements with its current link quality in order to detect potential HO candidates.

D018-COM-FUN-2650

The UT shall have the capability to receive a second FWD carrier specifically devoted to handover purposes (handover detection and handover execution).

D018-COM-FUN-2660

The handover detection process shall provide reliable and confident recommendation of neighbour channels quality (using hysteresis or filtering mechanisms) to avoid continuous handovers on coverage transition areas.

D018-COM-FUN-2670

The handover detection process shall recommend the HO in a beam coverage transition area allowing at least 120 s (TBC) to perform the handover before the current link quality is too low.

D018-COM-FUN-2680

The UT shall send a HO_RECOMMENDATION message to the GS when there is a neighbour channel with better quality than the current one, or when it is triggered by administrative, political or business related reasons, including manual HO triggered by the flight crew.

D018-COM-FUN-2690

The GS shall be able to receive and process HO_RECOMMENDATION messages from UTs or triggered by other GS subsystems (e.g., management module, redundancy module).

9.2.3.2.2 Handover decision

D018-COM-FUN-2700

After reception of HO_RECOMMENDATION message and deciding the type and target channel and GS element, the GS shall send a HO_COMMAND message to the UT. At least, the following HO types shall be identified:

HO Type	Description
1	Change of satellite service providers (SSP) (implies change GS elements)
3 4	Satellite change (same SSP) Beam change/channel change in which GES are the same entity (same satellite & SSP)
7	GES change (same satellite and SSP)

9.2.3.2.3 Handover execution

D018-COM-FUN-2710

A UT shall be capable of receiving simultaneously two FWD link MF-TDMA carriers (associated to same or different beams or to different satellites).

D018-COM-FUN-2720

A UT shall be capable of transmitting not simultaneously two different RTN link A-CDMA carriers, applying the corresponding Doppler pre-compensation for each of the carriers in case of different satellites involved in the handover on a burst-by-burst basis.

D018-COM-FUN-2730

A UT shall be able to handle two independent ARQ and header compression sessions one for each of the channels during HO execution.

D018-COM-FUN-2740

A UT shall be able to maintain two sessions in parallel during HO execution, using different or the same satellite channels for Rx and Tx, and with different or the same GSE.

D018-COM-FUN-2750

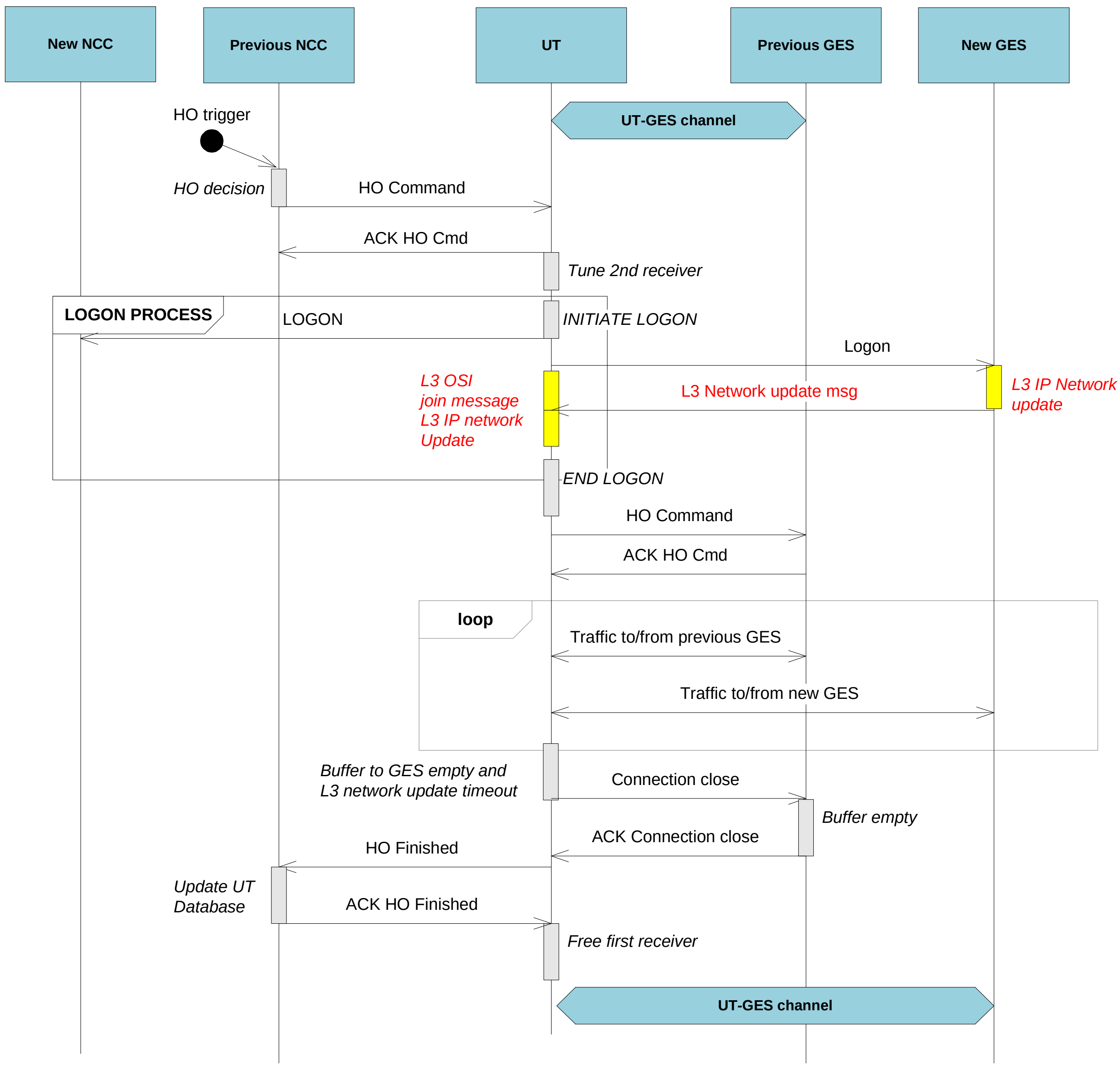
A UT shall be able to handle two independent ACM sessions one for each of the channels during HO execution.

9.2.3.3 Handover procedure specification

9.2.3.3.1 Procedure "SSP Change"

D018-COM-FUN-2760

The following procedure shall be followed by UT and GSE for the Satellite Service Provider change handover process:



The following steps shall be performed:

1. NCC receives a HO Recommendation message from UT or GS.

2. NCC validates and decides the target for the handover, and sends HO Command to UT.

3. UT confirms with ACK HO Cmd message.

4. UT tunes its secondary receiver to the new channel.

5. UT starts LOGON process with new NCC.

6. When LOGON process is completed, UT sends HO Command message to previous GES, which confirms with ACK HO Cmd, and UT starts L3 network update timer.

7. New GES triggers L3 Network update procedure[2], as final step of the LOGON process.

8. UT starts transmitting in parallel to both GES:

    a. It continues sending fragments of pending L3 packets to previous GES and new L3 packets with previous GES destination address.

    b. It starts sending incoming L3 packets with new GES destination address to new GES.

9. Both GES transmit traffic to the UT through their respective channels.

10. Once UT empties its buffer of packets to be sent through previous channel and L3 network update timeout has expired, UT sends Connection Close message to previous GES.

11. Once previous GES empties its buffer of packets to the UT, GES sends ACK Connection Close message to the UT.

12. UT sends HO Finished message to the previous NCC, which responds with ACK HO finished message and updates information related to the UT in its database.

13. UT releases first receiver, which was devoted to previous carrier.

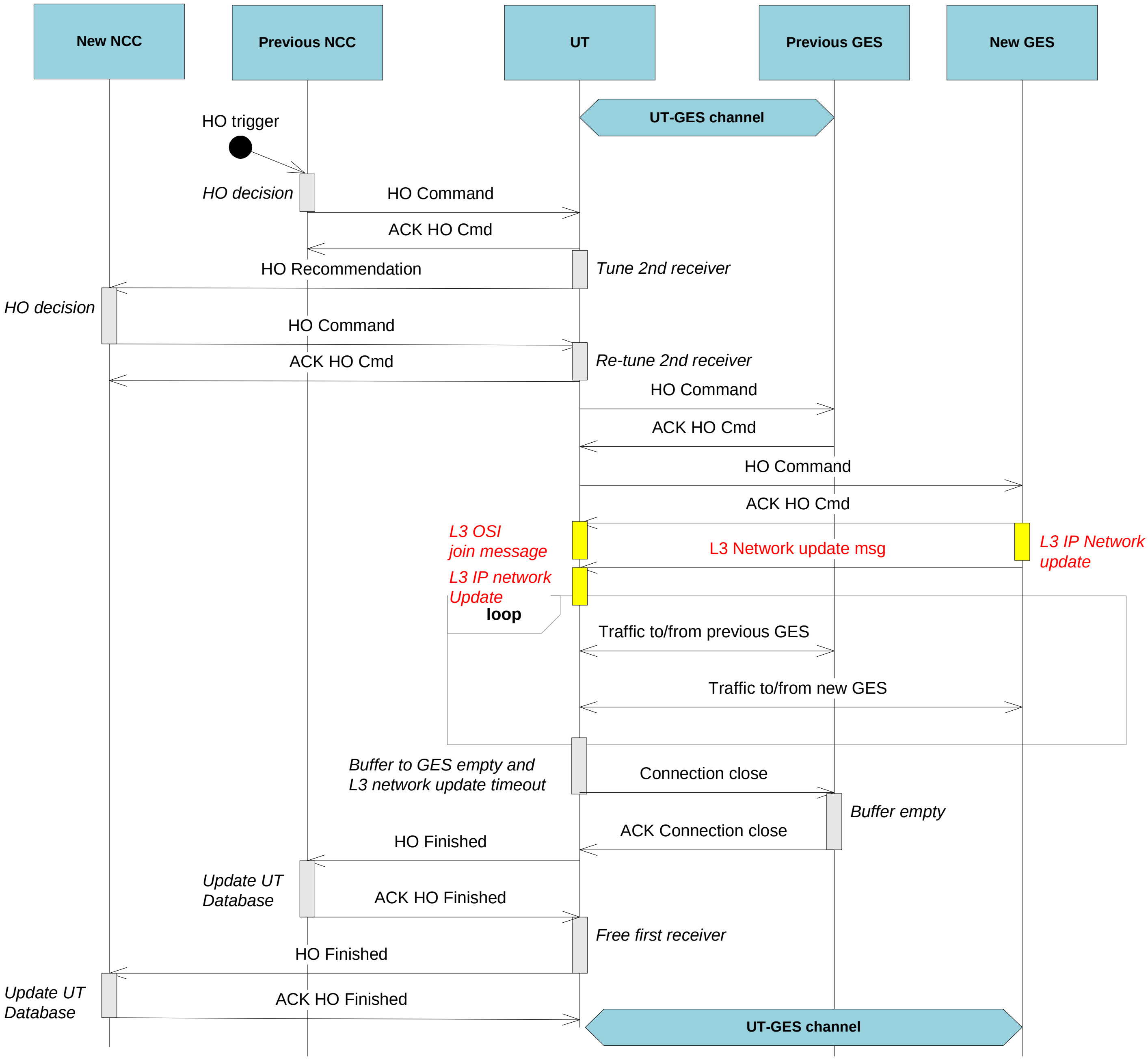
14. UT sends HO Finished message to the new NCC, which responds with ACK HO finished message and returns to non-HO state.

[2] *The L3 network update procedure is a logical representation of the L3 address update procedures for ATN/OSI and ATN/IPS.*

9.2.3.3.2 Procedure "Satellite Change"

D018-COM-FUN-2770

The following procedure shall be followed by UT and GSE for the satellite change handover process:



The following steps shall be performed:

1. NCC receives a HO Recommendation message from UT or GS.

2. NCC validates and decides the target for the handover, and sends HO Command to UT.

3. UT confirms with ACK HO Cmd message.

4. UT tunes its secondary receiver to the new channel and transmits HO Recommendation message to the new NCC.

5. New NCC validates HO and sends HO Command to UT.

6. UT re-tunes its secondary receiver to the new channel and sends HO Command message to previous GES, which confirms with ACK HO Cmd.

7. UT sends HO Command message to new GES, which confirms with ACK HO Cmd. UT starts L3 network update timer.

8. New GES triggers L3 Network update procedure[3]

9. UT starts transmitting in parallel to both GES:

a. It continues sending fragments of pending L3 packets to previous GES and new L3 packets with previous GES destination address.

b. It starts sending incoming L3 packets with new GES destination address to new GES.

10. Both GES transmit traffic to the UT through their respective channels.

11. Once UT empties its buffer of packets to be sent through previous channel and L3 network update timeout has expired, UT sends Connection Close message to previous GES.

12. Once previous GES empties its buffer of packets to the UT, GES sends ACK Connection Close message to the UT.

13. UT sends HO Finished message to the previous NCC, which responds with ACK HO finished message and updates information related to the UT in its database.

14. UT releases first receiver, which was devoted to previous carrier.

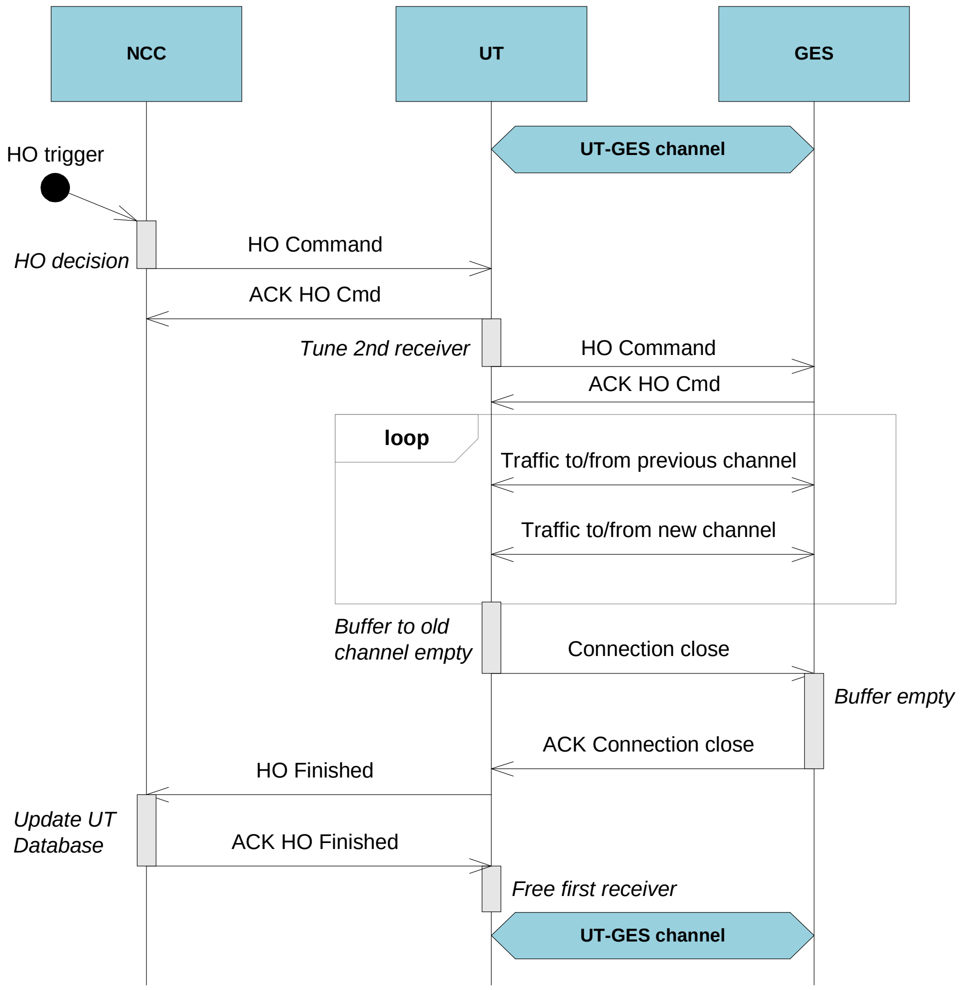
15. UT sends HO Finished message to the new NCC, which responds with ACK HO finished message and returns to non-HO state.

