Measurements in Universal Mobile Telecommunications System CPICH Channel

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***Abstract* – Second generation systems like GSM, werwe originally designed for efficient delivery of voice service. UMTS networks are, on the contrary, designed from the beginning for flexibile delivery of any type of service , where each new service does not require particular network optimization. In addition to the fxibility, the WCDMA radio solution bring advanced capabilities that enable new services.**

***Keywords*:handover, cpich channel, UTRAN, intra-modehandover, inter-mode hand over.**

I. INTRODUCTION

3G Systems are intended to provide a global mobility with wide range of services. Such capabilities are:

~ High bit rates up to 384 Kbps initially, and beyond 2 Mbps in 3GPP release 5.
~ Low delay with packet round trip times below 200 ms
~ Seamless mobility also for packet data applications
~ Quality service differentiation for high efficiency of service delivery
~ Interworking with existing GSM/GPRS networks
~ Simultaneous voice and data capability

All these essential conditions require a very systematic network structure. In this paper we describe the UMTS network by analyzing his structure and take into account some channel models like 802.15 UWB, and 3GPP. Here we consider these models in contrast to conventional communications systems that operate in narrow part of the spectrum, wideband signals can span the frequency range from DC to tens of GHz. Since they have a large bandwidth also means that conventional channel models do not correctly describe these types of channels. For example, the number of MPCs that fall within each resolvable delay bin is small, so that the central limit theorem is no longer applicable, and the amplitude statistics are not Rayleigh anymore. Also, the channel impulse response is real, since the signals do not have a carrier frequency any more. New channel models are thus required. First we introduce the UMTS network structure by giving a general description, section III we define the power control concept, in closed loop and open loop effects that affect handover. In Section IV we introduce some parameters that characterized handover and they can be measured by the MS, and in conclusion we reveal these parameters after a few measurements in specific locations.

II. NETWORK STRUCTURE

The base equipments that can be identified in UMTS system are depicted in Fig.1. The network consist three interacting domains; Core Network (CN), UMTS Terrestrial Radio Access Network (UTRAN) and user equipment. The basic Core Network architecture for UMTS is based on GSM network with GPRS. All equipment has to be modified for UMTS operation and services. The UTRAN provides the air interface access method for User Equipment. Base Station is referred as Node-B and control equipment for Node B-s is called Radio Network Controller (RNC).

The Core Network is divided in circuit switched and packet switched domains. Some of the circuit switched elements are Mobile services Switching Centre (MSC), Visitor location register (VLR) and Gateway MSC. Packet switched elements are Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN). Some network elements, like EIR, HLR, VLR and AUC are shared by both domains. The Asynchronous Transfer Mode (ATM) is defined for UMTS core transmission. ATM Adaptation Layer type 2 (AAL2) handles circuit switched connection and packet connection protocol AAL5 is designed for data delivery.

The Radio Acces use Wide band CDMA technology was selected to for UTRAN air interface. UMTS WCDMA is a Direct Sequence CDMA system where user data is multiplied with quasi-random bits derived from WCBMA spreading codes. In UMTS, in addition to channelisation, codes are used for synchronisation and scrambling. WCDMA has two basic modes of operation: Frequency division Duplex (FDD) and Time Division Duplex (TDD). The main functions of B-Nod are: Air interface Transmission / Reception, Modulation / Demodulation, CDMA Physical Channel coding, Micro Diversity, Error Handing, Closed loop power control.

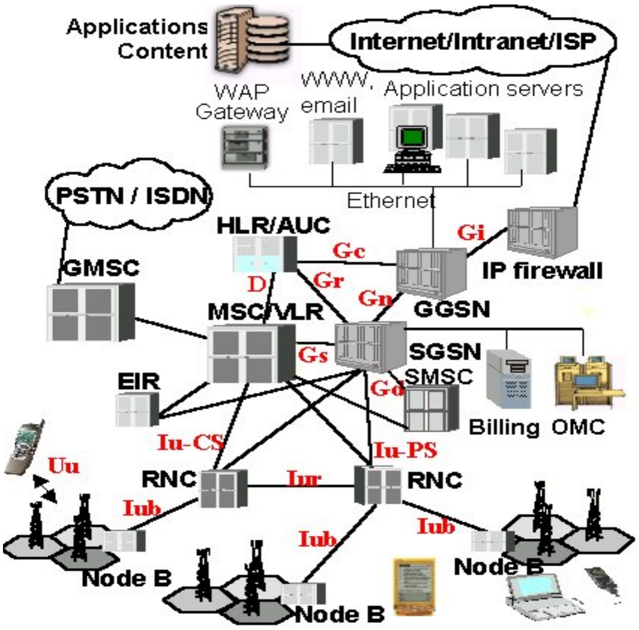

Fig.1 UMTS network structure

The functions of RNC are: Radio Resource Control, Admission Control, Channel Allocation, Power Control Settings, Handover Control, Macro Diversity, Ciphering, Segmentation / Reassembly, Broadcast Signalling, Open Loop Power Control.

