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Technical Specification

China Wireless Telecommunication Standard (CWTS);
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CWTS

Intellectual Property Rights

Foreword

This Technical Specification (TS) has been produced by CWTS working group 1(CWTS WG1).The contents of this TS are subject to continuing work within CWTS WG1 and may change following formal TSG approval.

1 Scope

This document establishes the characteristics of the spreading and modulation in the TD-SCDMA mode. The main objectives of the document are to be a part of the full description of the Layer 1, and to serve as a basis for the drafting of the actual technical specification (TS).

<Editor’s note: The content has to be reviewed according to the TD-SCDMA rules. >

2 References

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

References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

For a specific reference, subsequent revisions do not apply.

For a non-specific reference, subsequent revisions do apply.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] TSGR #3(99)240 (V2.0.0) “TS S1.23.(1999-04)

[2] TSGR1#4(99)522(V2.0.0) “TS S1.23 (1999-04)

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:
<defined term>: <definition>.

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:

CDMA	Code Division Multiple Access
PN	Pseudo Noise
QPSK	Quadrature Phase Shift Keying
DwPTS	Downlink Pilot Symbol
UpPTS	Uplink Pilot Symbol
DCA	Dynamic Channel Allocation
SF	Spreading Factor

4 General

In the following, a separation between the data modulation and the spreading modulation has been made. The data modulation is defined in section 5 and the spreading modulation in section 6.

Table 1: Basic modulation parameters.

Chip rate	1.28Mcps
Carrier spacing	1.6MHz
Data modulation	QPSK or 8PSK(optional)
Chip modulation	Root-raised cosine roll-off $\alpha = 0.22$
Spreading characteristics	Orthogonal Qchips/symbol, where $Q = 2^p$, $0 <= p <= 4$

5 Data modulation

5.1 Symbol rate

The symbol rate and duration are indicated below:

$T_s = Q \times T_c$, where $T_c = \frac{1}{chiprate} = 0.78125$ µs, the symbol time T_s depends upon the spreading factor Q.

5.2 Mapping of bits onto signal point constellation

A certain number K of CDMA codes can be assigned to either a single user or to different users who are simultaneously transmitting bursts in the same time slot and the same frequency. The maximum possible number of CDMA codes, which is smaller or equal to 16, depends on the individual spreading factors, the actual interference situation and the service requirements. In document C1.21 examples of bodies of such spread bursts associated with a particular user are shown.

The data modulation is QPSK, thus the data symbols $d_n^{(k)}$ are generated from two interleaved and encoded data bits

$$b_{l,n}^{(k)} = \{0 \quad 1\} \qquad l = 1,2;\ k = 1,2\ldots..K;\ \text{n is symbol index} \qquad (1)$$

using the equation

$$\mathrm{Re}\{d_n^{(k)}\} = 1 - 2b_{1,n}^{(k)} \qquad (2)$$

$$\mathrm{Im}\{d_n^{(k)}\} = 1 - 2b_{2,n}^{(k)} \qquad k = 1,2,\ldots\ldots K;\ \text{n is symbol index}$$

Equation (2) corresponds to a QPSK modulation of the interleaved and encoded data bits $b_{l,n}^{(k)}$ of equation (1).

5.3 Pulse shape filtering

The pulse shape filtering is applied to each chip at the transmitter. The impulse response of the pulse shape filter h(t) shall be a root-raised cosine. The corresponding raised cosine impulse h(t) is defined as

$$h(t) = \frac{\sin p \frac{t}{Tc}}{p \frac{t}{Tc}} . \frac{\cos ap \frac{t}{Tc}}{1 - 4a^2 \frac{t^2}{Tc^2}} \qquad (3)$$

The roll-off factor is α = 0.22.