[3] *The L3 network update procedure is a logical representation of the L3 address update procedures for ATN/OSI and ATN/IPS or a local L3 route update trigger to the EAMTN network access point depending on the GS architecture.*

9.2.3.3.3 Procedure "Beam/channel change within same GES"

D018-COM-FUN-2780

The following procedure shall be followed by UT and GSE for the cases of beam or channel change within same satellite and same GES:



The following steps shall be performed:

1. NCC receives a HO Recommendation message from UT or GS.

2. NCC validates and decides the target for the handover, and sends HO Command to UT.

3. UT confirms with ACK HO Cmd message.

4. UT tunes its secondary receiver to the new channel and transmits HO Command message to the GES, which confirms with ACK HO Cmd.

5. UT starts transmitting in parallel to in both channels:

    a. It continues sending fragments of pending L3 packets to previous channel.

    b. It starts sending new incoming L3 packets to new channel.

6. Both GES units transmit traffic to the UT through their respective channels.

7. Once UT empties its buffer of packets to be sent through previous channel, UT sends Connection Close message to the GES.

8. Once old GES unit empties its buffer of packets to the UT, GES sends ACK Connection Close message to the UT.

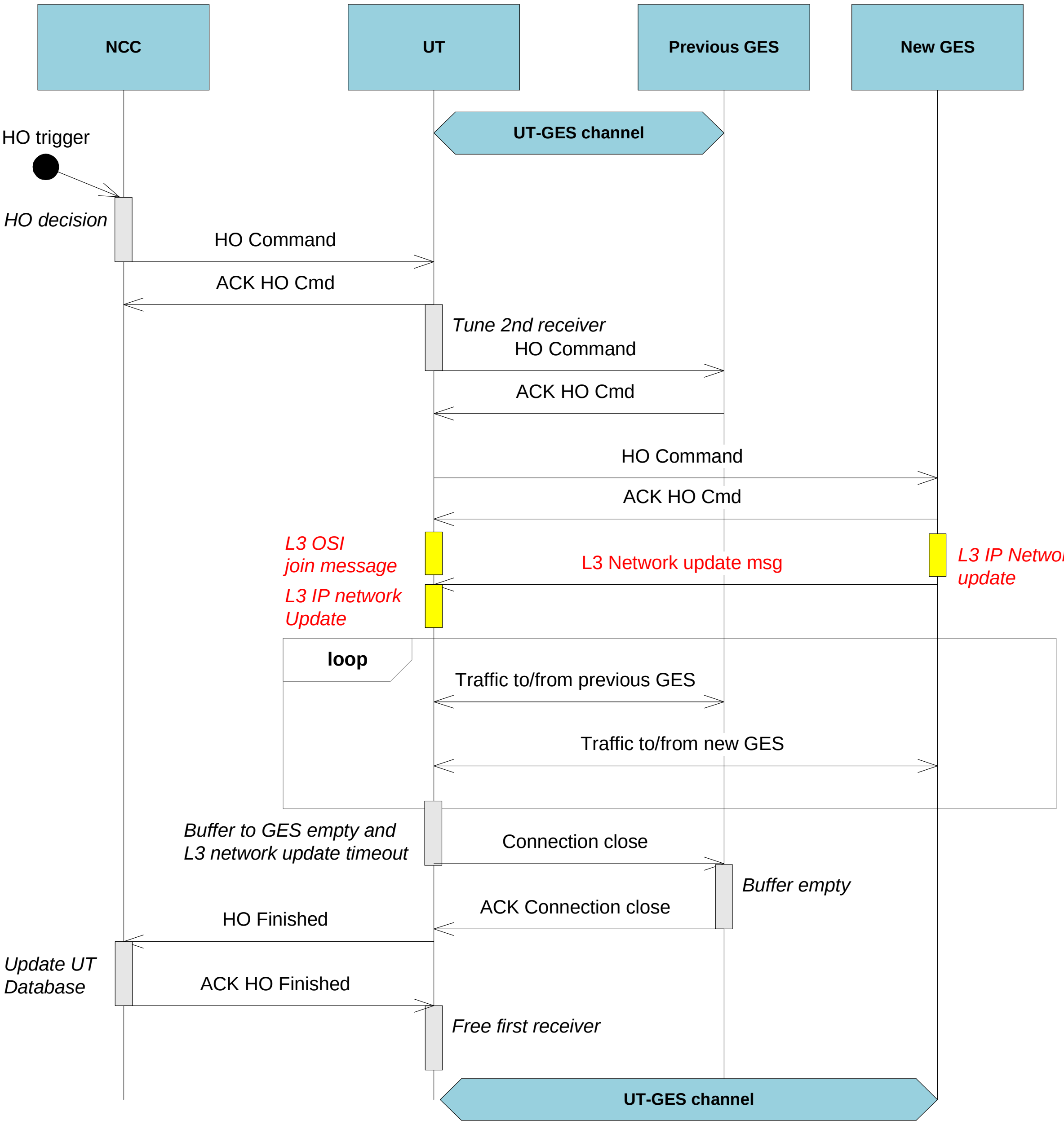
9. UT sends HO Finished message to the NCC, which responds with ACK HO finished message and updates information related to the UT in its database.

10. UT releases first receiver, which was devoted to previous carrier and returns to non-HO state.

9.2.3.3.4 Procedure "GES change"

D018-COM-FUN-2790

The following procedure shall be followed by UT and GSE for the cases of GES change within same satellite and same NCC:



The following steps shall be performed:

1. NCC receives a HO Recommendation message from UT or GS.

2. NCC validates and decides the target for the handover, and sends HO Command to UT.

3. UT confirms with ACK HO Cmd message

4. UT tunes its secondary receiver to the new channel and sends HO Command message to previous GES, which confirms with ACK HO Cmd.

5. UT sends HO Command message to new GES, which confirms with ACK HO Cmd. UT starts L3 network update timer.

6. New GES triggers an L3 Network update procedure[4]

7. UT starts transmitting in parallel to both GES:

a. It continues sending fragments of pending L3 packets to previous GES and new L3 packets with previous GES destination address.

b. It starts sending incoming L3 packets with new GES destination address to new GES.

8. Both GES transmit traffic to the UT through their respective channels.

9. Once UT empties its buffer of packets to be sent through previous channel and L3 network update timeout has expired, UT sends Connection Close message to previous GES.

10. Once previous GES empties its buffer of packets to the UT, GES sends ACK Connection Close message to the UT.

11. UT sends HO Finished message to the NCC, which responds with ACK HO finished message and updates information related to the UT in its database.

12. UT releases first receiver, and returns to non-HO state.

[4] *The L3 network update procedure is a logical representation of the L3 address update procedures for ATN/OSI and ATN/IPS or a local L3 route update trigger to the EAMTN network access point depending on the GS architecture.*

9.2.3.3.5 Procedure "Bulk Handover" for non-GEO satellites

Note: the concept of "Bulk Handover" is defined as a HO in which all traffic in a beam or a complete satellite is handled to another satellite in a single operation, being in this case several UTs involved.

D018-COM-FUN-2800

The GS shall be able to plan and detect in the non-GEO satellite case the overlapping period in which the current descending satellite coverage overlaps with the new ascending satellite coverage, based on SCC satellite information and GS location, to prepare in advance the synchronization to the new satellite.

D018-COM-FUN-2810

The GS shall configure one of its transmission and reception units to the new satellite and synchronise to the new satellite.

D018-COM-FUN-2820

The GS shall switch to the new satellite once the synchronisation on the new satellite is achieved, and stop all transmission to the old satellite.

9.2.4 Multicast control procedures

9.2.4.1 Overview of multicast membership management methods

Three different types of memberships are defined: static, GES-based and dynamic memberships for the CS.

- The concept of static group memberships involves that an aircraft is a member of a predefined set of multicast groups. The membership management scheme does not allow change of group subscriptions during the flight.
- The concept of dynamic memberships entails that hosts would be capable of joining and leaving multicast groups during the flight. Thus, subscriptions to multicast groups would change dynamically.
- GES-based memberships involves that the GES, and not the UT, subscribe to multicast groups and act as multicast members (or listeners). Then, the GES broadcasts all the multicast data received over the beam. This option is rather static and may fit with multicast groups linked with geographical areas.

At this point, as no information about the expected characteristics of multicast services and applications is provided, it is proposed to retain all the membership methods.

D018-COM-FUN-2830

The following membership management methods shall be supported:

- Static group membership
- GES-based group membership
- Dynamic group membership

Note: This requirement has been considered as no information was available about the detailed nature of multicast services. Hence, it is not possible to select the most suitable membership management method at this point.

9.2.4.2 Multicast membership management procedures

D018-COM-FUN-2840

Mechanisms such as re-broadcasting and answer suppression shall be supported in order to minimise the amount of resources used for multicast signalling in the satellite.

Note: How to perform these techniques will be indicated by the ANTARES-GMP protocol and how to implement and configure timers will be stated in the guidelines.

9.2.4.3 Multicast forwarding procedures

Dynamic selective forwarding is proposed for the CS.

D018-COM-FUN-2850

A CS-compliant system should be able to forward multicast traffic only over those specific beams with active members (if this information is available). (TBC)

9.2.5 Network synchronisation procedures

In this section the following concepts are used as follows:

- Feeder-to-Feeder links: GS-Satellite-GS fixed links operating at Ku, Ka or C band.
- Satellite ATM transceiver: satellite transceivers from/to Ku, Ka or C band to/from L band.

9.2.5.1 General synchronisation aspects

The requirements presented in this section are affecting both forward and return link network synchronisation.

D018-COM-FUN-2920

All GS elements shall compensate the Feeder link Doppler and Doppler rate with a normalised residual error lower than 10^{-3} by:

- Computing the Doppler Effect from
  - o GS element location
  - o Satellite location and speed derived from satellite ephemerides
  - o Nominal carrier and symbol/chip frequencies
- Compensating Feeder link Doppler Effect on
  - o Transmitter frequencies and time.
  - o Receiver frequencies and time

Feeder Link Doppler Effect compensation is mandatory for HEO and MEO constellations and optional for GEO constellations.

9.2.5.2 GS network synchronisation procedures

9.2.5.2.1 NCC network synchronisation procedures

D018-COM-FUN-2950

The NCC shall implement the following network synchronisation procedures:

• Feeder link Doppler pre-compensation in both uplink and downlink.

• Satellite clock error* estimation and distribution to all GS elements.

• Satellite translation error compensation in both forward link transmissions and return link receptions.

• Network clock reference (NCR) distribution to all GS elements.

• Reception of its own transmissions.

• SNIR estimation.

• Power corrections application to compensate uplink fades.

* *The satellite clock error is the satellite clock frequency bias, usually expressed in ppm.*

9.2.5.2.2 GES network synchronisation procedures

D018-COM-FUN-2960

The GES shall implement the following network synchronisation procedures:

• Feeder link Doppler pre-compensation in both uplink and downlink.

• Reception of the NCC and the own GES transmissions.

• NCR packets reception and Network clock reference recovery.

• Satellite clock error reception.

• Satellite translation error compensation in both forward link transmissions and return link receptions.

D018-COM-FUN-2970

The GES, at start up, shall implement the following forward link initial synchronisation procedure:

• Execution of the processes defined in D018-COM-FUN-2960.

• Round trip delay estimation from the satellite and its own locations.

• Computation of the initial transmission power based on link budgets. Alternatively, the initial transmission power can be provided to the GES as a configuration parameter.

• Transmission to a timeslot assigned to the GES. The recovered time reference (NCR) shall be used and the estimated round trip delay compensated.

• Reception of its own transmission.

• Estimation of the synchronisation (frequency and time) and SNIR errors with respect to those transmissions from the NCC.

• Synchronisation (frequency and time) and power corrections (to compensate uplink fades) application.

After completing the previous steps, the GES shall start the forward link synchronisation maintenance procedure.

D018-COM-FUN-2980

The GES shall implement the following forward link synchronisation maintenance procedure:

- Execution of the processes defined in D018-COM-FUN-2960.
- Transmission to timeslots assigned to the GES. The recovered time reference (NCR) shall be used.
- Reception of its own transmissions.
- Estimation of the synchronisation (frequency and time) and SNIR errors with respect to those transmissions from the NCC.
- Synchronisation (frequency and time) and power corrections application.

D018-COM-FUN-2990

The GES shall interrupt transmissions and go back to the forward link initial synchronisation stage, upon any of the following events:

- When no transmissions from NCC are received for NCC_loss_timeout seconds; NCC_loss_timeout = 2 (TBC).
- When GES_n_loss consecutive GES transmissions are not received; GES_n_loss = 2 (TBC).
- When the Network clock reference is not properly recovered.

9.2.5.2.3 Forward link synchonisation

D018-COM-FUN-3010

Forward link initial synchronisation and synchronisation maintenance procedures shall be implemented

- either by means of Feeder-to-Feeder links,
- or through the Forward Link Carrier.

D018-COM-FUN-3020

The NCC shall distribute to all GS elements the Network Clock Reference (NCR)

- either by broadcasting NCR packets through the FCH physical channel, if the forward link network synchronisation is implemented through the Forward Link Carrier;
- or by broadcasting NCR packets through specific channels, if the forward link network synchronisation is implemented through Feeder-to-Feeder links.

D018-COM-FUN-3030

The Network Clock Reference shall have a frequency of 27 MHz.

D018-COM-FUN-3040

The NCR packet shall contain the value of a 40-bit counter provided in tics of the Network Clock Reference. The value shall correspond

• either to the time at which the last preamble symbol of the FCH burst containing the NCR packet is transmitted, if the forward link network synchronisation is implemented through the Forward Link Carrier;

• or to the time at which the last preamble symbol of the specific channel burst containing the NCR packet is transmitted, if the forward link network synchronisation is implemented through Feeder-to-Feeder links.

D018-COM-FUN-3050

NCR packets shall be inserted with a periodicity that guarantees a proper recovery of the NCR to be used as a system time reference by any GS element.

• The minimum NCR packets periodicity shall be 2 packet/s.

D018-COM-FUN-3060

GS elements shall recover the Network Clock Reference from the received NCR packets.

D018-COM-FUN-3110

The forward link initial network synchronisation procedure shall guarantee that GS transmissions to the Forward Link Carrier at the satellite front-end are

• Synchronised in time: maximum time error lower than half the guard time.

• Synchronised in carrier frequency: maximum frequency error lower than half the guard band.

D018-COM-FUN-3120

The forward link network synchronisation maintenance procedure shall guarantee that GS transmissions to the Forward Link Carrier at the satellite front-end are

• Synchronised in time: maximum time error lower than half the guard time.

• Synchronised in carrier frequency: maximum frequency error lower than 10 Hz.

• Power balanced: uplink fades shall be compensated in order to guarantee a maximum power error with respect to NCC transmissions of 1 (TBC) dB.

D018-COM-FUN-3130

The SYNC (6) field of the FWD_DD descriptor of FCH bursts shall be filled as follows:

• 1 for all FCH bursts transmitted by the NCC.

• 1 for those FCH bursts transmitted by a GES while is in the forward link network synchronisation maintenance stage.

• 0 otherwise.

(6) *Note that the SYNC field is actually used by the UT to implement the transmitter Doppler pre-compensation in the return uplink. However, its value depends on the forward link network synchronisation stage of the GS element transmitting the FCH burst.*

9.2.5.2.4 Return Link synchronisation

The return link synchronisation procedures are depicted in Figure 9-1 and covered in the requirements in subsequent sections.

