ATIS STANDARD

ATIS-0700361

ATIS Standard on -

WIDEBAND GENERAL PACKET RADIO SERVICE (WGPRS) PACKET-DATA SERVICE – HIGH SPEED (HS) INDOOR PHYSICAL LAYER

As a leading technology and solutions development organization, the Alliance for Telecommunications Industry Solutions (ATIS) brings together the top global ICT companies to advance the industry's most pressing business priorities. ATIS' nearly 200 member companies are currently working to address the All-IP transition, network functions virtualization, big data analytics, cloud services, device solutions, emergency services, M2M, cyber security, network evolution, quality of service, billing support, operations, and much more. These priorities follow a fast-track development lifecycle — from design and innovation through standards, specifications, requirements, business use cases, software toolkits, open source solutions, and interoperability testing.

ATIS is accredited by the American National Standards Institute (ANSI). The organization is the North American Organizational Partner for the 3rd Generation Partnership Project (3GPP), a founding Partner of the oneM2M global initiative, a member of and major U.S. contributor to the International Telecommunication Union (ITU), as well as a member of the Inter-American Telecommunication Commission (CITEL). For more information, visit www.atis.org.

ATIS-0700361, *Wideband General Packet Radio Service (WGPRS) Packet – Data Service – High Speed (HS) Indoor Physical Layer*

Is an American National Standard developed by the **Radio Access Network (RAN)** Subcommittee under the **ATIS Wireless Technology and Systems Committee (WTSC)**.

Published by

Alliance for Telecommunications Industry Solutions
1200 G Street, NW, Suite 500
Washington, DC 20005

ATIS-0700361

ATIS Standard on

Wideband General Packet Radio Service (WGPRS) Packet-Data Service- High Speed (HS) Indoor Physical Layer

Alliance for Telecommunications Industry Solutions

Abstract

This document provides a standard defining the physical channels of the Wideband General Packet Radio Service (WGPRS) radio sub-system required to support the logical channels.

Foreword

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between providers, customers, and manufacturers. The Wireless Technologies and Systems Committee (WTSC) develops and recommends standards and technical reports related to wireless and/or mobile services and systems, including service descriptions and wireless technologies. WTSC develops and recommends positions on related subjects under consideration in other North American, regional and international standards bodies.

The mandatory requirements are designated by the word *shall* and recommendations by the word *should*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages. The word *may* denotes a optional capability that could augment the standard. The standard is fully functional without the incorporation of this optional capability.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, WTSC, 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time of consensus on this document, WTSC, which was responsible for its development, had the following leadership:

M. Younge, WTSC Chair (T-Mobile)

D. Zelmer, WTSC Vice-Chair (AT&T)

J, Ragsdale, WTSC RAN Chair (Ericsson)

F. Khatibi, WTSC RAN Vice-Chair (Qualcomm)

The **Radio Access Network [RAN]** Subcommittee was responsible for the development of this document.

Table of Contents

Table of Figures

Table of Tables

ATIS Standard on –

Wideband General Packet Radio Service (WGPRS) Packet-Data Service-High Speed (HS) Indoor Physical Layer

1 Introduction

Subclauses 2-5 of this standard define the physical channels of the WGPRS radio sub-system required to support the logical channels. They include a description of the logical channels, Time Division Multiple Access (TDMA) frames, timeslots, and bursts. Subclause 6 includes the specification of encoding, reordering, and interleaving of traffic and control data. Subclause 7 defines the modulation.

2 Logical Channels

2.1 General

The radio subsystem is required to support a certain number of logical channels. For purposes of this specification, they can be separated into two categories:

i) The traffic channels (TCHs)
ii) The control channels

More information is given about these logical channels in subclauses 2.2 and 2.3, which also defines also the special channels used by the WGPRS Indoor radio sub-system.

Subclause 3 of this document describes the physical resource available to the radio sub-system, subclause 4 defines physical channels based on that resource, and subclause 5 specifies how the logical channels shall be mapped onto physical channels.

2.2 Wideband Packet Traffic Channels (WPTCH)

Wideband packet traffic channels (WPTCHs) are intended to carry user data in packet switched mode. Multiple packet traffic channels can be allocated to the same MS. This is referred to as multislot packet configurations.

WPTCH corresponds to the resource allocated to a single MS on one physical channel for user data transmission. Due to the dynamic multiplexing onto the same physical channel of different logical channels, a WPTCH using Binary Quaternary Offset Quadrature Ampitude Modulation (B-O-QAM) modulation carries information at an instantaneous bit rate ranging from 0 to 28.8 kbit/s for the short bursts and 0 to 145.2 kbit/s for the long bursts. A WPTCH using Quaternary Offset Quadrature Ampitude Modulation (Q-O-QAM) modulation carries information at an instantaneous bit rate ranging from 0 to 57.6 kbit/s for the short bursts and 0 to 290 kbit/s for the long bursts.

All packet traffic channels are uni-directional, either uplink (WPTCH/U), for a mobile originated packet transfer or downlink (WPTCH/D) for a mobile terminated packet transfer.

2.3 Control Channels

2.3.1 General

Control channels are intended to carry signalling or synchronization data. Two categories of control channel are defined for WGPRS: broadcast and dedicated control channels. Specific channels within these categories are defined in the following subclauses.

2.3.2 Broadcast Channels

2.3.2.1 Wideband Frequency Correction Channel (WFCCH)

The wideband frequency correction channel (WFCCH) carries information for frequency correction of the mobile station. It is required only for the operation of the radio sub-system.

2.3.2.2 Wideband Synchronization Channel (WSCH)

The wideband synchronization channel (WSCH) carries information for frame synchronization of the mobile station and identification of a base transceiver station. It is required only for the operation of the radio sub-system. Specifically the synchronization channel shall contain two encoded parameters:

a) Base transceiver station identity code (BSIC): 6 bits (before channel coding) consists of 3 bits of Public Land Mobile Network (PLMN) color code with range 0 to 7 and 3 bits of Base Station (BS) color code with range 0 to 7.
b) Reduced TDMA frame number (RFN): 19 bits (before channel coding) =

T1	(10 bits)	range 0 to 1023	= FN div (51 x 52)
T2	(6 bits)	range 0 to 50	= (FN div 52) mod 51
T3	(2 bits)	range 0 to 3	= ((FN mod 52)-12) div 13
TS	(1 bit)	range 0 to 1	= 0 when timeslot 1, 1 when timeslot 31

2.3.3 Dedicated Control Channels

2.3.3.1 Packet Dedicated Control Channel

The Packet Associated Control channel (PACCH): The PACCH is bi-directional. For description purposes PACCH/U is used for the uplink and PACCH/D for the downlink.

3 The Physical Resource

3.1 General

The physical resource available to the radio sub-system is an allocation of part of the radio spectrum. This resource is partitioned both in frequency and time. Frequency is partitioned by radio frequency channels (RFCHs) divided into bands. Time is partitioned by timeslots and TDMA frames as defined in subclause 3.3 of this document.

3.2 Radio Frequency Channels

3.2.1 Cell Allocation & Mobile Allocation

The Radio Frequency (RF) channels are identified by their Absolute Radio Frequency Channel Number (ARFCN) channel numbers as per 3GPP TS 45.005, which allocates numbers to all the 200kHz radio frequency channels available to the system. Each cell is allocated a subset of these channels, defined as the cell allocation (CA). Each radio frequency channel of the CA shall carry synchronization information. The subset of the CA, allocated to a particular mobile, shall be known as the mobile allocation (MA). The channel spacing is 1.6 MHz, therefore the ARFCN for the subsequent channel is the ARFCN for the N+8th 200 kHz channel. The WGPRS HS Indoor RF channel is identified by the same ARFCN as would a 200 KHz EDGE carrier centered at the same frequency.

3.2.2 Downlink & Uplink

The downlink comprises radio frequency channels used in the base transceiver station to Mobile Station direction.

The uplink comprises radio frequency channels used in the mobile station to base transceiver station direction.

3.3 Timeslots & TDMA frames

3.3.1 General

A timeslot shall have a duration of 3/41600 seconds (~ 72 µs). Sixty-four timeslots shall form a TDMA frame (~4.62 ms in duration).

At the base transceiver station the start of a TDMA frame on the uplink is delayed by the fixed period of 24 timeslots from the start of the TDMA frame on the downlink.

The staggering of TDMA frames used in the downlink and uplink is in order to allow the same timeslot number to be used in the downlink and uplink whilst avoiding the requirement for the mobile station to transmit and receive simultaneously. The period includes time for transceiver tuning and receive/transmit switching.