T_c is the chip duration: $T_c = \frac{1}{chiprate}$ = 0.78125 µs

6 Spreading modulation

6.1 Basic spreading parameters

Each data symbol $d_n^{(k)}$ of equation (2) is spread with a spreading code c of length Q={1 , 2, 4, 8 ,16 }

6.2 Spreading codes

The spreading factor Q may varies from 1~16. The data symbol $d_n^{(k)}$ is spread with Orthogonal Variable Spreading Factor (OVSF) codes, which is showed follow

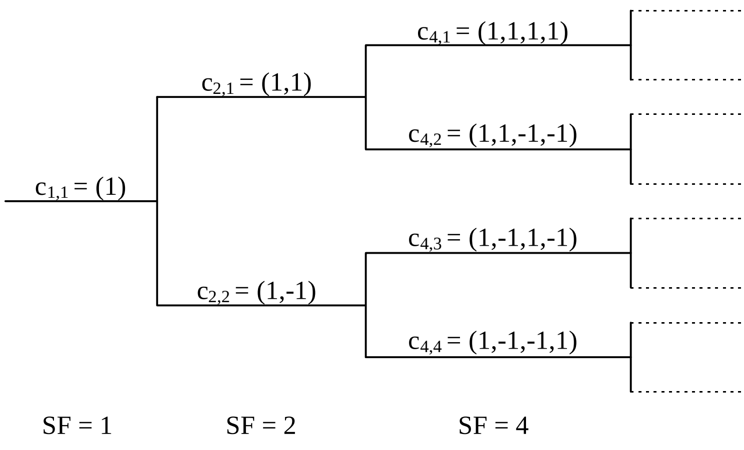

Figure 1. Code-tree for generation of Orthogonal Variable Spreading Factor (OVSF) codes.

In Figure 1, the OVSF code is described as $C_{SF,code\ number}$, where $SF_{d,n}$ represents the spreading factor of n^{th} code channel. Each level in the code tree defines channelization codes of length SF, corresponding to a spreading factor of SF in 1. All codes within the same code tree cannot be used simultaneously in the same time slot in the same cell.

The generation method for the channelization code can also be explained in Figure 2.

$$C_{1,1} = 1$$

$$\begin{bmatrix} C_{2,1} \\ C_{2,2} \end{bmatrix} = \begin{bmatrix} C_{1,1} & C_{1,1} \\ C_{1,1} & \overline{C_{1,1}} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

$$\begin{bmatrix} C_{4,1} \\ C_{4,2} \\ C_{4,3} \\ C_{4,4} \end{bmatrix} = \begin{bmatrix} C_{2,1} & C_{2,1} \\ C_{2,1} & \overline{C_{2,1}} \\ C_{2,2} & C_{2,2} \\ C_{2,2} & \overline{C_{2,2}} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

: :

$$\begin{bmatrix} C_{2^{n+1},1} \\ C_{2^{n+1},2} \\ C_{2^{n+1},3} \\ C_{2^{n+1},4} \\ \vdots \\ C_{2^{n+1},2^{n+1}-1} \\ C_{2^{n+1},2^{n+1}} \end{bmatrix} = \begin{bmatrix} C_{2^n,1} & C_{2^n,1} \\ C_{2^n,1} & \overline{C_{2^n,1}} \\ C_{2^n,2} & C_{2^n,2} \\ C_{2^n,2} & \overline{C_{2^n,2}} \\ \vdots & \vdots \\ C_{2^n,2^n} & C_{2^n,2^n} \\ C_{2^n,2^n} & \overline{C_{2^n,2^n}} \end{bmatrix}$$

Figure 2. Spreading Code Generation Method

6.3 Scramble codes

Scramble codes is used to identify different cells. Two sets of GL sequence of length 16 is used as the scramble codes. Preliminarily, 19(or 20) codes are chosen to be used in the system. The scramble codes are constructed with the help of two binary *m*-sequences of length 16, *x*, and *y*, respectively. The *x* sequence is constructed using the polynomial 1+x+x^4.The *y* sequence is constructed using the polynomial 1+x^3+x^4 . For the other set, the *x* sequence is constructed using the polynomial1+x^3+x^4 and the *y* sequence is constructed using the polynomial 1+x+x^4.

7. Generation of synchronisation codes

7.1 SYNC

SYNC is the downlink synchronization code in DwPTS.

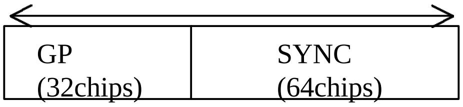

Figure 3. Burst structure of DwPTS

A set of 64 orthogonal Gold Codes can be used .The code sequences are constructed with the help of two binary *m*-sequences of length 64, *x*, and *y*, respectively. The *x* sequence is constructed using the polynomial `1+x+x^6.`The *y* sequence is constructed using the polynomial `1+x+x^3+x^4+x^6`.