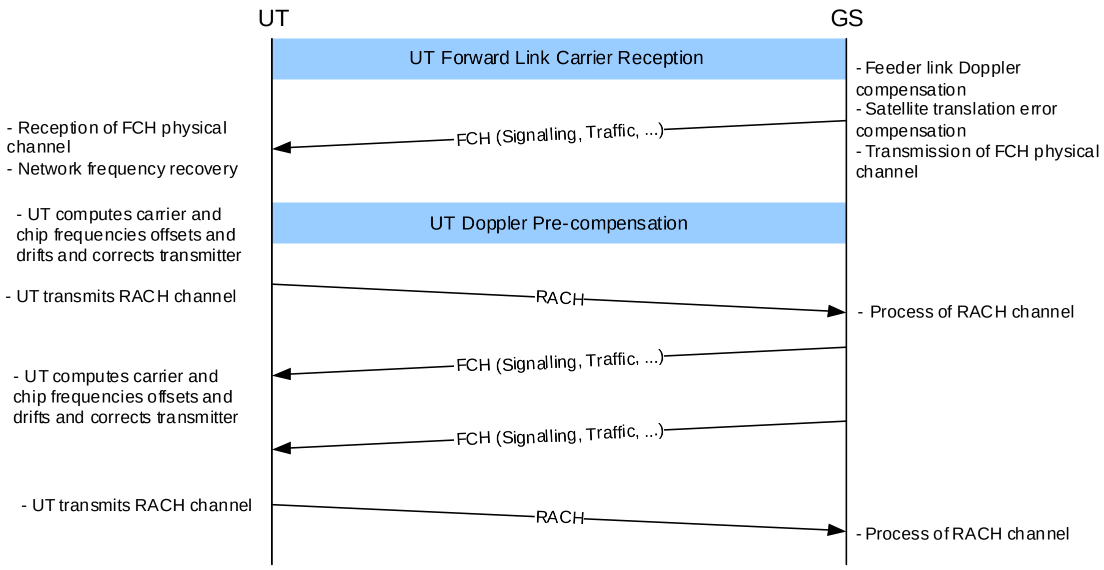


Figure 9-1: Return link synchronisation procedure

9.2.5.2.4.1 UT Forward Link Carrier reception

D018-COM-FUN-3160

The UT shall be able to detect, demodulate and decode Forward Link Carrier bursts affected by significant carrier frequency offsets. The sources of carrier frequency error are:

- GS (NCC or GES) reference clock instability
- Satellite reference clock instability (residual error after the compensation implemented by GS elements)
- UT reference clock instability
- Satellite motion (residual error after the Feeder link Doppler compensation implemented by GS elements)
- UT motion

The maximum carrier frequency offsets are:

- 7 kHz for GEO constellations (Feeder link operation in Ka-band is assumed)
- 22.5 kHz for MEO constellations (Feeder link operation in C-band is assumed)
- 37 kHz for HEO constellations (Feeder link operation in Ka-band is assumed)

D018-COM-FUN-3170

The UT shall be able to detect, demodulate and decode Forward Link Carrier bursts affected by significant time drifts. The sources of time drifts are:

• GS (NCC or GES) reference clock instability

• UT reference clock instability

• Satellite motion (residual error after the Feeder link Doppler compensation implemented by GS elements)

• UT motion

The maximum time drifts are:

• 3.9 us/s for GEO constellations

• 14.2 us/s for MEO constellations

• 22.6 us/s for HEO constellations

D018-COM-FUN-3180

The UT shall be able to detect, demodulate and decode Forward Link Carrier bursts affected by significant carrier frequency drifts. The sources of carrier frequency drifts are:

• Satellite acceleration (residual error after the Feeder link Doppler compensation implemented by GS elements)

• UT acceleration and angular movement

The maximum carrier frequency drift is 350 Hz/s.

D018-COM-FUN-3190

The UT shall be able to detect, demodulate and decode Forward Link Carrier bursts affected by significant time drift variations. The sources of time drift variations are:

• Satellite acceleration (residual error after the Feeder link Doppler compensation implemented by GS elements)

• UT acceleration and angular movement

The maximum time drift variation is 0.22 us/s^2.

9.2.5.2.4.2 UT Doppler pre-compensation

D018-COM-FUN-3200

The UT shall implement a transmitter Doppler pre-compensation mechanism aimed at:

• Minimising the carrier and chip frequency errors affecting RACH bursts

• Estimating and compensating the return uplink Doppler dynamics to reduce synchronisation errors

D018-COM-FUN-3210

The UT transmitter Doppler pre-compensation mechanism shall be based on the receiver carrier frequency offsets estimated by the UT demodulator upon reception of the Forward Link Carrier.

D018-COM-FUN-3220

The UT shall discard the following FCH bursts to implement the transmitter Doppler pre-compensation mechanism:

- FCH bursts recovered with errors (wrong CRC).
- FCH bursts with the SYNC field of the FWD_DD descriptor set to 0.

D018-COM-FUN-3230

The UT transmitter Doppler pre-compensation mechanism shall estimate the return uplink Doppler shift and drift by:

- Estimating the forward downlink Doppler shift and drift from the carrier frequency offsets estimated by the reception of FCH bursts.
- Deriving the return uplink Doppler shift and drift from the above estimations.

D018-COM-FUN-3240

The UT shall adjust its transmitter carrier and chip frequencies according to the estimated return uplink Doppler shift and drift.

D018-COM-FUN-3250

A UT, during the satellite HO execution process, shall be capable of transmitting not simultaneously two different sets of RTN link A-CDMA carriers, applying the corresponding transmitter Doppler pre-compensation for each carrier on a burst-by-burst basis.

D018-COM-FUN-3260

The UT shall guarantee that RACH bursts are received at the GS in the target contention channel with a carrier frequency error lower than half the RACH guard band.

D018-COM-FUN-3270

The UT shall guarantee that RACH bursts, once received at the GS, are affected by a maximum carrier frequency drift of 50 Hz/s.

D018-COM-FUN-3280

The UT shall guarantee that RACH bursts, once received at the GS, are affected by a time drift during the burst duration lower than $T_c/8$, being T_c the chip period.

D018-COM-FUN-3290

The UT shall interrupt transmissions in any of the following circumstances:

- When required to do so by the GS.
- When the Forward Link Carrier is lost, i.e. no FCH bursts are received for FLC_loss_timeout seconds; FLC_loss_timeout = 5 (TBC).

• When the UT transmitter Doppler pre-compensation mechanism is not able to estimate the return uplink Doppler shift and drift.

9.2.5.2.4.3 GS return link network synchronisation

The return link network synchronisation procedures implemented by the GS elements are common to the forward and return links and are included in section 9.2.5.2, being the most relevant the:

- Feeder link Doppler pre-compensation in both uplink and downlink.
- Satellite translation error compensation in both forward link transmissions and return link receptions.

D018-COM-FUN-3300

GS elements shall be able to detect, demodulate and decode RACH bursts affected by a carrier frequency error of up to half the RACH guard band.

D018-COM-FUN-3310

GS elements shall be able to detect, demodulate and decode RACH bursts affected by a carrier frequency drift of up to 50 Hz/s.

D018-COM-FUN-3320

GS elements shall be able to detect, demodulate and decode RACH bursts affected by a time drift during the burst duration of up to $T_c/8$, being T_c the chip period.

9.2.6 ACM

9.2.6.1 General ACM requirements

D018-COM-FUN-3330

On the FWD link,

- ACM shall be supported on the user plane only. The MODCODs specified in D018-COM-FUN-0850 shall be supported,

- Control plane bursts shall be transmitted with the most robust MODCOD (QPSK 1/4).

D018-COM-FUN-3340

The UT shall permanently monitor the Link Quality of the received signal in its serving beam, being the Link Quality based on PER measurements.

D018-COM-FUN-3350

Based on Link Quality measurements, the UT ACM module shall be able to determine the less robust FWD link MODCOD the GS can use to communicate with the UT, while keeping the target PER, in order to maximise the spectral efficiency.

Note: in the following requirements, the less robust MODCOD supported by a UT is called "preferred MODCOD"

D018-COM-FUN-3360

A UT, during a HO execution process, shall be able to maintain two ACM sessions.

9.2.6.2 ACM procedures

D018-COM-FUN-3370

At the UT power up, the GS shall use the most robust MODCOD to communicate with the UT.

D018-COM-FUN-3380

In case the preferred MODCOD changes, the UT shall indicate the new preferred MODCOD to the GS according to the Preferred MODCOD Indication procedure.

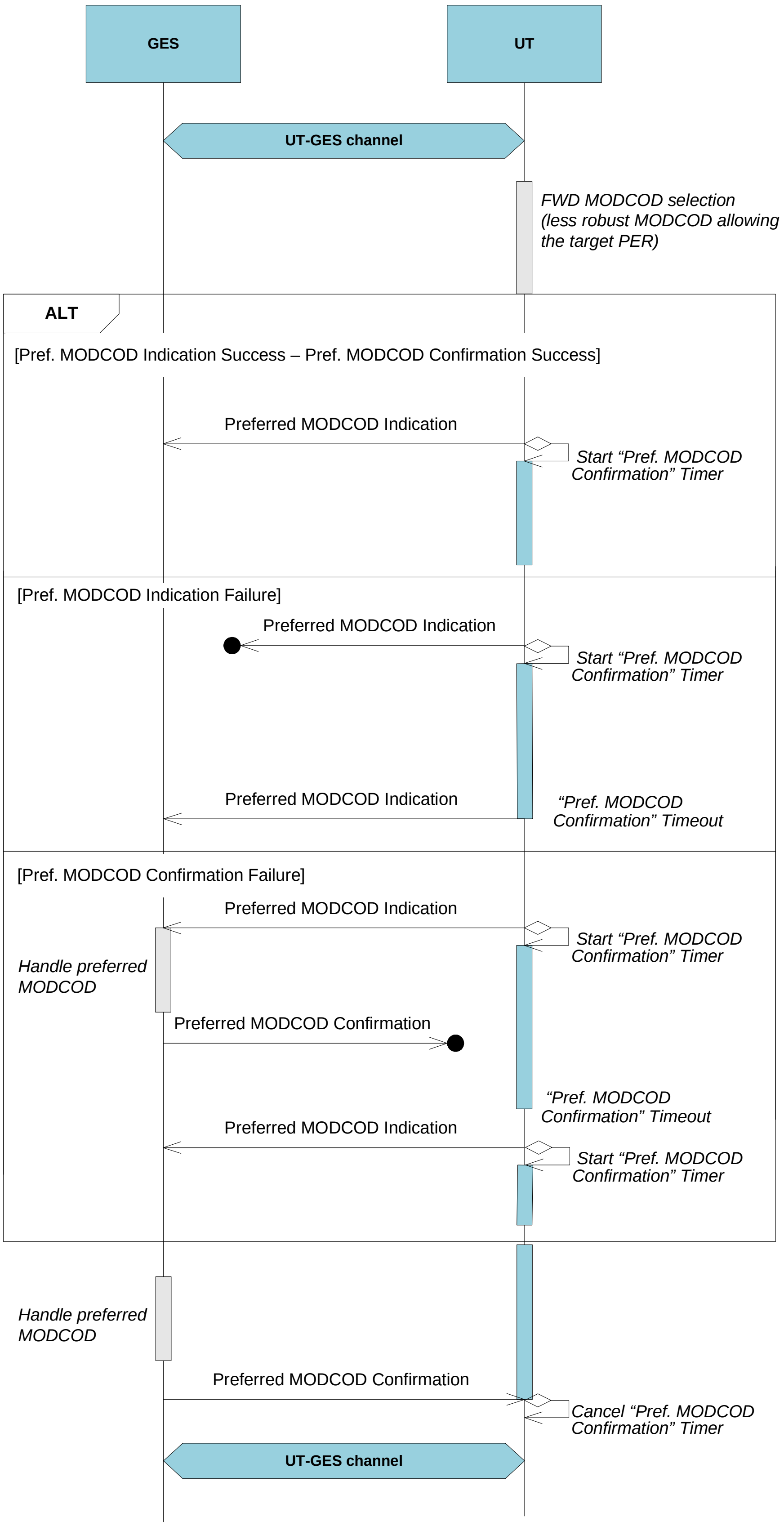


Figure 9-2: Preferred MODCOD Indication procedure

The following steps shall be performed during the Preferred MODCOD Indication procedure

(Note: the UT continuously monitor the Link Quality of the received signal in the serving beam)

(Nominal case: Pref. [MODCOD Indication success - Pref. MODCOD Confirmation success])

1. Based on Link Quality measurements, the UT determines the most efficient FWD Link MODCOD the GS can use to communicate with it.

a. In case the preferred MODCOD changes, UT shall send Preferred MODCOD Indication message to the GES.

b. Otherwise, the UT does not send any message and continues monitoring the Link Quality of the received signal

2. In order to prevent signalling messages losses, "Preferred MODCOD Confirmation" timer shall be triggered on the UT side

3. The GES, upon correct reception of the Preferred MODCOD Confirmation message, shall send Preferred MODCOD Confirmation message to the UT.

4. On the UT side, after reception of the Preferred MODCOD Confirmation message, cancels the Preferred MODCOD Confirmation timer.

In case of losing signalling messages:

- In case of Preferred MODCOD Indication failure, the UT, after expiration of "Preferred MODCOD Confirmation" timer, retransmits the Preferred MODCOD Indication message as in Step 1 of the Preferred MODCOD Indication procedure - Nominal case.

- In case of Preferred MODCOD Confirmation failure, the UT, after expiration of "Preferred MODCOD Confirmation" timer, retransmits the Preferred MODCOD Indication message as in Step 1 of the Preferred MODCOD Indication procedure - Nominal case.

D018-COM-FUN-3390

In case the UT detects a MODCOD change before receiving the Preferred MODCOD Confirmation message from the GS, the UT shall send a Preferred MODCOD Indication with the new MODCOD. The following procedure shall be followed:

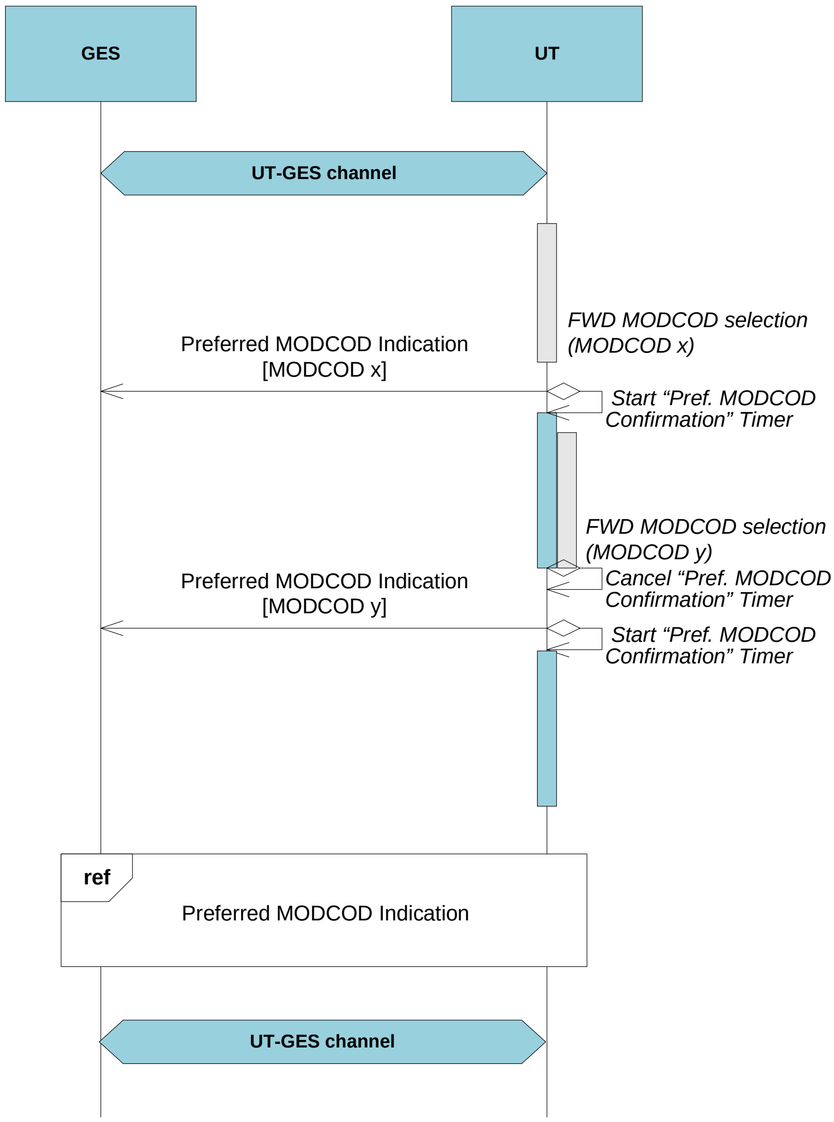


Figure 9-3: Revision of preferred MODCOD before GS acknowledgement (Preferred MODCOD Confirmation)

D018-COM-FUN-3400

In case the GS needs to request the Preferred MODCOD to a UT, the following procedure shall be followed:

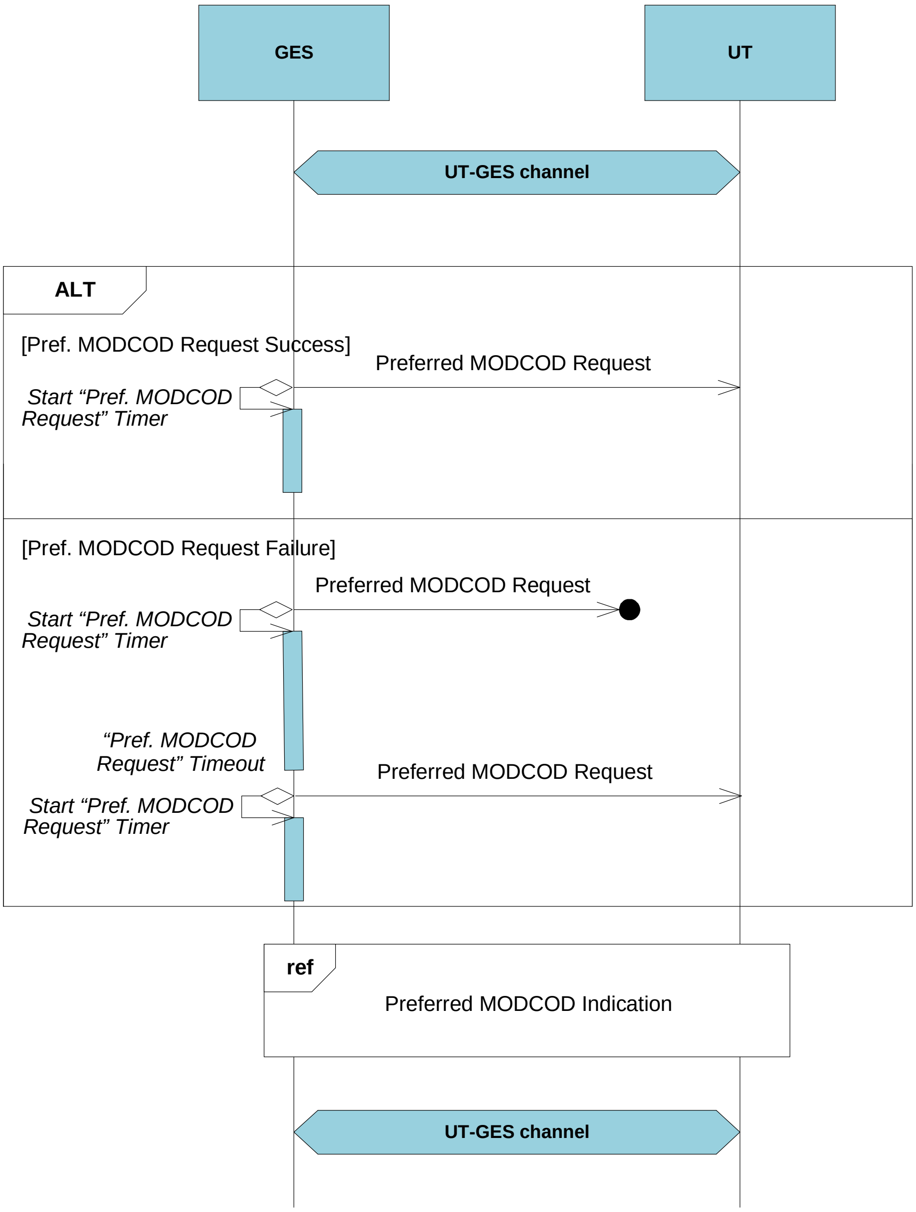


Figure 9-4: Preferred MODCOD request procedure

9.2.7 Radio resource management procedures

This section addresses:

- Congestion of the RACH (data and signalling)

9.2.7.1 Congestion control

The purpose of congestion control (CC) mechanisms is to control the amount of traffic entering in the communications network in order to avoid a collapse caused by oversubscription of either processing abilities or link capabilities of the networks and, furthermore, to ensure network stability, throughput efficiency and a fair allocation of resources.

Meaning of congestion control parameters indicated in this section is defined in section 8.7.1.1 (D018-COM-FUN-1610) and section 8.7.1.2 (D018-COM-FUN-1720)

9.2.7.1.1 Return Link congestion control protocol for data channel

D018-COM-FUN-3410

The UT shall support the congestion control mechanism indicated by the FLC through CC_CONFIG and CC_STATUS messages defined in section 11.5.1:

Congestion control mechanism	CC Parameter	CC Status
Backoff	tx_backoff Persistence Retransmission timeout	Traffic status (load)

Table 9-1: Congestion control signalling parameters and status

D018-COM-FUN-3420

The GS shall provide a set of congestion control parameters included in the CC_CONFIG message according to system load status (low traffic, medium traffic, high traffic, congested), supported spreading factors and supported CoS.

D018-COM-FUN-3430

The system load status shall be estimated by the GS based on the measured A-CDMA channel noise rise and its evolution, and sent to terminals within the CC_STATUS message.

D018-COM-FUN-3440

A CC_STATUS message shall be sent with a periodicity equal to 1 second.

D018-COM-FUN-3450

Terminals shall use the estimated system load status to select the appropriate set of CC parameters (those sent in the CC_CONFIG message)

D018-COM-FUN-3460

CC_CONFIG and CC_STATUS messages can be sent either as a standalone message or be integrated as a part of signalling framework.

9.2.8 Redundancy and failure detection procedures

Redundancy and failure detection procedures are basically transparent to the CS. Whenever a failure event happens, the communication system will reconfigure itself to use the backup entities, making the UT basically unaware of the event, except for any possible handover procedures execution.

9.2.9 Security control procedures

Refer to 8.3.

9.3 Control plane forward link specification

9.3.1 Link layer specification

9.3.1.1 ARQ protocol

Refer to User plane (section 8.6.1.1).

9.3.1.2 Encapsulation

Refer to User plane (section 8.6.1.1).

9.3.1.3 Security

Refer to 8.3.

9.3.2 Physical layer specification

D018-COM-FUN-3470

The forward link control shall use the following burst types:

- FCH burst

D018-COM-FUN-3480

The FWD Link Control Plane shall use the Physical layer specification detailed in section 8.5.2 for the FWD Link User Plane with the exception that ACM is not supported for signalling purposes.

The signalling bursts shall use QPSK 1/4.

9.4 Control plane return link specification

9.4.1 Link layer specification

9.4.1.1 ARQ protocol

Refer to User plane (section 8.7.1.1).

9.4.1.2 Encapsulation

Refer to section 8.7.1.3.

9.4.1.3 Security

Refer to 8.3.

9.4.2 Physical layer specification

D018-COM-FUN-3490

The return link control plane shall use the following burst types:

- RACH burst (Random Access burst)

D018-COM-FUN-3500

The RTN Link Control Plane shall use the Physical layer specification detailed in section 8.7.2 for the RTN Link User Plane.

10. MANAGEMENT PLANE SPECIFICATION

Management of the UT / GS is solely local to the aircraft / ground and does not require any exchange of information over the air interface. Refer also to section 6.

11. SIGNALLING STRUCTURES

This section provides detailed information about the PDUs of the signalling structures to be used for several control procedures.

11.1 System information tables

11.1.1 Logon table

D018-COM-FUN-3520

The logon table shall comply with the following structure:

Logon table		
Content of message	**Size (bytes)**	**comments**
NCC address	1	The NCC address for the pre logon request
Beam id	1	Beam identifier (case of GES in multiple beam)
Administrative parameters	1	System id : 4 bits, SSP Id : 4 bits.
RTN Pre-defined Freq Band id	1	If the System Id is pre-defined, this field gives the Id of the RTN frequency band to be used. Otherwise, the optional info will be needed
RTN Congestion control information	2	Information for the congestion control (2 int)
RACH ID	1	RACH ID to be used for the logon request
Neighbor FWD carrier id (TBC)	4	Define the allocated logon FWD carrier id on neighbor beams (used for HO procedure) (4id of 8 bits)
System config version number	1	Version number of basic and additional configuration settings
REDUCED SIZE (Bytes)	**18**	
OPTIONAL INFO		
information table	2	Description of the available optional information (0:no info, 1:info)
Administrative parameters	0,5	CSP Id
Satellite additional information (TBD)	4	Ephemeris, ... (TBD)
RTN frequency band central frequency	4	Central Frequency of the RTN link carrier band.
RTN carrier Roll-off	0,5	Value (0..0,35) by 0,05 step
DCH channelization code	1	DCH channelization code (8 bits)
ACH channelization code	1	ACH channelization code (8 bits)
Preamble and scrambling generators	25	Preamble / Complex scrambling sequence options and configuration. For each option (maximum 5 (TBC)): • Preamble sequence generator (9 bits) • Complex scrambling sequence generator (24 bits)
Additional information (reserved)	16	
TOTAL SIZE (Bytes)	**72**	

11.2 Handover

Note: the following message definition does not include generic control message header (size is TBD) which should identify the endpoints (GSE and UT).

11.2.1 HO Recommendation

D018-COM-FUN-3530

The HO Recommendation message shall comply with the following structure:

HO RECOMMENDATION		
Content of message	**size (bytes)**	**comments**
Message type	1	
HO type	1	
AES ID (optional)	2	
Signal power measurements	32	4 neighbour information
Position Coordinates	24	3 position coordinates (trajectory)
APB Preferences	20	10 preferences of 2 bytes
new GES ID (optional)	1	
TOTAL SIZE (bytes)	**81**	

11.2.2 HO Command

D018-COM-FUN-3540

The HO Command message shall comply with the following structure:

HO COMMAND		
Content of message	**size (bytes)**	**comments**
Message type	1	
HO type	1	
AES ID	2	
new GES ID	1	
new NCC ID	1	
Physical layer parameters	64	FWD and RET carriers information
TOTAL SIZE (bytes)	**70**	

11.2.3 ACK HO Command

D018-COM-FUN-3550

The ACK HO Command shall comply with the following structure:

ACK HO COMMAND		
Content of message	**size (bytes)**	**comments**
Message type	1	
Result	1	
TOTAL SIZE (bytes)	**2**	

11.2.4 Connection close

D018-COM-FUN-3560

The Connection close message shall comply with the following structure:

CONNECTION CLOSE		
Content of message	**size (bytes)**	**comments**
Message type	1	
TOTAL SIZE (bytes)	**1**	

11.2.5 ACK Connection close

D018-COM-FUN-3570

The ACK Connection close message shall comply with the following structure:

ACK CONNECTION CLOSE		
Content of message	**size (bytes)**	**comments**
Message type	1	
TOTAL SIZE (bytes)	**1**	

11.2.6 HO finished

D018-COM-FUN-3580

The HO finished message shall comply with the following structure:

HO FINISHED		
Content of message	**size (bytes)**	**comments**
Message type	1	
Result	1	
TOTAL SIZE (bytes)	**2**	

11.2.7 ACK HO finished

D018-COM-FUN-3590

The ACK HO finished message shall comply with the following structure:

ACK HO FINISHED		
Content of message	**size (bytes)**	**comments**
Message type	1	
TOTAL SIZE (bytes)	**1**	

11.3 Multicast

One multicast signalling message can contain reports for multiple multicast groups. In this sense, the size of multicast join messages is variable and depends on the number of multicast groups reported.

11.3.1 Multicast join

D018-COM-FUN-3600

The Multicast join message shall comply with the following structure:

Multicast join		
Content of message	**size (Bytes)**	**comments**
Message type	1	
Number of Mcast address records (N)	1	Multicast groups reported
Filter mode	1	Include/Exclude
Multicast address record	>34	Multicast address + N source addresses
TOTAL SIZE (Bytes)	>36	

11.3.2 Multicast join ACK

D018-COM-FUN-3610

The Multicast join ACK message shall comply with the following structure:

Multicast join ACK		
Content of message	**size (Bytes)**	**comments**
Message type	1	
Number of Mcast address records (N)	1	Multicast groups reported
Filter mode	1	Include/Exclude
Multicast address record	>34	Depends on the number of source addresses
TOTAL SIZE (Bytes)	>36	

11.3.3 Multicast leave

D018-COM-FUN-3620

The Multicast leave message shall comply with the following structure:

Multicast leave		
Content of message	**size (Bytes)**	**comments**
Message type	1	
Number of Mcast address records (N)	1	Multicast groups reported
Filter mode	1	Include/Exclude
Multicast address record	>34	Depends on the number of source addresses
TOTAL SIZE (Bytes)	>36	

11.3.4 Multicast change state report

D018-COM-FUN-3630

The Multicast change state report shall comply with the following structure:

Multicast change report		
Content of message	size (Bytes)	comments
Message type	1	
Number of Mcast address records (N)	1	Multicast groups reported
Filter mode	1	Include/Exclude
Multicast address record	>34	Depends on the number of source addresses
TOTAL SIZE (Bytes)	>36	

11.4 Logon

11.4.1 Logon request - control

D018-COM-FUN-3640

The Logon request - control message shall comply with the following structure:

Logon Request - Control		
Content of message	Size (bytes)	comments
NCC address	1	The NCC address for the pre logon request
Beam id	1	Beam identifier (case of GES in multiple beam)
ICAO id	3	UT identification
UT parameters and NCC cabilities	16	This field also used to inform the NCC that the system id is known (additional parameter settings are available) or not (System Id = 0)
TOTAL SIZE (Bytes)	21	

11.4.2 Logon accept - control

D018-COM-FUN-3650

The Logon accept - control message shall comply with the following structure:

Logon Accept - Control		
Content of message	Size (bytes)	comments
NCC address	1	The NCC address for the pre logon request
ICAO id	3	UT identification
UT L2 address	2	The network address of the UT
GES address	1	The GES address for the pre logon request.
RTN Pre-defined Freq Band IDs	2	If the System Id is pre-defined, this field gives the IDs of the RTN frequency band to be used. Otherwise, the optional info will be needed. Let assume here that N = 2.
RTN Congestion control information	8	We assume that N carrier definition could be used. Let assume here that N=2
FWD Pre-defined Carrier ID	1	If the System Id is pre-defined, this field give the ID of the FWD carrier to be used. We assume that M carrier definition could be used. Let assume here that M=1
REDUCED SIZE (Bytes)	18	
OPTIONAL INFO		
Information table	4	Description of the available optional informaiton (0:no info, 1:info)
FWD max number of carrier ID	0,5	Maximum number of possible FWD carrier (1 to 16). Current baseline is 1 FWD carrier.
FWD carrier frequency ID definition	4	Central Frequency for each carrier Id (Freq Id 1 = 1456MHz, ...) 4*M Here M=1
FWD carrier type	0,5	Currently, global / regional. Here M = 1.
FWD carrier roll-off	0,5	Value (0..0,35) by 0.05 step. Here M = 1.
RTN max number of freq band ID	0,5	Maximum number of possible RTN frequency band IDs (1 to 16).
RTN frequency band central frequency	8	Central Frequency for each RTN link frequency band (Freq Id 1 = 1456MHz, ...). Here N = 2
List of supported RACH ID	1	Supported RACH Ids per frequency band. Here N = 2
RTN carrier Roll-off	2	Value (0..0,35) by 0,05 step. For each RACH ID and frequency band (here, L=2 and N=2)
DCH channelization code	4	DCH channelization code (8 bits). Here, L=2 and N=2
ACH channelization code	4	ACH channelization code (8 bits). Here, L=2 and N=2
Preamble and scrambling generators	100	Preamble / Complex scrambling sequence options and configuration. For each option (maximum 5 (TBC)): • Preamble sequence generator (9 bits) • Complex scrambling sequence generator (24 bits) Here, L=2 and N=2
Authentication information (TBC)	32	TBD
TOTAL SIZE (Bytes)	179	

11.4.3 *Logon request - traffic*

D018-COM-FUN-3660

The Logon request - traffic shall comply with the following structure:

Logon Request - Traffic		
Content of message	Size (bytes)	comments
UT L2 address	2	The network address of the UT
GES address	1	The GES address for the pre logon request
ICAO id	3	UT identification
Logon request identifier	0,125	To inform the GES that the in course communication is linked to other steps
TOTAL SIZE (Bytes)	7	

11.4.4 *Logon accept - traffic*

D018-COM-FUN-3670

The Logon accept - traffic shall comply with the following structure:

Logon Accept - Traffic		
Content of message	Size (bytes)	comments
GES address	1	The GES address for the pre logon request
UT L2 address	2	The network address of the UT
OSI Join parameters	30	8208 AGR address(es). Up to 5 addresses considered.
Logon validation	0,125	
TOTAL SIZE (Bytes)	34	

11.4.5 Logon accept ACK - traffic

D018-COM-FUN-3680

The Logon accept ACK - traffic shall comply with the following structure:

Logon Accept ACK - Traffic		
Content of message	Size (bytes)	comments
UT L2 address	2	The network address of the UT
GES address	1	The GES address for the pre logon request
Logon validation reception	0,125	
TOTAL SIZE (Bytes)	4	

11.4.6 Logon request - ground

D018-COM-FUN-3690

The Logon request - ground message shall comply with the following structure:

Logoff Request - Ground		
Content of message	Size (bytes)	comments
NCC address	1	NCC address for the pre logon request
GES address	1	The GES address for the pre logon request
UT L2 address	2	The network address of the UT
Logoff initiate request	0,125	Logoff initate identifier
TOTAL SIZE (Bytes)	5	

11.4.7 Logoff request

D018-COM-FUN-3700

The Logoff request message shall comply with the following structure:

Logoff Request		
Content of message	Size (bytes)	comments
NCC address	1	NCC address for the pre logon request
GES address	1	The GES address for the pre logon request
UT L2 address	2	The network address of the UT
Logoff request	0,125	Logoff identifier
TOTAL SIZE (Bytes)	5	

11.4.8 Logoff accept

D018-COM-FUN-3710

The Logoff accept message shall comply with the following structure:

Logoff Accept		
Content of message	Size (bytes)	comments
NCC address	1	NCC address for the pre logon request
UT L2 address	2	The network address of the UT
Logoff acknowledgement	0,125	The network address of the UT
TOTAL SIZE (Bytes)	4	

11.5 Random Access

The signalling structures used for RA are mainly involved with congestion control functions and control checks. This section details the used PDUs.