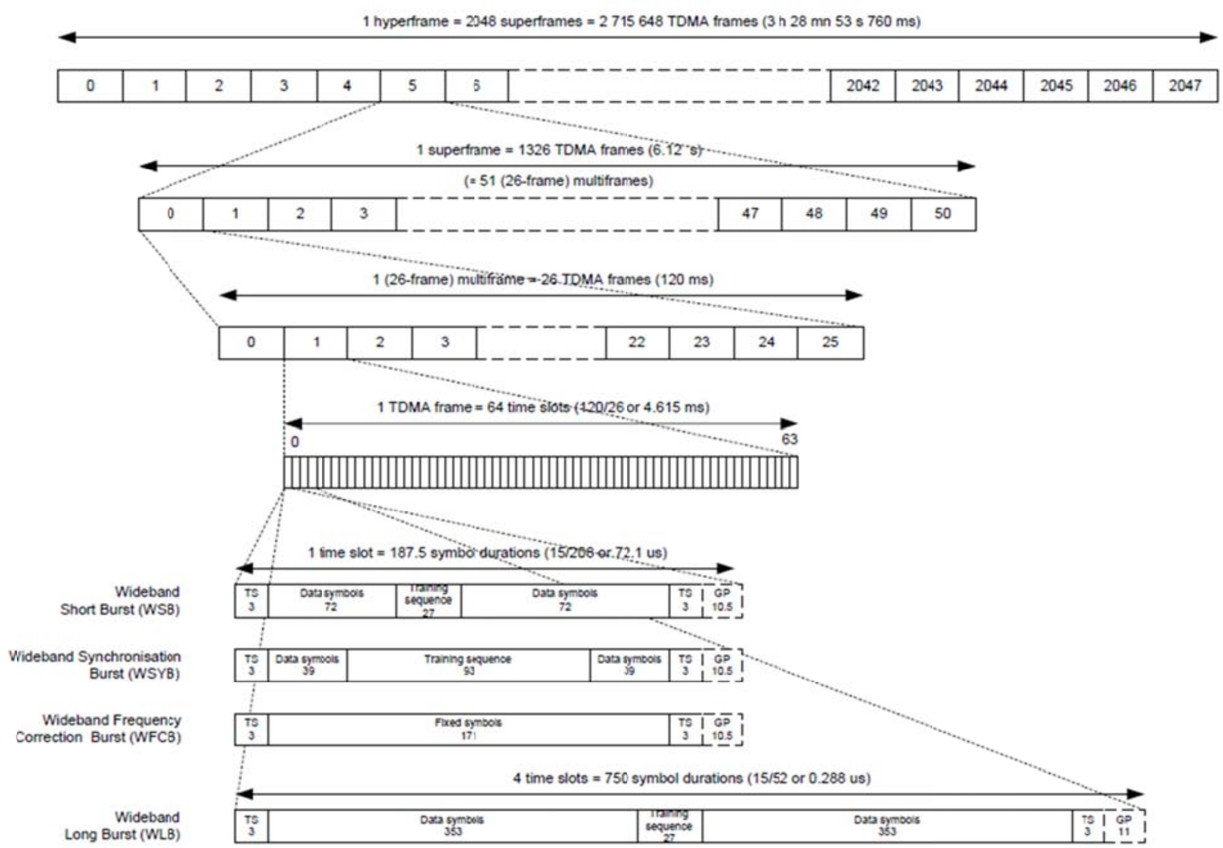


Figure 3. 1 – Multiframe and burst structure

3.3.2 Timeslot Number

The timeslots within a TDMA frame shall be numbered from 0 to 63 and a particular timeslot shall be referred to by its timeslot number (TN).

3.3.3 TDMA Frame Number

TDMA frames shall be numbered by a frame number (FN). The frame number shall be cyclic and shall have a range of 0 to FN_MAX where FN_MAX = (52 x 51 x 1024) -1 = 2715647. The frame number shall be incremented at the end of each TDMA frame when TN changes count from 63 to 0.

The complete cycle of TDMA frame numbers from 0 to FN_MAX is defined as a hyperframe. A hyperframe consists of 2048 superframes where a superframe is defined as 26 x 51 TDMA frames. A 26- multiframe, comprising 26 TDMA frames, is used to support traffic and associated control channels. Due to block structure used for packet data, it is more practical to speak about a 52-multiframe, comprising of two 26-multiframes.

The need for a hyperframe of a substantially longer period than a superframe arises from the requirements of the encryption process which uses FN as an input parameter.

3.3.4 Timing of Transmitted Signals

The MS can use the timing of receipt of the synchronization burst to set up its timebase counters as follows:

TN = $(TS \times 30) + 1$

FN = $(T1 \times 51 + T2) \times 52 + (T3 \times 13) + 12$ when synchronization burst is received

4 Physical Channels

4.1 General

A physical channel uses a combination of frequency and time division multiplexing and is defined as a sequence of radio frequency channels and time slots. The complete definition of a particular physical channel consists of a description in the frequency domain, and a description in the time domain.

The description in the frequency domain is addressed in subclause 4.4; the description in the time domain is addressed in subclause 4.5.

4.2 Bursts

4.2.1 General

A burst is a period of RF carrier, which is modulated by a data stream. A burst therefore represents the physical content of a timeslot.

4.2.2 Types of Burst & Burst Timing

A timeslot is divided into 187.5 symbol periods. For support of long bursts, four timeslots can be combined, which combination consists then of 750 symbol periods.

For B-O-QAM modulation (see clause 7) a symbol is equivalent to a bit. A particular bit period within a timeslot is referenced by a bit number (BN), with the first bit period being numbered 0, and the last (half) bit period for slots carrying short bursts being numbered 187 and the last bit period for a combination of four time slots carrying a long burst is being numbered 749.

For Q-O-QAM modulation (see clause 7) one symbol corresponds to two bits. A particular bit period within a timeslot is referenced by a BN, with the first bit being numbered 0, and the last bit period for slots carrying short bursts being numbered 374 and for the combination of four time slots carrying a long burst being numbered 1499. The bits are mapped to symbols in ascending order according to clause 7. The bit with the lowest bit number is transmitted first.

Different types of bursts exist in the system. One characteristic of a burst is its useful duration. This document defines short bursts of 177 symbols useful duration and long bursts of 739 symbols useful duration. The useful part of a burst is defined as beginning from half way through the symbol number 0. The definition of the useful part of a burst needs to be considered in conjunction with the requirements placed on the phase and amplitude characteristics of a burst as specified in subclause 8 (see ATIS-0700362)

The period between bursts appearing in successive timeslots is termed the guard period. Subclause 4.2.8 details constraints that relate to the guard period.

4.2.3 Wideband Short Burst (WSB)

4.2.3.1 Wideband Short Burst for B-O-QAM

Table 4.1 – Wideband short burst for B-O-QAM

Bit Number (BN)	Length of field	Contents of field	Definition
0 - 2	3	tail bits	(below)
3 - 74	72	Encrypted bits (e0 . e71)	Subclause 5
75 - 101	27	Training sequence bits	(below)
102 - 173	72	Encrypted bits (e72 . e143)	Subclause 5
174 - 176	3	tail bits	(below)
177 – 187	10.5	Guard period (bits)	Subclause 4.2.8

- Where the tail bits are defined as modulating bits with states as follows:

  (BN0, BN1, BN2) = (0, 0, 0) and

  (BN174, BN175, BN176) = (0, 0, 0)

- Where *the training sequence* bits are defined as modulating bits with states as given in the Table 4.5 (Subclause 4.2.5) according to the training sequence code (TSC).

4.2.3.2 Wideband Short Burst for Q-O-QAM

Table 4. 2 – Wideband short burst for Q-O-QAM

Bit Number (BN)	Length of field	Contents of field	Definition
0 - 5	6	tail bits (B-O-QAM)	(below)
6 - 149	144	Encrypted bits (e0 . e71)	Subclause 5
150 - 203	54	Training sequence bits	(below)
204 - 347	144	Encrypted bits (e72 . e143)	Subclause 5
348 - 353	6	tail bits	(below)
(354 - 374	21	Guard period (bits)	Subclause 4.2.8

- Where *the tail bits* are defined as modulating bits with states as follows:

  (BN0, BN1, BN2, BN3, BN4, BN5) = (0, 1, 0, 1, 0, 1) and

  (BN348, BN349, BN350, BN351, BN352, BN353) = (0, 1, 0, 1, 0, 1)

- Where *the training sequence bits* are defined as modulating bits which give the same states as B-O-QAM symbols according to the Table 4.5 (Subclause 4.2.5) for each TSC.

4.2.4 Wideband Long Burst (WLB)

4.2.4.1 Wideband Long Burst for B-O-QAM

Table 4.3 – Wideband long burst for B-O-QAM

Bit Number (BN)	Length of field	Contents of field	Definition
0 - 2	3	tail bits	(below)
3 - 355	353	Encrypted bits (e0 . e352)	Subclause 5
356 - 382	27	Training sequence bits	(below)
383 - 735	353	Encrypted bits (e353 . e706)	Subclause 5
736 - 738	3	tail bits	(below)
(739 - 749	11	Guard period (bits)	Subclause 4.2.8

- Where the *tail bits* are defined as modulating bits with states as follows:

  (BN0, BN1, BN2) = (0, 0, 0) and

  (BN736, BN737, BN738) = (0, 0, 0)
- Where *the training sequence bits* are defined as modulating bits with states as given in Table 4.5 (Subclause 4.2.5) according to the TSC.

4.2.4.2 Wideband Long Burst for Q-O-QAM

Table 4.4 – Wideband long burst for Q-O-QAM

Bit Number (BN)	Length of field	Contents of field	Definition
0 - 5	6	tail bits	(below)
6 - 711	706	Encrypted bits (e0 . e352)	Subclause 5
712 - 765	54	Training sequence bits	(below)
766 - 1471	706	Encrypted bits (e353 . e706)	Subclause 5
1472 - 1477	6	tail bits	(below)
(1478 - 1499	22	Guard period (bits)	Subclause 4.2.8

- Where the *tail bits* are defined as modulating bits with states as follows:

  (BN0, BN1, BN2, BN3, BN4, BN5) = (0, 1, 0, 1, 0, 1) and

  (BN1472, BN1473, BN1474, BN1475, BN1476, BN1477)= (0, 1, 0, 1, 0, 1)
- Where the *training sequence bits* are defined as modulating bits which give the same states as B-O-QAM symbols according to the Table 4.5 (Subclause 4.2.5) for each TSC.

4.2.5 Training Sequences

The training sequences given in the table below will be used both for short and long bursts and B-O-QAM and Q-O-QAM modulation. Each bit is mapped to one symbol according to B-O-QAM mapping rules, also for the Q-O-QAM modulated bursts.

