TSG-RAN Working Group 1 (Radio) meeting #3 ***TSGR1#3(99)157***
NYNÄSHAMN, Sweden 22-26, March 1999

Agenda Item: **7.1**

Source: **Editor**

Title: **S1.01 (V1.0.1): Physical layer – General description**

Document for:

S1.01 has been revised from Version 0.0.1 (TSR1#2(99)047) which has become Version 1.0.0 as TSG agreed in its 2nd meeting. The following revisions are made:

1. apply the 3GPP template;
2. update the reference list;
3. revise the text in Section 6;
4. remove S1.15 and S1.25 subsections in Section 6, and make S1.31 subsection;
5. copy Fig.7-1 “Protocol architecture” from S2.01 V0.0.1;
6. merge the ETSI and ARIB texts in Section 7.2.1, and revise the text related to spreading factors;
7. remove Section 7.3 “Elements for layer-to-layer communication”.

TS S1.01 V1.0.1 (1999-03)

Technical Specification

3rd Generation Partnership Project (3GPP); Technical Specification Group (TSG) Radio Access Network (RAN); Working Group 1 (WG1); Physical layer - General description

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Reference

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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project, Technical Specification Group Radio Access Network, Working Group 1 (3GPP TSG RAN WG1).

The contents of this TS may be subject to continuing work within the 3GPP and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released with an identifying change of release date and an increase in version number as follows:

Version m.t.e

where:

- m indicates [major version number]
- x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the third digit is incremented when editorial only changes have been incorporated into the specification.

1 Scope

This specification describes the documents being produced by the 3GPP TSG RAN WG1and first complete versions expected to be available by end of 1999. This specification gives also general description of the physical layer of the UTRA air interface,

The S1 series specifies Um point for the 3G mobile system. This series defines the minimum level of specifications required for basic connections in terms of mutual connectivity and compatibility.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

<Editor's Note: Relevant references should be discussed>

~~[1] ITU-T Recommendation G.729: "Coding of speech at 8kbit/s using conjugate-structure algebraic-code-excited linear-prediction"~~

~~[2] ITU-T Recommendation I.361: "B-ISDN ATM layer specification"~~

~~[3] ITU-T Recommendation I.363: "B-ISDN ATM adaptation layer (AAL) specification"~~

~~[4] ITU-T Recommendation I.363.2: "B-ISDN ATM Adaptation layer specification: Type 2 AAL"~~

~~[5] ITU-T Recommendation I.432.2: "B-ISDN user-network interface – Physical layer specification: 155 520 kbit/s and 622 080 kbit/s operation"~~

~~[6] ITU-T Recommendation Q.1224: "Distributed functional plane for Intelligent Network Capability Set 2"~~

~~[7] ITU-T Recommendation Q.FIF: "Information flows for IMT-2000"~~

~~[8] ITU-T Recommendation Q.1701: "Framework for IMT-2000 Networks"~~

~~[9] ITU-T Recommendation Q.1711: "Network Functional Model for IMT-2000"~~

~~[10] ITU-T Recommendation Q.FSR-L2: "FPLMTS Signaling Requirements for Radio Interface – Layer 2 "~~

~~[11] ITU-T Recommendation Q.FSR-L3: "FPLMTS Signaling Requirements for Radio Interface – Layer 3 "~~

[1] TS S1.02 (V1.0.0): "UE capabilities"

[2] TS S1.11 (V1.0.0): "Transport channels and physical channels (FDD)"

[3] TS S1.12 (V1.0.0): "Multiplexing and channel coding (FDD)"

[4] TS S1.13 (V1.0.0): "Spreading and modulation (FDD)"

[5] TS S1.14 (V1.0.0): "Physical layer procedures (FDD)"

[6] TS S1.21 (V1.0.0): "Transport channels and physical channels (TDD)"

[7] TS S1.22 (V1.0.0): "Multiplexing and channel coding (TDD)"

[8] TS S1.23 (V1.0.0): "Spreading and modulation (TDD)"

[9] TS S1.24 (V1.0.0): "Physical layer procedures (TDD)"

[10] TS S1.31 (V1.0.0): “Measurements”

[11] TS S2.01 (V1.0.0): “Radio Interface Protocol Architecture”

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

<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> <Explanation>

3.3 Abbreviations

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

<ACRONYM> <Explanation>

6 Document structure of physical layer specification

6.1 Overview

~~This~~ The physical layer specification consists of two general documents (S1.01, S1.02), ~~five~~ four FDD mode documents (S1.11 through S1.~~15~~14), ~~and five~~four TDD mode documents (S1.21 through S1.~~25~~24), and one special issue document (S1.31).