11.5.1 RACH Congestion control

D018-COM-FUN-3720

The RACH Congestion control message shall comply with the following structure:

CC _CONFIG		
Content of message	size (Bytes)	comments
Message type	1	
CC Type	1	Backoff mechanism
for each Spreading Factor in {4, 16} {		
for each CoS in {Normal, High} {		
for each traffic state in {low , medium, high, congested} {		
tx_backoff	1 (TBC)	
persistency	1 (TBC)	
retransmission_timeout	1 (TBC)	
}		
}		
}		
TOTAL SIZE (Bytes)	50 (TBC)	

CC_STATUS		
Content of message	size (Bytes)	comments
Message type	1	
CC Type	1	Backoff mechanism
number of channels		
for each channel		
channelID	1	
traffic_status	1	
}		
}		
TOTAL SIZE (Bytes)		

11.6 Network synchronisation

11.6.1 NCR field

D018-COM-FUN-3730

The NCR field shall comply with the following structure:

NCR Packet					
Message content	Size [bits]	Step	Range	Units	Comments
Message type	8	NA	0 - 256	NA	
NCR counter	40	NA	-	Hz	Tics of the 27 MHz Network Clock Reference
Total size	48			bits	
Total size	**6**			**bytes**	

11.7 ACM

11.7.1 FWD Preferred MODCOD Request

D018-COM-FUN-3740

The FWD Preferred MODCOD Request message shall comply with the following structure:

Preferred MODCOD Request		
Content of message	**Size (bytes)**	**comments**
Message type	1	
UT ID	2	
TOTAL SIZE (bytes)	**3**	

11.7.2 FWD Preferred MODCOD Indication

D018-COM-FUN-3750

The FWD Preferred MODCOD Indication message shall comply with the following structure:

Preferred MODCOD Indication		
Content of message	**Size (bytes)**	**comments**
Message type	1	
UT ID	2	
Preferred MODCOD	0,5	The preferred MODCOD is coded in 4 bits as follows: - "0000": MODCOD0 - "0001": MODCOD1 - "0010": MODCOD2 - "0011": MODCOD3 - "0100": MODCOD4 - "0101": MODCOD5 - "0110": MODCOD6
Sequence number	0,5	
TOTAL SIZE (bytes)	**4**	

11.7.3 FWD Preferred MODCOD Confirmation

D018-COM-FUN-3760

The FWD Preferred MODCOD Confirmation message shall comply with the following structure:

Preferred MODCOD Confirmation		
Content of message	**Size (bytes)**	**comments**
Message type	1	
UT ID	2	
Preferred MODCOD	0,5	The preferred MODCOD is coded in 4 bits as follows: - "0000": MODCOD0 - "0001": MODCOD1 - "0010": MODCOD2 - "0011": MODCOD3 - "0100": MODCOD4 - "0101": MODCOD5 - "0110": MODCOD6
Sequence number	0,5	
TOTAL SIZE (bytes)	**4**	

12. ANNEX A: AERONAUTICAL CHANNEL

See implementation guidelines document (D023).

13. ANNEX B: ADDRESSES OF PARITY BIT ACCUMULATORS FOR IRA LDPC

13.1 Addresses of parity bit accumulator for r=1/4 and k_{ldpc} = 1536 bits

145 925 1446 2183 2568
134 306 362 979 2245
147 158 2907 4447 4580
1316 2205 2920 3592 3795
340 2242 2441 2525 2757
2182 2580 2999 3725 4140
414 754 1166 2026 2668
127 2201 2567 3903 4031
1420 1604 1980 1986 3090
849 1909 2347 3365 4279
1196 2578 3170 3560 3684
2255 2487 3253 3645 4317

Table 13-1: Addresses of parity bit accumulator for r=1/4 and k_{ldpc} = 1536 bits

13.2 Addresses of parity bit accumulator for r=1/3 and k_{ldpc} = 2048 bits

469 962 2940 3752
2173 2953 3587 3894
202 1796 2110 4023
299 997 2431 3568
536 550 1676 2513
313 711 2157 3730
115 1710 2074 3040
463 673 2011 3828
1446 2093 2396 2839
592 846 1021 2279
672 1150 1873 4015
1522 2184 2687 3649
184 809 3234 3859
842 1716 3171 4057
171 533 1380 2234
172 1659 1974 2373

Table 13-2: Addresses of arity bit accumulator for r=1/3 and k_{ldpc} = 2048 bits

13.3 Addresses of parity bit accumulator for r=1/2 and k_{ldpc} = 3072 bits

1001 1397 1561 2604 2768

407 439 1589 2293 2416
37 828 1203 1376 1702
622 1027 1224 1845 2457
963 1188 1639 2109 2521
471 2215 2266 2372 2730
257 1120 1931 2103 2136
31 506 754 945 1811
449 695 739 1677 1946
451 854 1114 2934 2992
12 740 1719 1857 2022
854 2139 2274 2790 2805
418 1049 1777 2163 2672
443 1088 2286 2442 2878
97 1113 1720 2404 2682
657 1245 2174 2339 2837
1235 1602 1652 2308 2519
412 595 782 1481 1704
288 293 301 1419 1484
266 1752 2639 2724 3062
366 410 1096 1405 1484
697 1339 2247 2524 2725
242 1102 1311 2143 2716
646 944 1223 1426 1493

Table 13-3: Addresses of parity bit accumulator for r=1/2 and k_{ldpc} = 3072 bits

13.4 Addresses of parity bit accumulator r=2/3 and k_{ldpc} = 4096 bits

191 918 1451 1730
28 326 627 1272
168 439 595 1516
1696 1751 1901 1961
89 1325 1572 1712
510 1377 1396 1546
1073 1125 1694 1802
53 107 466 783
254 307 1337 1862
1206 1567 1610 1763
234 416 1175 1951
60 768 795 967
299 1068 1108 1553
61 273 1428 2008

226 285 488 1045
146 453 1086 1833
465 1097 1175 1948
215 1194 1282 1740
125 266 306 1876
35 941 1732 1947
363 1603 1694 1813
149 152 304 702
552 758 831 1024
241 1110 1449 1567
547 1245 1562 1861
1126 1982 2027 2032
112 235 822 1358
481 600 847 1911
127 215 1384 1617
1266 1481 1892 1948
274 329 588 1316
405 861 1091 1418

Table 13-4: Addresses of parity bit accumulator for r=2/3 and k_{ldpc} = 4096 bits

13.5 Addresses of parity bit accumulator r=1/2 and k_{ldpc} = 4608 bits

1821 2669 2747 3099 3393
1273 2195 2562 4062 4107
1 644 862 1355 1663
462 1468 2539 2977 3683
1387 2741 2824 3070 3734
31 591 906 2503 3924
896 1136 1227 1780 2547
485 872 3412 3898 3980
311 1532 1547 3962 4547
60 1178 1930 2787 3719
529 561 1563 2730 4106
312 2966 3684 3826 4495
2564 2797 2953 3180 3726
265 1097 1611 3165 3409
1166 1372 3625 3698 4247
44 1245 1759 2337 3832
1264 1630 2319 2461 3421
481 776 2305 2817 3190

226 1434 2215 2608 3994
248 3059 3370 3510 4037
1347 1787 2348 3159 3641
196 576 2000 4420 4607
605 1380 3422 3960 4382
281 877 2507 4135 4338
806 1515 1746 2229 2942
1762 2057 2933 3010 4243
405 1756 2954 4470 4497
1123 2457 2514 3974 4229
543 2544 2770 4457 4472
19 794 1004 2004 4517
1287 1922 2369 2377 2598
2526 2912 3964 4277 4521
94 244 3274 3316 4476
765 1569 2070 3967 4296
36 1951 2157 2927 4487
459 1644 1764 2059 3784

Table 13-5: Addresses of parity bit accumulator for r=1/2 and k_{ldpc} = 4608 bits

13.6 Addresses of parity bit accumulator r=2/3 and k_{ldpc} = 6144 bits

1400 1564 2615 2773
446 989 1593 2298
399 672 1219 2410
40 827 1369 1700
1025 1226 2454 2541
963 1198 1639 1788
263 472 2090 2263
185 507 944 3066
1356 1497 2155 2764
1066 1397 2029 2252
1392 1526 1619 2253
687 1662 2545 2830
574 2747 2797 2954
182 1035 1535 2694
220 1098 2503 2871
440 1963 2069 3016
2040 2225 2564 2673
490 1173 2172 2977
417 541 1196 1417

1082 1094 2733 2938
238 255 747 1331
1703 1924 2152 2718
173 209 631 1194
504 948 1520 2851
453 1827 2147 2244
1822 2029 2430 2956
974 1133 2311 2399
320 1146 3015 3024
619 1504 1681 3009
730 1145 2666 2876
990 1048 1847 3051
127 412 426 1121
1304 1421 1675 2580
609 648 1628 2821
405 806 1345 2770
303 770 1318 2699
569 652 656 2202
365 1089 1404 2083
476 1117 2338 2712
73 717 1454 2867
118 1239 1566 1898
1720 1827 2335 2783
825 1250 2293 2300
734 2098 2181 2283
803 2758 2991 3028
280 342 2549 2615
1553 1962 2568 2599
636 2360 2545 2995

Table 13-6: Addresses of parity bit accumulator for r=2/3 and k_{ldpc} = 6144 bits

13.7 Addresses of parity bit accumulator r=2/3 and k_{ldpc} = 8192 bits

763 2006 2831 3202
1772 2035 2424 3062
359 2867 3640 3676
32 781 2359 2809
512 900 905 2237
1822 2436 2538 3329
990 1649 1738 2869

351 1138 3013 3531
403 1318 1902 4041
618 675 1398 3071
192 1495 3695 3994
155 800 1143 2172
321 2276 3099 4092
1633 2932 2952 2973
61 1848 2533 3394
85 649 2542 2738
1623 1793 1900 2137
82 2332 2586 3943
957 1780 1978 2594
811 2669 3811 4004
963 2565 3259 3982
992 1550 1560 1893
159 1112 2310 3264
166 1103 1785 3905
547 1757 3157 3658
1488 1782 1806 3035
1451 1456 1470 2982
15 2552 2855 4001
727 2577 2696 2879
18 2132 2345 3564
1385 2306 2892 3940
2021 2451 2618 2813

Table 13-7: Addresses of parity bit accumulator for r=2/3 and k_{ldpc} = 8192 bits

14. ANNEX C: REQUIREMENTS CHANGE TRACEABILITY

From draft02 to draft03:

PUID	Change Record
D018-COM-ITF-0010	Deleted as per CSIDR ESA RID SCO-CS-011 (action A-CS-027)
D018-COM-ITF-0030	Deleted as per CSIDR ESA RID SCO-CS-011 (action A-CS-027)
D018-COM-ITF-0040	Deleted as per CSIDR ESA RID SCO-CS-011 (action A-CS-027)
D018-COM-FUN-0320	Rewording / Clarified ESA RID 98 PBU-CS-004 A-CS-002
D018-COM-SEC-0490	Removed according to CSIDR TAS.I RID VV-002.
D018-COM-FUN-0510	Removed, as per A-CS-015 and A-CS-014 (CSIDR RIDs GA-CS-008 and GA-CS-007).
D018-COM-FUN-0520	Updated as per A-CS-015 and A-CS-014 (CSIDR RIDs GA-CS-008 and GA-CS-007).
D018-COM-FUN-0580	Splitted: shall refer to "NSDU-layer TD95/ET" instead of application layer TD95/ET, and shall be split into two (one for RTN and one for FWD) referring to schedulers (ESA RID #227 SCO-CS-005, action A-CS-011)
D018-COM-FUN-0581	Splitted: from D018-COM-FUN-0580 (ESA RID #227 SCO-CS-005, action A-CS-011)
D018-COM-FUN-0590	Rewording / Clarified: replace "application layer message" with "NSDU" (ESA RID #227 SCO-CS-005, action A-CS-011)
D018-COM-FUN-0740	Rewording / Clarification Clarification of the definition of N^{ACK}. ESA RID 238 GA-CS-016, A-CS-029 Rewording / Clarification Rewording to use "shall not". TAS-I RID 26 GP-009
D018-COM-FUN-0760	Typo Ammend figure's title to refer to receiver rather than transmitter. ESA RID 267 PBU-D018-minor, SCO-CS-027
D018-COM-FUN-0770	Obsolete / Not required Redundant with D018-COM-FUN-0830.

PUID	Change Record
	ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-0790	Obsolete / Not required Redundant with D018-COM-FUN-0830. ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-0800	Obsolete / Not required Redundant with D018-COM-FUN-0830. ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-0810	Obsolete / Not required Redundant with D018-COM-FUN-0830. ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-0820	Rewording / Clarified Rewording to use PPDU payload rather than PSDU. ESA RID 242 GA-CS-020, A-CS-019
D018-COM-FUN-0830	Rewording / Clarified Removing references to custom scheme to FL encapsulation. Reword CRC-32 description to change "by system design" to "mandatory" ESA RID 267 PBU-267-minor, SCO-CS-029 ESA RID 267 PBU-267-minor, SCO-CS-031
D018-COM-FUN-0850	Rewording / Clarified. Requirement was incorrectly phrased. ESA RID 267 PBU-D018 minor SCO-CS-027
D018-COM-PER-1600	- Obsolete / Not required (moved to D023 IG). [ESA RID 101 PBU-CS-015, Action A-CS-003]
D018-COM-FUN-1610	Typo Correct the formula to compute the mean value of backoff time. ESA RID 209 GA-009, A-ACDMA-013
D018-COM-FUN-1630	Obsolete / Not required Moving the ALOHA MAC Stack to Implementation Guidelines document

PUID	Change Record
	(D023). ESA RID 208 GA-008, A-ACDMA-012
D018-COM-FUN-1730	Obsolete / Not required Redundant with D018-COM-FUN-1780. Coherency with ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-1740	Obsolete / Not required Redundant with D018-COM-FUN-1780. Coherency with ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-1750	Obsolete / Not required Redundant with D018-COM-FUN-1780. Coherency with ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-1760	Obsolete / Not required Redundant with D018-COM-FUN-1780. Coherency with ESA RID 267 PBU-D018-minor, SCO-CS-028
D018-COM-FUN-1770	Rewording / Clarified Rewording to use PPDU payload rather than PSDU. ESA RID 242 GA-CS-020, A-CS-019
D018-COM-PER-2460	- Obsolete / Not required (moved to D023 IG). [ESA RID 101 PBU-CS-015, Action A-CS-003]
D018-COM-FUN-2570	Removed according to CSIDR TAS.I RID VV-003.
D018-COM-FUN-2620	Obsolete / Not required: This has to be understood as constraint for the systems which are designed to implement this CS specification. Moved to D023 CS Implementation Guidelines. (ESA RID CMO-CS-007, action A-CS-007)
D018-COM-FUN-2640	Rewording / Clarified Added at least 3 neighbour channels. TASI RID AF-001
D018-COM-FUN-2660	Rewording / Clarified

PUID	Change Record
	Added hysteresis or filtering mechanisms clarification. TASI RID AF-002
D018-COM-FUN-2700	Rewording / Clarified Removed analysis reference. TASI RID AF-007
D018-COM-FUN-2710	Rewording / Clarified Deleted word "set" to clarify. TASI RID GP-014
D018-COM-FUN-2720	Rewording / Clarified Deleted word "set" to clarify. TASI RID GP-014
D018-COM-FUN-2860	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001; TAS-I RID CC-003]
D018-COM-FUN-2870	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001; TAS-I RID CC-004]
D018-COM-FUN-2880	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001; TAS-I RID CC-005]
D018-COM-FUN-2890	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001; TAS-I RID CC-006]
D018-COM-FUN-2900	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001]
D018-COM-FUN-2910	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001; TAS-I RID CC-007]
D018-COM-FUN-2930	Merged (included in D018-COM-FUN-2950). [TAS-I RID CC-009]

PUID	Change Record
D018-COM-FUN-2940	Merged (included in D018-COM-FUN-2960). [TAS-I RID CC-010]
D018-COM-FUN-2950	Rewording / Clarified (The word "permanently" has been removed). [ESA RID 127 CMO-CS-008, Action A-CS-008] (Added clarification of the concept "satellite clock error"). [TAS-I RID GP-017]
D018-COM-FUN-2960	Rewording / Clarified (The word "permanently" has been removed). [ESA RID 127 CMO-CS-008, Action A-CS-008] Rewording / Clarified. The second bulled has been reworded to be completely system independent [TAS-I RID GP-016].
D018-COM-FUN-2970	Rewording / Clarified (The bullet related to the initial transmission power has been reworded). [ESA RID 267 Minor SCO-CS-042]
D018-COM-FUN-3000	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001]
D018-COM-FUN-3020	Rewording / Clarified (Removed reference to ATM links). [ESA RID 267 Minor SCO-CS-041]
D018-COM-FUN-3060	Rewording / Clarified. [ESA RID 131 SCO-CS-004, Action A-CS-010]
D018-COM-FUN-3070	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001]
D018-COM-FUN-3080	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001]
D018-COM-FUN-3090	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001]
D018-COM-FUN-3100	Obsolete / Not required (moved to D023 IG). [ESA RID 85 PBU-IG-003, ESA Action A-IG-001]
D018-COM-FUN-3110	This requirement relates to Forward Link network synchronisation. Its verification is not supported by VTB as agreed during the working meeting held at INDRA premises on 9/11/2012.

