TS 5G.201 v1.0 (2016-1)

Technical Specification

KT PyeongChang 5G Special Interest Group (KT 5G-SIG); KT 5th Generation Radio Access; Physical Layer; General description (Release 1)

Ericsson, Intel Corp., Nokia, Qualcomm Technologies Inc., Samsung Electronics & KT

Document History

Version	Date	Change
1.0	2016-01-28	First Draft Version

Contents

Foreword

This Technical Specification has been produced by the KT PyeongChang 5G Special Interest Group (KT 5G-SIG).

1 Scope

The present document describes a general description of the physical layer of the 5G RA radio interface. The present document also describes the document structure of physical layer specifications, i.e. TS 5G.200 series.

2 References

[1] TS 5G.211: "5G Radio Access (5G RA); Physical channels and modulation".

[2] TS 5G.212: "5G Radio Access (5G RA); Multiplexing and channel coding".

[3] TS 5G.213: "5G Radio Access (5G RA); Physical layer procedures".

[4] TS 5G.214: "5G Radio Access (5G RA); Physical layer – Measurements".

3 Definitions, symbols and abbreviations

3.1 Definitions

Definition format

***<defined term>**: <definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

BPSK	Binary Phase Shift Keying
CP	Cyclic Prefix
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
CSI	Channel State Information
5G Node-B	5G Node B
5G RA	5G Radio Access
HARQ	Hybrid Automatic Repeat Request
LTE	Long Term Evolution
MAC	Medium Access Control
MBSFN	Multicast/Broadcast over Single Frequency Network
MIMO	Multiple Input Multiple Output
OFDM	Orthogonal Frequency Division Multiplexing
P5G	PyeongChang 5G
xPBCH	5G Physical Broadcast Channel
xPDSCH	5G Physical Downlink Shared Channel
xPDCCH	5G Physical Downlink Control Channel
xPRACH	5G Physical Random Access Channel
xPUCCH	5G Physical Uplink Control Channel

xPUSCH	5G Physical Uplink Shared Channel
QAM	Quadrature Amplitude Modulation
QPP	Quadratic Permutation Polynomial
QPSK	Quadrature Phase Shift Keying
RLC	Radio Link Control
RRC	Radio Resource Control
RSSI	Received Signal Strength Indicator
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
SAP	Service Access Point
TDD	Time Division Duplex
TX Diversity	Transmit Diversity
UE	User Equipment

4 General description of PyeongChang 5G Layer 1

4.1 Relation to other layers

4.1.1 General Protocol Architecture

The radio interface described in this specification covers the interface between the User Equipment (UE) and the network. The radio interface is composed of the Layer 1, 2 and 3. The TS 5G.200 series describes the Layer 1 (Physical Layer) specifications. Layers 2 and 3 are described in the 5G.300 series.

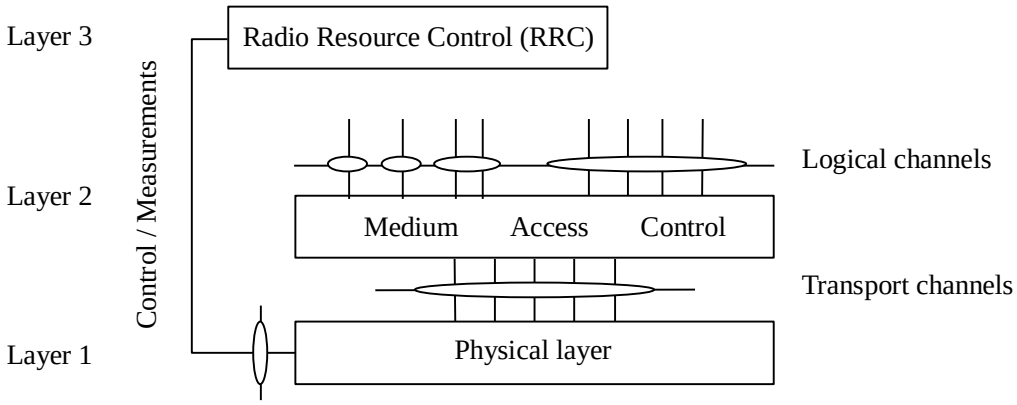

Figure 1: Radio interface protocol architecture around the physical layer

Figure 1 shows the PyeongChang 5G radio interface protocol architecture around the physical layer (Layer 1). The physical layer interfaces the Medium Access Control (MAC) sub-layer of Layer 2 and the Radio Resource Control (RRC) Layer of Layer 3. The circles between different layer/sub-layers indicate Service Access Points (SAPs). The physical layer offers a transport channel to MAC. The transport channel is characterized by how the information is transferred over the radio interface. MAC offers different logical channels to the Radio Link Control (RLC) sub-layer of Layer 2. A logical channel is characterized by the type of information transferred.

4.1.2 Service provided to higher layers

The physical layer offers data transport services to higher layers. The access to these services is through the use of a transport channel via the MAC sub-layer. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on the transport channel and indication to higher layers
- FEC encoding/decoding of the transport channel
- Hybrid ARQ soft-combining

- Rate matching of the coded transport channel to physical channels
- Mapping of the coded transport channel onto physical channels
- Power weighting of physical channels
- Modulation and demodulation of physical channels
- Frequency and time synchronisation
- Radio characteristics measurements and indication to higher layers
- Multiple Input Multiple Output (MIMO) antenna processing
- Transmit Diversity (TX diversity)
- Digital and Analog Beamforming
- RF processing

4.2 General description of Layer 1

4.2.1 Multiple Access

The multiple access scheme for the PyeongChang 5G physical layer is based on Orthogonal Frequency Division Multiplexing (OFDM) with a cyclic prefix (CP) in both downlink and uplink. One duplex mode is supported: Time Division Duplex (TDD) for half duplex operation.