~~6.1 General documents~~

6.2 S1.01: Physical layer – ~~general~~ General description

The scope is to describe:

- ~~Describes~~ the contents of the Layer 1documents (S1 series);
- ~~Where~~ where to find information;
- ~~General~~ a general description of Layer 1.

6.3 S1.02: UE capabilities

The scope is to describe:

- ~~Describes~~ the capabilities of the UE.

  <Not clear if this belongs in TSG RAN WG1, but information is vital to TSG RAN WG1 >

~~6.2 FDD mode documents~~

6.4 S1.11: Transport channels and physical channels (FDD)

The scope is to establish the characteristics of the Layer 1 transport channels and physical channels in the FDD mode, and to specify:

- ~~Specifies~~ the different transport channels that exist;
- ~~Which~~ which physical channels exist;
- ~~What~~ what is the structure of each physical channel, slot format etc.;
- ~~Relative~~ relative timing between different physical channels in the same link, and relative timing between uplink and downlink;
- ~~Mapping~~ mapping of data onto the physical channels.

6.5 S1.12: Multiplexing and channel coding (FDD)

The scope is to describe multiplexing, channel coding and interleaving in the FDD mode, and to specify:

- ~~Coding~~ coding and multiplexing of transport channels into CCTrCHs;
- ~~Specifies~~ channel coding alternatives;

- ~~Specifies~~ coding for Layer 1 control information, such as TFCI;
- ~~Specifies~~ the different interleavers;
- ~~How~~ how is rate matching done;
- ~~Multiplexing~~multiplexing.

6.6 S1.13: Spreading and modulation (FDD)

The scope is to establish the characteristics of the spreading and modulation in the FDD mode, and to specify:

- ~~Specifies~~ the spreading (channelization plus scrambling);
- ~~Generation~~ generation of channelization and scrambling codes;
- ~~Generation~~ generation of RACH preamble codes;
- ~~Generation~~ generation of SCH synchronization codes;
- ~~Pulse-shaping~~ pulse-shaping filtering;
- ~~Modulation~~ modulation and pulse shaping;
- RF channel arrangements.

6.7 S1.14: Physical layer procedures (FDD)

The scope is to establish the characteristics of the physical layer procedures in the FDD mode, and to specify:

- ~~Power~~ power control procedures;
- ~~Random~~ random access procedure;
- ~~Paging~~ paging procedure.

~~S1.15 Measurements (FDD)~~

- ~~Specifies the measurements that L1 is to perform~~
- ~~Reporting of measurements to higher layers and network~~
- ~~Handover measurements, idle mode measurements etc.~~

~~6.3 TDD mode documents~~

6.8 S1.21: Transport channels and physical channels (TDD)

The scope is to establish the characteristics of the Layer 1 transport channels and physical channels in the TDD mode, and to define:

- ~~Defines~~ transport channels;
- ~~Defines~~ physical channels, structure and contents;
- ~~Timing~~ timing relationship between physical channels;
- ~~Mapping~~ mapping of data to the physical channels.

6.9 S1.22: Multiplexing and channel coding (TDD)

The scope is to describe multiplexing, channel coding and interleaving in the TDD mode, and to specify:

- ~~Specifies~~ channel coding;
- ~~Interleaving~~interleaving;
- ~~Rate~~ rate matching;
- ~~Multiplexing~~multiplexing.

6.10 S1.23: Spreading and modulation (TDD)

The scope is to establish the characteristics of the spreading and modulation in the TDD mode, and to specify:

- ~~Specifies~~ data modulation;
- ~~Spreading~~spreading;
- ~~Generation~~ generation of codes;
- RF channel arrangements.

6.11 S1.24: Physical layer procedures (TDD)

The scope is to establish the characteristics of the physical layer procedures in the TDD mode, and to specify:

- BS synchronisation;
- Dynamic channel allocation (DCA);
- ~~Timing~~ timing advance;
- ~~Power~~ power control procedures;
- ~~Idle~~ idle mode tasks.

6.12 S1.~~25~~31: Measurements ~~(TDD)~~

The scope is to specify:

- ~~Specifies~~ the measurements that Layer 1 is to perform;
- ~~Reporting~~ reporting of measurements to higher layers and network;
- ~~Handover~~ handover measurements, idle-mode measurements etc.

7 General description of Layer 1

7.1 Relation to other layers

7.1.1 General Protocol Architecture

<7.1.1 and 7.1.2 come from ARIB Section 2 >

Air-interface which is prescribed by this specification means the Um point between ~~mobile station~~UE and network. Air-interface is composed of Layers 1, 2 and 3. Layer 1 is based on WCDMA technology and ~~main part of this~~the S1 series describes the Layer-1 specification. Layers 2 and 3 of air-interface ~~fundamentally accord with Q.FSR L2 and Q FSR L3, which are standardized by ITU-T~~are described in the S2 and S3 series, respectively.