Table 4.5 – Training sequences for wideband bursts

Training Sequence Code (TSC)	Training sequence bits (BN75, BN76 .. BN101)

0	1 1 0 1 0 1 1 0 0 0 0 0 0 1 0 1 1 0 0 1 1 1 0 1 0 1 1
1	1 0 0 1 1 0 1 0 0 0 0 0 0 1 1 0 1 0 1 1 1 0 0 1 1 0 1
2	1 0 1 0 1 1 1 0 0 0 0 0 1 0 0 0 1 1 0 1 1 0 1 0 1 1 1
3	0 1 0 0 1 1 1 0 0 0 0 0 1 0 0 1 0 1 0 0 0 1 0 0 1 1 1
4	0 0 1 1 1 0 1 0 0 0 0 0 1 0 0 1 0 1 1 1 0 0 1 1 1 0 1
5	0 1 0 1 0 1 1 0 0 0 0 0 1 0 0 1 1 0 0 0 0 1 0 1 0 1 1
6	0 1 0 0 0 1 1 0 0 0 0 0 1 0 1 1 0 1 0 0 0 1 0 0 0 1 1
7	1 1 0 1 0 0 1 0 0 0 0 0 1 0 1 1 1 0 0 1 1 1 0 1 0 0 1
8	0 1 0 1 1 0 1 0 0 0 0 0 1 1 0 0 0 1 0 0 0 1 0 1 1 0 1
9	0 0 1 1 0 0 1 0 0 0 0 0 1 1 0 1 0 1 0 0 0 0 1 1 0 0 1
10	0 1 0 1 0 0 1 0 0 0 0 0 1 1 1 0 0 1 0 0 0 1 0 1 0 0 1
11	0 1 1 0 0 0 1 0 0 0 0 0 1 1 1 0 1 0 1 1 0 1 1 0 0 0 1
12	0 1 0 1 1 1 1 0 0 0 0 1 0 0 0 1 0 0 1 1 0 1 0 1 1 1 1
13	0 1 1 1 1 0 1 0 0 0 0 1 0 0 0 1 0 1 1 0 0 1 1 1 1 0 1
14	1 0 0 1 1 0 1 0 0 0 0 1 0 0 0 1 0 1 1 1 1 0 0 1 1 0 1
15	1 0 1 0 0 1 1 0 0 0 0 1 0 0 0 1 0 1 1 1 1 0 1 0 0 1 1
16	1 0 0 0 1 0 1 0 0 0 0 1 0 0 1 1 0 1 1 1 1 0 0 0 1 0 1
17	1 0 1 0 1 1 1 0 0 0 0 1 0 0 1 1 0 1 1 1 1 0 1 0 1 1 1
18	1 1 0 1 1 1 1 0 0 0 0 1 0 1 0 0 1 1 0 1 1 1 0 1 1 1 1
19	1 0 1 0 0 0 1 0 0 0 0 1 0 1 1 0 0 1 1 1 1 0 1 0 0 0 1
20	1 0 0 1 1 0 1 0 0 0 0 1 0 1 1 1 0 1 1 1 1 0 0 1 1 0 1
21	1 0 1 0 0 0 1 0 0 0 0 1 0 1 1 1 1 0 0 1 1 0 1 0 0 0 1

The training sequences are also used to indicate the modulation scheme and radio block size. The actual training sequence can be selected based on Table 4.6.

Table 4.6 – Use of training sequences

	Long burst	Short burst
WMCS-1 (B-O-QAM)	TSC	TSC
WMCS-2 (B-O-QAM)	TSC + 4 mod 21	TSC
WMCS-3 (Q-O-QAM)	TSC + 8 mod 21	TSC + 8 mod 21
WMCS-4 (Q-O-QAM)	TSC + 12 mod 21	TSC + 8 mod 21

4.2.6 Wideband Frequency Correction Burst (WFCB)

Table 4.7 – Wideband frequency correction burst

Bit Number (BN)	Length of field	Contents of field	Definition
0 - 2	3	Tail bits	(below)

3 - 173	171	Fixed bits	(below)
174 - 176	3	Tail bits	(below)
177 - 187	10.5	Guard period (bits)	Subclause 4.2.8

- Where the *tail bits* are defined as modulating bits with states as follows:

  (BN0, BN1, BN2) = (0, 0, 0) and

  (BN174, BN175, BN176) = (0, 0, 0)

- Where the *fixed bits* are defined as modulating bits with states as follows:
  (BN3, BN4 .. BN144) = (0, 0 .. 0)

NOTE: This burst is equivalent to unmodulated carrier with a +1625/3 kHz frequency offset, above the nominal carrier frequency.

4.2.7 Wideband Synchronization Burst (WSYB)

Table 4.8 – Wideband synchronization burst

Bit Number (BN)	Length of field	Contents of field	Definition
0 - 2	3	tail bits	(below)
3 - 41	39	Encrypted bits (e0 . e38)	Subclause 5
42 - 134	93	Extended training sequence bits	(below)
135 - 173	39	Encrypted bits (e39 .. e77)	Subclause 5
174 - 176	3	tail bits	(below)
177 - 187	10.5	Guard period (bits)	Subclause 4.2.8

- Where *the tail bits* are defined as modulating bits with states as follows:

  (BN0, BN1, BN2) = (0, 0, 0) and

  (BN174, BN175, BN176) = (0, 0, 0)

- Where *the extended training sequence bits* are defined as modulating bits with states as follows:

  (BN42, BN43 .. BN134) = (1 1 1 1 1 1 1 0 1 1 1 0 1 1 0 1 1 1 1 0 1 0 0 0 1 0 1 1 0 0 1 0 1 1 1 1 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 1 1 0 1 1 0 0 0 1 1 1 0 0 1 1 1 0 1 0 1 1 1 0 0 0 0 1 0 0 1 1 0 0 0 0 0 1 0 1 0 1 0 1 1 0 1 0 0 1 0 0 1 0 1 0 0 1 1 1 1 0 0 1 0 0 0 1 1 0 1 0 1 0 0 0 0)

4.2.8 Guard Period

The guard period is provided because it is required for the MSs that transmission be attenuated for the period between bursts with the necessary ramp up and down occurring during the guard periods as defined in ATIS-0700362. A base transceiver station is not required to have a capability to ramp down and up between adjacent bursts, but is required to have a capability to ramp down and up for non-used time-slots, as defined in ATIS-0700362. In any case where the amplitude of transmission is ramped up and down, applying an appropriate modulation, bit stream interference to other RF channels can be minimized.

4.3 Physical Channels & Bursts

The description of a physical channel will be made in terms of timeslots and TDMA frames and not in terms of bursts. This is because there is not a one-to-one mapping between a particular physical channel and the use of a particular burst.

4.4 Radio Frequency Channel Sequence

The radio frequency channel sequence is determined by a function that, in a given cell, with a given set of general parameters and with a given TN and a MA, maps the TDMA FN to a radio frequency channel.

In a given cell there is therefore, for a physical channel assigned to a particular mobile, a unique correspondence between radio frequency channel and TDMA frame number.

4.5 Timeslot & TDMA Frame Sequence

A given physical channel shall always use the same timeslot number in every TDMA frame. Therefore a timeslot sequence is defined by:

i) A TN; and
ii) A TDMA frame number sequence.

The physical channels where the TDMA frame number sequence is 0,1. . FN_MAX (where FN_MAX is defined in subclause 3.3.3) are called *basic wideband physical channels*.

4.6 Parameters for Channel Definition & Assignment

4.6.1 General

This subclause describes the set of parameters necessary to describe fully the mapping of any logical channel onto a physical channel. These parameters may be divided into general parameters, that are characteristic of a particular base transceiver station, and specific parameters, that are characteristic of a given physical channel.

4.6.2 General Parameters

These are:

i) The set of radio frequency channels used in the cell (CA)
ii) The TDMA FN, which can be derived from the RFN which is in the form T1, T2, T3, see 3.3.4.

These parameters are broadcast (or derived from parameters broadcast) in the broadcast channels and SCH.

4.6.3 Specific Parameters

These parameters define a particular physical channel in a base transceiver station. They are:

i) The TSC;
ii) The TN;
iii) The MA;
iv) The type of logical channel.

5 Mapping of Logical Channels onto Physical Channels

5.1 General

The detailed mapping of logical channels onto physical channels is defined in the following subclauses. Subclause 5.2 defines the mapping from TDMA FN to RFCH. Subclause 5.3 defines the mapping of the physical channel onto TDMA frame number.

5.2 Mapping in Frequency of Logical Channels onto Physical Channels

5.2.1 General

The parameters used in the function which maps TDMA frame number onto radio frequency channel are defined in subclause 5.2.2.

5.2.2 Parameters

The following parameters are required in the mapping from TDMA frame number to radio frequency channel for a given assigned channel.

General parameters of the BTS, specific to one BTS, and broadcast in the broadcast channel and WSCH:

i) CA: Cell allocation of radio frequency channels.
ii) FN: TDMA frame number, broadcast in the WSCH, in form T1, T2, T3.

Specific parameters of the channel, defined in the channel assignment message:

i) MA: Mobile allocation of radio frequency channels, defines the radio frequency channel.

5.3 Mapping in Time of Logical Packet Channels onto Physical Channels

5.3.1 General

A physical channel allocated to carry packet logical channels is called a packet switched channel (PDCH). A PDCH shall carry packet logical channels only.

Packet switched logical channels are mapped dynamically onto a 52-multiframe.

