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Technical Specification

Working Group 1 (WG1);
Physical layer Procedures

CWTS

Contents

1 Intellectual Property Rights

2 Foreword

This document describes physical layer procedures for Physical Layer.

The C1 series specifies Um point for the 3G TD-SCDMA mobile system. This series defines the minimum level of specifications required for basic connections in terms of mutual connectivity and compatibility.

3 Scope

This specification describes the documents being produced by the CWTS WG1and first complete versions expected to be available by end of 1999. This specification gives also general description of the physical layer procedure of the UTRA TDD mode air interface,

4 References

References may be made to:

a) Specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply;

b) Publications without mention of a specific version, in which case the latest version applies.

[1] CWTS TS C102, Physical channels and mapping of transport channels onto physical channels

[2] CWTS TS C101, Physical layer –General Description

[3] CWTS TS C103, Multiplexing and channel coding

[4] CWTS TS C104, Spreading and modulation

5 Definitions, symbols and abbreviations

5.1 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.

5.2 Symbols

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

<symbol> <Explanation>

5.3 Abbreviations

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

BCH	Broadcasting channel
BER	Bit Error Rate
BS	Base Station
C-	Control-
CCTrCH	Coded Composite Transport Channel

DC	Dedicated Control (SAP)
DCA	Dynamic channel allocation
DCH	Dedicated Channel
DTCH	Dedicated Traffic Channel
DS-CDMA	Direct-Sequence Code Division Multiple Access
DwPTS	Downlink Pilot Timeslot
FACH	Forward Access Channel
FDD	Frequency Division Duplex
FEC	Forward Error Correction
FER	Frame Error Rate
GC	General Control (SAP)
GSM	Global System for Mobile Communication
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
LAC	Link Access Control
MAC	Medium Access Control
Mcps	Mega Chip Per Second
Nt	Notification (SAP)
ODMA	Opportunity Driven Multiple Access
PC	Power Control
PCH	Paging Channel
PCS	Personal Communications System
PHS	Persona Handyphone System
PHY	Physical layer
QPSK	Quaternary Phase Shift Keying
RACH	Random Access Channel
RF	Radio Frequency
RLC	Radio Link Control
RRC	Radio Resource Control
SAP	Service Access Point
SCH	Synchronisation Channel
SIR	Signal-to-Interference Ratio
SS	Synchronization Shift
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TD-SCDMA	Time Division Synchronous CDMA
TFCI	Transport-Format Combination Indicator
U-	User-
UE	User Equipment
Um	U interface in a mobile network
UpPTS	Uplink Pilot Timeslot
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
WCDMA	Wide-band Code Division Multiple Access

6 Physical layer procedures

6.1 General

In TD-SCDMA system, more new technologies such as smart antenna, uplink synchronization, ODMA, baton handover, and etc. are adopted. Most of the above mentioned technologies require the support of physical layer signalling. The related operation procedures of physical layer are reported in this section below.

6.2 Synchronisation of Node Bs and ODMA Relays

6.2.1 Synchronisation of TDD Node Bs

In several scenarios, there is a need to synchronise Node Bs in order to optimise system capacity and to performance cell search in handover procedure. One example is a scenario for co-ordinated operation with overlapping coverage areas of the cells, i.e. there is contiguous coverage for a certain area.

Several alternatives can be used to synchronise Node Bs.

< Editors note: The specification of this Node B synchronisation protocol is for further study and depends on required synchronisation accuracy. The protocol shall fulfil the following requirements:

- *Reliability and stability*
- *Low implementation effort*
- *Minimum impact on air interface traffic capacity.*

For example the two (three) schemes below are considered in WG1:

1. *For Node B synchronisation via the air interface a special burst, the network synchronisation burst, is used. This burst is sent on a predetermined TS at regular intervals. During the reception of the network synchronisation burst in a cell the transmission in this cell has to be switched off. The Node Bs receive this burst and adjust their frame timing accordingly.*
2. *Node Bs are synchronised by means of receiving other cells Downlink Pilot Timeslot (DwPTS).*
3. *Syncronization information comes from RNC in Iub interface. >*

6.2.1.1 Inter-system-synchronisation

The Node B synchronization will be limited in the systems operated by one operator. Based on a master-slave structure, the network synchronization burst will be send to each Node B by the RNC when only one RNC in a local network, or be send by MSC to each RNC and then to each Node B in a larger network.

In a multiple MSC systems, the inter-system synchronisation may come from a common clock set by the operator.

