Performance Analysis of Turbo coded HSDPA systems

Shailendra Mishra[1] and D.S.Chauhan[2]
[1]*Kumaon Engineering College, Dwarahat, India*
[2]*V.C.Uttrakhand Technical University, Dehradun*
{skmishra1, pdsc}@gmail.com

Abstract

In this paper, we study the performance benefits of turbo coded HSDPA system. This paper provide an overview of high speed data packet access (HSDPA) and focus on the business values that such a highly-efficient access technology would bring to wireless operators, including higher capacity and newer services. In this paper each frame is encoded using a turbo code and channel coding is done by turbo codes is the best method for transmitting information with fewer errors and lower signal power. Turbo coding includes two main modules in it, one being turbo encoder made up of recursive systematic code encoders and second turbo decoder where Log Map algorithm is implemented. HSDPA increases the downlink data rate within a cell to a theoretical maximum of 14Mbps, with 2Mbps on the uplink. The changes that HSDPA enables include better quality and more reliable, more robust data services. In other words, while realistic data rates may only be a few Mbps, the actual quality and number of users achieved will improve significantly.

Keywords: *HSDPA, UMT, 3GPP, HARQ, CQI, WCDMA, AMC, Log Map Algorithm*

1. Introduction

HSDPA introduces a new common High Speed Downlink Shared Channel (HS-DSCH) shared by several users. Nowadays when the quest for bandwidth is accelerating competition among wireless technologies, WCDMA appears to have hit a speed bump. WCDMA technology, which provides the radio interface in the 3G UMTS mobile system defined by the 3GPP, theoretically can deliver peak data rates up to 2.4 Mb/s. In actual networks, though, the average data throughput rate reportedly doesn't go much beyond 384 kb/s. Release 5 of the 3GPP WCDMA specification adds HSDPA technology in an effort to make the system more efficient for bandwidth-intensive data applications

A WCDMA network upgraded to HSDPA will support downlink data rates well over 2 Mb/s, up to a theoretical 14 Mb/s [[1], [2]]. Because the new technology is backwards compatible with 3GPP Release 99, voice and data applications developed for WCDMA still can be run on the upgraded networks, and the same radio channel will support WCDMA and HSDPA services simultaneously. Although industry predictions regarding the ultimate performance of HSDPA vary, it likely will increase WCDMA downlink speeds by a factor of five, double the network capacity, and support a greater number of users on the network. With these significant improvements for data, WCDMA systems will be able to shift gears and move ahead to the enhanced performance enabled by this latest inter-generational mobile communication technology.

High Speed Downlink Packet Access (HSDPA) is a concept included in WCDMA 3GPP (Third Generation Partnership Project) Release 5 specifications[3]. The main target is to increase the user peak data rates and quality of service (QoS), and in general improve the spectral efficiency for downlink asymmetrical and bursty packet data services.When HSDPA will be implemented, it can coexist on the same carrier as the current Release'99 WCDMA services. This will enable a smooth and cost-efficient introduction of HSDPA into the existing WCDMA networks. The driving force for high data rates are greater speed, shorter delays when downloading audio, video and large files which will be used in PDA's, smart phones etc. Further a user can download packet data over HSDPA, while at the same time having a speech call. HSDPA offers theoretical peak rates of up to 10MB/ s and in practice more than 2Mbs[7]. The technical aspects behind the HSDPA concept include the following:

Shared channel transmission, Adaptive Modulation and Coding (AMC), Fast Hybrid Automatic Repeat Request (H-ARQ), Fair and fast scheduling at Node B, Fast cell site selection (FCSS) and Short transmission time interval (TTI).

High Speed Downlink Packet Access (HSDPA) was finalized by the 3GPP as part of the Release 5 specifications back in 2003, and over the past year has undergone a number of high-profile field trials with cellular operators. Full commercial services are expected to be operational in some countries by the end of the year. Designed as an upgrade to the existing 3G networks, HSDPA offers theoretical data rates up to 14 Mbits/s and reduced latencies to support real-time applications. HSDPA doesn't just provide the user with improved services. The technology introduces a number of techniques that let network operators use and manage their valuable radio spectrum more efficiently. While existing established cellular systems attempt to transmit the data independently of channel conditions, using brute force techniques based on more power to overcome deep fades, HSDPA applies some intelligence to problem [7]. In fact, by considering multi-user diversity, HSDPA targets the highest data rates towards users with the best instantaneous channel quality.