III. POWER CONTROL

In the physical layer of WCDMA system there are many procedures essential for system operation. Examples include fast power control and random access procedures.

A. Fast Closed Loop Power Control Procedure

The fast closed loop power control procedure is denoted in the UTRA specifications as inner loop power control. It is known to be essential in a CDMA-based system due to the uplink near–far problem illustrated in Fig. 2. The fast power control operation operates on a basis of one command per slot, resulting in a 1500 Hz command rate.

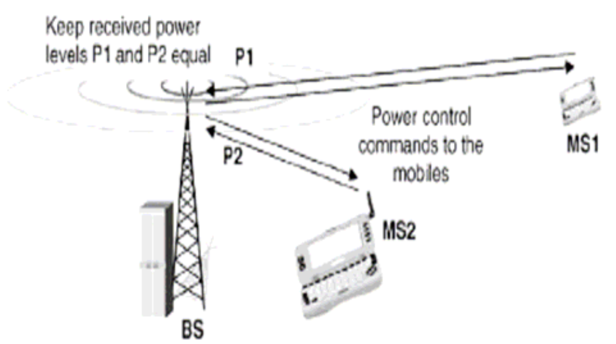

Fig.2 Closed loop power control in wcdma

The basic step size is 1dB. Additionally, multiples of that step size can be used and smaller step sizes can be emulated. The emulated step size means that the 1 dB step is used, for example, only everysecond slot, thus emulating the 0.5 dB step size.

'True' step sizes below 1 dB are difficult to implement with reasonable complexity, as the achievable accuracy over the large dynamic range is difficult to ensure. The specifications define the relative accuracy for a 1 dB power control step to be _0.5 dB. The other 'true' step size specified is 2 dB. Fast power control operation has two special cases: operation with soft handover and with compressed mode in connection with handover measurements.

Soft handover needs specialconcern as there are several base stations sending commands to a single terminal, while with compressed mode operation breaks in the command stream are periodically provided to the terminal.

In soft handover the main issue for terminals is how to react to multiple power control commands from several sources. This has been solved by specifying the operation such that the terminal combines the commands but also takes the reliability of each individual command decision into account in deciding whether to increase or decrease the power.

In the compressed mode case, the fast power control uses a larger step size for a short period after a compressed frame. This allows the power level to converge more quickly to the correct value after a break in the control stream. The need for this method depends heavily on the environment and it is not relevant for the lower terminal or very short transmission gap lengths.

The SIR target for closed loop power control is set by the outer loop power control. On the terminal side, what is expected to be done inside a terminal in terms of (fast) power control operation is specified rather strictly. On the network side there is much greater freedom to decide how a base station should behave upon reception of a power control command, as well as the basis on which the base station should tell a terminal to increase or decrease the power.

B. Open Loop Power Control

In UTRA FDD there is also open loop power control, which is applied only prior to initiating the transmission on the RACH or CPCH. Open loop power control is not very accurate, since it is difficult to measure large power dynamics accurately in the terminal equipment. The mapping of the actual received absolute power to the absolute power to be transmitted shows large deviations, due to variation in the component properties as well as to the impact of environmental conditions, mainly temperature. Also, the transmission and reception occur at different frequencies, but the internal accuracy inside the terminal is the main source of uncertainty.

The requirement for open loop power control accuracy is specified to be within _+9 dB in normal conditions.

Open loop power control was used in earlier CDMA systems, such as IS-95, being active in parallel with closed loop power control. The motivation for such usage was to allow corner effects or other sudden environmental changes to be covered. As the UTRA fast power control has almost double the command rate, it was concluded that a 15 dB adjustment range does not need open loop power control to be operated simultaneously.Additionally, the fast power control step size can be increased from 1 dB to 2 dB, which would allow a 30 dB correction range during a 10 ms frame.

The use of open loop power control while in active mode also has some impact on link quality. The large inaccuracy of open loop power control can cause it to make adjustments to the transmitted power level even when they are not needed. As such, behaviour depends on terminal unit tolerances and on various environmental variables, running open loop power control makes it more difficult from the network side to predict how a terminal will behave in different conditions.

IV. HANDOVER PROCEDURES AND PARAMETERS

Other important physical layers procedures are paging, operations with transmit diversity, and handover measurements.

Within the UTRA FDD the possible handovers are as follows:

_ Intra-mode handover, which can be soft handover, softer handover or hard handover.

Hard handover may take place as intra- or inter-frequency handover.

_ Inter-mode handover as handover to the UTRA TDD mode.