The set of orthogonal Gold Codes are defined as following:

Let $n_5 \ldots n_0$ be the binary representation of the scrambling code number *n* (decimal) with n_0 being the least significant bit. The *x* sequence depends on the chosen code number *n* and is denoted x_n in the sequel. Furthermore, let $x_n(i)$ and $y(i)$ denote the *i*th symbol of the sequence x_n and *y*, respectively

The *m*-sequences x_n and *y* are constructed as:

Initial conditions:

$x_n(0)=n_0$, $x_n(1)= n_1$,$x_n(2)= n_2$, …… $x_n(5)= n_5$

$y(0)=y(1)= y(2)= \ldots\ldots=y(5)=1$

Recursive definition of subsequent symbols:

$x_n(i+6) =x_n(i+1) +x_n(i)$ modulo 2, $i=0,\ldots, 56$

$y(i+6) = y(i+4)+ x_n(i+3)+ x_n(i+1)+y(i)$ modulo 2, $i=0,\ldots, 56$.

Definition of the *n*:th cell identification code word follows:

$C_{,cell,n} = < 0, x_n(0)+y(0), x_n(1)+y(1), \ldots, x_n(62)+y(62) >$,

All sums of symbols are taken modulo 2.

Before modulation and transmission these binary code words are converted to real valued sequences by the transformation ‘0’ -> ‘+1’, ‘1’ -> ‘-1’.

The configuration of the code generator is presented in Figure.4

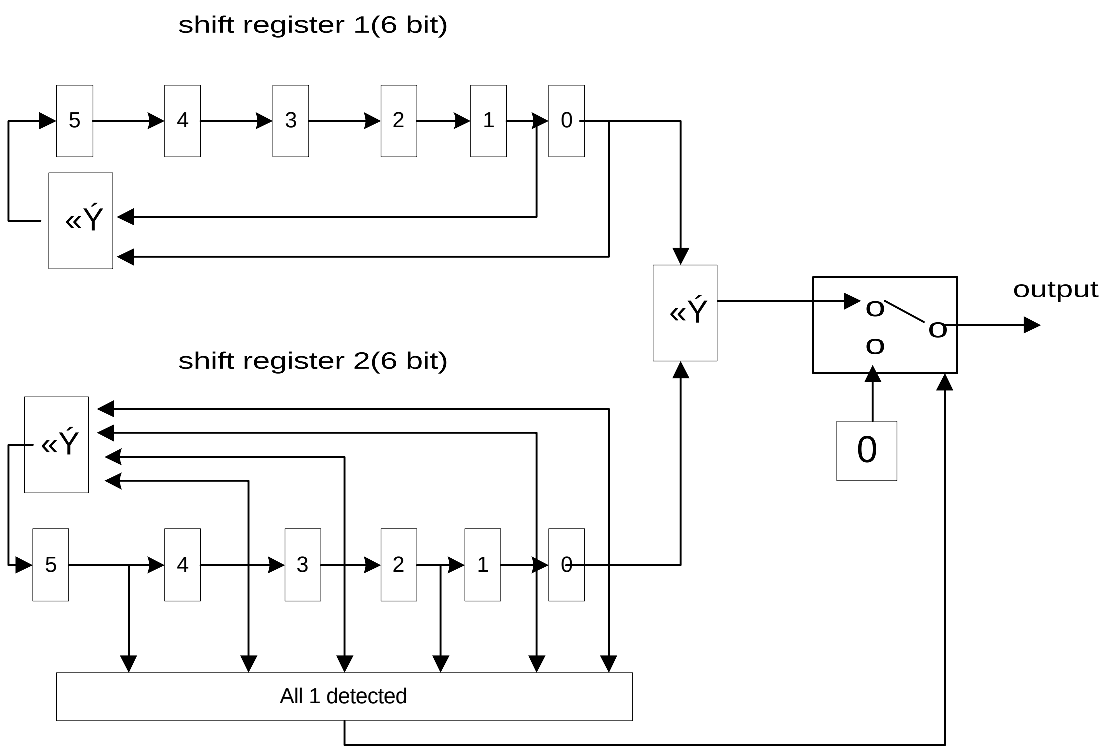

Figure 4. 64 chips orthogonal Gold code generator

- The initial value of shift register 1 shall be cell identification code number n (range 0~63)
- The initial value of shift register 2 shall be all ones.
- When all ones of register 2 is detected, shift shall be suspended and "0"shall be inserted.