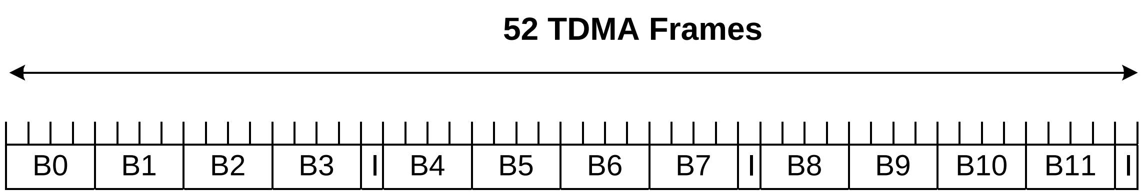
The 52-multiframe consists of 12 blocks of 4 consecutive frames and 4 idle frames. A block allocated to a given logical channel comprises of one radio block. The type of channel may vary on a block by block basis. Table 5.1 below indicates the frame numbers for each of the blocks (B0...B11) transmitted in the multiframe. In case of wideband long bursts with channel coding WGPRS Modulation and Coding Scheme (WMCS)-2 and WMCS-4 one burst forms one radio block, and each frame can be referred to as a subblock of the bigger block (B0.0, B0.1, B0.2, B0.3, B1.0, B1.1 … B11.3).

In the downlink direction, the logical channel type shall be indicated by the message type contained in the block header part.

The frequency correction channel and synchronization channel will be always transmitted after each other. Transmission takes place twice during each idle frame. First pair of bursts is sent in time slots 0 and 1, the second pair on time slots 32 and 33.

Table 5.1 – Allowed channel and time-slot assignments

Channel designation	Allowable time-slot assignment	Allowable RF channel assignment	Burst type	Radio block to TDMA frame mapping
WPTCH, WPACCH	0, 1, 2, ..., 63	C0...Cn	WSB WLB (WMCS1 and 3)	B0(0...3), B1(4...7), B2(8...11), B3(13...16), B4(17...20), B5(21..24), B6(26...29), B7(30...33), B8(34...37), B9(39...42), B10(43...46), B11(47...50)
WPTCH	0, 4, 8, …, 60	C0...Cn	WLB (WMCS2 and 4)	B0.0(0), B0.1(1), B0.2 (2), B0.3(3), B1.0(4), B1.1(5), B1.2(6), B1.3(7), …B11.0(47), B11.1(48), B11.2(49), B11.3(50)
WFCCH	0, 32	C0…Cn	WFB	(12), (24), (36), (48)
WSCH	1, 33	C0…Cn	WSYB	(12), (24), (36), (48)



I = Idle frame (WSCH, WFCCH), B0 ... B11 = Radio Blocks

Figure 5.1 – 52 multiframe for PTCH

5.3.2 Mapping of Uplink Packet Traffic Channels (WPTCH/U & WPACCH/U)

The WPDCHs where the MS may expect occurrence of its WPTCH/U(s) or WPACCH/U for a mobile originated transfer is indicated in resource allocation messages (see ATIS-0700362). WPACCH/U shall be allocated respecting the resources allocated to the MS and the MS multislot class. For each WPDCH allocated to the MS, an Uplink State Flag (R0... R7) is given to the MS.

The occurrence of the WPTCH/U and/or the WPACCH/U at given block(s) Bx (where Bx = B0...B11) in the 52-multiframe structure for a given MS on a given PDCH shall be indicated by the value of the Uplink State Flag (USF) contained in the header of the preceding block transmitted in the downlink of the same PDCH, that is to say B(x-1) in the same multiframe if $x \geq 1$ or B(11) in the previous multiframe if x=0. If the USF in block B(x-1) indicates that block B(x) shall be used by an MS for which the USF_GRANULARITY is set to 1 (corresponding to 4 blocks) in the last assignment message, that MS shall also use the three following blocks. The USF corresponding to the last three blocks shall be set to an unused value. The MS may transmit a WPTCH block or a WPACCH block on any of the uplink blocks used by the MS. The occurrence of the WPACCH/U associated to a WPTCH/D shall be indicated by the network by polling the MS (see ATIS-0700362).

If a long burst spanning over time slots n….n+3 are used in the downlink and short bursts in the uplink, then Bx.0 carries the USF for the time slot position n, Bx.1 for the TS position n+1 and so on. If short bursts are used in the down link to address allocation of uplink long slots, then time slot n carries USF for Bx.0, TS n+1 for Bx.1 and so on.

NOTE: This subclause specifies how the network shall signal that the MS is allowed to use the uplink. The operation of the MS is specified in ATIS-0700362. In particular cases of fixed allocation or extended dynamic allocation the MS may not need to monitor the USF on all allocated PDCHs.

5.3.3 Mapping of the Downlink Packet Traffic Channels (WPTCH/D & WPACCH/D)

The WPDCH where the MS may expect occurrence of its WPTCH/D(s) for a mobile terminated transfer or its WPACCH/D, for both mobile originated and mobile terminated transfer are indicated in resource allocation messages (see ATIS-0700362). The logical channel type shall be indicated in the block header. The mobile owner of the WPTCH/D or WPACCH/D shall the indicated by the Temporary Flow Identifier (TFI) (see ATIS-0700362).

5.4 Multislot Configurations

A multislot configuration consists of multiple packet switched traffic channels together with associated control channels, allocated to the same MS. The multislot configuration occupies up to 8 basic physical channels, with different TNs but with the same frequency parameters [ARFCN or MA and Mobile Allocation Index Offset (MAIO)] and the same TSC.

An MS may be allocated several WPTCH/Us or WPTCH/Ds for one mobile originated or one mobile terminated communication respectively. In this context allocation refers to the list of WPDCH that may dynamically carry the WPTCHs for that specific MS. The WPACCH may be mapped onto any of the allocated WPDCHs.

6 Channel Coding

6.1 General Organization

Each channel has its own coding and interleaving scheme. However, the channel coding and interleaving is organized in such a way as to allow, as much as possible, a unified decoder structure.

Each channel uses the following sequence and order of operations:

- The information bits are coded with a systematic block code, building words of information + parity bits.
- These information + parity bits are encoded with a convolutional code, building the coded bits.
- Encoded bits are punctured to achieve final coding rate.
- Reordering and interleaving the coded bits gives the interleaved bits.

All these operations are made block by block, the size of which depends on the channel.

6.2 Naming Convention

For ease of understanding a naming convention for bits is given for use throughout the technical specification:

- General naming:

  k and *j* for numbering of bits in data blocks and bursts;

  K_x gives the amount of bits in one block, where *x* refers to the data type;

  n is used for numbering of delivered data blocks where;

  N marks a certain data block;

  B is used for numbering of bursts or blocks where;

  B_0 marks the first burst or block carrying bits from the data block with n = 0 (first data block in the transmission).

- Data bits delivered to the encoding unit:

  d(k) for k = 0,1,...,K_d-1

- Code identifying the used coding scheme (for packet switched channels only):

q(k) for k = 0,1,..., 7

- Data bits after the first encoding step (block code, cyclic code):

  u(k) for k = 0,1,...,K_u-1

- Data put into the shift register of the convolutional code and calculated from the data bits u(k) and the feedback bits in recursive systematic convolutional codes:

  r(k) for k= 0,1,..., K_r-1

- Data after the second encoding step (convolutional code):

  c(n,k) or c(k) for k = 0,1,...,K_c-1

  n = 0,1,...,N,N+1,...

- Interleaved data bits:

  i(B,k) for k = 0,1,...,Ki-1 B = B_0, B_0+1,....

- Bits in one burst:

  e(B,k)for k = 0,1,…176 B = B_0,B_0+1,...

6.3 Wideband Modulation & Coding Scheme WMCS-1 Downlink

6.3.1 Block Constitution for Short Bursts

The message delivered to the encoder has a size of 241 {d(0),d(1),...,d(240)} information bits when short bursts are used.

6.3.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 1365 {d(0),d(1),...,d(1364)} information bits when long bursts are used.

6.3.3 USF Precoding

a) USF precoding:

The first three bits d(0),d(1),d(2) are block coded into twelve bits u’(0),u’(1),...,u’(11) according to the following table.

Table 6.1 – Uplink state flag precoding for B-O-QAM

d(0),d(1),d(2)	u'(0),u'(1),...,u'(11)
000	000 000 000 000
001	000 011 011 101
010	001 101 110 110
011	001 110 101 011
100	110 100 001 011
101	110 111 010 110
110	111 001 111 101
111	111 010 100 000

USF is always transmitted as if it were B-O-QAM modulated, so USF can be decoded without knowledge of the modulation and coding scheme used for the burst.

6.3.4 Header Coding

a) Parity bits:

Eight header parity bits p(0),p(1),...,p(7) are defined in such a way that in GF(2) the binary polynomial:

$d(3)D^{35} + ... + d(30)D^{8} + p(0)D^{7} + ... + p(7)$, when divided by:

$D^{8} + D^{6} + D^{3} + 1$, yields a remainder equal to:

$D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail biting:

The six last header parity bits are added before information and parity bits, the result being a block of 42 bits {u"(-6),…,u"(0),u"(1),...,u"(35)} with six negative indexes:

u"(k-6) = p(k+2) for k = 0,1,...,5
u"(k) = d(k+3) for k = 0,1,...,27
u"(k) = p(k-28) for k = 28,29,...,35

c) Convolutional encoder

This block of 42 bits {u"(-6),…,u"(0),u"(1),...,u"(35)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^{2} + D^{3} + D^{5} + D^{6}$

$G7 = 1 + D + D^{2} + D^{3} + D^{6}$

$G5 = 1 + D + D^{4} + D^{6}$

This results in a block of 108 coded bits: {C(0),C(1),...,C(107)} defined by:

C(3k) = u"(k) + u"(k-2) + u"(k-3) + u"(k-5) + u"(k-6)
C(3k+1) = u"(k) + u"(k-1) + u"(k-2) + u"(k-3) + u"(k-6)
C(3k+2) = u"(k) + u"(k-1) + u"(k-4) + u"(k-6) for k = 0,1,...,35

The output of encoder is thus a block of 108 bits {hc(0),hc(1),...,hc(107)}, where hc(k) = C(k).