_ Inter-system handover, which in Release '99 means only GSM handover. The GSM handover may take place to a GSM system operating at 850 MHz, 900 MHz, 1800 MHz and 1900 MHz.

The main relevance of the handover to the physical layer is what to measure for handover criteria and how to obtain the measurements.

A. Intra-Mode Handover

The UTRA FDD intra-mode handover relies on the Ec=N0 measurement performed from the common pilot channel (CPICH). The quantities defined that can be measured by the terminal from the CPICH are as follows:

_ Received Signal Code Power (RSCP), which is the received power on one code after despreading, defined on the pilot symbols.

_ Received Signal Strength Indicator (RSSI), which is the wideband received power within the channel bandwidth.

_ Ec=N0, representing the received signal code power divided by the total received power in the channel bandwidth, which is defined as RSCP/RSSI.

There are also other items that can be used as a basis for handover decisions in UTRAN, as the actual handover algorithm decisions are left as an implementation issue. One such parameter mentioned in the standardisation discussions has been the dedicated channel SIR, giving information on the cell orthogonality and being measured in any case for power control purposes.

Additional essential information for soft handover purposes is the relative timing information between the cells. As in an asynchronous network, there is a need to adjust the transmission timing in soft handover to allow coherent combining in the Rake receiver, otherwise the transmissions from the different base stations would be difficult to combine, and especially the power control operation in soft handover would suffer additional delay.

The timing measurement in connection with the soft handover operation is illustrated in Fig.3.

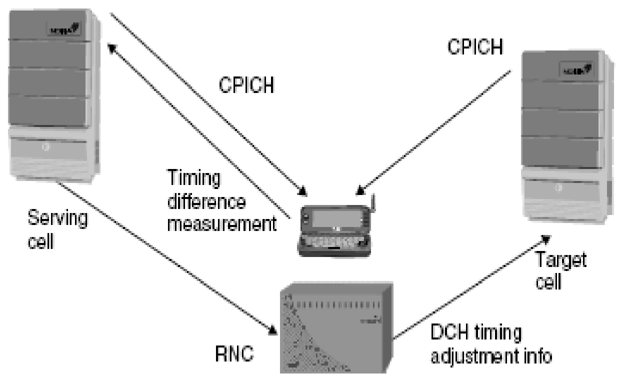

Fig.3 Measurements for soft handover

The new base station adjusts the downlink timing in steps of 256 chips based on the information it receives from the RNC.

When the cells are within the 10 ms window, the relative timing can be found from the primary scrambling code phase, since the code period used is 10 ms. If the timing uncertainty is larger, the terminal needs to decode the System Frame Number (SFN) from the Primary CCPCH. This always takes time and may suffer from errors, which requires also a CRC check to be made on the SFN. The 10 ms window has no relevance when the timing information is provided in the neighbouring cell list. In such a case only the phase difference of the scrambling codes needs to be considered, unless the base stations are synchronised to chip level.

For the hard handover between frequencies such accurate timing information on chip level is not needed. Obtaining the other measurements is slightly more challenging as the terminal must make the measurements on a different frequency. This is typically done with the aid of compressed mode, which is described later in this chapter.

B. Inter-Mode Handover

On request from UTRAN, the dual-mode FDD–TDD terminals operating in FDD measure the power level from the TDD cells available in the area. The TDD CCPCH bursts sent twice during the 10 ms TDD frame can be used for measurement, since they are guaranteed to always exist in the downlink. The TDD cells in the same coverage area are synchronised, thus finding one slot with the reference midamble means that other TDD cells have roughly the same timing for their burst with reference power.

C. Inter-System Handover

For UTRA–GSM handover, basically similar requirements are valid as for GSM–GSM handover. Normally the terminal receives the GSM Synchronisation Channel (GSM SCH) during compressed frames in UTRA FDD to allow measurements from other frequencies.

IV. CONCLUSION

In this paper we have described the main structure of UMTS network. In particular we have presented the handover protocols and the main parameters that characterized the MS received signal. Moreover, using special software designed for this type of measurement, we measure these parameters for several site positions and related they values in the table below.

Freq.cod-10564	**POZITION**	**Freq.cod-10564**
BS.Id. 431	$270\text{-}330^{0}$	**BS.Id. 433**
RSSI - 770	BILDING 50m	RSSI- 757
RSCP- 971		RSCP - 780
Ec/No (-104)		Ec/No (-32)
	$0\text{-}285^{0}$	
RSSI -780	BILDING 150m	RSSI-778
RSCP -902		RSCP-833
Ec/No (-135)		Ec/No (-51)

An interesting subject will be the study of these parameters values depending on the site position with LOS and NLOS, with a distribution function, that possible will approximate the Rayleigh, Ricean, Nakagami, or Weibull. Finally with this function improve the mobile communication channel model for WB and UWB systems.

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