6.2.1.2 Timing offset between neighbouring cells

For cell search in handover procedures, timing offset between neighbouring cells is required. The BTSs in the same cell shall transmit their DwPTS in the same time with different carrier frequency, but the BTSs in different neighbouring cells shall transmit their DwPTS at a different time separation (offset) with the same or different carrier frequency. The value of timing offset is determined in network engineering. It is suggested that the value should be that as follows:

$$T_{off} = (0.3 - 0.5) * D / C \qquad (1)$$

where T_{off} is the timing offset; D is the distance between the two cells; and C is the speed of light.

6.2.2 Synchronisation of ODMA Relays

Due to the relatively short range of transmissions, the inclusion of ODMA does not impose any additional guard period or frame synchronisation requirements over those discussed above for standard TDD.

Any potential overlap caused by relay transmissions will be localised to a node and its neighbours by the ODMA protocol.

The inclusion of ODMA could relax the guard period requirements when relaying between nodes (not involving the BS) since neighbouring UEs are regarded as relay opportunities and any communications between neighbours (on an ODCH) could be synchronised further

6.3 Transmitter Power Control

6.3.1 General Parameters

Power control is applied for the TDD mode to limit the interference level within the system thus reducing both the intracell and intercell interference level and to reduce the power consumption in the UE.

Table -1: TPC characteristics

	Uplink	**Downlink**
Dynamic range	80 dB	30 dB
Power control rate	Variable Closed loop: 0-200 cycles/sec. Open loop: 1-7 slots delay	Variable closed loop: 0-200 cycles/sec.
Step size	[1 ... 3] dB	[1 ... 3] dB
Remarks	All figures are without TPC decoding and received power measurements.	within one timeslot the powers of all active codes may be balanced to within a range of [20] dB

- All codes within one timeslot allocated to the same bearer service use the same transmission power.
- In case of one user with simultaneous RT and NRT bearer service, the closed loop power control is used both for RT and NRT bearer service. However, depending on the current services different power levels are used.

6.3.2 ODMA Power Control

<for further study>

6.3.3 Uplink Control

6.3.3.1 Common Physical Channel

The transmitter power of UE shall be calculated by the following equation:

$$P_{PRACH} = L_{CCPCH} + I_{BTS} + \text{Constant value}$$

where, P_{PRACH} : transmitter power level in dBm,

L_{CCPCH}: measured path loss in dB (transmit power is broadcasted on BCH),

I_{BTS}: interference signal power level at cell's receiver in dBm, which is broadcasted on BCH

Constant value: This value shall be set via Layer 3 message (operator matter).

6.3.3.2 Dedicated Physical Channel

The initial transmission power is decided in a similar manner as PRACH. After the synchronisation between nodeB and UE is established, the UE transits into open-loop or closed-loop transmitter power control (TPC).

UL Open Loop Power Control:

The UE transmit power is set based on the measured path loss in the same way as for the PRACH.

UL Closed Loop Power Control:

Closed-loop TPC is based on SIR, and the TPC processing procedures are the same as the FDD mode. During this power control process, the nodeB periodically makes a comparison between the received SIR measurement value and the target SIR value. When the measured value is higher than the target SIR value, TPC bit = „0". When this is lower than the target SIR value, TPC bit = „1". At the UE, soft decision on the TPC bits is performed, and when it is judged as „0", the mobile transmit power shall be reduced by one power control step, whereas if it is the mobile transmit power shall be raised by one TPC step. A higher layer outer loop adjusts the target SIR. This scheme allows quality based power control.

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed for being out-of-synchronisation, the TPC bit shall always be = „1" during the period of being out-of-synchronisation.

6.3.4 Downlink Control

6.3.4.1 Common Physical Channel

The primary CCPCH transmit power can be changed based on network determination on a slow basis. The exact power of CCPCH is signalled on the BCH on a periodic basis.

6.3.4.2 Dedicated Physical Channel

The initial transmission power of the downlink Dedicated Physical Channel is set by the network. After the initial transmission, the node B transits into SIR-based closed-loop TPC as similar to the UTRA FDD mode.

The measurement of received SIR shall be carried out periodically at the UE. When the measured value is higher than the target SIR value, TPC bit ="0". When this is lower than the target SIR value, TPC bit = "1". At the

Node B, soft decision on the TPC bits is performed, and when it is judged as “0“, the transmission power shall be reduced by one step, whereas if judged as “1“, the transmission power shall be raised by one step.

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed due to out-of-synchronisation, the TPC bit shall always be = “1“ during the period of being out-of-synchronisation.

6.4 DPCH Description

6.4.1. Basic Frame Structure

Figure 1 shows the primary burst structure and the time slots assignment in one subframe.