In addition, it introduces enablers for the high speed transmission at the physical layer like the use of a shorter TTI (2 ms), the use of adaptive modulation and coding, and the use of fast retransmission based on hybrid ARQ (HARQ) techniques. These key mechanisms are located within the UMTS BTS. The scheduler has not been standardized in 3GPP and Nortel proposes a two stage scheduler integrating the subscriber's differentiation. With this "packetized" air interface, more users are on a cell and the scheduler is more efficient by having more opportunity to deal with a constructive fading. This is the Multi-User Gain of the HSDPA scheduler. In many aspects, the new transport channel type HS-DSCH is very similar to the DSCH transport channel. As in DSCH, the HS-DSCH transport channel is associated to a dedicated DPCH channel (in the uplink for HS-DSCH, contrary to DSCH) [6].

To improve WCDMA system performance, HSDPA makes a number of changes to the radio interface that mainly affects the physical and transport layers: Shorter radio frame, new high-speed downlink channels, Use of 16 QAM in addition to QPSK modulation, Fast link adaptation using AMC, use of HARQ. Each frame is encoded using a Turbo code, interleaved, and modulated to symbols. Channel coding done by turbo codes is the best method for transmitting information with fewer errors and lower signal power [8]. Turbo coding includes two main modules in it. One being turbo encoder made up of recursive systematic code encoders and turbo decoder where LogMap algorithm is implemented [4]. We have taken this coding scheme as our area of interest and shown how it helps HSDPA in achieving its goal.

2. Features of HSDPA

Shared channel transmission

The HSDPA concept introduced few additional physical channels. They are High Speed Physical Downlink Shared Channel (HS-PDSCH) and a dedicated HS-Physical Control Channel (HS-DPCCH).

HS-PDSCH: This channel is both time and code shared between users attached to a Node-B. It is the transport mechanism for additional logical channels; they are HS-Downlink Shared Channel (HSDSCH) and HS-Shared Control Channel (HS-SCCH).The HS-DSCH code resources consist of one or more canalization codes with a fixed spreading factor (SF) of 16. At the most 15 such codes can be allocated leaving sufficient room for other required control and data carriers. The available code resources are primarily shared in time domain but it is possible to share the code resources using code multiplexing [4]. When it is both time and code shared, two to four users can share the code resources with the same TTI.

HS-DPCCH: This channel is an uplink channel used to carry the acknowledgement signals to the Node-B for each block. It is also used to indicate the Channel Quality (CQI) which is used for Adaptive Modulation and Coding.

Adaptive Modulation and Coding (AMC)

In present WCDMA networks fast power control is used for radio link adaptation. This power control is done per slot in WCDMA. Basically link adaptation is required because, in cellular communication systems the SINR of the received signal at the UE (Mobile Equipment is called User Equipment for 3rd generation mobile systems) varies over time by as much as 30-40 dB due to fast fading and geographic location in a particular cell. In order to over come this fading effect and improve the system capacity and peak data rates, the transmitted signal to a particular UE is modified in accordance with the signal variations through a process called link adaptation.

In HSDPA the transmission power is kept constant over the TTI (length of the frame is referred to as Transmit Time Interval) and uses adaptive modulation and coding (AMC) as an alternative method to power control in order to improve the spectral efficiency [7]. HSDPA uses higher order modulation schemes like 16-quadrature amplitude modulation (16QAM) besides QPSK. The modulation to be used is adapted according to the radio channel conditions. QPSK can support 2 bits/ symbol where as 16QAM can support 4 bits/ symbol, and hence twice the peak rate capability as compared to QPSK, using the channel bandwidth more efficiently. Different code rates used are 1/4, 1/2, 5/8, 3/4. The Node-B (Base Station) receives the Channel Quality indicator (CQI) report and power measurements on the associated channels. Based on these information it determines the transmission data rate. In HSDPA, users close to the Node-B are generally assigned higher modulation with higher code rates (e.g. 16QAM and 3/4 code rate), and both decreases as the distance between UE and Node-B increases [8].

