ATIS-0700360

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

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ATIS-0700360, *Wideband General Packet Radio Service (WGPRS) Packet – Data Service – High Speed (HS) Indoor Overview*

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 Standard on

Wideband General Packet Radio Service (WGPRS) Packet-Data Service – High Speed (HS) Indoor Overview

Alliance for Telecommunications Industry Solutions

Abstract

This document provides a standard for the High Speed (HS) Indoor bearer channel, configured as a packet traffic channel (PTCH), for Wideband General Packet Radio Service (WGPRS).

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.

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

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1   Introduction

To provide very high data rates, WGPRS uses a 1.6 MHz bearer channel, also known as HS Indoor. The upper layers of the GPRS protocol stack are common throughout Time Division Multiple Access-Single Carrier (TDMA-SC), applying to both individual bearers (HS Outdoor (Enhanced Data rates for Global Evolution (EDGE)), and HS Indoor). This document provides an overview of the HS Indoor bearer channel, configured as a PTCH, for WGPRS. A Radio Link Control/Medium Access Control (RLC/MAC) entity for the HS Indoor bearer channel is specified in ATIS-0700362 and a Physical Layer is specified in ATIS-0700361.

2   Layer 1 (Physical Radio Interface)

This overview describes the physical layer specified in ATIS-0700361. If this overview conflicts with ATIS-0700361, then ATIS-0700361 shall govern.

2.1   Multiple Access

The access scheme is Time Division Multiple Access (TDMA) with from sixteen to sixty-four basic physical channels per carrier. The carrier separation is a multiple of 200 kHz, typically 1.6 MHz. A physical channel is therefore defined as a sequence of TDMA frames and a time slot number (modulo 64).

The basic radio resource is a long timeslot (1/16 of a TDMA frame) or a short timeslot (1/64 of a TDMA frame) lasting ~288 µs (15/52 ms) or 72 µs (15/208 ms) and transmitting information at a modulation rate of ~2.6 Msymbols/s. This means that the time slot duration, including guard time, is 750 or 187.5 symbol durations.

2.2   Hyperframes, Superfames, & Multiframes

A diagrammatic representation of all the time frame structures is in Figure 2.1. The longest recurrent time period of the structure is called a hyperframe and has a duration of 3 h 28 mn 53 s 760 ms (or 12,533.76 s). The TDMA frames are numbered modulo in this hyperframe (TDMA frame number, or FN, from 0 to 2,715,647).

One hyperframe is subdivided in 2,048 superframes which have a duration of 6.12 seconds. The superframe is itself subdivided in multiframes. A 52-multiframe has a duration of 240 ms, comprising 52 TDMA frames. This multiframe carries WGPRS Packet Associated Control Channel (WPACCH), WGPRS Packet Traffic Channel (WPTCH), wideband frequency correction channel (WFCCH), and wideband synchronization channel (WSCH). The 52-multiframe itself is not shown in Figure 2.1, but can be seen as two 26-multiframes, with TDMA frames numbered from 0 to 51. A TDMA frame comprises sixty-four short (1/64) time slots and has a duration of ~4.62 (60/13) ms.

2.3   Timeslot and Burst Structure

Four different types of bursts exist in the system. A diagram of these bursts appears in Figure 2.1 and fields are specified in Table 2.1.

- Wideband short burst (WSB): this burst is used to carry information on traffic and associated control channels. It contains 144 symbols and includes a guard time of 10.5 symbol durations (~4.04 µs);
- Wideband long burst (WLB): this burst is used to carry information on traffic channels. It contains 706 symbols and includes a guard time of 11 symbol durations (~4.23 µs);
- Wideband frequency correction burst (WFCB): this burst is used for frequency synchronization of the mobile device. It is equivalent to an unmodulated carrier, shifted in frequency, with the same guard time as the normal burst. The repetition of Wideband Frequency Correction Bursts (WFBs) is also named WFCCH.