The duration of each subframe is 5ms as shown in Figure 1. In each 5ms TDD interval, there are total 7 main time slots and 3 special time slots, which are defined as follows:

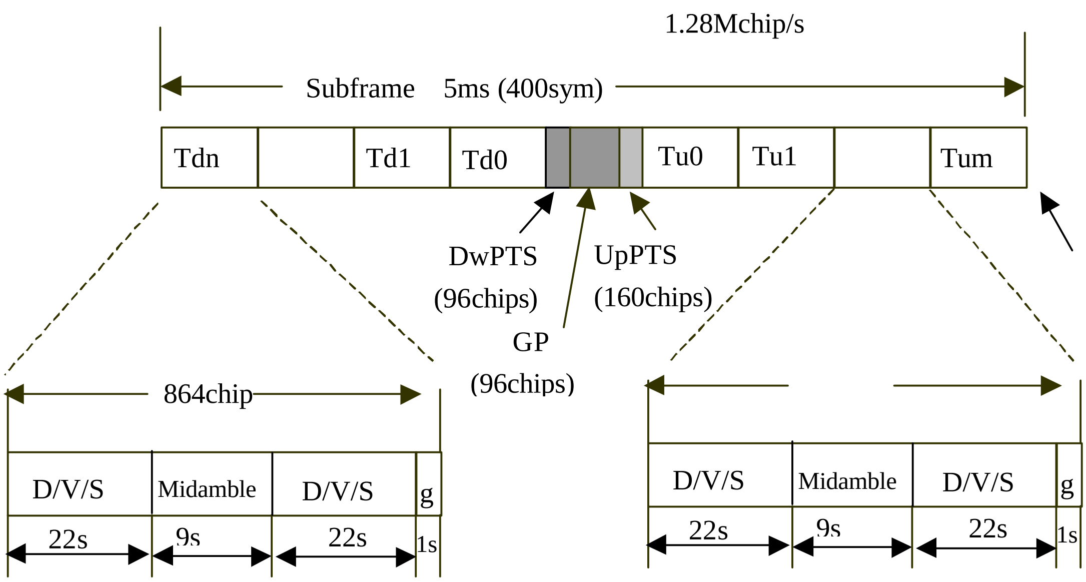
DwPTS: a time slot including 64 chips of SYNC and 32 chips of guard period for downlink Pilot and open loop downlink SCH.

GP: a time slot including more than 96 chips of guard period at base station Tx/Rx switching point to compensate the TDD transmission delay

UpPTS: a time slot including 128 chips of SYNC1 and 32 chips of guard period for uplink Pilot and open loop uplink SCH.

The TDD switching point (position of GP) may be varied depending on the uplink and downlink transmission data rate, but there is only one switching point in one subframe.

Among the 7 main time slots, the uplink and the downlink are separated by single switching point, all the main time slots (at least one main time slot) before the single switching point are allocated as downlink, while all the main time slots (at least one main time slot) behind the single switching point are allocated as uplink. In detail, the first code channel in Td0 time slot is allocated as BCH or PCH, and among other code channels in Td0 time slot, maximum 8 code channels could be allocated as FACH. The other code channels in Td0 and other main downlink time slots could be assigned as downlink traffic channels. At the UEs’ side, maximum 8 code channels in Tu0 time slot could be allocated as RACH. The other code channels in Tu0 and main uplink time slots could be assigned as uplink traffic channels. As an option, when smart antenna feature is used in Node B side, the first downlink time slot (Td0) could be used as dedicated broadcast time slot (in which BCH and PCH may mapped).The change of the subframe structure will be broadcast over the BCH. In each main time slot, there may be 1/2/4/8/16 code channels according to the spreading factor value. Due to the synchronous character, only 16 chips period as guard time between each main time slot is required.



Where n+m+2=7

And 1symbol=16chips

Figure 1. Time slot assignment for the TDD subframe

[Note: the above time slot assignment is the example figure using burst structure 1,spreading factor of 16, for more information about the frame structure and burst type, refer to [1]]

6.4.2. DPCCH

Reference to Figure 1, the physical and transport channels related to PDCCH are allocated in a pair of time slot Td0 and Tu0. An example for the detailed structure of these two time slots is shown in Figure 3.