Fast Hybrid Automatic Repeat Request (H-ARQ)

The H-ARQ protocol used for HSDPA is stop and wait (SAW). In SAW the transmitter sends a block of TTI (3 slots) and waits until acknowledge or negative acknowledge is received from the UE. In order to utilize the time when it waits for the acknowledgements, N parallel SAW-ARQ processes maybe set for a UE, so different processes transmit in separate TTI's. The value of N is explicitly signaled using 3 bits, hence at the most N can be 8. The UE requests the retransmission of erroneous data received earlier [11]. Ones the UE receives the 2nd transmission, it combines the information from the original transmission with that of the 2nd transmission before trying to decode the message.

Fast and fair scheduling at Node B

Typically in WCDMA networks the packet scheduling is done at the RNC (radio network connection), but in HSDPA the packet scheduler (medium access layer-hs) is shifted to the Node-B. This makes the packet scheduling decisions almost instantaneous. In addition to this, the TTI length is shortened to 2ms. Hence the scheduling is done very fast as its done every TTI. A first approach for fair scheduling can be Round-Robin method where every user is served in a sequential manner so all the users get the same average allocation time. However, the requirement of high scheduling rate along with the large AMC availability with the HSDPA concept, where the channel is allocated according to the instantaneous channel conditions [7]. Another popular packet scheduling is proportional fair packet scheduling. Here, the order of service is determined by the highest instantaneous relative channel quality. Since the selection is based on relative conditions, still every user gets approximately the same amount of allocation time depending on its channel condition.

Fast cell site selection (FCSS)

Typically on an average 20-30% of the MS's are in soft or softer handover condition. Soft handover is a handover between two Node-B's where as softer hand over is between sectors of a Node-B. So it's very important to track the active set of Node-B's connected to a UE for communication. FCSS allows a UE to select the Node-B with the best current transmission characteristics [UMTS evolution to HSDPA]. The advantage of this system is that higher data rates can be achieved at most of the time.

Short transmission time interval (TTI)

The length of the frame is referred to as Transmission Time Interval (TTI). The HS-DSCH which is added in the HSDPA standard uses this TTI of 2ms than the Release'99 transport channel TTI. This is done to reduce the round trip time, increases the granularity in the scheduling process and for better tracking of the time varying radio channel. Actually the length of the frame is variable and is selected based on traffic supported and the number of supported users. A typical value is 2ms.

H-ARQ

The AMC uses an appropriate modulation and coding scheme according to the channel conditions. Even after AMC, we may land up with errors in the received packets due to the fact that the channel may vary during the packet is on the fly. An automatic repeat request (ARQ) scheme can be used to recover from these link adaptation errors. When the transmitted packet is received erroneous then the receiver requests the transmitter for the retransmission of that erroneous packet. The basic technique is to use the energy of the previously transmitted signal along with the new retransmitted signal to decode the block.

3. How HSDPA works

HSDPA is a packet-based technology. Data is transmitted to the mobile handset or user equipment (UE) in short (2-ms) packets. The amount of data sent in each packet depends on the state of the propagation channel. The base station, known as the Node

B, learns about the quality of the downlink channel using Channel Quality Indicator (CQI) reports from each HSDPA-capable UE in the cell. These CQI reports are made periodically by the UE, and are based on signal-to-interference ratio (SIR) measurements that the UE has made on the downlink pilot channel. Depending upon the environment, the channel conditions may change rapidly or could remain largely static. For example, a user driving through a busy urban environment is likely to experience greater and more rapid changes in channel quality than a stationary user in an open space.

The user data is transported over the High Speed Downlink Shared Channel (HS-DSCH). The HS-DSCH is shared between all the HSDPA users in the cell and so resources can be shared equally between several users or all allocated to one user [6]. The process of sharing the downlink resource requires intelligent coordination by the Node B. In addition, HSDPA incorporates adaptive modulation and coding (AMC) techniques, allowing the downlink data rate to each user to be adapted to the user's channel conditions. For example, if interference is low, then the Node B can transmit a large packet using 16-QAM modulation and reduce the number of parity bits. In poor signal conditions, the packet will contain less user data with the HS-DSCH being restricted to QPSK modulation, and allowing more parity bits for forward error correction.