- Wideband synchronization burst (WSYB): this burst is used for time synchronization of the mobile. It contains a long training sequence and carries the reduced TDMA frame number (RFN) and base station identity code (BSIC, see ATIS-0700361). It is broadcast together with the frequency correction burst. The repetition of WSYBs is also named WSCH.
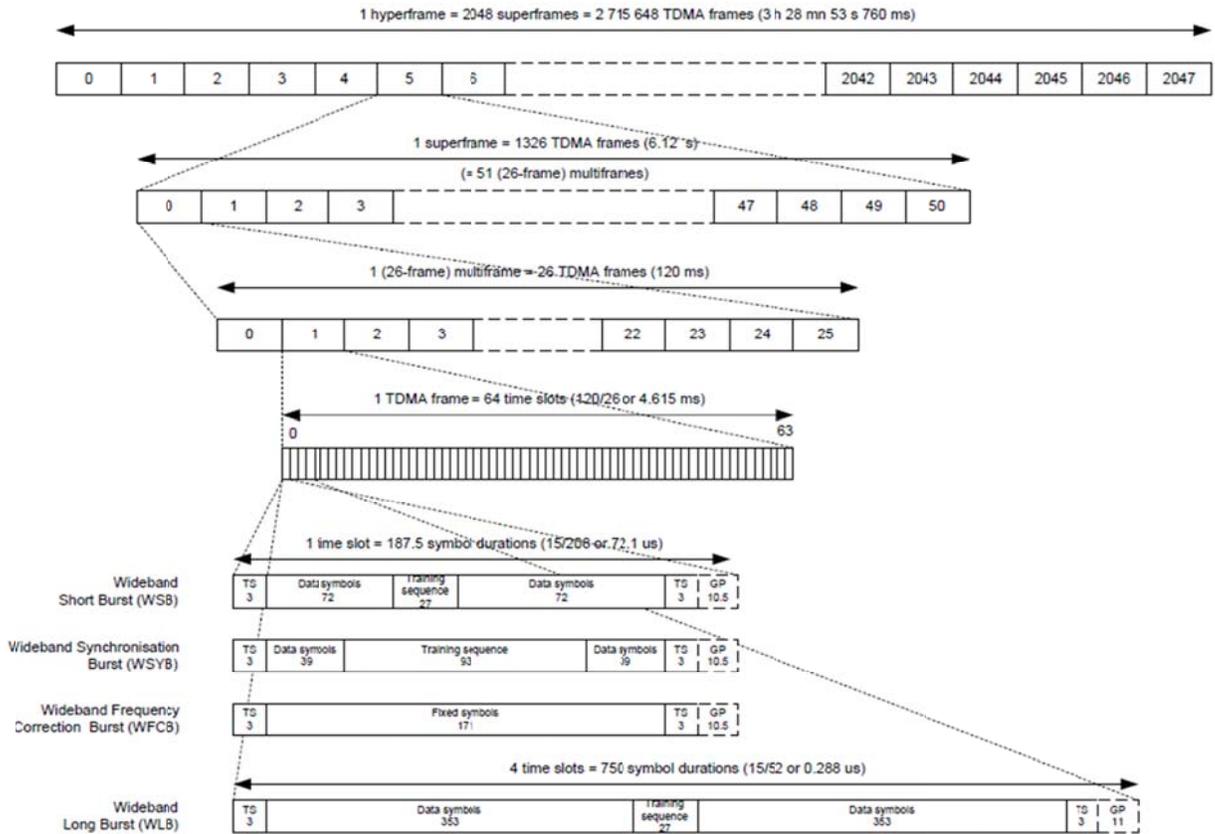
Figure 2.1 – Multiframe and Burst Structure

Table 2.1 – Wideband Short Burst and Wideband Long Burst Fields

Wideband Short Burst		Wideband Long Burst		
Symbol number	Length of field	Symbol number	Length of field	Contents of field
0-2	3	0-2	3	Tail symbols
3-74	72	3-355	353	Data symbols
75-101	27	356-382	27	Training sequence
102-173	72	383-735	353	Data symbols
174-176	3	736-738	3	Tail symbols
177-187	10.5	739-749	11	Guard period

2.4 Channel Coding

Four different wideband modulation and coding schemes, WGPRS Modulation and Coding Scheme (WMCS)-1 to WMCS-4, are defined for the Radio Blocks carrying RLC Data blocks. For the Radio Blocks carrying RLC/MAC Control blocks WMCS-1 is always used.

The first step of the coding procedure is to add a Block Check Sequence (BCS) for error detection. The second step consists of pre-coding Uplink State Flag (USF), adding six tail bits and rate 1/3 convolutional coding for error correction that is punctured to give the desired coding rate.

The details of the codes are shown in Table 2.2, including:

- The modulation scheme
- The number of user data bits in each RLC block
- The peak data throughput per time slot
- The code rates for header and data blocks
- Data and header block check sequence length

Table 2.2 – Channel Coding Details

	Link	Burst	Modulation	Data Blocksize (bits)	Data rate (kbit/sec)	Header code rate	Data code rate	BCS	HCS
WMCS-1	Uplink	Short	BOQAM	210	10.5	1/3	0.5	12	8
		Long	BOQAM	1334	66.7	1/3	0.5	12	8
	Downlink	Short	BOQAM	210	10.5	1/3	0.5	12	8
		Long	BOQAM	1334	66.7	1/3	0.5	12	8
WMCS-2	Uplink	Short	BOQAM	441	22.1	1/3	1	12	8
		Long	BOQAM	571	114.2	1/3	1	12	8
	Downlink	Short	BOQAM	438	21.9	1/3	1	12	8
		Long	BOQAM	568	113.6	1/3	1	12	8
WMCS-3	Uplink	Short	QOQAM	492	24.6	1/3	0.5	12	8
		Long	QOQAM	2740	137.0	1/3	0.5	12	8
	Downlink	Short	QOQAM	492	24.6	1/3	0.5	12	8
		Long	QOQAM	2740	137.0	1/3	0.5	12	8
WMCS-4	Uplink	Short	QOQAM	1017	50.9	1/3	1	12	8
		Long	QOQAM	1277	255.4	1/3	1	12	8
	Downlink	Short	QOQAM	1002	50.1	1/3	1	12	8
		Long	QOQAM	1262	252.4	1/3	1	12	8