6.3.5 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{221} + ... + d(240)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 228 bits {u(0),u(1),...,u(227)}:

u(k) = d(k+31) for k = 0,1,...,209
u(k) = p(k-210) for k = 210,211,...,221
u(k) = 0 for k = 222,223,…,227 (tail bits)

c) Convolutional encoder

The block of 228 bits {u(0),u(1),...,u(227)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$
$G7 = 1 + D + D^2 + D^3 + D^6$
$G5 = 1 + D + D^4 + D^6$

This results in a block of 684 coded bits: {C(0),C(1),...,C(683)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)
C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)
C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,227; u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 0,1,...,227} are not transmitted
P2	{C(1+3j), for j = 0,1,...,227} are not transmitted

The result is a block of 456 coded bits {dc(0),dc(1),...,dc(455)}.

6.3.6 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{1345} + ... + d(1364)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 1352 bits {u(0),u(1),...,u(1351)}:

u(k) = d(k+31) for k = 0,1,...,1333
u(k) = p(k-1334) for k = 1334,1335,...,1345
u(k) = 0 for k = 1346,1347,…,1351 (tail bits)

c) Convolutional encoder:

The block of 1352 bits {u(0),u(1),...,u(1351)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$
$G7 = 1 + D + D^2 + D^3 + D^6$
$G5 = 1 + D + D^4 + D^6$

This results in a block of 4056 coded bits: {C(0),C(1),...,C(4055)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)
C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)
C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,1351; u(k) = 0 for k < 0

The code is punctured depending on the value of the Puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 0,1,...,1351} are not transmitted
P2	{C(1+3j), for j = 0,1,...,1351} are not transmitted

The result is a block of 2704 coded bits {dc(0),dc(1),...,dc(2703)}.

6.3.7 Interleaving for Short Bursts

The USF, header and data are put together as one entity as described by the following rule:

c(2*k+1) = u'(k)	for k = 0, 1, …, 11
c(2*k) = hc(k)	for k = 0, 1, …, 11
c(k) = hc(k-24)	for k = 24, 25, ..., 119
c(k) = dc(k-120)	for k = 120, 121, ..., 575

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+8*j$

$B_h = 0 \dots 7$

$j = 0 \dots 71$

6.3.8 Interleaving for Long Bursts

The USF, header and data are put together as one entity as described by the following rule:

c(k) = u'(k)	for k = 0, 1, …, 11
c(2*k) = hc(k)	for k = 0, 1, …, 11
c(k) = hc(k-24)	for k = 24, 25, ..., 119
c(k) = dc(k-120)	for k = 120, 121, ..., 2823

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+8*j$

$B_h = 0 \dots 7$

$j = 0 \dots 352$

6.3.9 Mapping on a Short Burst

The mapping is given by the rule:

$e(B_0+B,j) = i(B_h,j)$ and $e(B_0+B,72+j) = i(B_h+1,j)$ for $j = 0,1,...,71$

$B_h = 0, 2, 4, 6$

$B = int(B_h/2)$

6.3.10 Mapping on a Long Burst

The mapping is given by the rule:

$e(B,j) = i(B_h,j)$ and $e(B,353+j) = i(B_h+1,j)$ for $j = 0,1,...,352$

$B_h = 0, 2, 4, 6$

$B = int(B_h/2)$

6.4 Wideband Modulation & Coding Scheme WMCS-1 Uplink

6.4.1 Block Constitution for Short Bursts

The message delivered to the encoder has a size of 241 {d(0),d(1),...,d(240)} information bits when short bursts are used.

6.4.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 1365 {d(0),d(1),...,d(1364)} information bits when long bursts are used.

6.4.3 Header Coding

a) Parity bits:

Eight header parity bits p(0),p(1),...,p(7) are defined in such a way that in GF(2) the binary polynomial:

$d(0)D^{38} + ... + d(30)D^8 + p(0)D^7 + ... + p(7)$, when divided by:

$D^8 + D^6 + D^3 + 1$, yields a remainder equal to:

$D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail biting:

The six last header parity bits are added before information and parity bits, the result being a block of 45 bits {u"(-6),…,u"(0),u"(1),...,u"(38)} with six negative indexes:

$u''(k-6) = p(k+2)$ for $k = 0,1,...,5$

$u''(k) = d(k)$ for $k = 0,1,...,30$

$u''(k) = p(k-30)$ for $k = 31,32,...,38$

c) Convolutional encoder:

This block of 45 bits {u"(-6),…,u"(0),u"(1),...,u"(38)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 117 coded bits: {C(0),C(1),...,C(116)} defined by:

$C(3k) = u''(k) + u''(k-2) + u''(k-3) + u''(k-5) + u''(k-6)$

C(3k+1) = u"(k) + u"(k-1) + u"(k-2) + u"(k-3) + u"(k-6)
C(3k+2) = u"(k) + u"(k-1) + u"(k-4) + u"(k-6) for k = 0,1,...,38

The output of encoder is thus a block of 117 bits {hc(0),hc(1),...,hc(116)}, where hc(k) = C(k).

6.4.4 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{221} + ... + d(240)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:
$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to:
$D^{11} + D^{10} + D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 228 bits {u(0),u(1),...,u(227)}:

u(k) = d(k+31) for k = 0,1,...,209
u(k) = p(k-210) for k = 210,211,...,221
u(k) = 0 for k = 222,223,…,227 (tail bits)

c) Convolutional encoder:

he block of 228 bits {u(0),u(1),...,u(227)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$
$G7 = 1 + D + D^2 + D^3 + D^6$
$G5 = 1 + D + D^4 + D^6$

This results in a block of 684 coded bits: {C(0),C(1),...,C(683)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,227; u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 3, 4, 5, ..., 227} are not transmitted
P2	{C(1+3j), for j = 3, 4, 5, ..., 227} are not transmitted

The result is a block of 456 coded bits {dc(0),dc(1),...,dc(455)}.

6.4.5 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{1345} + ... + d(1364)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:
$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to:
$D^{11} + D^{10} + D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 1352 bits {u(0),u(1),...,u(1351)}:

u(k) = d(k+31) for k = 0,1,...,1333
u(k) = p(k-1334) for k = 1334,1335,...,1345
u(k) = 0 for k = 1346,1347,…,1351 (tail bits)

c) Convolutional encoder:

The block of 1352 bits {u(0),u(1),...,u(1351)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 4056 coded bits: {C(0),C(1),...,C(4055)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,1351; u(k) = 0 for k < 0

The code is punctured depending on the value of the Puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 3 ,4 ,5, ..., 1351} are not transmitted
P2	{C(1+3j), for j = 3, 4, 5,..., 1351} are not transmitted

The result is a block of 2704 coded bits {dc(0),dc(1),...,dc(2703)}.

6.4.6 Interleaving for Short Bursts

The header and data are put together as one entity as described by the following rule:

c(k) = hc(k)   for k = 0, 1, ..., 116

c(k) = dc(k-117)   for k = 117, 118, ..., 575

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$,   for $k = B_h+8*j$

$B_h = 0 \dots 7$

$j = 0 \dots 71$

6.4.7 Interleaving for Long Bursts

The header and data are put together as one entity as described by the following rule:

c(k) = hc(k)   for k = 0, 1, ..., 116

c(k) = dc(k-117)   for k = 117, 118, ..., 2823

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$,   for $k = B_h+8*j$

$B_h = 0 \dots 7$

$j = 0 \dots 352$

6.4.8 Mapping on a Short Burst

The mapping is done as in subclause 6.3.9.

6.4.9 Mapping on a Long Burst

The mapping is done as in subclause 6.3.10.

6.5 Wideband Modulation & Coding Scheme WMCS-2, Downlink

6.5.1 Block Constitution for Short Bursts

The message delivered to the encoder has a size of 469 {d(0),d(1),...,d(468)} information bits when short bursts are used.

6.5.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 599 {d(0),d(1),...,d(598)} information bits when long bursts are used.

6.5.3 USF Precoding

USF precoding is done as in subclause 6.3.3.

6.5.4 Header Coding

Header coding is done as in subclause 6.3.4.

6.5.5 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{449} + ... + d(468)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:
$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:
$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 456 bits {u(0),u(1),...,u(455)}:

u(k) = d(k+31) for k = 0,1,...,437
u(k) = p(k-438) for k = 438, 439, ..., 449
u(k) = 0 for k = 450, 451 ,…, 455 (tail bits)

c) Convolutional encoder:

The block of 456 bits {u(0),u(1),...,u(455)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 1368 coded bits: {C(0),C(1),...,C(1367)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

$C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6)$ for $k = 0,1,...,455$; $u(k) = 0$ for $k < 0$

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2 or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 455} are transmitted
P2	{C(1+3j), for j = 0,1,...,455} are transmitted
P3	{C(2+3j) for j = 0,1,...,455} are transmitted

The result is a block of 456 coded bits {dc(0),dc(1),...,dc(455)}.