HSPDA must, however, allow for the fact that some packets transmitted by the Node B won't be received correctly by the UE. A mechanism known as hybrid automatic repeat request (HARQ) is used to retransmit these erroneous packets. Providing this retransmission functionality in the Node B, erroneous packets can be retransmitted quickly without the need to get higher protocol layers involved. This in turn reduces the average packet latency through the system, making popular real-time services a reality.

4. Triggering the data usage with HSDPA

HSDPA innovations compared to today’s UMTS include the increase in the range of applications available to the end user, enabling access to broader content due to the high-speed downlink transmission (because it is ~5x faster), and the increase of the data users per cell due to the better spectral efficiency (~10x more spectrally efficient). This will boost the use of applications by the end users, which will generate more revenues for wireless operators. The usage increase of the Internet today is mainly due to the huge deployment of broadband solutions, making bandwidth a commodity and enabling richer content based on a friendly format using video, pictures, music and interactive gaming. Looking back in history at what happened with the adoption of mobile services for voice provides a good example of what will happen with data. At the beginning of the ‘90s, it was believed that voice service would be dedicated for specific professional users like medicine, or a sales force on the road. Finally, instead of a niche application, wireless voice services are now widely spread all over the globe with more than three billion users. Even at home, people are now using their mobile phone because the quality is equivalent to their fixed phone.

HSDPA will change wireless communications by delivering broadband in wireless access. This is the next big technological advancement needed to increase usage. It will boost usage in business sectors by providing a virtual office environment anywhere and it will also trigger usage by the consumer market by leveraging the end-user experience of fixed broadband.

HSDPA a new radio Interface

HSDPA is a UMTS packet air interface (add-on solution on top of 3GPP R99/R4 architecture) that allows up to 3.6 Mbps peak data rate for a Category 6 Mobile per user with a classical Rake receiver and up to 14.4 Mbps peak data rate for a Category 10 mobile per user with advanced receiver solutions [10]. HSDPA terminals will co-exist with R99 terminals, but new terminals will be required to support HSDPA.

No core network impacts

It is important to note that HSDPA is a pure 3GPP Rel'5 access evolution without any core network impacts except for minor changes due to the higher bandwidth access. For instance, in the 3GPP Rel'5, the maximum throughput set into the signaling protocol has been increased from 2 Mbps to 16 Mbps in order to support the theoretical maximum limit of HSDPA data rate, which is 14.4 Mbps. This is why the signaling between the UTRAN, SGSN and GGSN need to be changed in order to support newly expanded QoS parameters (hence GTP protocol and Session Management layer changes) [5].

5. Turbo Codes

Turbo codes are a class of recently-developed high-performance error correction codes finding use in deep-space satellite communications and other applications where designers seek to achieve maximal information transfer over a limited-bandwidth communication link in the presence of data-corrupting noise.

The Turbo Encoder

The turbo encoder reference design uses a stream-driven implementation and feeds the incoming information bits through to the output [4]. In addition, it encodes them using encoder 1, a recursive convolutional encoder. It also feeds the information bits via a pseudo random interleaver into encoder 2. The encoded bit streams can be punctured to save bandwidth.

The Turbo Decoder

The decoder consists of two Log-Map (soft decision) decoders, DEC1 and DEC2 in a parallel-concatenated scheme. The inputs to DEC1 are noisy versions of the systematic bit, the redundant encoding information and a third 'a priori' input , which accepts feed back from DEC2. DEC2 accepts information from DEC1, which it cannot derive from its own redundant input.

In order for third-generation (3G) wireless systems to take off, design engineers must once again turn to advanced error correction schemes. 3G wireless systems will no longer be tasked with only delivering voice services. Rather they will be expected to deliver video, data, audio, and voice services over the same air link. But to effectively achieve this goal, designers must first deal with errors in the radio channel. If these errors go undetected or uncorrected, performance can degrade, response time can weaken, and human intervention can increase. Introduced back in 1993, turbo coding is seen by many in the wireless sector as the forward-error-correction (FEC) technology of choice for 3G applications. In fact, many of the International Telecommunication Union (ITU) specifications recommend using turbo coding for 3G architectures.