	Td1	Td0	DwPTS	UpPTS	Tu0
Code ch 0		BCH			RACH
Code ch 1		BCH			RACH
Code ch 2					RACH
Code ch 3					RACH
Code ch 4					
Code ch 5					
Code ch 6					
Code ch 7					
Code ch 8					
Code ch 9					
Code ch A					
Code ch B					
Code ch C	(FACH)	FACH			
Code ch D	(FACH)	FACH			
Code ch E	(FACH)	FACH			
Code ch F	(FACH)	FACH			

Figure 3. An example of access channel allocation

In this example, the power level of BCH/PCH is 8 times that of one FACH channel when smart antenna is used and the FACH should be in Td1 while Td0 become the dedicated broadcast time slot. The 4 pairs of RACH and FACH are allocated in code channels 0 to 3 in Tu0 and in code channels C to F in Td0 or Td1 respectively. The maximum number of FACH and RACH pairs is 8 in TD-SCDMA RTT. The remained code channels maybe used as traffic code channel as those in other time slots. Each RACH is paired with a Gold code (SYNC1) in UpPTS when random access.

6.4.3 BCH and PCH

BCH is the channel for cell information broadcast. In this channel, information is transmitted in omni-direction to cover the whole cell range. PCH is a special broadcast channel used to paging UEs from base station side.

BCH and PCH are mapped into downlink time slot0 followed by DwPTS. (see reference [1]). In time slot Td0, code channel 0 and 1 are used as the omni-directional broadcast channel. In this channel, multi-frame structure is used. BCH and PCH will occupy their own blocks in the multi-frame structure.

6.4.4 FACH and RACH

RACH channel is used for uplink random access by UE and FACH is used for making response to UE's random access request. FACH and RACH are used in pairs, the number of RACH channel and the number of FACH channel are the same with the maximum number of 8. FACH locate in the first or second downlink time slot (Td0 or Td1) while the RACH locate in the first uplink time slot (Tu0).

6.5. Uplink Synchronisation

6.5.1. The establishment of uplink synchronisation

In physical layer signalling, two special fields in each main downlink time slot are designed. One is called synchronization shift (SS); the other is named as power control (PC) ,refer to [1]. Once the UE's uplink synchronization sets up, the Node B can calculate the distance between the UE and the Node B based on the Tx time of the UE.

When a UE is powered on, it will search the first 4 strongest SYNC sequences in downlink pilot time slot DwPTS from the nearby Node Bs and choose the most suitable one to try to random access, i.e.; Since the SYNC in DwPTS are always transmitted by the Node B to whole coverage of the cell with the specified Gold code sequences and with higher Tx power level than any other main downlink time slots. the SYNC will be easily recognised by the UE. Meanwhile, the UE will try to read the contents in BCH followed by DwPTS to find RACH/FACH pairs and their B/I status, etc.

Although the UE can receive the downlink synchronization signal from the Node B at this moment, it is not sure when to transmit and how to establish the uplink synchronization with other UEs, because the UE does not know its distance from the Node B. In this case, the UE will estimate its next Tx time and Tx power level coarsely by itself based on the detected arrival time and power level of the received training sequence (SYNC) in DwPTS, and then will randomly choose a SYNC1 sequence in UpPTS and a pair of RACH/FACH among the idle access channel pairs, and send the SYNC1 and access request on the RACH with the estimated Tx time and Tx power level. These are the open loop uplink synchronization procedures.

The SYNC1 sequence following the guard time slot is used only in the UpPTS for uplink synchronization; it is a known orthogonal Gold code sequence. In this period, only the UEs (maximum 8 UEs) that want to establish the uplink synchronization will transmit with random chose Gold code sequences followed by RACHs. Once the Node B detects the transmission from one UE, or has found the correlated peak value exceeding the minimum threshold, the SS and PC could be obtained by comparing the detected arrival time and power level of the SYNC1 with the expected arrival time and power level. Meanwhile, the Node B will try to despread the signals in the following RACH. If the following contents are verified to be correct by the CRC and other methods, the Node B will response to the UE by sending its control signalling over the chose FACH in the following subframe. The control signalling includes the adjust of the sync shift (SS) and the uplink power control (SS), etc. And then the packets of higher layer signalling such as Link_Grant and assigned traffic channel information.

Once the UE receives the above mentioned control signalling in the chose FACH, its access request has been accepted by the Node B. Then the UE will switch to the assigned time slot/code channel (traffic channel). Meanwhile, it must adjust its Tx time and Tx power level according to the received SS and PC information, and then continue its access procedures in the same RACH/FACH pair of the next subframe. These are the closed loop uplink synchronization procedures.

When a collision happened or in bad propagation environment, the Node B can’t receive SYNC1 and RACH. In these cases, the UE will not get any useful response from the Node B in the FACH of next subframe, thus the UE will have to adjust it’s Tx time and Tx power level based on the new SYNC response and re-send the access request in RACH with SYNC1 after a random delay.