<Editor's Note: The following figure comes from ARIB >

<Editor's Note: The following figure comes from S2.01 V0.0.1 >

Fig. ~~2-1~~ 7-1 Radio interface~~General~~ protocol architecture (Service Access Points marked by circles)

Figure ~~2.1~~7-1 shows the UTRA radio interface protocol architecture. The circles between different sub-layers indicate Service Access Points (SAPs). The physical layer (Layer 1) offers different Transport channels to L2/MAC. A transport channel is characterized by how the information is transferred over the radio interface. L2/MAC offers different Logical channels to L2/~~LAC~~RLC. A logical channel is characterized by the type of information transferred. Physical channels are defined in the physical layer. In the FDD mode a physical channel is characterized by the code, frequency and in the reverse link the relative phase (I/Q). In the TDD mode the physical channels is also characterized by the timeslot. RRC controls ~~LAC~~RLC, MAC and Physical layer via primitives.

Remark : In Fig. ~~2-1~~7-1, "Multicast Channel" (MCH, defined in section 3.2.1.1.2.2,<Editor's note: Section number should be checked.>*) is not indicated. After detailed clarification about the feature of MCH and required functions to support it in each (sub) layer, the above Fig. ~~2-1~~7-1 will be revised to describe an appropriate structure.*

<Editors Note Downlink Shared Channel (DSCH) and Opportunity Driven Multiple Access (ODMA) ~~is~~are defined in ETSI only and MCH is defined in ARIB only. When agreed the figures needs respective update to be aligned with S2.02 from TSG RAN WG2 >

7.1.2 Service provided to upper layer

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

- FEC encoding/decoding of transport channels
- Macrodiversity distribution/combining and soft handover execution
- Multiplexing/demultiplexing of transport channels and of coded composite transport channels
- Mapping of coded composite transport channels on physical channels
- Modulation and spreading/demodulation and despreading of physical channels
- Frequency and time (chip, bit, slot, frame) synchronization
- Closed-loop power control
- Power weighting and combining of physical channels
- RF processing
- Error detection
- Rate matching (data multiplexed on DCH)
- Radio characteristics measurements including FER, SIR, Interference Power, etc.

7.2 General description of Layer 1

<7.2.1 comes from ETSI xx.02 Section 5 and ARIB Section 3.1 >

7.2.1 Multiple Access

The access scheme is Direct-Sequence Code Division Multiple Access (DS-CDMA) with information spread over approximately 5 MHz bandwidth, thus also often denoted as Wideband CDMA (WCDMA) due that nature.

UTRA has two modes, FDD (Frequency Division Duplex) & TDD (Time Division Duplex), for operating with paired and unpaired bands respectively. The possibility to operate in either FDD or TDD mode allows for efficient utilization

of the available spectrum according to the frequency allocation in different regions. FDD and TDD modes are defined as follows;

FDD: A duplex method whereby forward link and reverse link transmissions use two separated radio frequency. In the FDD, each forward and reverse link uses the different frequency band. A pair of frequency bands which have specified separation shall be assigned for the system.

TDD: A duplex method whereby forward link and reverse link transmissions are carried over same radio frequency by using synchronized time intervals. In the TDD, time slots in a physical channel are divided into transmission and reception part. Information on forward link and reverse link are transmitted reciprocally.

In UTRA TDD there is TDMA component in the multiple access in addition to DS-CDMA. Thus the multiple access has been also often denoted as TDMA/CDMA due added TDMA nature.

The carrier separation is 4.6-5 MHz depending on the deployment scenario with 200 kHz carrier raster. A 10 ms radio frame is divided into 16 0.625 ms slots. A physical channel is therefore defined as a code (or number of codes) and additionally in TDD mode the sequence of 0.625 ms time slots completes the definition of a physical channel. The both UTRA modes use 72-frame multiframe structure. The resulting longer frame duration is under discussion (hyperframe etc.) <Editor's note: Some discussion on the terminology between multiframe/superframe etc. needed >

The information rate of the channel varies with the symbol rate being derived from the 4.096 M chips/s chip rate and the spreading factor. Spreading factors are from 256 to 4 with FDD uplink, from512 to 4 with FDD downlink, and from 16 to 1 for TDD uplink and downlink. Thus the respective modulation symbol rates vary from 1.024 M symbols/s to 16 k symbols/s (8 k symbols/s) for FDD uplink (downlink), and for TDD the momentary modulation symbol rates shall vary from 4.096 M symbols/s to 256 k symbols/s.