Turbo codes are a class of recently-developed high-performance error correcting codes finding use in deep-space satellite communications and other applications where designers seek to achieve maximal information transfer over a limited-bandwidth communication link in the presence of data-corrupting noise.While offering a great deal of promise, however, turbo coding is a difficult concept to understand and implement [4] . We lay out below the key components required to develop a turbo coding solution. Specifically, we look at the turbo encoder and turbo decoder.

The Shannon limit

Of all practical error correction methods known to date, turbo codes, together with low density parity-check codes, come closest to approaching the Shannon Limit, the theoretical limit of maximum information transfer rate over a noisy channel. Turbo codes make it possible to increase available bandwidth without increasing the power of a transmission, or they can be used to decrease the amount of power used to transmit at a certain data rate. Its main drawbacks are the relative high decoding complexity and a relatively high latency, which makes it unsuitable for some applications.For satellite use, this is not of great concern, since the transmission distance itself introduces latency due to the limited speed of light [13]. Prior to Turbo codes, the best known technique combined a Reed -Solomon error correction block code with a Viterbi Algorithm convolutional code also known as RSV codes. These RSV codes never were able to approach the Shannon limit as closely as Turbo codes.

6. Log Map Algorithm

The MAP algorithm is a maximum a posteriori decoding algorithm in the sense that it computes the a posteriori probability of a bit being a zero or a one. In this sense it is a symbol-by-symbol decoding algorithm as opposed to the Viterbi algorithm, which is a Maximum-likelihood sequence Estimation (MLSE) algorithm [11]. This algorithm minimizes the probability of bit or symbol error.

LOG-MAP Algorithm used in turbo decoding process:

MAP stands for "Maximum Aposteriori Probability”. It is an algorithm for estimating random parameters with prior distributions.Up till now we were using Viterbi coding and decoding algorithm but the introduction of Turbo Codes have brought about an increased interest about this algorithm because of the following reasons.

The Maximum Likelihood Algorithms (like the Viterbi Algorithm) find the most probable information sequence that was transmitted, while the MAP algorithm finds the most probable information bit to have been transmitted given the coded sequence. The information bits returned by the MAP algorithm need not form a connected path through the trellis.

The error performance of both the Viterbi and the MAP algorithms are not much different under high Eb/N0 and low BER's. But at low Eb/N0 and high BER's, the MAP algorithm is found to outperform the Viterbi Algorithm by quite a margin.The MAP algorithm is considerably more complex than the Viterbi Algorithm. It is an inherently soft - Input, Soft - Output algorithm (SISO algorithm) and it very well suited for Iterative Decoding (as it is used in Turbo codes). The Viterbi algorithm is an inherently hard output algorithm and it has to be modified to provide soft outputs. (The modification resulted in the Soft Output Viterbi Algorithm (generally called SOVA), which is approximately twice as complex as the Viterbi algorithm (but not as complex than the MAP).

The most widely used soft-values are the log-likelihood ratios (LLR's).If the LLR of a bit is positive, it implies that the bit is most likely to be a 1 and if it is negative, the bit is most likely to be a zero and make a hard-decision on these ratios .