6.5.6 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{579} + ... + d(598)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to: $D^{11} + D^{10} +$

$D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 586 bits {u(0),u(1),...,u(585)}:

$u(k) = d(k+31)$ for $k = 0, 1, ..., 567$

$u(k) = p(k-568)$ for $k = 568, 569, ..., 579$

$u(k) = 0$ for $k = 580, 581, …, 585$ (tail bits)

c) Convolutional encoder:

The block of 586 bits {u(0),u(1),...,u(585)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 1758 coded bits:

C(0),C(1),...,C(1757)} defined by: $C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)$

$C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)$

$C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6)$ for $k = 0, 1, ..., 1757$, $u(k) = 0$ for $k < 0$

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2 or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 585} are transmitted
P2	{C(1+3j), for j = 0,1,..., 585} are transmitted
P3	{C(2+3j) for j = 0,1,..., 585} are transmitted

The result is a block of 586 coded bits {dc(0),dc(1),...,dc(585)}.

6.5.7 Interleaving for Short Bursts

Interleaving is done as in subclause 6.3.7.

6.5.8 Interleaving for Long Bursts

The USF, header, and data are put together as one entity as described by the following rule:

c(k) = u'(l) for k = 353, 317, 281, 245, 209, 173, 137, 101, 65, 29, 699, 663
when l = 0, 1, …, 11
c(k) = hc(k) for k = 0, 1, … 28
c(k) = hc(k-1) for k = 30, 31, … 64
c(k) = hc(k-2) for k = 66, 67, … 100
c(k) = hc(k-3) for k = 102, 103, … 110
c(k) = dc(k-111) for k = 111, 112, … 136
c(k) = dc(k-112) for k = 138, 139, … 172
c(k) = dc(k-113) for k = 174, 175, … 208
c(k) = dc(k-114) for k = 210, 211, … 244
c(k) = dc(k-115) for k = 246, 247, … 280
c(k) = dc(k-116) for k = 282, 283, … 316
c(k) = dc(k-117) for k = 318, 319, … 352
c(k) = dc(k-118) for k = 354, 355, … 662
c(k) = dc(k-119) for k = 664, 665, … 698
c(k) = dc(k-120) for k = 700, 701, … 705

The resulting block is interleaved according to the following rule:

i(B,j) = c(n, k) for k = 0, 1, …, 705
n = 0, 1, …, N, N+1, …
$B = B_0$
j = (49*k) mod 343

6.5.9 Mapping on a Short Burst

Mapping is done as in subclause 6.3.9

6.5.10 Mapping on a Long Burst

The mapping is given by the rule:

e(B, j) = i(B,j) for j = 0,1,...,705

6.6 Wideband Modulation & Coding Scheme WMCS-2 Uplink

6.6.1 Block Constitution for Short Bursts

The message delivered to the encoder has a size of 472 {d(0),d(1),...,d(471)} information bits when short bursts are used.

6.6.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 602 {d(0),d(1),...,d(601)} information bits when long bursts are used.

6.6.3 Header Coding

Header coding is done as in subclause 6.4.3.

6.6.4 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{452} + \ldots + d(471)D^{12} + p(0)D^{11} + \ldots + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to: $D^{11} + D^{10} +$

$D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 459 bits {u(0),u(1),...,u(458)}:

u(k)	= d(k+31)	for k = 0,1,...,440
u(k)	= p(k-441)	for k = 441, 442,...,452
u(k)	= 0	for k = 453, 454, …, 458 (tail bits)

c) Convolutional encoder:

The block of 459 bits {u(0),u(1),...,u(458)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^{2} + D^{3} + D^{5} + D^{6}$ $G7 = 1 + D +$

$D^{2} + D^{3} + D^{6}$ $G5 = 1 + D + D^{4} + D^{6}$

This results in a block of 1377 coded bits: {C(0),C(1),...,C(1376)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,458; u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2 or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 458} are transmitted
P2	{C(1+3j), for j = 0,1,...,458} are transmitted
P3	{C(2+3j) for j = 0,1,...,458} are transmitted

The result is a block of 459 coded bits {dc(0),dc(1),...,dc(458)}.

6.6.5 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{582} + ... + d(601)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to: $D^{11} + D^{10} +$

$D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 589 bits {u(0),u(1),...,u(588)}:

u(k) = d(k+31) for k = 0, 1, ..., 570

u(k) = p(k-571) for k = 571 ,572 ,..., 582

u(k) = 0 for k = 583, 584, …, 588 (tail bits)

c) Convolutional encoder:

The block of 589 bits {u(0),u(1),...,u(588)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^{2} + D^{3} + D^{5} + D^{6}$

$G7 = 1 + D + D^{2} + D^{3} + D^{6}$

$G5 = 1 + D + D^{4} + D^{6}$

This results in a block of 1767 coded bits: {C(0),C(1),...,C(1766)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0 ,1 ,..., 1766, u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2 or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 588} are transmitted
P2	{C(1+3j), for j = 0,1,..., 588} are transmitted
P3	{C(2+3j) for j = 0,1,..., 588} are transmitted

The result is a block of 589 coded bits {dc(0),dc(1),...,dc(588)}.

6.6.6 Interleaving for Short Bursts

Interleaving is done as in subclause 6.4.6

6.6.7 Interleaving for Long Bursts

The header and data are put together as one entity as described by the following rule:

c(k) = hc(k) for k = 0, 1, … 116

c(k) = dc(k-117) for k = 117, 118, … 705

The resulting block is interleaved according to the following rule:

i(B,j) = c(n, k) for k = 0, 1, …, 705

n = 0, 1, …, N, N+1, …

B = B0

j = (49*k) mod 343

6.6.8 Mapping on a Short Burst

The mapping is done as in subclause 6.3.9.

6.6.9 Mapping on a Long Burst

The mapping is done as in subclause 6.5.10.

6.7 Wideband Modulation & Coding Scheme WMCS-3 Downlink

6.7.1 Block Constitution for Short Bursts

The message delivered to the encoder has a size of 523 {d(0),d(1),...,d(522)} information bits when short bursts are used.

6.7.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 2771 {d(0),d(1),...,d(2770)} information bits when long bursts are used.

6.7.3 USF Precoding

a) USF precoding:

The first three bits d(0),d(1),d(2) are block coded into twenty-four bits u'(0),u'(1),...,u'(23) according to the following table.

Table 6.2 – Uplink state flag precoding for Q-O-QAM

d(0),d(1),d(2)	u'(0),u'(1),...,u'(23)
000	010101 010101 010101 010101
001	010101 011111 011111 110111
010	010111 110111 111101 111101
011	010111 111101 110111 011111
100	111101 110101 010111 011111
101	111101 111111 011101 111101
110	111111 010111 111111 110111
111	111111 011101 110101 010101

Output of USF transmissions is such that it can be decoded without knowledge of the modulation and coding scheme used for the burst.

6.7.4 Header Coding

Header coding is done as in subclause 6.3.4.

6.7.5 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{503} + ... + d(522)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 510 bits {u(0),u(1),...,u(509)}:

u(k) = d(k+31) for k = 0,1,..., 492

u(k) = p(k-492) for k = 492, 493, ..., 503

u(k) = 0 for k = 504 ,505 ,…, 509 (tail bits)

c) Convolutional encoder:

The block of 510 bits {u(0),u(1),...,u(509)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$$G4 = 1 + D^2 + D^3 + D^5 + D^6$$

$$G7 = 1 + D + D^2 + D^3 + D^6$$

$$G5 = 1 + D + D^4 + D^6$$

This results in a block of 1530coded bits: {C(0),C(1),...,C(1529)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,509; u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 0, 1, ..., 509} are not transmitted
P2	{C(1+3j), for j = 0, 1, ..., 509} are not transmitted

The result is a block of 1020 coded bits {dc(0),dc(1),...,dc(1019)}.

6.7.6 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{2751} + ... + d(2770)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 2758 bits {u(0),u(1),...,u(2757)}:

u(k) = d(k+31) for k = 0, 1, ..., 2739

u(k) = p(k-1334) for k = 2740, 2741, ..., 2751

u(k) = 0 for k = 2752, 2753, …, 2757 (tail bits)

c) Convolutional encoder:

The block of 2758 bits {u(0),u(1),...,u(2757)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$$G4 = 1 + D^2 + D^3 + D^5 + D^6$$

$$G7 = 1 + D + D^2 + D^3 + D^6$$

$$G5 = 1 + D + D^4 + D^6$$

This results in a block of 8274 coded bits: {C(0),C(1),...,C(8273)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0,1,...,8273; u(k) = 0 for k < 0

The code is punctured depending on the value of the Puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 0, 1, ..., 2757} are not transmitted
P2	{C(1+3j), for j = 0, 1, ..., 2757} are not transmitted

The result is a block of 5516 coded bits {dc(0),dc(1),...,dc(5515)}.

6.7.7 Interleaving for Short Bursts

The USF, header, and data are put together as one entity as described by the following rule:

c(2*k+1) = u'(k) for k = 0, 1, …, 23

c(2*k) = hc(k) for k = 0, 1, …, 23

c(k) = hc(k-48) for k = 48, 49, ..., 131

c(k) = dc(k-132) for k = 132, 133, ..., 1151

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+8*j$

$B_h = 0 … 7$

$j = 0 … 143$

6.7.8 Interleaving for Long Bursts

The USF, heade,r and data are put together as one entity as described by the following rule:

c(2*k+1) = u'(k) for k = 0, 1, …, 23

c(2*k) = hc(k) for k = 0, 1, …, 23

c(k) = hc(k-48) for k = 48, 49, ..., 131

c(k) = dc(k-132) for k = 132, 133, ..., 5647

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+8*j$

$B_h = 0 … 7$

$j = 0 … 706$

6.7.9 Mapping on a Short Burst

The mapping is given by the rule:

$e(B,j) = i(B_h,j)$ and $e(B,144+j) = i(B_h+1,j)$ for $j = 0,1,...,144$

$B_h = 0 ,2, 4, 6$

$B = int(B_h /2)$

6.7.10 Mapping on a Long Burst

The mapping is given by the rule:

$e(B,j) = i(B_h,j)$ and $e(B,706+j) = i(B_h+1,j)$ for $j = 0,1,...,705$

$B_h = 0 ,2, 4, 6$

$B = int(B_h /2)$

6.8 Wideband Modulation & Coding Scheme WMCS-3 Uplink

6.8.1 Block constitution for Short Bursts

The message delivered to the encoder has a size of 523 {d(0),d(1),...,d(522)} information bits when short bursts are used.