2.5 Modulation

The data modulation is either Binary Offset Quadrature Amplitude Modulation (BOQAM), which is sometimes also referred to as Offset Quadrature Phase Shift Keying (OQPSK), or Quaternary Offset QAM (QOQAM), which is sometimes also referred to as Offset 16QAM. Offset Quadrature Amplitude Modulation (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.

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).

2.6 Set of Channels

The radio subsystem provides the following two logical channels:

1) The PTCH carries user information streams. The allocated uplink and downlink PTCH are used independently of each other. Independent allocation of uplink and downlink is possible. In this document, ATIS-0700361 and ATIS-0700362, the terms PTCH, HS Indoor PTCH, and WPTCH have the same meaning unless otherwise stated.

   Multislot configurations are defined as multiple (1 up to 64) PTCH/Us (Uplink PTCHs) and one packet associated control channel (PACCH)for one mobile originated communication, or multiple (1 up to 64) PTCH/Ds (Downlink PTCHs) and one PACCH for one mobile terminated communication respectively, allocated to the same MS. In this context allocation refers to the list of Packet Data Channel (PDCH) that may dynamically carry the PTCHs for that specific MS. The PACCH shall be mapped onto one PDCH carrying one PTCH/U or PTCH/D.

2) The signaling channel:PACCH. An associated control channel is always allocated in conjunction to one or multiple PTCH, concurrently assigned to one MS. An associated control channel has the same direction as the channels they are associated to. In this document, ATIS-0700361 and ATIS-0700362, the terms PACCH, HS Indoor PACCH, and WPACCH have the same meaning unless otherwise stated.

3) The repetition of WFCBs is also named the wideband frequency correction channel (WFCCH).

4) The repetition of WSYBs is also named the WSCH.

The logical channels mentioned above are mapped on physical channels that are described in the ATIS-0700361. The different physical channels provide for the transmission of information pertaining to higher layers according to a block structure.

3 Layer 2 (LLC, RLC, & MAC)

The overall function of layer 2 is to realize radio bearers for layer 3, taking into consideration the requested QoS objectives. Layer 2 is structured into Logical Link Control (LLC), RLC, and MAC, and a Radio Resource Management Entity (RRME).

The general layered structure of Layer 2 is shown in Figure 3.1. Specific to the HS Indoor bearer, the Radio Resource Protocol layer provides protocols and functions necessary for

- RRME that controls HS Indoor PTCH assignments from a GPRS PCCH
- HS Indoor RLC/MAC that includes RLC and MAC protocols on 1.6MHz packet data physical channels.
- HS Indoor RLC/MAC also controls channel assignments on 1.6 MHz PTCH during packet transfer mode