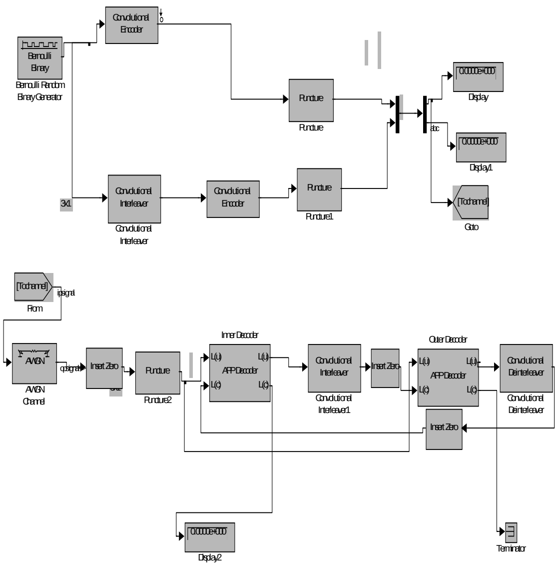

Figure 1. Turbo Encoder and Decoder model implemented in MATLAB

The MAP algorithm tries to calculate the a-posteriori probabilities (APP) of each state transition, message bit, and/or code symbol produced by a Markov process, given the noisy observation vector y. (Again, that's just the definition, read along....). When used as a SISO algorithm (for example, in iterative decoding), the MAP algorithm calculates the a-posteriori probabilities P [m (i) = 1 | y] and P [m (i) = 0 | y], which are then put into the LLR form according to the previous equation. In the other cases, the MAP algorithm makes hard decisions based on the following rules-:

- si represents the state of the trellis at the time i. It can be any of the 2m possible states. (m = Constraint Length -1).
- L represents the state of the decoder
- y and "\hat y" represent the received observation vector. It is the output of the Demodulator. It consists of the sequence y(0), y(1) , y(2) .. y(L-1), where L is the length of the Convolutional Coded block and the values of y are the soft-outputs of the previous block.
- zi is the a-priori information to the decoder. This is the output of the previous channel decoder block. It is in the form of a Log Likelihood Ratio (LLR). These LLR's must be converted into proper values before processing.
- mi is the message bit associated with the state transition si to si+1.
- xi is the output bit associated with the state transition si to si+1.
- P[x] represents the probability of x and P[y/x] is the probability of y conditioned on x.

Turbo Encoder and Decoder Model:

Figure 1, shows Turbo Encoder and Decoder model implemented in MATLAB

7. Simulation Result

```
Variables created in current workspace.
 Please enter the decoding algorithm. (0:Log-MAP, 1:SOVA)  default 0      0
 Please enter the frame size (= info + tail, default: 200)                    200
 Please enter code generator: (default: g = [1 1 1; 1 0 1])
 Please choose punctured / unpunctured (0/1): default 0
 Please enter number of iterations for each frame: default 5              2
 Please enter number of frame errors to terminate: default 15                     3
 Please enter Eb/N0 in dB : default [2.0]
---------------------------------------------------
 === Log-MAP decoder ===
 Frame size = 200
 Code generator:
    1     1     1
    1     0     1
 Punctured, code rate = 1/2
 Iteration number =       2
 Terminate frame errors =      3
 Eb / N0 (dB) =       2.00
---------------------------------------------------
+ + + + Waiting for the result. + + + +
************** Eb/N0 =  2.00 db ************
Frame size = 200, rate 1/2.
3 frames transmitted, 0 frames in error.
Bit Error Rate (from iteration 1 to iteration 2):
3.3670e-003    0.0000e+000
Frame Error Rate (from iteration 1 to iteration 2):
6.6667e-001    0.0000e+000
******************************************
************** Eb/N0 =  2.00 db************
Frame size = 200, rate 1/2.
6 frames transmitted, 1 frames in error.
Bit Error Rate (from iteration 1 to iteration 2):
3.4512e-002    2.5253e-003
Frame Error Rate (from iteration 1 to iteration 2):
8.3333e-001    1.6667e-001
******************************************
************** Eb/N0 =  2.00 db ************
Frame size = 200, rate 1/2.
9 frames transmitted, 1 frames in error.
Bit Error Rate (from iteration 1 to iteration 2):
2.6375e-002    1.6835e-003
Frame Error Rate (from iteration 1 to iteration 2):
6.6667e-001    1.1111e-001
******************************************
************** Eb/N0 =  2.00 db ************
Frame size = 200, rate 1/2.
12 frames transmitted, 2 frames in error.
Bit Error Rate (from iteration 1 to iteration 2):
2.6936e-002    5.0505e-003
Frame Error Rate (from iteration 1 to iteration 2):
6.6667e-001    1.6667e-001
******************************************************** Eb/N0 =  2.00 db ************
```

Frame size = 200, rate 1/2.
14 frames transmitted, 3 frames in error.
Bit Error Rate (from iteration 1 to iteration 2):
3.0664e-002   7.5758e-003
Frame Error Rate (from iteration 1 to iteration 2):
7.1429e-001   2.1429e-001

- -

8. Performances with HSDPA

We presented all the innovations that make HSDPA so efficient and we aim to provide the key performances with HSDPA.