7.2 SYNC1

SYNC1 is used to achieve uplink synchronization in UpPTS.

SYNC1 **(128chips)**	GP **(32chips)**

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The SYNC1 codes are constructed with the help of binary m-sequences of length 128. The colds are using the polynomial $x^7 + x^3 + 1$ (211) and $x^7 + x^3 + x^2 + x + 1$ (217).

8. RF Channel Allocation

A physical channel is characterized by the combination of its carrier frequency, time slot, spreading code and scramble code as explained in the chapter on the physical channel structure
Channel allocation covers both:

- resource allocation to cells (slow DCA)
- resource allocation to bearer services (fast DCA)

8.1 Resource allocation to cells

Channel allocation to cells follows the slow DCA rules below:

- A reuse one cluster is used in the frequency domain. A reuse one cluster in frequency domain does not need frequency planning. If there is more than one carrier available for a single operator also other frequency reuse patters >1 are possible.
- Any specific time slot within the TDD frame is available either for uplink or downlink transmission. UL/DL resources allocation is thus able to adapt itself to time varying asymmetric traffic.
- Different cells are identified by different scramble codes. So the same time slots and the same spreading codes scrambled by different scramble codes can be allocated to different cells.

Due to idle periods between successive receive and transmit bursts, UEs can provide the network with interference measurements in time slots different from the currently used one. The availability of such information enables the operator to implement the DCA algorithm suited to the network.

8.2 Resource allocation to bearer service

Fast channel allocation refers to the allocation of one or multiple physical channels to any bearer service Resource units (RUs) are acquired (and released) according to a cell-related preference list derived from the slow DCA scheme.

The following principles hold for fast channel allocation:

1. The basic RU used for channel allocation is one code / time slot / (frequency).
2. Multi-rate services are achieved by pooling of resource units. This can be made both in the code domain (pooling of multiple codes within one time slot = **multi-code** operation) and time domain (pooling of multiple time slots within one frame = **multi-slot** operation). Additionally, any combination of both is possible.
3. Since the maximum number of codes per time slot in UL/DL depends on several physical circumstances like, channel characteristics, environments, etc. (see description of physical layer) and additional techniques (for example smart antennas and joint detection) to enhance capacity are applied, the DCA algorithm has to be independent of this number. Additionally, time hopping can be used to average inter-cell interference in case of low-medium bit rate users.
4. Channel allocation differentiates between RT and NRT bearer services:

- RT services: Channels remain allocated for the whole duration the bearer service is established. The allocated resources may change because of a channel reallocation procedure (e.g. VBR).
- NRT services: Channels are allocated for the period of the transmission of a dedicated data packet only UDD channel allocation is performed using ‘best effort strategy’, i.e. resources available for NRT services are distributed to all admitted NRT services with pending transmission requests. The number of channels allocated for any NRT service is variable and depends at least on the number of current available resources and the number of NRT services attempting for packet transmission simultaneously. Additionally, prioritization of admitted NRT services is possible.

5. Channel reallocation procedures (intra-cell handover) can be triggered for many reasons:

- To cope with varying interference conditions.
- In case of high rate RT services (i.e. services requiring multiple resource units) a channel reshuffling procedure is required to prevent a fragmentation of the allocated codes over to many timeslots. This is achieved by freeing the least loaded timeslots (timeslots with minimum used codes) by performing a channel reallocation procedure.
- When using smart antennas, channel reallocation is useful to keep spatially separated the different users in the same timeslot.

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History

Document history		
Date	**Version**	**Comment**
July 1999	0.0.1	Document created. Based on TSGR and TAGR1 TS1.23 v2.0.0
August 6, 1999	1.0.0	Document created. Based on TSGR and TAGR1 TS1.23 v2.0.0 And CWTS TS C1.04 V0.0.1
August 22, 1999	1.1.0	Document created. Based on TSGR and TAGR1 TS1.23 v2.0.0 And CWTS TS C1.04 V0.0.1 and V1.0.0
August 30, 1999	2.0.0	Document updated based on CWTS WG1#5, Beijing
October 2, 1999	2.1.0	Chip rate change to 1.28Mcps

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