Figure 3.1 only shows the logical channel on the HS Indoor bearer. For brevity, logical channels on the other bearers are not shown.
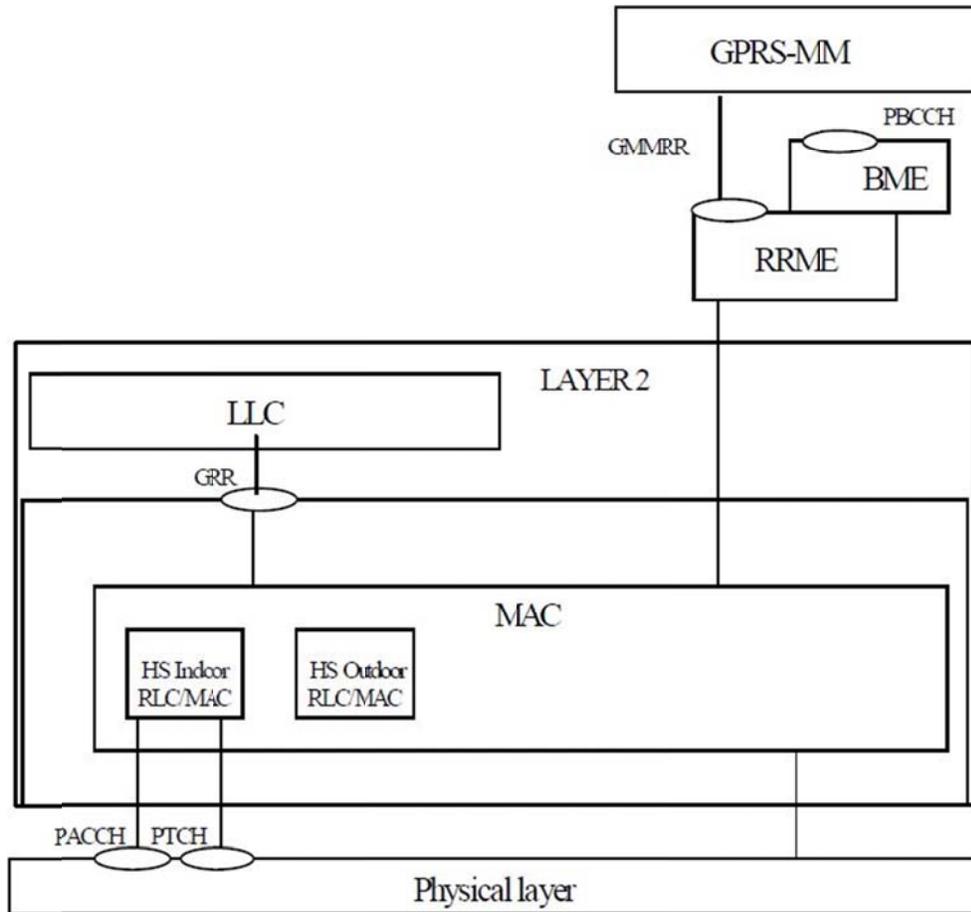
Figure 3.1 – MS Protocol Architecture of Layer 2

3.1 Layer Services

The HS Indoor RLC/MAC provides services for the transfer of upper layer Packet Data Units (PDUs) using a shared medium between multiple mobile stations and the network. The HS Indoor RLC/MAC function supports two modes of operation:

- Unacknowledged operation; and
- Acknowledged operation.

The HS Indoor RLC/MAC transfers data and control channel assignments during packet transfer mode on HS Indoor PTCH. In Packet idle mode, the mobile station monitors its paging channel on the PCCH.

3.2 Layer Functions

The HS Indoor RLC/MAC includes functions for RLC and MAC.

The RLC function defines the procedures for segmentation and reassembly of LLC PDUs into RLC/MAC blocks and, in RLC acknowledged mode of operation, for the Backward Error Correction (BEC) procedures enabling the selective retransmission of unsuccessfully delivered RLC/MAC blocks. In RLC acknowledged mode of operation, the RLC function preserves the order of higher layer PDUs provided to it.

The RLC function also provides link adaptation.

In RLC acknowledged mode of operation, the RLC function may provide Incremental Redundancy (IR). The MAC function defines the procedures that enable multiple mobile stations to share a common transmission medium, which may consist of several physical channels. The function may allow a mobile station to use

several physical channels in parallel, i.e. use several timeslots within the TDMA frame. Additionally the HS Indoor RLC/MAC provides radio resource management functions during packet transfer mode on the HS Indoor PTCH.

The HS Indoor RLC/MAC uses the services provided by the physical link layer as defined in ATIS-0700361.

4   Acronyms

ATIS	Alliance for Telecommunications Industry Solutions
BCS	Block Check Sequence
BEC	Backward Error Correction
BME	Broadcast Management Entity
B-O-QAM	Binary Quatenary Offset Quadrature Ampitude Modulation
BSIC	Base Transceiver Station Identity Code
CCCH	Common Control Channel
EDGE	Enhanced Data rates for Global Evolution
FN	Frame Number
GMMRR	GPRS Mobility Management Radio Resource
GPRS	General Packet Radio Service
GPRS-MM	General Packet Radio Service - Mobility Management
GRR	General Packet Radio Service Radio Resource SAP
HS	High Speed
LLC	Logical Link Control
MAC	Medium Access Control
O-QAM	Offset Quadrature Ampitude Modulation
OQPSK	Offset Quadrature Phase Shift Keying
PACCH	Packet Associated Control Channel
PBCCH	Packet Broadcast Control Channel
PCCH	Packet Control Channel
PDCH	Packet Data Channel
PDU	Packet Data Unit
PTCH	Packet Traffic Channel
QAM	Quadrature Ampitude Modulation
Q-O-QAM	Quatenary Offset Quadrature Ampitude Modulation
QPSK	Quadrature Phase Shift Keying
RFN	Reduced TDMA Frame Number
RLC	Radio Link Control
RR	Radio Resources
RRME	Radio Resource Management Entity
TDMA-SC	Time Division Multiple Access-Single Carrier
USF	Uplink State Flag
WFB	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
WPTCH	WGPRS Packet Traffic Channel
WSB	Wideband Short Burst
WSCH	Wideband Synchronization Channel
WSYB	Wideband Synchronization Burst