Furthermore, relaying between nodes can be used by means of Opportunity Driven Multiple Access (ODMA) in TDD mode. <ODMA is defined only in ETSI >

~~<Editor's Note: In ARIB there are additional chip rates and spreading factors range from 512 to 1 in FDD and are different in TDD as well >~~

~~UTRA frames~~

~~The both UTRA modes use 72-frame multiframe structure. The resulting longer frame duration is under discussion (hyperframe etc.)~~

<ARIB Section 3.1.2 "Relationship of FDD and TDD mode" is not included because it is not needed as specification >

<The rest of 7.2 comes from ETSI xx.02 Sections 6 through 9 >

7.2.2 Coding and interleaving

For the channel coding in UTRA two options are supported:

- Convolutional coding, either 1/2 rate or 1/3 rate for packet data and services requiring less than 10E-6 quality level over the physical layer with forward error correction (FEC).
- Turbo coding for the services requiring quality level 10E-6 or higher. <Editor's note: Turbo coding method under refinement >

<Editor's Note: Options seem to be as above or using Turbo codes for all services at 32 k bits/s and above as in ARIB. To be updated after Ad Hoc #5 outcome >

7.2.3 Modulation and spreading

The UTRA modulation scheme is QPSK with root raised cosine pulse shaping with roll-of factor 0.22.

With CDMA nature the spreading (& scrambling) process is closely associated with modulation. In UTRA different families of spreading codes are used to spread the signal.

- For separating channels from same source, channelisation codes derived with the code tree structure as given in S1.13 and S1.23 are used.
- For separating different base station the following solutions are supported:
  - FDD mode: Gold codes with 10 ms period ~~of 40960 chips~~ used, with the actual code itself length 241-1 chips, as defined in S1.13;~~.~~ <The value 40960 is based on a chip rate of 4.096 Mcps>
  - TDD mode: Scrambling codes with the length 16 used as defined in S1.23.
- For separating different mobiles the following code families are defined:
  - FDD mode: Gold codes with 10 ms period, or alternatively S(2) codes 256 chip period ~~(VL-Kasami)~~;
  - TDD mode: codes with period of 16 chips and midamble sequences of different length depending on the environment.

~~<Editor's Note: This section needs update following selection for scrambling codes and their periods. In ARIB uplink period is longer and short code family is different >~~

7.2.4 Transmission and reception

The UTRA frequency bands assumed for operation are:~~.~~

1) Unpaired spectrum at 1900-1920 MHz and at 2010-2025 MHz
for TDD mode operation, and ~~Used~~ used for both base and mobile transmission;
(1895-1918.1 MHz band is occupied by PHS in Japan. 1850-1990 MHz band is occupied by PCS 1900 in US)

2) Paired spectrum:
at 1920-1980 MHz for mobile transmit, base station to receive;
at 2110- 2170 MHz for base station transmit, mobile to receive~~.~~;

3) Other bands, such as GSM 900 band~~,~~ and GSM 1800 band and other bands that can be used being currently occupied by other cellular systems;

4) Possible new spectrum allocations that may become available.

Several power classes are being defined currently.

<Editor's Note: PCS 1900 spectrum (1850-1990 MHz) and PHS (1895-1918.1 MHz) to be added? >

7.2.5 Physical layer procedures

There are several physical layer procedures involved with UTRA operation. Such a procedures covered by physical layer description are:

1) The power control, with both fast closed loop and slow quality loop for FDD mode and for TDD mode open loop power control together with slow closed loop; <Editor's Note: TDD fast power control is FFS >

2) Handover measurements for handover within UTRA. Specific features being determined in addition to the relative strength of the base station, for the FDD mode the timing relation between for the base stations for support of asynchronous soft handover;

3) The measurement procedures for preparation for handover to GSM900/GSM1800;

4) The measurements procedures for ~~MS~~ UE before random access process;

5) Dynamic Channel Allocation (DCA) with TDD mode operation;

6) ODMA specific procedures such as probing. <Editors Note: This is only in ETSI documents >

<Editor's Note: Section 7.3 "Elements for layer-to-layer communication" was removed >

History

Document history		
V0.0.1	1999-02-12	New document merged from ETSI & ARIB, produced jointly by the editors. To be updated after the conclusions from Ad Hocs. Forwarded to TSG/RAN/WG1 for agreement.
V1.0.0	1999-03-05	Agreed by 3GPP TSG.
1st temporary editor for S1.01, Physical Layer – General Description, is: Antti Toskala, Nokia Telecommunications, Email:antti.toskala@ntc.nokia.com 2nd temporary editor for S1.01, Physical Layer – General Description, is: Takashi Mochizuki, NEC Corporation, Email: mochizuki@pccrd.fc.nec.co.jp		
V1.0.1	1999-03-17	Update References and Section 6 “Document structure”. Remove Section 7.3 “Elements for layer-to-layer communication”.
Editor for S1.01, Physical Layer – General Description, is: Takashi Mochizuki NEC Corporation Email: mochizuki@pccrd.fc.nec.co.jp This document is written in Microsoft Word 97.		