The Layer 1 is defined in a single component carrier bandwidth of 100MHz, and 8 component carriers are supported. A resource block spans 12 sub-carriers with a sub-carrier bandwidth of 75kHz over a subframe duration of 0.2ms.

The radio frame consists of 50 subframes and has a length of 10ms. Each subframe has a length of 0.2ms and link direction (downlink or uplink) for data transmission can be dynamically switched on a subframe basis. A subframe can be configured as one of following combinations of DL control/data and UL control/data:

- a subframe including DL control and DL data
- a subframe including DL control, DL data and UL control
- a subframe including DL control and UL data
- a subframe including DL control, UL data and UL control

There exists a TDD GP of one OFDM symbol between DL control/data and UL data/control within a subframe. Further details on the 5G frame structure are specified in [1].

Analog beamforming is supported and its beam direction is dynamically switched for mobility support. Digital precoding is supported with MIMO transmission. MIMO configurations in the downlink with up to 8 transmit antennas are supported, which allows for multi-layer downlink transmissions with up to eight streams (up to two streams per UE). Multi-layer uplink transmissions with up to two streams per UE are supported.

Aggregation of multiple cells is supported in the uplink and downlink with up to 8 serving cells, where each serving cell can use a transmission bandwidth of 100 resource blocks.

4.2.2 Physical channels and modulation

The physical channels defined in the downlink are:

- the Physical Downlink Shared Channel (xPDSCH),
- the Physical Downlink Control Channel (xPDCCH),
- the Physical Broadcast Channel (xPBCH).

The physical channels defined in the uplink are:

- the Physical Random Access Channel (xPRACH),
- the Physical Uplink Shared Channel (xPUSCH),
- and the Physical Uplink Control Channel (xPUCCH).

In addition, signals are defined as reference signals, primary and secondary synchronization signals.

The modulation schemes supported are:

- QPSK, 16QAM and 64QAM in the downlink and the uplink.

4.2.3 Channel coding and interleaving

The channel coding scheme for transport blocks in PyeongChang 5G is LDPC coding with H-matrix structure defined in IEEE802.11n system. There are thirteen H-matrices in which twelve H-matrices are used for the combination of four different code rate (R=1/2, 2/3, 3/4, 5/6) and 3 codeword sizes (648, 1296, 1944), and. one H-matrix for one code rate (R=1/3) which has single parity check extension form from 5/6 code. The thirteenth H-matrix can support the variable codeword size by using lifting method. Before the LDPC coding, transport blocks are segmented into byte aligned segments with a maximum information block size of 1620 bits. Error detection is supported by the use of 24 bit CRC. Further channel coding schemes for BCH and control information are specified in [2].

4.2.4 Physical layer procedures

There are several Physical layer procedures involved with PyeongChang 5G operation. Such procedures covered by the physical layer are;

- Cell search,
- Beam acquisition,
- Power control,
- Uplink synchronisation and Uplink timing control,
- Random access related procedures,
- HARQ related procedures,
- Channel Access procedures.

Through the control of physical layer resources in the frequency domain as well as in the time and power domains, implicit support of interference coordination is provided in PyeongChang 5G.

4.2.5 Physical layer measurements

Radio characteristics are measured by the UE and the 5G Node-B and reported to higher layers in the network.

5 Document structure of LTE physical layer specification

5.1 Overview

The physical layer specification consists of a general document (TS 5G.201), and four documents (TSs 5G.211, 5G.212, 5G.213 and 5G.214).

5.2 TS 5G.201: Physical layer – General description

The scope is to describe:

- The contents of the Layer 1 documents (TS 5G.200 series);
- Where to find information;
- A general description of PyeongChang 5G Layer 1.

5.3 TS 5G.211: Physical channels and modulation

The scope of this specification is to establish the characteristics of the Layer-1 physical channels, generation of physical layer signals and modulation, and to specify:

- Definition of the uplink and downlink physical channels;
- The structure of the physical channels, frame format, physical resource elements, etc.;
- Modulation mapping (BPSK, QPSK, etc);
- Physical shared channel in uplink and downlink;
- Reference signals in uplink and downlink;
- Random access channel;
- Primary and secondary synchronization signals;
- OFDM signal generation in downlink;
- Scrambling, modulation and up conversion;
- Uplink-downlink timing relations;
- Layer mapping and precoding in downlink and uplink.

5.4 TS 5G.212: Multiplexing and channel coding

The scope of this specification is to describe the transport channel and control channel data processing, including multiplexing, channel coding and interleaving, and to specify:

- Channel coding schemes;
- Coding of Layer 1 / Layer 2 control information;
- Interleaving;
- Rate matching.

5.5 TS 5G.213: Physical layer procedures

The scope of this specification is to establish the characteristics of the physical layer procedures, and to specify:

- Synchronisation procedures, including cell search procedure and timing synchronisation;
- Beam acquisition procedure;
- Power control procedure;
- Random access procedure;
- Physical downlink shared channel related procedures, including CSI feedback reporting;

- Physical uplink shared channel related procedures, including UE sounding and HARQ ACK/NACK detection;
- Physical shared control channel procedures, including assignment of shared control channels.

5.6 TS 5G.214: Physical layer – Measurements

The scope of this specification is to establish the characteristics of the physical layer measurements, and to specify:

- Measurements to be performed by Layer 1 in UE and 5G Layer 1;
- Reporting of measurement results to higher layers and the network.