Besides above detailed mentioned situations, all kinds of following procedures for the UE could be concluded as follows:

1. If the UE has detected no answer or error answer in the control signalling packets in the FACH, it will abandon these packets. To avoid the risk of collision with other UEs, it will re-send the access request with the newly estimated Tx time and Tx power level based on new SYNC after a random delay.

2. If the UE has correctly received the downlink control signalling packets in the FACH, but the PID does not match, the UE will abandon these packets. To avoid the risk of collision with other UEs, it will re-send the access request with the newly estimated Tx time and Tx power level based on new SYNC after a random delay.

3. If the UE has correctly received the downlink control signalling packets in the FACH, but without PID, the UE will abandon these packets. To avoid the risk of collision with other UEs, it will adjust its Tx time and Tx power level as the SS and PC information informed by the Node B and re-send the access request after a random delay.

4. If the access request in RACH can be correctly received by the Node B, and the response from Node B in FACH is also correctly received by the UE with the PID matched, the UE understands that the Node B has accepted its access request. Then the UE will adjust its Tx time and Tx power level as the SS and PC information informed by the Node B. And it will continue its access procedures in the same RACH/FACH pair of the next subframe

If the UE can not access the Node B as the above 4 procedures within the fixed period, it will turn into standby state.

6.5.2. Maintenance of uplink synchronisation

The maintenance of the uplink synchronization is vital in the proposed system, the midamble field in frame structure is used in each traffic channel of each main uplink time slot. In each main uplink time slot, the midamble in each code channel is different. The BS can estimate the power level and timing shift by measuring the midamble field of each code channel in the same time slot. Then in the following downlink time slot, the BS will send the L1 control signalling of power control (PC) and Sync shift (SS) By use of this mechanism, the Node B will successfully obtain the correlation peak value and the arrival time from the active UE. Based on the arrival time, the Node B can calculate the uplink synchronization tolerance of the UE and hence feed back the SS information to the UE in the corresponding downlink traffic channel of the next subframe, and then enable the UE to adjust its Tx time correctly. These procedures guarantee the reliability of the uplink synchronisation. the uplink synchronization can be checked once per TDD interval. Because the accuracy in uplink synchronization is less than 1/2 chip duration, or approximately 390.4ns in 1.28Mcps chiprate, the maximum distance variation between Node B and the UE will be $390.4\times10^{-9}\times3\times10^{8}=117\mathrm{m}$. When the UE is moving at the speed of 120km/h, the distance variation will be 0.16m only in 5ms duration. Actually, a UE will need to adjust its Tx time once or twice per second only. In other words, some burst with error bit will not affect the maintenance of uplink synchronization.

6.5.3. The estimation of the distance between Node B and UE

The uplink synchronization asks the UE to transmit in advance a time shift (ΔT), which depends upon the distance between Node B and the UE. Obviously, one may estimate the distance between Node B and the UE by use the known time shift that:

$$d = C * \Delta T \qquad (2)$$

where C is the speed of light.

6.6. Smart Antenna

6.6.1. Smart antenna structure in Node B

The proposed TD-SCDMA RTT is mainly based on the smart antenna technology as described. Generally speaking, a smart antenna based Node B should be that shown in Figure 4. The smart antenna array is composed of N antenna elements, N related feed cables and N coherent RF transceivers in RF part. By use of the A/D converters or D/A converters in analog baseband (ABB), the Rx and Tx analog signals are interfaced to the digital baseband (DBB) part over the high-speed data bus. In this model, all antenna elements related feed cables and coherent RF transceivers will be calibrated before operating.