6.8.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 2771 {d(0),d(1),...,d(2770)} information bits when long bursts are used.

6.8.3 Header Coding

Header coding is done as in subclause 6.4.3.

6.8.4 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{503} +...+ d(522)D^{12} + p(0)D^{11} +...+ p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 510 bits {u(0),u(1),...,u(509)}:

u(k)	= d(k+31)	for k = 0,1,..., 492
u(k)	= p(k-492)	for k = 492, 493, ..., 503
u(k)	= 0	for k = 504 ,505 ,…, 509 (tail bits)

c) Convolutional encoder:

The block of 510 bits {u(0),u(1),...,u(509)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 1530coded bits: {C(0),C(1),...,C(1529)} defined by:

$C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)$

$C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)$

$C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6)$ for $k = 0,1,...,509$; $u(k) = 0$ for $k < 0$

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 15, 16, ..., 509} are not transmitted
P2	{C(1+3j), for j = 15, 16, ..., 509} are not transmitted

The result is a block of 1020 coded bits {dc(0),dc(1),...,dc(1019)}.

6.8.5 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{2751} + ... + d(2770)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 2758 bits {u(0),u(1),...,u(2757)}:

u(k)	= d(k+31)	for k = 0, 1, ..., 2739
u(k)	= p(k-1334)	for k = 2740, 2741, ..., 2751
u(k)	= 0	for k = 2752, 2753, …, 2757 (tail bits)

c) Convolutional encoder:

The block of 2758 bits {u(0),u(1),...,u(2757)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^{2} + D^{3} + D^{5} + D^{6}$

$G7 = 1 + D + D^{2} + D^{3} + D^{6}$

$G5 = 1 + D + D^{4} + D^{6}$

This results in a block of 8274 coded bits: {C(0),C(1),...,C(8273)} defined by:

$C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)$

$C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)$

$C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6)$ for $k = 0,1,...,8273$; $u(k) = 0$ for $k < 0$

The code is punctured depending on the value of the Puncturing scheme indicator field as defined in ATIS-0700362. Two puncturing schemes named P1 or P2 are applied in such a way that the following coded bits:

P1	{C(2+3j) for j = 15, 1, ..., 2757} are not transmitted
P2	{C(1+3j), for j = 15, 1, ..., 2757} are not transmitted

The result is a block of 5531 coded bits {dc(0),dc(1),...,dc(5530)}.

6.8.6 Interleaving for Short Bursts

The header and data are put together as one entity as described by the following rule:

c(k) = hc(k) for k = 0, 1, ..., 116

c(k) = dc(k-117) for k = 117, 118, ..., 1135

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+8*j$

$B_h = 0 \ldots 7$

$j = 0 \ldots 143$

6.8.7 Interleaving for Long Bursts

The header and data are put together as one entity as described by the following rule:

c(k) = hc(k-48) for k = 0, 1, ..., 116

c(k) = dc(k-117) for k = 117, 118, ..., 5647

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+8*j$

$B_h = 0 \ldots 7$

$j = 0 \ldots 706$

6.8.8 Mapping on a Short Burst

The mapping is done as in subclause 6.7.9.

6.8.9 Mapping on a Long Burst

The mapping is done as in subclause 6.7.10.

6.9 Wideband Modulation & Coding Scheme WMCS-4 Downlink

6.9.1 Block constitution for Short Bursts

The message delivered to the encoder has a size of 1033 {d(0),d(1),...,d(1032)} information bits when short bursts are used.

6.9.2 Block constitution for Long Bursts

The message delivered to the encoder has a size of 1293 {d(0),d(1),...,d(1292)} information bits when long bursts are used.

6.9.3 USF Precoding

USF precoding is done as in subclause 6.7.3.

6.9.4 Header Coding

Header coding is done as in subclause 6.3.4.

6.9.5 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{1013}$ +...+ $d(1032)D^{12}$ + $p(0)D^{11}$ +...+ p(11), when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 1020 bits {u(0),u(1),...,u(1019)}:

u(k) = d(k+31) for k = 0,1,...,1001

u(k) = p(k-1002) for k = 1002, 1003, ..., 1013

u(k) = 0 for k = 1014, 1015, …, 1019 (tail bits)

c) Convolutional encoder:

The block of 1020 bits {u(0),u(1),...,u(1019)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^{2} + D^{3} + D^{5} + D^{6}$

$G7 = 1 + D + D^{2} + D^{3} + D^{6}$

$G5 = 1 + D + D^{4} + D^{6}$

This results in a block of 3060 coded bits: {C(0),C(1),...,C(3059)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0, 1, ..., 3059; u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2, or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 1019} are transmitted
P2	{C(1+3j), for j = 0,1,..., 1019} are transmitted
P3	{C(2+3j) for j = 0,1,..., 1019} are transmitted

The result is a block of 1020 coded bits {dc(0),dc(1),...,dc(1019)}.

6.9.6 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{1273}$ +...+ $d(1292)D^{12}$ + $p(0)D^{11}$ +...+ p(11), when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 1280 bits {u(0),u(1),...,u(1279)}:

u(k) = d(k+31) for k = 0, 1, ..., 1261

u(k) = p(k-1262) for k = 1262 ,1263 ,..., 1273

u(k) = 0 for k = 1274, 1275, …, 1279 (tail bits)

c) Convolutional encoder

The block of 1280 bits {u(0),u(1),...,u(1279)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 3840 coded bits: {C(0),C(1),...,C(3839)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)

C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6) for k = 0 ,1 ,..., 3839, u(k) = 0 for k < 0

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2, or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 1279} are transmitted
P2	{C(1+3j), for j = 0,1,..., 1279} are transmitted
P3	{C(2+3j) for j = 0,1,..., 1279} are transmitted

The result is a block of 1280 coded bits {dc(0),dc(1),...,dc(1279)}.

6.9.7 Interleaving for Short Bursts

Interleaving is done as in subclause 6.7.7.

6.9.8 Interleaving for Long Bursts

The USF, header and data are put together as one entity as described by the following rule: c(2*k+1) = u'(k) for k = 0, 1, …, 23

c(2*k) = hc(k) for k = 0, 1, …, 23

c(k) = hc(k-48) for k = 48, 49, ..., 131

c(k) = dc(k-132) for k = 132, 133, ..., 1411

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$, for $k = B_h+2*j$

$B_h = 0 … 1$

$j = 0 … 706$

6.9.9 Mapping on a Short Burst

Mapping is done as in subclause 6.7.9.

6.9.10 Mapping on a Long Burst

The mapping is given by the rule:

$e(B, j) = i(B_h,j)$ an $e(B, 706 + j) = i(B_h+1,j)$ for j = 0,1,...,705

6.10 Wideband Modulation & Coding Scheme WMCS-4 Uplink

6.10.1 Block Constitution for Short Bursts

The message delivered to the encoder has a size of 1048 {d(0),d(1),...,d(1047)} information bits when short bursts are used.

6.10.2 Block Constitution for Long Bursts

The message delivered to the encoder has a size of 1308 {d(0),d(1),...,d(1307)} information bits when long bursts are used.

6.10.3 Header Coding

Header coding is done as in subclause 6.4.3.

6.10.4 Data Coding for Short Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{1028} + ... + d(1047)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^8 + D^5 + D^4 + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^9 + D^8 + D^7 + D^6 + D^5 + D^4 + D^3 + D^2 + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 1035 bits {u(0),u(1),...,u(1034)}:

u(k)	= d(k+31)	for k = 0,1,...,1016
u(k)	= p(k-1017)	for k = 1017, 1018,...,1028
u(k)	= 0	for k = 1029, 1030, …, 1034 (tail bits)

c) Convolutional encoder:

The block of 1035 bits {u(0),u(1),...,u(1034)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^2 + D^3 + D^5 + D^6$

$G7 = 1 + D + D^2 + D^3 + D^6$

$G5 = 1 + D + D^4 + D^6$

This results in a block of 3105 coded bits: {C(0),C(1),...,C(3104)} defined by:

C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)

$C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)$

$C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6)$ for $k = 0,1,...,3104$; $u(k) = 0$ for $k < 0$

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2 or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 1294} are transmitted
P2	{C(1+3j), for j = 0,1,..., 1294} are transmitted
P3	{C(2+3j) for j = 0,1,..., 1294} are transmitted

The result is a block of 1035 coded bits {dc(0),dc(1),...,dc(1034)}.