PUID	Change Record
D018-COM-FUN-3120	This requirement relates to Forward Link network synchronisation. Its verification is not supported by VTB as agreed during the working meeting held at INDRA premises on 9/11/2012.
D018-COM-FUN-3140	Obsolete / Not required (Not required, already covered by D018-COM-FUN-3110 and D018-COM-FUN-3120).
D018-COM-FUN-3150	Obsolete / Not required (Not required, already covered by D018-COM-FUN-3110 and D018-COM-FUN-3120).
D018-COM-FUN-3190	Typo
D018-COM-FUN-3240	Rewording / Clarified (The word "continuously" has been removed). [ESA RID 127 CMO-CS-008, Action A-CS-008]
D018-COM-FUN-3330	Rewording / Clarified. TAS-I RID DQN-005
D018-COM-FUN-3340	Rewording / Clarified. Clarification added indicating that Link Quality relies on PER measurements. ESA RID 117 PBU-CS-019 A-CS-005 TAS-I RID DQN-006
D018-COM-FUN-3430	Typo Change GW to GS. TAS-I RID GP-022
D018-COM-FUN-3510	Obsolete / Not required: splitted into reqs from D018-COM-FUN-3520 to D018-COM-FUN-3750 (TAS-I RID GP-008)
D018-COM-FUN-3520	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3530	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3540	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3550	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3560	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3570	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3580	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3590	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3600	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)

PUID	Change Record
D018-COM-FUN-3610	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3620	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3630	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3640	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3650	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3660	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3670	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3680	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3690	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3700	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3710	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3720	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3730	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3740	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3750	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)
D018-COM-FUN-3760	Splitted: from D018-COM-FUN-3510 (TAS-I RID GP-008)

From draft01 to draft02 updated:

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-0010	D018-COM-FUN-0500	Moved and Updated	Rewording / Clarified	Wording and req section aligned with revised CS interface definition.
CSREQ-0011	D018-COM-FUN-0510	New	Analysis update	Address resolution analyses
CSREQ-0015	D018-COM-FUN-0530	New	Analysis update	Address resolution analyses
CSREQ-0020		Deleted	Obsolete / Not required	Already covered by CSREQ-0010
CSREQ-0030		Deleted	Obsolete / Not required	Already covered by CSREQ-0010
CSREQ-0040		Deleted	Obsolete / Not required	Already covered by CSREQ-0010
CSREQ-0050		Deleted	Obsolete / Not required	Already covered by CSREQ-0010
CSREQ-0060		Deleted	Obsolete / Not required	Already covered by CSREQ-0010
CSREQ-0065	D018-COM-ITF-0010	Unchanged		
CSREQ-0090		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0100		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0110		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0120		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0130		Deleted	Obsolete / Not required	Ground interface no longer covered by the CS
CSREQ-0140		Deleted	Obsolete / Not required	Ground interface no longer covered by the CS
CSREQ-0150		Deleted	Obsolete / Not required	Ground interface no longer covered by the CS
CSREQ-0160		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0170		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0180		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0190		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0200		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0210		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0220		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0230		Deleted	Obsolete / Not required	No need for voice interface with A-CDMA
CSREQ-0240		Deleted	Obsolete / Not required	Ground interface no longer covered by the CS
CSREQ-0260	D018-COM-ITF-0030	Updated	Rewording / Clarified	Added TBC
CSREQ-0270	D018-COM-ITF-0040	Updated	Rewording / Clarified	Added TBC. Updated entry on ATN OSI.

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-0275		Deleted	Obsolete / Not required	Avoid unnecessary restrictions. To be moved to guidelines.
CSREQ-0280	D018-COM-ITF-0050	Updated	Rewording / Clarified	Added TBC
CSREQ-0290	D018-COM-FUN-0670	Moved and Updated	Rewording / Clarified	Wording and req section aligned with revised CS interface definition.
CSREQ-0291	D018-COM-FUN-0680	New	Analysis update	More implementation independent version of a number of reqs (see reference in comments to other reqs).
CSREQ-0292	D018-COM-FUN-0690	New	Analysis update	More implementation independent version of a number of reqs (see reference in comments to other reqs).
CSREQ-0300		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-0310		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-0320		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0290.
CSREQ-0340		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-3098.
CSREQ-0350		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS).
CSREQ-0360		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-0370		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-0380		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0290.
CSREQ-0400		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0290.
CSREQ-0410		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0290.
CSREQ-0420		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-3098.

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-0430		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS).
CSREQ-0440		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-0450		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-0460		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0290.
CSREQ-0470		Deleted	Obsolete / Not required	Ground interface no longer covered by the CS
CSREQ-0480		Deleted	Obsolete / Not required	Ground interface no longer covered by the CS
CSREQ-0490		Deleted	Merged	Merged with CSREQ-0270
CSREQ-0500	D018-COM-FUN-0660	Moved and Updated	Rewording / Clarified	Wording and req section aligned with revised CS interface definition.
CSREQ-0510	D018-COM-FUN-0550	Moved and Updated	Rewording / Clarified	Wording and req section aligned with revised CS interface definition.
CSREQ-0511	D018-COM-FUN-0560	New	Analysis update	Refinement of legacy mode
CSREQ-0512	D018-COM-FUN-0570	New	Analysis update	Refinement of legacy mode
CSREQ-0520		Deleted	Obsolete / Not required	Already covered by CSREQ-0510
CSREQ-0530		Deleted	Obsolete / Not required	Removed (internal GS interface, not covered by the CS).
CSREQ-0540		Deleted	Obsolete / Not required	Already covered by CSREQ-0510
CSREQ-0550		Deleted	Obsolete / Not required	Already covered by CSREQ-0510
CSREQ-0560		Deleted	Analysis update	No support for legacy conversion mode.
CSREQ-0570		Deleted	Analysis update	No support for legacy conversion mode.
CSREQ-0580		Deleted	Analysis update	No support for legacy conversion mode.
CSREQ-0590		Deleted	Analysis update	No support for legacy conversion mode.
CSREQ-0600		Deleted	Analysis update	No support for Iris mode.
CSREQ-0620		Deleted	Analysis update	No support for Iris mode.
CSREQ-0630		Deleted	Analysis update	No support for Iris mode.
CSREQ-0640		Deleted	Analysis update	No support for Iris mode.
CSREQ-0650		Deleted	Analysis update	No support for Iris mode.
CSREQ-0660		Deleted	Analysis update	No support for Iris mode.
CSREQ-0670		Deleted	Analysis update	No support for Iris mode.
CSREQ-0680		Deleted	Analysis update	No support for Iris mode.
CSREQ-0700		Deleted	Analysis update	No support for Iris mode.
CSREQ-0710		Deleted	Analysis update	No support for Iris mode.
CSREQ-0720		Deleted	Analysis update	No support for Iris mode.

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-0730		Deleted	Analysis update	No support for Iris mode.
CSREQ-0740		Deleted	Analysis update	No support for Iris mode.
CSREQ-0750		Deleted	Analysis update	No support for Iris mode.
CSREQ-0760		Deleted	Analysis update	No support for Iris mode.
CSREQ-0770	D018-COM-FUN-0060	Unchanged		
CSREQ-0790	D018-COM-FUN-0070	Updated	Analysis update	TBC removed
CSREQ-0800	D018-COM-FUN-0080	Unchanged		
CSREQ-0810	D018-COM-FUN-0090	Updated	Rewording / Clarified	Super frame definition removed as it is not required.
CSREQ-6000		Deleted	Obsolete / Not required	It is not required to specify the number of slots per frame, the UT does not need it and it is system dependent.
CSREQ-6005		Deleted	Obsolete / Not required	Super frame definition removed as it is not required.
CSREQ-0820	D018-COM-FUN-0100	Unchanged		
CSREQ-0830	D018-COM-FUN-0110	Unchanged		
CSREQ-0840	D018-COM-FUN-0120	Updated	Rewording / Clarified	
CSREQ-0850	D018-COM-FUN-0130	Unchanged		
CSREQ-0860	D018-COM-FUN-0140	Unchanged		
CSREQ-5780	D018-COM-FUN-0150	Updated	Analysis update	TBC removed
CSREQ-0870	D018-COM-FUN-0160	Updated	Analysis update	Guard bands updated
CSREQ-0880	D018-COM-FUN-0170	Unchanged		
CSREQ-0900	D018-COM-FUN-0180	Unchanged		
CSREQ-0930	D018-COM-FUN-0190	Unchanged		
CSREQ-0940	D018-COM-FUN-0200	Unchanged		
CSREQ-0960	D018-COM-FUN-0210	Unchanged		
CSREQ-5790	D018-COM-FUN-0220	Updated	Analysis update	TBC removed
CSREQ-0980	D018-COM-FUN-0230	Updated	Analysis update	Guard bands updated
CSREQ-0990	D018-COM-FUN-0240	Unchanged		
CSREQ-1000	D018-COM-FUN-0250	Unchanged		
CSREQ-1010	D018-COM-FUN-0260	Unchanged		
CSREQ-1020		Deleted	Obsolete / Not required	Already covered by CSREQ-1010 (bi-directional).
CSREQ-1030	D018-COM-FUN-0270	Unchanged		
CSREQ-1040	D018-COM-FUN-0280	Unchanged		
CSREQ-1050	D018-COM-FUN-0290	Updated	Nomenclature change	UCCH is now bi-directional
CSREQ-1060		Deleted	Obsolete / Not required	UCCH is now bi-directional (CSREQ-1050)
CSREQ-1070		Deleted	Obsolete / Not required	UCCH is now bi-directional (CSREQ-1050)
CSREQ-1080		Deleted	Obsolete / Not required	UCCH is now bi-directional (CSREQ-1050)
CSREQ-1110	D018-COM-FUN-0300	Unchanged		
CSREQ-1120	D018-COM-FUN-0310	Unchanged		

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-2020	D018-COM-FUN-0320	Moved and Updated	Analysis update	Guard time updated
CSREQ-1190	D018-COM-FUN-0330	Unchanged		
CSREQ-1200	D018-COM-FUN-0340	Unchanged		
CSREQ-1210	D018-COM-FUN-0350	Unchanged		
CSREQ-1280	D018-COM-FUN-0360	Updated	Nomenclature change	UCCH is now bi-directional (CSREQ-1050)
CSREQ-1300	D018-COM-FUN-0370	Unchanged		
CSREQ-1310	D018-COM-FUN-0380	Unchanged		
CSREQ-1320	D018-COM-FUN-0390	Updated	Rewording / Clarified	Clarified bit numbering interpretation
CSREQ-1330	D018-COM-FUN-0400	Unchanged		
CSREQ-1340	D018-COM-FUN-0410	Unchanged		
CSREQ-1350	D018-COM-FUN-0420	Unchanged		
CSREQ-1360	D018-COM-FUN-0430	Unchanged		
CSREQ-1370	D018-COM-FUN-0440	Unchanged		
CSREQ-1380	D018-COM-FUN-0450	Unchanged		
CSREQ-1390	D018-COM-FUN-0460	Unchanged		
CSREQ-1400	D018-COM-FUN-0470	Unchanged		
CSREQ-1410	D018-COM-FUN-0480	Unchanged		
CSREQ-6020		Deleted	Obsolete / Not required	Unnecessary requirement (negative statement: "shall not")
CSREQ-6030		Deleted	Obsolete / Not required	Unnecessary requirement (negative statement: "shall not")
CSREQ-6040	D018-COM-SEC-0490	Unchanged		
CSREQ-1420	D018-COM-FUN-0520	Moved and Updated	Analysis update	Address resolution analyses
CSREQ-1425	D018-COM-FUN-0540	Moved	Rewording / Clarified	Placed in adequate section.
CSREQ-1430		Deleted	Analysis update	Diffserv can not provide the guaranteed QoS required for applications, so it has been discarded.
CSREQ-1440		Deleted	Analysis update	Diffserv can not provide the guaranteed QoS required for applications, so it has been discarded.
CSREQ-1450		Deleted	Analysis update	Diffserv can not provide the guaranteed QoS required for applications, so it has been discarded.
CSREQ-1460		Deleted	Analysis update	Diffserv can not provide the guaranteed QoS required for applications, so it has been discarded.
CSREQ-1461	D018-COM-FUN-0580	New	Analysis update	
CSREQ-1462	D018-COM-FUN-0590	New	Analysis update	
CSREQ-1468	D018-COM-FUN-0600	New	Splitted	Extracted from CSREQ-1470. ROHC may be optional at UT level
CSREQ-1469	D018-COM-FUN-0610	New	Splitted	Extracted from CSREQ-1470. ROHC shall be mandatory at GS level

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-1470	D018-COM-FUN-0620	Updated	Splitted	Added requirements CSREQ-1468 and CSREQ-1469.
CSREQ-1471	D018-COM-FUN-0630	New	Analysis update	Detailed ROHC configuration parameters
CSREQ-1472	D018-COM-FUN-0640	New	Analysis update	Detailed ROHC configuration parameters
CSREQ-1473	D018-COM-FUN-0650	New	Analysis update	Detailed ROHC configuration parameters
CSREQ-1480		Deleted	Obsolete / Not required	Unnecessary requirement (negative statement: "shall not")
CSREQ-1490		Deleted	Analysis update	Replaced by requirements CSREQ-0511 and CSREQ-0512
CSREQ-1500	D018-COM-FUN-0700	Updated	Analysis update	ATN/OSI supports single CoS
CSREQ-1510	D018-COM-FUN-0710	Unchanged		
CSREQ-1520		Deleted	Obsolete / Not required	Already covered by CSREQ-1510
CSREQ-1530		Deleted	Obsolete / Not required	Unnecessary requirement ("should" statement).
CSREQ-1540	D018-COM-FUN-0720	Updated	Analysis update	Remove of RL references. Presence of Fragment Counter only required in fragmented packets.
CSREQ-1545	D018-COM-FUN-0730	Updated	Analysis update	Definition of the ARQ ACK packet format to fragments received in the FL.
CSREQ-1549	D018-COM-FUN-0740	New	Analysis update	Definition of the FL ARQ characteristics.
CSREQ-1550	D018-COM-FUN-0750	Updated	Analysis update	Definition of the FL ARQ algorithm at transmitter end. Splittedfrom CSREQ-1550
CSREQ-1551	D018-COM-FUN-0760	New	Splitted	Definition of the FL ARQ algorithm at receiver end. Splitted from CSREQ-1550
CSREQ-1560	D018-COM-FUN-0770	Unchanged		
CSREQ-1565	D018-COM-FUN-0780	New	Analysis update	Statement of a encapsulator requirement (max LPDU size) for LPDUs requiring ARQ support.
CSREQ-1570	D018-COM-FUN-0790	Unchanged		
CSREQ-1580	D018-COM-FUN-0800	Unchanged		
CSREQ-1590	D018-COM-FUN-0810	Unchanged		
CSREQ-1595	D018-COM-FUN-0820	New	Analysis update	Derived from GSE standard
CSREQ-1610	D018-COM-FUN-0830	Updated	Analysis update	Includes rewording. Modifications derived from the integration with ARQ field (CSREQ-1540)
CSREQ-1711	D018-COM-FUN-0840	Unchanged		
CSREQ-1720	D018-COM-FUN-0850	Updated	Analysis update	Added QPSK 1/4
CSREQ-1712	D018-COM-FUN-0860	Updated	Analysis update	Added functional modules for the burst waveform generation
CSREQ-1710	D018-COM-FUN-0870	Updated	Analysis update	
CSREQ-1731	D018-COM-FUN-0880	Updated	Typo	
CSREQ-1732	D018-COM-FUN-0890	Unchanged		