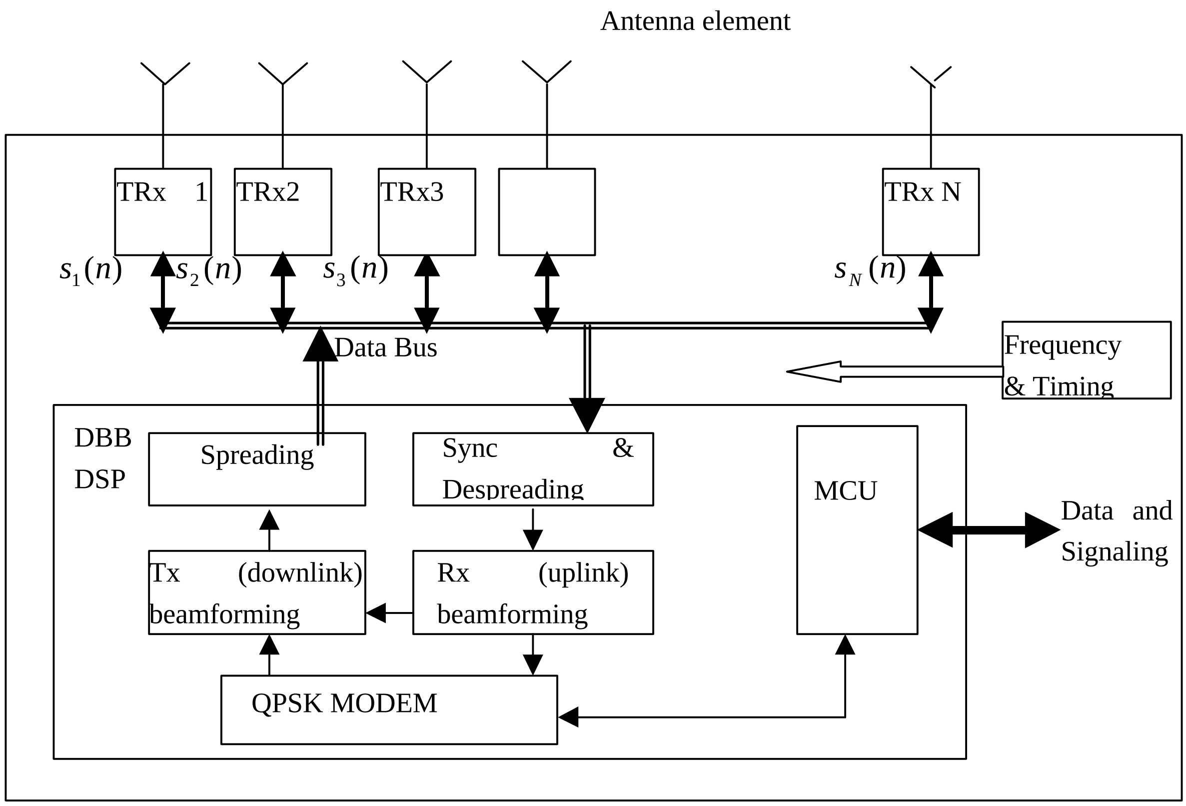


Figure 4. Block diagram of Node B with smart antenna

6.6.2. Beamforming

Reference to Figure 4, the Node B is equipped with smart antenna array and DBB DSP. When a signal comes from one UE within the coverage of the Node B, each antenna element and coherent RF receiver will get it. Because of the different location of the different antenna element, the phase of the Rx signal will be different. In case of multipath propagation, each path will come from different directions with different amplitude and delay. Then the Rx signal at each antenna element will show different phase and amplitude. After the front-end processing in RF part and A/D converters processing in ABB, digitized Rx signal with the phase and amplitude information will be sent to DSP in DBB part. In a CDMA cellular system, there are many UEs working simultaneously. The Rx signals will be the sum of the signals (including main path and multipath) coming from all the active UEs within the cell and the interference coming from nearby cells.

Let the output of the i-th receiver be $s_i(n)$ at the time n. After despreading, one may obtain the Rx data of each code channel as $x_{ji}(l)$ for the l-th symbol, where j means the j-th code channel. The purpose of smart antenna in uplink is to find the best E_b/I_0 after the combination, The signal of the l-th symbol in the j-th code channel is denoted as $X_j(l)$, then

$$X_j(l) = \sum_{i=1}^{N} x_{ji}(l) w_{ij}(l) \tag{3}$$

where W is the uplink beamforming matrix with element $w_{ij}(l)$.

Many beamforming algorithms can be found in published papers. Theoretically, the uplink beamforming can add up all useful signals while cancelling all multipath interference.

Next step in smart antenna is to realize downlink beamforming. The Tx signal of the j -th code channel is denoted as $Y_j(l)$ for the l -th symbol. Let the UE obtain the best E_b/I_0 , then it can be obtained that

$$y_{ij}(l) = \sum_{i=1}^{N} Y_j(l) u_{ji}(l) \qquad (4)$$

where

$y_{ij}(l)$ is the Tx signal on the i -th antenna for the l -th symbol in the j -th code channel;

U is the downlink beamforming matrix with element $u_{ji}(l)$.

In TDD system, the uplink and downlink are operated at the same frequency but in different time slots. This make it possible to directly use the uplink beamforming results (W in equation (3)) to downlink beamforming (U in equation (4)) because of the symmetrical performance in wave propagation. The reciprocal principle in electro-magnetic theory provides the theoretical foundation.