Indoor vs. outdoor HSDPA solutions

In the indoor environment, the small cell size, the very good and controlled coverage, and low mobility lead to a very high spectrum efficiency and very high data rate per user. Even if the 16 QAM modulation is very sensitive to the radio conditions, this modulation will be used most of the time in an Indoor environment. In addition, there is a very low impact on PA power for HSDPA operation, which means the downlink throughput is not significantly impacted by the minimum power required for the signaling HS-SCCH channel. However, when dealing with outdoor configurations, the broadband performances are much more challenging due to higher interference at the cell edge and larger cell size compared to indoor coverage for WLAN-type services. Basically, there is a significant impact on PA power for HSDPA operation, i.e., lower downlink throughput due to required power for HS-SCCH. Therefore, HS-SCCH power control is required to reduce impact on HSDPA throughput as described below. Otherwise, more than 10 percent of the PA should be reserved for the HS SCCH Signaling channel.

Typically, as depicted on the above distribution, in an outdoor environment, the signal to interference ratio is less than -2 dB for more than 90 percent of the cell, which means a minimum power of – 9 dB on HS-SCCH to guarantee a probability of error on the signaling downlink channel of one percent. This results in 12 percent of the PA. As there is a linear relationship between the radio conditions of the terminal equipment and the power needed on the HS-SCCH signaling channel, it is possible to build a smart RF algorithm within the UMTS BTS. This is able to provide the right power for HS-SCCH to every user of the cell due to the CQI information. For example, with a reasonable error rate of two percent of HS-SCCH, a user reporting a CQI of 7 will require -12 dB of HSSCCH Power and another user reporting a CQI of 12 will require only -19 dB of HSSCCH Power.

Throughput per cell and throughput per user

The capability to change the modulation, the coding and the number of SF16 codes during the communication enables a higher average data rate and higher spectrum efficiency. But the support of a high number of SF 16 codes and the support of the 16 QAM modulation require very good radio conditions, i.e., high CQI.When dealing with more than five SF16 codes, a classical Rake Receiver is not able to counter the Multiple Access Interferences and even if fast retransmissions enable the partial coping with Multiple Access interference, it leads to an asymptotic throughput of 2 Mbps.

Coverage

In most cases, wireless operators have already deployed a large number of UMTS BTSs by using RF dimensioning for 64-kbps services. It is very important to understand the impact of a migration towards HSDPA in terms of capacity and coverage. Paradoxically, HSDPA enables a wider coverage than UMTS R'99 due to the adaptive modulation and coding and the fast scheduler in the BTS, which provides more granularity in term of radio and resource management·

9. Conclusion and Future work

It is clear from the above simulation results that the Bit error rate of the transmission decreases as the numbers of iterations are increasing. With an increase in the number of iterations, the frame error rate is also decreases. The loop gets terminated when the maximum specified limit of Frames in error is encountered. It can be deduced from above points that by using Turbo Coding in HSDPA systems, an error free and secure transmission with very high data rates can be achieved.

HSDPA technology is incorporated in WCDMA Release 5 to increase data throughput and improve the efficiency of the system for downlink data traffic. The main changes introduced by HSDPA are new high-speed data channels, the combination of time-division multiplexing with code-division multiplexing, the use of AMC and HARQ techniques, and the relocation of MAC layer scheduling to the Node-B. With a thorough understanding of these changes, design and test engineers can begin to successfully implement HSDPA into network and UE.

Looking forward to Release 6, the content of which is being finalized at this time, the most significant feature targeted for the radio interface is the EUDCH. This feature will introduce techniques similar to HSDPA to improve coverage, increase throughput, and reduce delay on the uplink this time. Release 7 will likely include MIMO antennas, which support higher data rates and are considered an enhancement to HSDPA. HSDPA provides lower latency with a Round Trip Delay of 70 ms, enabling great interactive applications like multi-user gaming.