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-1740	D018-COM-FUN-0900	Updated	Nomenclature change	
CSREQ-1730	D018-COM-ITF-0910	Updated	Rewording / Clarified	
CSREQ-1760	D018-COM-ITF-0920	Updated	Analysis update	Added QPSK 1/4 and Maximum PSDU size update
CSREQ-1761	D018-COM-FUN-0930	Unchanged		
CSREQ-1762		Deleted	Merged	Merged with CSREQ-1770
CSREQ-1770	D018-COM-FUN-1000	Updated	Analysis update	Update of FWD Data Descriptor fields and merged with CSREQ-1762
CSREQ-6050		Deleted	Analysis update	FWD_Alternate_Descriptor field has been removed from FWD_DD. No need to include the FWD_Alternate_Descriptor_flag
CSREQ-1810	D018-COM-FUN-1010	Updated	Rewording / Clarified	
CSREQ-1808	D018-COM-FUN-1020	New	Analysis update	GS field specification (part of FWD_DD header)
CSREQ-1809	D018-COM-FUN-1030	New	Analysis update	SYNC field specification (part of FWD_DD header)
CSREQ-1811	D018-COM-FUN-1040	Updated	Nomenclature change	
CSREQ-1812	D018-COM-FUN-1050	Updated	Nomenclature change	
CSREQ-1820		Deleted	Merged	Merged with CSREQ-1830
CSREQ-1830	D018-COM-FUN-1060	Updated	Merged	Merged with CSREQ-1820
CSREQ-2030		Deleted	Merged	Merged with CSREQ-2040
CSREQ-2040	D018-COM-FUN-1070	Updated	Merged	Merged with CSREQ-2030
CSREQ-2041	D018-COM-FUN-1080	Unchanged		
CSREQ-2051	D018-COM-FUN-1090	Updated	Rewording / Clarified	
CSREQ-2052	D018-COM-FUN-1100	Unchanged		
CSREQ-2050	D018-COM-FUN-1110	Updated	Rewording / Clarified	
CSREQ-2060	D018-COM-FUN-1120	Updated	Analysis update	Added shift register for binary pseudo-random sequence generation
CSREQ-2061	D018-COM-FUN-1130	New	Analysis update	
CSREQ-6071	D018-COM-FUN-1140	Unchanged		
CSREQ-6072	D018-COM-FUN-1150	Unchanged		
CSREQ-6070	D018-COM-FUN-1160	Updated	Analysis update	Added QPSK 1/4
CSREQ-6080	D018-COM-FUN-1170	Unchanged		
CSREQ-2080	D018-COM-FUN-1180	Unchanged		
CSREQ-2090	D018-COM-FUN-1190	Updated	Nomenclature change	
CSREQ-2110	D018-COM-FUN-1200	Updated	Rewording / Clarified	Included procedure the compute the LDPC parity bits (in a former version was included in an Annex)
CSREQ-2120		Deleted	Analysis update	Puncturing not required.
CSREQ-7260		Deleted	Analysis update	Puncturing not required.
CSREQ-2130	D018-COM-FUN-1210	Updated	Analysis update	Added QPSK 1/4
CSREQ-6160	D018-COM-FUN-1220	Unchanged		

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6170	D018-COM-FUN-1230	Unchanged		
CSREQ-6180	D018-COM-FUN-1240	Unchanged		
CSREQ-2141	D018-COM-FUN-1250	Unchanged		
CSREQ-2142	D018-COM-FUN-1260	Unchanged		
CSREQ-2140	D018-COM-FUN-1270	Unchanged		
CSREQ-6200	D018-COM-FUN-1280	Updated	Analysis update	Added QPSK 1/4
CSREQ-6100	D018-COM-FUN-1290	Unchanged		
CSREQ-2150	D018-COM-FUN-1300	Updated	Rewording / Clarified	
CSREQ-2160		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-2170	D018-COM-FUN-1310	Updated	Rewording / Clarified	
CSREQ-2180		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-2190	D018-COM-FUN-1320	Unchanged		
CSREQ-2200	D018-COM-FUN-1330	Updated	Rewording / Clarified	
CSREQ-2210	D018-COM-FUN-1340	Unchanged		
CSREQ-2220		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-6211	D018-COM-FUN-1350	Unchanged		
CSREQ-6212	D018-COM-FUN-1360	Updated	Nomenclature change	
CSREQ-6210	D018-COM-FUN-1370	Updated	Analysis update	Added QPSK 1/4
CSREQ-6230	D018-COM-FUN-1380	Unchanged		
CSREQ-6240	D018-COM-FUN-1390	Unchanged		
CSREQ-1941	D018-COM-FUN-1400	New	Analysis update	FWD Burst Descriptor construction and insertion
CSREQ-1940	D018-COM-FUN-1410	Moved and Updated	Analysis update	FWD Burst Descriptor construction and insertion
CSREQ-1950	D018-COM-FUN-1420	Moved and Updated	Analysis update	MODCOD Id coding (FWD Burst Descriptor)
CSREQ-1970	D018-COM-FUN-1430	Moved and Updated	Analysis update	FWD Burst Descriptor encoding specification
CSREQ-1971	D018-COM-FUN-1440	Moved and Updated	Analysis update	FWD_BD modulation format specification
CSREQ-1972	D018-COM-FUN-1450	Moved and Updated	Analysis update	FWD_BD insertion
CSREQ-2021	D018-COM-FUN-1460	Updated	Analysis update	
CSREQ-2022	D018-COM-FUN-1470	Updated	Analysis update	
CSREQ-1981	D018-COM-FUN-1480	Updated	Analysis update	Pilot symbols specification
CSREQ-1980	D018-COM-FUN-1490	Updated	Analysis update	Pilot symbols insertion
CSREQ-1990		Deleted	Merged	Merged with CSREQ-1982
CSREQ-6150		Deleted	Merged	Merged with CSREQ-1982
CSREQ-1900	D018-COM-FUN-1500	Moved and Updated	Analysis update	
CSREQ-1901	D018-COM-FUN-1510	Updated	Analysis update	
CSREQ-1910		Deleted	Merged	Merged with CSREQ-1900
CSREQ-1902		Deleted	Analysis update	POSTAMBLE not required
CSREQ-1903		Deleted	Analysis update	POSTAMBLE not required

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-1904		Deleted	Analysis update	POSTAMBLE not required
CSREQ-1905	D018-COM-FUN-1520	New	Analysis update	Physical layer scrambling spcification
CSREQ-1906	D018-COM-FUN-1530	New	Analysis update	Physical layer scrambling spcification
CSREQ-1907	D018-COM-FUN-1540	New	Analysis update	Physical layer scrambling spcification
CSREQ-1908	D018-COM-FUN-1550	New	Analysis update	Physical layer scrambling spcification
CSREQ-2010	D018-COM-FUN-1560	Updated	Nomenclature change	
CSREQ-2230	D018-COM-FUN-1570	Unchanged		
CSREQ-2240	D018-COM-FUN-1580	Unchanged		
CSREQ-2250	D018-COM-FUN-1590	Updated	Typo	
CSREQ-2255	D018-COM-PER-1600	New	Analysis update	L1 performance requirements
CSREQ-6470	D018-COM-FUN-1610	Updated	Analysis update	Clarifications on the description of the parameters. Fixed typo in the definition of the mean value of the exponential distribution. Update of the ALOHA State Machine.
CSREQ-6480	D018-COM-FUN-1620	Updated	Rewording / Clarified	
CSREQ-6490	D018-COM-FUN-1630	Updated	Analysis update	Nomenclature change. Addition of queue priorities
CSREQ-6492	D018-COM-FUN-1640	Updated	Analysis update	Statement of the strategy to follow upon expiration timeout. Drop the whole LSDU.
CSREQ-6494	D018-COM-FUN-1650	Updated	Analysis update	Statement of the strategy for in-order reassembly of LSDUs.
CSREQ-6496	D018-COM-FUN-1660	Unchanged		
CSREQ-6498	D018-COM-FUN-1670	Updated	Analysis update	Definition of the information to be send in the ARQ ACKs for LPDUs received in the FL.
CSREQ-6500	D018-COM-FUN-1680	Unchanged		
CSREQ-6510	D018-COM-FUN-1690	Updated	Analysis update	Definition of the RL ARQ protocol.
CSREQ-6520	D018-COM-FUN-1700	Unchanged		
CSREQ-6525	D018-COM-FUN-1710	Unchanged		
CSREQ-6530	D018-COM-FUN-1720	Unchanged		
CSREQ-2260	D018-COM-FUN-1730	Unchanged		
CSREQ-2270	D018-COM-FUN-1740	Unchanged		
CSREQ-2280	D018-COM-FUN-1750	Unchanged		
CSREQ-2290	D018-COM-FUN-1760	Unchanged		
CSREQ-2295	D018-COM-FUN-1770	New	Analysis update	Derived from GSE standard
CSREQ-2310	D018-COM-FUN-1780	Unchanged		
CSREQ-2320	D018-COM-FUN-1790	Unchanged		
CSREQ-2321	D018-COM-FUN-1800	Updated	Rewording / Clarified	Nomenclature change as well
CSREQ-2640	D018-COM-FUN-1810	Updated	Nomenclature change	

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6540	D018-COM-FUN-1820	Updated	Analysis update	Addition of a new RACH configuration, TBC removal, nomenclature change.
CSREQ-2661	D018-COM-FUN-1830	Updated	Typo	
CSREQ-2662	D018-COM-FUN-1840	Updated	Nomenclature change	Typo correction and nomenclature change as well
CSREQ-2660	D018-COM-FUN-1850	Unchanged		
CSREQ-2650	D018-COM-ITF-1860	Updated	Rewording / Clarified	
CSREQ-2680	D018-COM-ITF-1870	Updated	Analysis update	Addition of a new RACH configuration, TBC removal, nomenclature change.
CSREQ-2691	D018-COM-FUN-1880	Unchanged		
CSREQ-2692		Deleted	Merged	Merged to CSREQ-2690
CSREQ-2690	D018-COM-FUN-1890	Updated	Analysis update	
CSREQ-6550		Deleted	Obsolete / Not required	Not required after update of CSREQ-2690
CSREQ-2730	D018-COM-FUN-1900	Updated	Rewording / Clarified	
CSREQ-2741	D018-COM-FUN-1910	Updated	Rewording / Clarified	
CSREQ-2742	D018-COM-FUN-1920	Updated	Rewording / Clarified	Nomenclature change as well
CSREQ-2740		Deleted	Merged	Merged to CSREQ-2750
CSREQ-2750	D018-COM-FUN-1930	Updated	Rewording / Clarified	Nomenclature change as well
CSREQ-2760	D018-COM-FUN-1940	Updated	Rewording / Clarified	Removed reference to a deleted requirement
CSREQ-2911	D018-COM-FUN-1950	Updated	Rewording / Clarified	
CSREQ-2912	D018-COM-FUN-1960	Updated	Nomenclature change	
CSREQ-2910	D018-COM-FUN-1970	Updated	Rewording / Clarified	
CSREQ-2920	D018-COM-FUN-1980	Updated	Analysis update	Added specification on how to generate the base-band scrambling sequence
CSREQ-2921	D018-COM-FUN-1990	New	Analysis update	Added specification on how to generate the base-band scrambling sequence
CSREQ-2781	D018-COM-FUN-2000	Unchanged		
CSREQ-2782	D018-COM-FUN-2010	Updated	Nomenclature change	
CSREQ-2780	D018-COM-FUN-2020	Updated	Nomenclature change	
CSREQ-2940	D018-COM-FUN-2030	Unchanged		
CSREQ-2960	D018-COM-FUN-2040	Updated	Nomenclature change	
CSREQ-2970	D018-COM-FUN-2050	Unchanged		
CSREQ-3010	D018-COM-FUN-2060	Updated	Merged	The content of an annex has been moved inside the requirement content.

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6660	D018-COM-FUN-2070	Updated	Analysis update	Addition of a new RACH configuration and nomenclature change.
CSREQ-3030	D018-COM-FUN-2080	Updated	Analysis update	Addition of a new RACH configuration and typo correction.
CSREQ-6670	D018-COM-FUN-2090	Unchanged		
CSREQ-6680	D018-COM-FUN-2100	Unchanged		
CSREQ-6690	D018-COM-FUN-2110	Unchanged		
CSREQ-6601	D018-COM-FUN-2120	Updated	Rewording / Clarified	
CSREQ-6600	D018-COM-FUN-2130	Updated	Rewording / Clarified	Nomenclature change as well
CSREQ-6610	D018-COM-FUN-2140	Updated	Analysis update	Addition of a new RACH configuration, TBC removal, nomenclature change.
CSREQ-6611	D018-COM-FUN-2150	Updated	Analysis update	Added specification on how to generate the Auxiliary Channel pilot sequence
CSREQ-6701	D018-COM-FUN-2160	Unchanged		
CSREQ-6702	D018-COM-FUN-2170	Updated	Nomenclature change	
CSREQ-6703	D018-COM-FUN-2180	Unchanged		
CSREQ-6700	D018-COM-FUN-2190	Updated	Rewording / Clarified	
CSREQ-6711	D018-COM-FUN-2200	Unchanged		
CSREQ-6712	D018-COM-FUN-2210	Updated	Nomenclature change	
CSREQ-6710	D018-COM-FUN-2220	Updated	Nomenclature change	
CSREQ-6720	D018-COM-FUN-2230	Updated	Nomenclature change	
CSREQ-6730	D018-COM-FUN-2240	Updated	Analysis update	TBC removed
CSREQ-6740	D018-COM-FUN-2250	Updated	Typo	
CSREQ-6750	D018-COM-FUN-2260	Updated	Typo	
CSREQ-6770	D018-COM-FUN-2270	Updated	Nomenclature change	Typo correction as well
CSREQ-6780	D018-COM-FUN-2280	Unchanged		
CSREQ-6790	D018-COM-FUN-2290	Updated	Analysis update	Added specification of the RTN_DCH channelisation code
CSREQ-6800	D018-COM-FUN-2300	Updated	Analysis update	Added specification of the RTN_ACH channelisation code
CSREQ-6810	D018-COM-FUN-2310	Updated	Rewording / Clarified	
CSREQ-6815	D018-COM-FUN-2320	New	Analysis update	Added specification of the complex scrambling
CSREQ-6820	D018-COM-FUN-2330	Updated	Analysis update	Added specification of the complex scrambling
CSREQ-6830		Deleted	Obsolete / Not required	Not applicable anymore after addition of CSREQ-6815
CSREQ-6840	D018-COM-FUN-2340	Updated	Analysis update	Addition of a new RACH configuration.