6.10.5 Data Coding for Long Bursts

a) Parity bits:

Twelve data parity bits p(0),p(1),...,p(11) are defined in such a way that in GF(2) the binary polynomial:

$d(31)D^{1288} + ... + d(1307)D^{12} + p(0)D^{11} + ... + p(11)$, when divided by:

$D^{12} + D^{11} + D^{10} + D^{8} + D^{5} + D^{4} + 1$, yields a remainder equal to:

$D^{11} + D^{10} + D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

b) Tail bits:

Six tail bits equal to 0 are added to the information and parity bits, the result being a block of 1295 bits {u(0),u(1),...,u(1294)}:

u(k)	= d(k+31)	for k = 0, 1, ..., 1276
u(k)	= p(k-1277)	for k = 1277 ,1278,..., 1288
u(k)	= 0	for k = 1289, 1290, …, 1294 (tail bits)

c) Convolutional encoder:

The block of 1295 bits {u(0),u(1),...,u(1294)} is encoded with the 1/3 rate convolutional mother code defined by the polynomials:

$G4 = 1 + D^{2} + D^{3} + D^{5} + D^{6}$

$G7 = 1 + D + D^{2} + D^{3} + D^{6}$

$G5 = 1 + D + D^{4} + D^{6}$

This results in a block of 3885 coded bits: {C(0),C(1),...,C(3884)} defined by:

$C(3k) = u(k) + u(k-2) + u(k-3) + u(k-5) + u(k-6)$

$C(3k+1) = u(k) + u(k-1) + u(k-2) + u(k-3) + u(k-6)$

$C(3k+2) = u(k) + u(k-1) + u(k-4) + u(k-6)$ for $k = 0 ,1 ,..., 3884$, $u(k) = 0$ for $k < 0$

The code is punctured depending on the value of the puncturing scheme indicator field as defined in ATIS-0700362. The puncturing scheme named P1, P2, or P3 is applied in such a way that the following coded bits:

P1	{C(3j) for j = 0,1,..., 1294} are transmitted
P2	{C(1+3j), for j = 0,1,..., 1294} are transmitted
P3	{C(2+3j) for j = 0,1,..., 1294} are transmitted

The result is a block of 1295 coded bits {dc(0),dc(1),...,dc(1294)}.

6.10.6 Interleaving for Short Bursts

Interleaving is done as in subclause 6.8.6.

6.10.7 Interleaving for Long Bursts

The header and data are put together as one entity as described by the following rule:

c(k) = hc(k) for k = 0, 1, … 116

c(k) = dc(k-117) for k = 117, 118, … 1528

The resulting block is interleaved according to the following rule:

$i(B_h,j) = c(k)$

$B_h = (k + \text{int}(k / 706) \bmod 2)$

6.10.8 Mapping on a Short Burst

The mapping is done as in subclause 6.7.9.

6.10.9 Mapping on a Long Burst

The mapping is done as in subclause 6.9.10.

6.11 Wideband Synchronization Channel (WSCH)

The burst carrying the synchronization information on the downlink contains 25 information bits {d(0),d(1),..., d(24)}, 10 parity bits {p(0),p(1),..., p(9)} and 4 tail bits. The precise ordering of the information bits is given in ATIS-0700362.

The ten parity bits {p(0),p(1),...,p(9)} are defined in such a way that in GF(2) the binary polynomial:

$d(0)D^{34} + ... + d(24)D^{10} + p(0)D^{9} + ... + p(9)$, when divided by:

$D^{10} + D^{8} + D^{6} + D^{5} + D^{4} + D^{2} + 1$, yields a remainder equal to:

$D^{9} + D^{8} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D^{2} + D + 1$.

Thus the encoded bits {u(0),u(1),...,u(38)} are:

u(k)	= d(k)	for k = 0,1,...,24
u(k)	= p(k-25)	for k = 25,26,...,34
u(k)	= 0	for k = 35,36,37,38 (tail bits)

The bits {e(0),e(1),..., e(77)} are obtained by the convolutional code of rate ½, defined by the polynomials:

$G0 = 1 + D^3 + D^4$

$G1 = 1 + D + D^3 + D^4$

and with:

e(2k) = u(k) + u(k-3) + u(k-4)

e(2k+1) = u(k) + u(k-1) + u(k-3) + u(k-4) for k = 0,1,....,77 ; u(k) = 0 for k < 0

7 Modulation

7.1 Modulating Symbol Rate

The modulating symbol rate is 1/T = 2.6 Msymb/s, which corresponds to 2.6 Mbit/s with B-O-QAM and 5.2 Mbit/s with Q-O-QAM.

7.2 Data Modulation

The data modulation is either Binary Offset QAM (B-O-QAM), which is sometimes also referred to as Offset Quadrature Phase Shift Keying (OQPSK), or Quaternary Offset QAM (Q-O-QAM), which is sometimes also referred to as Offset 16QAM. Offset QAM may in general be expressed as:

$$s(t)=\left[\sum_k a_{2k}h(t-2kT)\right]\cos(\omega_c t)-\left[\sum_k a_{2k+1}h(t-(2k+1)T)\right]\sin(\omega_c t),$$

where $\omega_c=2\pi f_c$, f_c is the carrier frequency, 1/T is the symbol rate ($T=T_b$ for Binary Offset QAM and $T=2T_b$ for Quaternary Offset QAM), a_k is the kth data symbol taking on values of ±1 for Binary Offset QAM and ±1 and ±3 for Quaternary Offset QAM and h(t) is the impulse response of the shaping filter. The difference between Offset QAM and conventional QAM is the delay of T (half a symbol period for QAM) in the quadrature branch. This time shift prevents zero-crossing signal transitions.

Data symbols are mapped to modulation symbols as shown in Table 7.1

Table 7.1 – Data mapping to symbols

	Source data	Modulation symbol
B-O-QAM	1	1
	0	-1
Q-O-QAM	11	3
	10	1
	00	-1
	01	-3

7.3 Pulse Shaping

The pulse shaping filter has square root raised cosine spectrum with impulse response given by:

$$h(t)=\sqrt{\frac{E}{2T}}\frac{1}{\pi t/2T}\left[\frac{\sin\pi(1-\alpha)t/2T+4\alpha t/2T\cos\pi(1+\alpha)t/2T}{1-(4\alpha t/2T)^2}\right],$$

which is uniquely defined by the roll-off factor α. Here, the value 0.35 is chosen for the roll-off factor α. *E* is the energy of the pulse h(*t*) (usually normalized to 1).

7.4 Start & Stop of the Burst

Before the first bit of the bursts as defined in subclause 6 enters the modulator, the modulator has an internal state as if a modulating bit stream consisting of consecutive ones ($d_i = 1$) had entered the differential encoder. Also after the last bit of the time slot, the modulator has an internal state as if a modulating bit stream consisting of consecutive ones ($d_i = 1$) had continued to enter the differential encoder. These bits are called dummy bits and define the start and the stop of the active and the useful part of the burst as illustrated in Figure 3.1. Nothing is specified about the actual phase of the modulator output signal outside the useful part of the burst. For the normal burst the useful part lasts for 177 (short burst) or 739 (long burst) symbol periods.

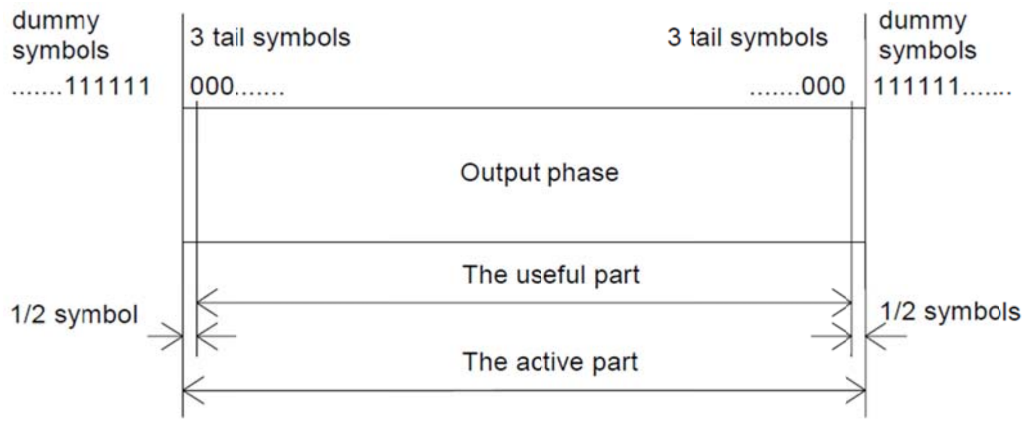


Figure 7.1 – Relation between the active part, the tail bits, and the dummy bits of a burst

Annex A: Acronyms

ARFCN	Absolute Radio Frequency Channel Number
ATIS	Alliance for Telecommunications Industry Solutions
BSIC	Base Transceiver Station Identity Code
BN	Bit Number
B-O-QAM	Binary Quatenary Offset Quadrature Ampitude Modulation
BS	Base Station
BTS	Base Transceiver Station
CA	Cell Allocation
FN	Frame Number
HS	High Speed
MA	Mobile radio frequency channel Allocation
MAIO	Mobile Allocation Index Offset
MS	Mobil Station
OQPSK	Offset QPSK
PACCH	Packet Associated Control Channel
PCCCH	Packet Common Control Channel
PCCH	Packet Control Channel
PDCH	Packet Data Channel
PLMN	Public Land Mobile Network
PTCH	Packet Traffic Channel
QAM	Quadrature Ampitude Modulation
Q-O-QAM	Quaternary Offset Quadrature Ampitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RFCH	Radio Frequency Channel
RFN	Reduced TDMA Frame Number
SCH	Synchronization Channel
TCH	Traffic Channel
TDMA	Time Division Multiple Access
TN	Timeslot Number
TS	Transmitted Signal
TSC	Training Sequence Code
USF	Uplink State Flag
WFCB	Wideband Frequency Correction Burst
WFCCH	Wideband Frequency Correction Channel
WGPRS	Wideband General Packet Radio Service
WLB	Wideband Long Burst
WMCS	WGPRS Modulation and Coding Scheme
WPACCH	WGPRS Packet Associated Control Channel
WPDCH	WGPRS Packet Data Channel
WPTCH	WGPRS Packet Traffic Channel
WSB	Wideband Short Burst
WSCH	Wideband Synchronization Channel
WSYB	Wideband Synchronization Burst

EDGE	Enhanced Data rates for Global Evolution