6.7. Synchronisation and Cell Search Procedures

6.7.1 Cell Search

During the initial cell search, the UE searches for a cell. It then determines the DwPTS, frame synchronisation of that cell and then decodes the contents in BCH. The initial cell search uses the DwPTS and BCH are described in [1].

This initial cell search is carried out in three steps:

Step 1: Search DwPTS

During the first step of the initial cell search procedure the UE receives a subframe (5ms) signal. Then moving a window to find the maximum correlation peaks by using known Gold Code sequences. This peak should be located in the position of DwPTSs.

Step 2: Frame synchronisation

The Step 2 is described for the case where multiple Node Bs are located in the area.

During the second step of the initial cell search procedure, the UE uses the searched correlation peaks related to each Node B in nearby area to determine the related Node B. The UE will one by one try to despreading the received signals in BCH followed by the DwPTS.

Step 3: BCH recognise

During the third or last step of the initial cell-search procedure, the UE determines the exact contents in the decoded contents in each BCH. Then the UE will record the first 3 or 4 Node Bs with the strongest signal.

6.8 ODMA Relay Probing

This section describes the probe-response procedure used by ODMA nodes to detect neighbours which may be used as relays during a call.

6.8.1 Initial Mode Probing

The initial mode probing procedure is activated by a UE when it is switched on and has no information about its surroundings. In this case the UE will synchronise with the ODMA Random Access Channel (ORACH) which is used by all UEs to receive and broadcast system routing control information and data. The UE begins a probing session by periodically broadcasting a probe packet on the ORACH. The broadcast probe includes the current neighbour list for the UE which will initially be empty. If a neighbouring UE, UE*a*, receives the broadcast packet it will register the UE as a neighbour and send an addressed response probe. The response probe is transmitted at random to avoid contention with other UEs and typically one response is sent for every *n* broadcast probes received from a particular UE.

The next time the UE transmits a broadcast probe the neighbour list will have one new entry, *UEa*, and an associated quality indicator (a weighted factor based on the received signal strength of the response probe). It is through this basic mechanism that each UE builds a neighbour list.

6.8.2 Idle Mode Probing

The Idle Mode Probing procedure is activated when the UE has synchronised with the ORACH but is not transmitting data. This procedure is the same as that described above after ORACH synchronisation.

The ODMA Idle Mode Probing procedure controls the rate of probing on the ORACH to reduce interference levels and regulate power consumption. The procedure is governed by a state machine, which consists of the following states: full probing, duty maintained probing, and relay prohibited. Each state defines the number of probing opportunities within one N multiframe, and a probing activity parameter *K* which is the ratio of probe transmission time to probe monitoring time.

Full probing

Full probing is the case where probing is allowed on every ORACH timeslot within an *N* multiframe. The UE_R will probe on the ORACH at a rate defined by the probing activity parameter *K*.

Duty Maintained probing

The duty maintained probing is the case where probing is allowed on *M* slots of an *N* multiframe. The UE_R will probe on the *M* ORACH slots in an *N* multiframe at a rate defined by the probing activity parameter *K*.

Relay Prohibited

In this mode the UE_R would cease all of its ODMA probing activities and will fall into standard TDD or FDD operation.

The probing activity levels for given state machines are illustrated in Figure 5 for a system with an ORACH for M slots per N $\times$ 16 multiframe.

Note that the distribution of probing opportunities within a multiframe may not necessarily be consecutive and located at the beginning of a multiframe.