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6570	D018-COM-FUN-2350	Moved and Updated	Analysis update	Addition of a new RACH configuration, TBC removal, nomenclature change.
CSREQ-6571	D018-COM-FUN-2360	New	Analysis update	Added specification of the RTN_PREAMBLE generation
CSREQ-6585	D018-COM-FUN-2370	New	Analysis update	The preamble spreading has been introduced as a new concept
CSREQ-6590	D018-COM-FUN-2380	Moved and Updated	Analysis update	Added specificaton on how to implement the preamble spreading
CSREQ-6592	D018-COM-FUN-2390	New	Analysis update	Added preamble channelisation code assignment
CSREQ-6594	D018-COM-FUN-2400	New	Analysis update	Added preamble gain factor specification
CSREQ-2801	D018-COM-FUN-2410	Updated	Nomenclature change	
CSREQ-2802	D018-COM-FUN-2420	Updated	Rewording / Clarified	Nomenclature change as well
CSREQ-3070	D018-COM-FUN-2430	Unchanged		
CSREQ-3080	D018-COM-FUN-2440	Unchanged		
CSREQ-3090	D018-COM-FUN-2450	Updated	Typo	Figure correction: "X" changes by "+"
CSREQ-3095	D018-COM-PER-2460	New	Analysis update	
CSREQ-3089	D018-COM-FUN-2480	New	Analysis update	Based on logon analyses
CSREQ-3091	D018-COM-FUN-2490	New	Analysis update	Based on logon analyses
CSREQ-3092	D018-COM-FUN-2500	New	Analysis update	Based on logon analyses
CSREQ-3093	D018-COM-FUN-2510	New	Analysis update	Based on logon analyses
CSREQ-3094	D018-COM-FUN-2520	New	Analysis update	Based on logon analyses
CSREQ-3096	D018-COM-FUN-2530	New	Analysis update	Based on logon analyses
CSREQ-3097	D018-COM-FUN-2540	New	Analysis update	Based on logon analyses
CSREQ-3098	D018-COM-FUN-2550	New	Analysis update	Based on logon analyses
CSREQ-3099	D018-COM-FUN-2560	New	Analysis update	Based on logon analyses
CSREQ-7270	D018-COM-FUN-2470	Updated	Analysis update	Based on RTN MAC refinements
CSREQ-3100		Deleted	Merged	Covered by CSREQ-3098
CSREQ-3110		Deleted	Merged	Covered by CSREQ-3098
CSREQ-3120		Deleted	Obsolete / Not required	No need for synchro
CSREQ-3130		Deleted	Merged	Covered by CSREQ-3098
CSREQ-3135		Deleted	Merged	Covered by CSREQ-3098
CSREQ-3140		Deleted	Merged	Covered by CSREQ-3089
CSREQ-3150		Deleted	Merged	Covered by CSREQ-3098
CSREQ-6250	D018-COM-FUN-2570	Unchanged		
CSREQ-6255		Deleted	Obsolete / Not required	LOGON CONFIRM message is no longer required
CSREQ-3160	D018-COM-FUN-2580	Moved and Updated	Rewording / Clarified	Wording
CSREQ-3180		Deleted	Obsolete / Not required	Requirement specified actions internal to the GS
CSREQ-3190		Deleted	Merged	Covered by CSREQ-3213
CSREQ-3210	D018-COM-FUN-2590	Unchanged		
CSREQ-3211	D018-COM-FUN-2600	New	Analysis update	Based on logon analyses
CSREQ-3212	D018-COM-FUN-2610	New	Analysis update	Based on logon analyses
CSREQ-3215	D018-COM-FUN-2620	New	Analysis update	

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-3220	D018-COM-FUN-2630	Updated	Rewording / Clarified	
CSREQ-3230	D018-COM-FUN-2640	Updated	Rewording / Clarified	
CSREQ-3225	D018-COM-FUN-2650	Updated	Rewording / Clarified	
CSREQ-3240	D018-COM-FUN-2660	Updated	Rewording / Clarified	
CSREQ-3245	D018-COM-FUN-2670	New	Analysis update	
CSREQ-3250	D018-COM-FUN-2680	Updated	Rewording / Clarified	
CSREQ-3260	D018-COM-FUN-2690	Unchanged		
CSREQ-3270	D018-COM-FUN-2700	Updated	Analysis update	
CSREQ-3280		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3290		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3300	D018-COM-FUN-2710	Updated	Rewording / Clarified	
CSREQ-3310	D018-COM-FUN-2720	Updated	Rewording / Clarified	
CSREQ-3320		Deleted	Obsolete / Not required	
CSREQ-3311	D018-COM-FUN-2730	New	Analysis update	
CSREQ-3312	D018-COM-FUN-2740	New	Analysis update	
CSREQ-3313	D018-COM-FUN-2750	New	Analysis update	
CSREQ-3330		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3340		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3350		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3360		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3370		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3380		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3390		Deleted	Merged	Generic, affects CSREQ-3331 to CSREQ-3334
CSREQ-3400		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3410		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3420		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3430		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3440		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3450		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3460		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3470		Deleted	Merged	Merged into CSREQ-3332
CSREQ-3480		Deleted	Merged	Merged into CSREQ-3331
CSREQ-3490		Deleted	Merged	Merged into CSREQ-3331
CSREQ-3500		Deleted	Merged	Merged into CSREQ-3331

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-3510		Deleted	Merged	Merged into CSREQ-3331
CSREQ-3520		Deleted	Merged	Merged into CSREQ-3331
CSREQ-3530		Deleted	Merged	Merged into CSREQ-3331
CSREQ-3540		Deleted	Merged	Merged into CSREQ-3331
CSREQ-3550		Deleted	Merged	Merged into CSREQ-3333
CSREQ-3560		Deleted	Merged	Merged into CSREQ-3333
CSREQ-3570		Deleted	Merged	Merged into CSREQ-3333
CSREQ-3580		Deleted	Merged	Merged into CSREQ-3333
CSREQ-3590		Deleted	Merged	Merged into CSREQ-3333
CSREQ-3600		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3610		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3620		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3630		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3640		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3650		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3660		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3670		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3680		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3690		Deleted	Obsolete / Not required	TBC after non-nominal case analysis
CSREQ-3700		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3710		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3720		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3730		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3740		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3750		Deleted	Merged	Merged into CSREQ-3334
CSREQ-3331	D018-COM-FUN-2760	New	Merged	
CSREQ-3332	D018-COM-FUN-2770	New	Merged	
CSREQ-3333	D018-COM-FUN-2780	New	Merged	
CSREQ-3334	D018-COM-FUN-2790	New	Merged	
CSREQ-3751	D018-COM-FUN-2800	New	Analysis update	
CSREQ-3752	D018-COM-FUN-2810	New	Analysis update	
CSREQ-3753	D018-COM-FUN-2820	New	Analysis update	
CSREQ-3760	D018-COM-FUN-2830	Unchanged		
CSREQ-3770	D018-COM-FUN-2840	Unchanged		
CSREQ-3780	D018-COM-FUN-2850	Unchanged		
CSREQ-3790	D018-COM-FUN-2860	Unchanged		
CSREQ-3800	D018-COM-FUN-2870	Unchanged		
CSREQ-3810	D018-COM-FUN-2880	Unchanged		
CSREQ-6860	D018-COM-FUN-2890	Unchanged		
CSREQ-3820	D018-COM-FUN-2900	Unchanged	Error	Deletion not agreed. To be restored in the next version
CSREQ-6880	D018-COM-FUN-2910	Updated	Typo	
CSREQ-6260	D018-COM-FUN-2920	Updated	Rewording / Clarified	
CSREQ-3860	D018-COM-FUN-2930	Updated	Rewording / Clarified	
CSREQ-6270	D018-COM-FUN-2940	Updated	Rewording / Clarified	

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-3822	D018-COM-FUN-2950	New	Analysis update	Added specification of GS elements network synchronisation procedures
CSREQ-3825	D018-COM-FUN-2960	New	Analysis update	Added specification of GS elements network synchronisation procedures
CSREQ-3826	D018-COM-FUN-2970	New	Analysis update	Added specification of GS elements network synchronisation procedures
CSREQ-3827	D018-COM-FUN-2980	New	Analysis update	Added specification of GS elements network synchronisation procedures
CSREQ-3828	D018-COM-FUN-2990	New	Analysis update	Added specification of GS elements network synchronisation procedures
CSREQ-3830	D018-COM-FUN-3000	Unchanged		
CSREQ-3870	D018-COM-FUN-3010	Unchanged		
CSREQ-3840	D018-COM-FUN-3020	Updated	Rewording / Clarified	
CSREQ-3841	D018-COM-FUN-3030	Unchanged		
CSREQ-3842	D018-COM-FUN-3040	Updated	Rewording / Clarified	
CSREQ-3850	D018-COM-FUN-3050	Unchanged		
CSREQ-6890	D018-COM-FUN-3060	Updated	Rewording / Clarified	
CSREQ-6900		Deleted	Obsolete / Not required	Not required after removing the option to implement fwd link network synchr. by means of a remote closed loop between GS elemenst and NCC
CSREQ-3875	D018-COM-FUN-3070	Unchanged		
CSREQ-3880	D018-COM-FUN-3080	Unchanged		
CSREQ-3890	D018-COM-FUN-3090	Unchanged		
CSREQ-6290	D018-COM-FUN-3100	Unchanged		
CSREQ-3895	D018-COM-FUN-3110	New	Analysis update	
CSREQ-3900	D018-COM-FUN-3120	Updated	Rewording / Clarified	
CSREQ-3905	D018-COM-FUN-3130	New	Analysis update	
CSREQ-3910	D018-COM-FUN-3140	Unchanged		
CSREQ-3920	D018-COM-FUN-3150	Unchanged		
CSREQ-3930	D018-COM-FUN-3160	Updated	Rewording / Clarified	
CSREQ-3940	D018-COM-FUN-3170	Updated	Rewording / Clarified	
CSREQ-3950	D018-COM-FUN-3180	Updated	Rewording / Clarified	
CSREQ-3960	D018-COM-FUN-3190	Updated	Rewording / Clarified	
CSREQ-4000	D018-COM-FUN-3200	Updated	Rewording / Clarified	
CSREQ-4005	D018-COM-FUN-3210	Unchanged		
CSREQ-4006	D018-COM-FUN-3220	New	Analysis update	
CSREQ-4007	D018-COM-FUN-3230	New	Analysis update	
CSREQ-4008	D018-COM-FUN-3240	New	Analysis update	
CSREQ-4009	D018-COM-FUN-3250	New	Analysis update	

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6910		Deleted	Analysis update	No need to implement any specific synchronisation procedure in the first access to the system
CSREQ-4010	D018-COM-FUN-3260	Updated	Rewording / Clarified	
CSREQ-4025		Deleted	Analysis update	No need to implement any specific synchronisation procedure in the first access to the system
CSREQ-4030		Deleted	Analysis update	No need to implement any specific synchronisation procedure in the first access to the system
CSREQ-4040		Deleted	Analysis update	No need to implement any specific synchronisation procedure in the first access to the system
CSREQ-6920		Deleted	Analysis update	No need to implement any specific synchronisation procedure in the first access to the system
CSREQ-6930		Deleted	Analysis update	No need to implement any specific synchronisation procedure in the first access to the system
CSREQ-4115	D018-COM-FUN-3270	Unchanged		
CSREQ-4120	D018-COM-FUN-3280	Unchanged		
CSREQ-4130		Deleted	Analysis update	No need to implement closed loop corrections
CSREQ-4140		Deleted	Analysis update	No need to implement closed loop corrections
CSREQ-4160		Deleted	Analysis update	No need to implement closed loop corrections
CSREQ-4170	D018-COM-FUN-3290	Updated	Rewording / Clarified	
CSREQ-4135	D018-COM-FUN-3300	Moved and updated	Rewording / Clarified	
CSREQ-4136	D018-COM-FUN-3310	New	Analysis update	
CSREQ-4137	D018-COM-FUN-3320	New	Analysis update	
CSREQ-5590	D018-COM-FUN-3330	Updated	Analysis update	
CSREQ-5592	D018-COM-FUN-3340	New	Analysis update	
CSREQ-5593	D018-COM-FUN-3350	New	Analysis update	
CSREQ-5594	D018-COM-FUN-3360	New	Analysis update	
CSREQ-5600		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-6940		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-6950		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-6960	D018-COM-FUN-3370	Unchanged		
CSREQ-6961	D018-COM-FUN-3380	New	Analysis update	
CSREQ-6962	D018-COM-FUN-3390	New	Analysis update	
CSREQ-6963	D018-COM-FUN-3400	New	Analysis update	
CSREQ-6970		Deleted	Obsolete / Not required	It is not a CS specification

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6980		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-6990		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7000		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7030		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7050		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7060		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7080		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7320		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7090		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7120		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7330		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7140		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7160		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7170		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7180		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-7190		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-4280	D018-COM-FUN-3410	Updated	Analysis update	Consolidation of the RL congestion control and ReTx parameters.
CSREQ-4282	D018-COM-FUN-3420	Updated	Rewording / Clarified	
CSREQ-4284	D018-COM-FUN-3430	Updated	Rewording / Clarified	
CSREQ-4286		Deleted	Obsolete / Not required	Moved to Guidelines
CSREQ-4288	D018-COM-FUN-3440	Updated	Analysis update	Statement of the minimum congestion control cadence from D021 Annex.
CSREQ-4289	D018-COM-FUN-3450	New	Analysis update	Statement of how terminal shall apply CC information generated by the GS.
CSREQ-4290	D018-COM-FUN-3460	Updated	Rewording / Clarified	
CSREQ-4380		Deleted	Obsolete / Not required	To be revised after redundancy analyses
CSREQ-4500		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-3098.

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-4510		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-3098.
CSREQ-4520		Deleted	Obsolete / Not required	Removed (internal GS interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-4530		Deleted	Obsolete / Not required	Removed (internal GS interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-4540		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-4550		Deleted	Obsolete / Not required	Removed (internal GS interface, not covered by the CS). It is now covered indirectly by CSREQ-0291 and CSREQ-0292.
CSREQ-4560		Deleted	Obsolete / Not required	Removed (internal GS interface, not covered by the CS). It is now covered indirectly by CSREQ-0291, CSREQ-0292 and CSREQ-0510.
CSREQ-4570		Deleted	Obsolete / Not required	Removed (internal aircraft interface, not covered by the CS). It is now covered indirectly by CSREQ-0291, CSREQ-0292 and CSREQ-0510.
CSREQ-4580		Deleted	Obsolete / Not required	Removed (internal GS interface, not covered by the CS). It is now covered indirectly by CSREQ-0291, CSREQ-0292 and CSREQ-0510.
CSREQ-4590		Deleted	Obsolete / Not required	Iris mode no longer supported.
CSREQ-4600		Deleted	Obsolete / Not required	Iris mode no longer supported.
CSREQ-4610		Deleted	Obsolete / Not required	Iris mode no longer supported.
CSREQ-4620		Deleted	Obsolete / Not required	Legacy conversion mode no longer supported.
CSREQ-4630		Deleted	Obsolete / Not required	Legacy conversion mode no longer supported.
CSREQ-4640		Deleted	Obsolete / Not required	Legacy conversion mode no longer supported.
CSREQ-4650		Deleted	Obsolete / Not required	Legacy conversion mode no longer supported.
CSREQ-4660		Deleted	Obsolete / Not required	Legacy conversion mode no longer supported.
CSREQ-4670		Deleted	Obsolete / Not required	Legacy conversion mode no longer supported.
CSREQ-6300		Deleted	Obsolete / Not required	Unnecessary requirement (negative statement: "shall not")

REQ ID	PUID	Review Result	Reason for review	Review Explanation/Comments
CSREQ-6310		Deleted	Obsolete / Not required	Unnecessary requirement (negative statement: "shall not")
CSREQ-6320		Deleted	Obsolete / Not required	Unnecessary requirement (negative statement: "shall not")
CSREQ-4700	D018-COM-FUN-3470	Updated	Rewording / Clarified	
CSREQ-7210	D018-COM-FUN-3480	Updated	Analysis update	Most robust MODCOD is QPSK 1/4
CSREQ-4990	D018-COM-FUN-3490	Unchanged		
CSREQ-4991	D018-COM-FUN-3500	Unchanged		
CSREQ-5800		Deleted	Merged	Already covered by CSREQ-0065
CSREQ-5460	D018-COM-ITF-0020	Moved	Rewording / Clarified	Placed in management interface section
CSREQ-5470		Deleted	Obsolete / Not required	Not required for interoperability
CSREQ-5480		Deleted	Obsolete / Not required	Internal GS management interface, not covered by CS. Refer to CSREQ-0280, which provides external management interface details.
CSREQ-5490		Deleted	Obsolete / Not required	Internal GS management interface, not covered by CS. Refer to CSREQ-0280, which provides external management interface details.
CSREQ-5540		Deleted	Obsolete / Not required	Diversity techniques which are part of the CS are specified in section 8 and 9
CSREQ-5550		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5560		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5570		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5580		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5640		Deleted	Obsolete / Not required	Diversity techniques which are part of the CS are specified in section 8 and 9
CSREQ-5650		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5660		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5670		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5680		Deleted	Obsolete / Not required	It is not a CS specification
CSREQ-5770	D018-COM-FUN-3510	Updated	Analysis update	New signalling messages and contents.

Table 14-1: Requirements Change Traceability from Draft01 to Draft02.1

END OF DOCUMENT

DISSEMINATION RIGHTS

Doc ID	Doc Title	Public	SESAR Stakeholders and ESA National Delegates	ANTARES participants	Iris Programme	ESA and Prime
D018	Communication Standard Technical Specifications	x	x	x	x	x