ABSTRACT

In this article, we study the performance benefits of the cell search algorithm. The purpose of the cell search algorithm in Universal Mobile Telecommunication Systems (UMTS) is to estimate the spreading code of the serving base-station and its corresponding timing offset. We study the performance benefits of estimating multiple “code-time” hypotheses in each stage of the cell search process. In addition, we also study the effect of oversampling and nonideal sampling. The improved cell search design (CSD) proposed in this article aims to achieve faster synchronization between the mobile station (MS) and the base station (BS) and thus improves system performance, also has lower hardware utilization when compared with the third generation partnership project (3GPP)-comma free cell search design scheme under the same design constraints.

Keywords: 3GPP; CSD; FHT; $P_{c0}$, PSC; SSC; UMTS; WCDMA; $V_{1l}$

INTRODUCTION

WCDMA is a wideband direct sequence code division multiple access (DS-CDMA) system, which means that the user information bits (symbols) are spread over a wide frequency bandwidth by multiplying the user data bits with a spreading code sequence of “chips.” To be able to support different bit rates as high as 2Mbps, the use of variable spreading factor and multicode connections is supported. There are two basic modes of operation in WCDMA, Frequency Division Duplex (FDD) and Time Division Duplex (TDD) (3GPP RAN TS 25.211 v4.0.0, 2001-2003). In the FDD mode, separate carrier frequencies are used for the downlink and uplink and in TDD mode only one carrier is used and it is time-shared between the downlink and uplink. TDD mode requires more synchronization between the different mobile terminals and the base stations (3GPP TS 25.104, v3.7.0, 2001). WCDMA uses a large bandwidth (5MHz) for each channel carrier (Ojanpera & Prasad, 1998). WCDMA is designed to be operational in conjunction with GSM. Therefore, handover between GSM and WCDMA systems is supported in order to be able to leverage the GSM
coverage for the introduction of WCDMA (Dahlman, Berning, Knutsson, Ovesjo, Persson, 
& Roobol, 1998). WCDMA permits continuous transmission from many users to the same 
base station on the same carrier frequency at the same time, the transmission from the base 
station to all the users in one cell is on another carrier frequency (3GPP RAN TS 25.214 v4.0.0, 
20012003; Holma & Toskala, 2000).

WCDMA is quite resistant against interference and frequent selective fading. In a “normal” wireless data transmission system
the used bandwidth more or less equal to user data rate, in wireless data transmission systems 
based on Spread Spectrum, the used bandwidth is much higher than the data rate. The result of
this is that the transmitted power is spread over a wide frequency band. Common methods to
achieve spread spectrum are Direct Sequence (DS) and Frequency Hopping (FH). The radio
signal propagation through the air (“channel”) is influenced by many factors; among them
are reflections, diffraction, and attenuation of the signal energy. These are caused by natural
obstacles, such as buildings, mountains, and so forth. The reflections of the signal results
in multipath propagation. In the asynchronous
WCDMA system each base station is identified
by a unique scrambling code (3GPP TS 25.213, 
v4.0.0, 20012003). The mobile station has
to synchronize to the scrambling code of the
serving base station in order to descramble the
downlink traffic channels (Wang & Ottoson, 
2000). The synchronization process is com-
monly referred to as the cell search procedure.
A three-step hierarchical cell search process has
been introduced in the UMTS standard that is
supported by several auxiliary synchronization
channels. These include the Primary Synchro-
nization Channel (P-SCH), the Secondary
Synchronization Channel (S-SCH), and the
Common Pilot Channel (CPICH) (Li, Sheen, 

The purpose of the cell search algorithm in
UMTS is to estimate the spreading code of the
serving base station and its corresponding
timing offset. The search procedure consists of 3
sequential and distinct stages: (1) slot-boundary
synchronization, (2) frame-boundary synchro-
nization with code-group identification, and (3)
scrambling code identification. Algorithms that
have appeared for cell search have confined the
“code-time” estimation in each stage to a single
hypothesis (Nielsen & Korpela, 2000; Sriram 
& Hosur, 2000). In this article, we also study
the performance benefits of estimating multiple
“code-time” hypotheses in each stage of the
cell search process.

In this article, we address the initial cell
search procedure (as opposed to the target cell
search), which is carried out when the mobile
station is switched on. It is assumed that the
mobile station has no preliminary information
about the scrambling code of the serving cell,
and a frequency offset of 20kHz at a carrier
frequency of 2GHz is present (worst case sce-
nario). An additional DFT stage following stage
3 can bring down the frequency offset to 200Hz
with a high degree of reliability (Kiessling & 
Mujtaba, 2002; Nielsen & Korpela, 2000).

In this article, when the received signal
was correlated with the primary synchronization
code (PSC) sequences generated at the
MS, some peak values were obtained and the
maximum of those peak values was displayed
as the slot value for that particular frame. In
frame synchronization process, a Fast Had-
amard Transformer (FHT) was used to match
arbitrary secondary synchronization code (SSC)
sequences with the frames and 16 values were
obtained. In code synchronization process, the
16 values obtained are match with the values
generated at the MS and the maximum of
those values will be taken. In this article, we
focus on minimizing the acquisition time while
maintaining a given probability of false alarm.
Prior work (Wang & Ottoson, 1999, 2000a, 
2000b) has considered chip rate sampling at
the receiver (i.e., an oversampling ratio of 1),
and neglected the impact of nonideal sampling
that may arise due to clock jitter and/or residual
frequency offset. Furthermore, performance
results from these studies were obtained with 1
time-code candidate passed between the various
stages of the cell search process. In this article,
we extend the previously published results by
18 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/article/performance-analysis-stage-cell-search/1442

Related Content

Semantic Federation of Product Information from Structured and Unstructured Sources
www.irma-international.org/article/semantic-federation-product-information-structured/55303/

Efficient Configurations for Dynamic Applications in Next Generation Mobile Systems
www.irma-international.org/chapter/efficient-configurations-for-dynamic-applications-in-next-generation-mobile-systems/136556/

The Role of Business Model Innovation on the Disruptive Potential of PWLAN in the Western European Hotspot Markets

The Power of Integrated Wireless and Mobile Communication Technologies and Their Impact on the Corporate World
Implementation of FFT on General-Purpose Architectures for FPGA
www.irma-international.org/article/implementation-fft-general-purpose-architectures/45871/