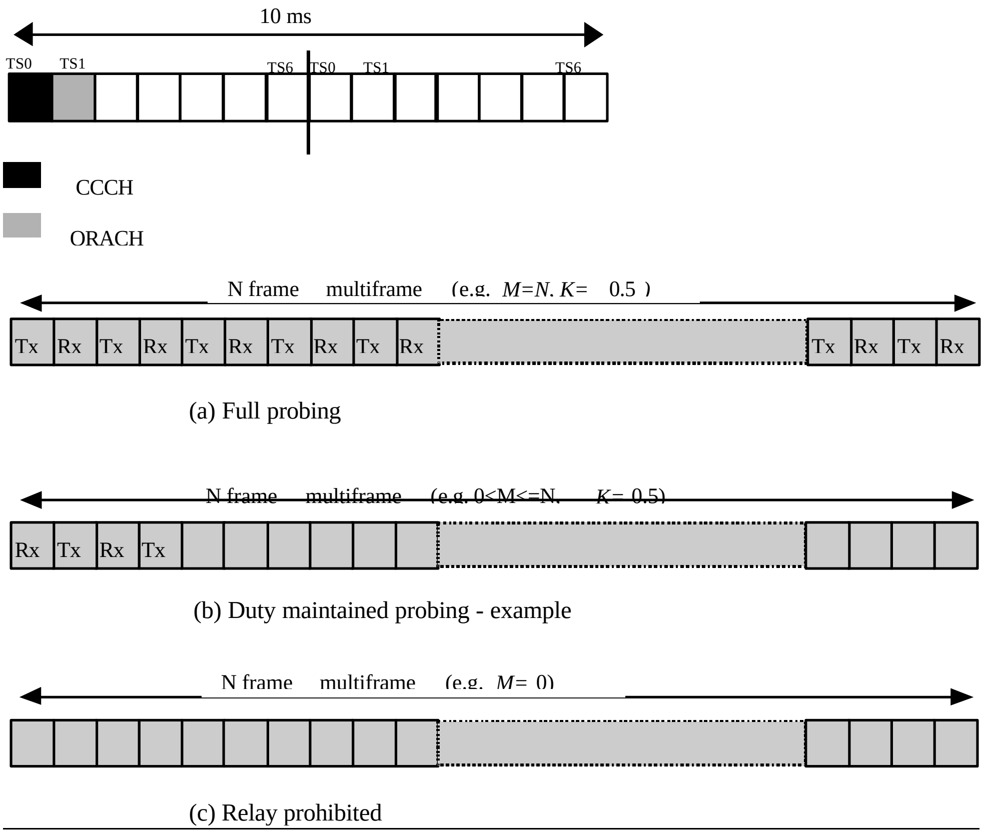


Figure 5: Probing state machines and mechanism.

6.8.3 Active Mode Probing

The Active Mode Probing procedure is activated when the UE has synchronised with the ORACH and is transmitting data.

With ODMA, data may be relayed on either the ODMA Random Access Channel (ORACH) or the ODMA dedicated transport channel (ODCH), depending on the volume of data to be sent. When a UE has small amounts of data to send it may transmit an addressed probe response packet on the ORACH at an interval proportional to air interface modem rate, R_{CCH}, and is defined by *Probe_timer_1*. This interval also defines the broadcast probe interval, *Probe_timer_2*, which is typically five times longer than *Probe_timer_1*. Every time an UE transmits a response probe containing data on the ORACH, it may be received, but not acknowledged, by third party neighbour UEs, and provides an implicit indication of activity. In this instance broadcast probes are not necessary and *Probe_timer_2* is reset after every addressed probe transmission. Only when an UE has no data to send is it necessary to transmit a broadcast probe every *Probe_timer_2* seconds to register its active status with its neighbours.

In order to avoid overlapping packet transmissions the length of the packet may not exceed the probe timer interval, *Probe_timer_1*. The relationship between the different probe timers is illustrated in Figure 6.

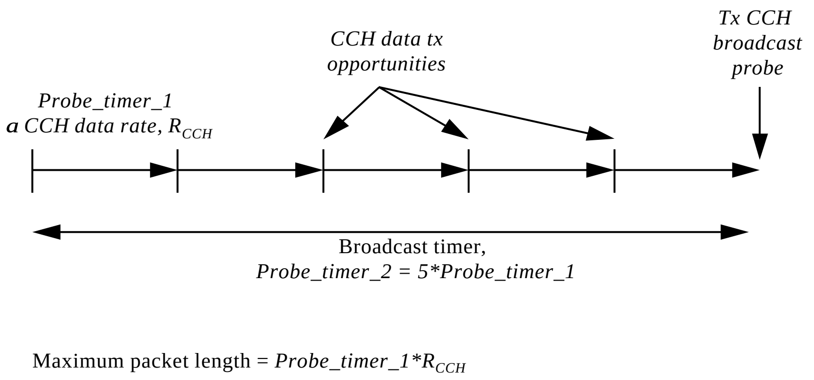


Figure 6: Probe timer relationships.

7 History

Document history		
V1.0.0	1999-05-28	Document created based on TD-SCDMA RTT
V1.0.1	1999-06-20	Changes after discussion with Siemens
V1.1.0	1999-07-30	Version send to WG1, Ad Hoc1 for discussion
V 1.1.1	1999-08-03	Version modified according to physical layer defination
V1.2.0	1999-08-05	Version based on CWTS 2nd discussion in cupt (Aug5-7,1999)
V2.0.0	1999-08-30	Updated in the CWTS #3 meeting in beijing (Aug29-30,1999)
V2.0.1	1999-9-16	Text modification only
V2.1.0	1999-10-2	Chip rate change to 1.28Mcps

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