HSDPA is an important ingredient needed to ignite global commerce and to enhance human experience as it will provide a ubiquitous access to Wi-Fi applications without any constraint of hot spots and provide seamless access to every type of broadband service that is already used with ADSL.In addition, to meet the growing demand for data services, innovations in MIMO and OFDM radio technology will allow the ability to cost-effectively add capacity to support the emerging broadband wireless era. With wireless mobile radio communication, there is an endless quest for increased capacity and improved quality. As HSDPA is about to launch, new technologies are promising even more bandwidth and new services like HSUPA (Enhanced DCH in 3GPP Release 6), MIMO (Multiple-Input Multiple-Output) and OFDM (Orthogonal Frequency Division Multiplexing) in 3GPP Release 7.

References

[1] T. Ojanpera and R.Prasad, "An overview of air interface multiple access for IMT- 2000/UMTS", IEEE Commun. Mag., vol. 36, pp. 82-95, Sept. 1998.

[2] Correal, N.S., Swanchara, S.F. and Woerner, B.D., Implementation issues for multiuser DS-CDMA receivers, Int. J. Wireless Inform. Networks, 5(3), 257–279, 1998.

[3] Niyato, D Hossain, E Wavegedara, K.CBhargava, Radio Link Level Performance in Multi-Rate MIMO Wireless Networks: Analysis and Optimization, Wireless Comm.and Networking Conference, 2007.WCNC 2007. IEEE
Volume , Issue , 11-15 March 2007 ,pp294 – 298

4]Claude Berrou, Alain Glavieux, "Near Optimum Error Correcting Coding and Decoding: Turbo Codes", IEEE Transactions on Communication, Vol.44, No.10, October 1996.

[5]Javel, A., Nortel Networks ‘‘Evolving Enabling Technologies for 4G’’, Third Generation (3G) Mobile World Summit, Tokyo, Japan, 15–18th Jan 2002.

[6]. 3GPP TR 25.848 V4.0.0 (2001-03), Physical layer aspects of UTRA High Speed Downlink Packet Access, Release 4.

[7]J. R. Fonollosa, M. Heikkilä, X. Mestre, A. Pagès, A. Pollard, L.Schumacher, A. Wiesel and J. Ylitalo, “Adaptive Modulation Schemes for MIMO HSDPA,” IST Mobile & Wireless Telecommunications Summit 2002, Thessaloniki, Greece, June 2002.

[8] B. Hassibi and Bertrand M. Hochwald. “High rate codes that are linear in space and time”, IEEE Trans. Info. Theory, April 2001.

[9] S. M. Alamouti, “A Simple Transmitter Diversity Scheme for Wireless Communications”, IEEE J. Sel. Area Comm., pp. 1451-1458, Oct. 1998.

[10] Motorola, “Voice and HSDPA Data Peformance Results”, 3GPP TSG_R WG1 Document TSGR1#20(01)-0545, 21st-25th May, 2001,

[11]IST-2000-30148 I-METRA, Deliverable 3.1, "Design, Analysis and Selection of Suitable Algorithms", www.istimetra.org.

[12] IST-2000-30148 I-METRA, Deliverable 3.2, "Implementation of Relevant Algorithms", www.ist-imetra.org.

[13] METRA Project Deliverable D5.1, "Architectural Design and Cost Impact", www.ist-imetra.org.

Authors

Shailendra Mishra

Received Ph.D degree from G Kangri Vishwavidyalaya (Deemed University), India,Master of Engineering Degree (M E) in Computer Science & Engineering (Specialization: Software Engineering) from MotiLal Nehru National Institute of Technology (MNNIT), Allahabad (Deemed University), India. From August 1994 to Feb 2001, he was associated with the Department of Computer Science and Electronics at ADC, University of Allahabad, India as a faculty and coordinator Computer Science & Electronics Department. From Feb 2001 to Feb 2002 he has been with RG Engineering College, Meerut affiliated to UP Technical University, Lucknow, India as Assistant Professor, Department of Computer Science and Engineering. From Feb 2002 to Aug 2009 he has been with Dehradun Institute of Technology (DIT) affiliated to UA Technical University, Dehradun, as Professor & Head, Department of Computer Science & Engineering India Presently he is Professor & Head, Department of Computer Science & Engineering ,Kumaon Engineering College,Dwarahat,India. His recent research has been in the field of ICT, Mobile Computing & Communication and Computer Network. He has also been conducting research on Communication System & Computer Networks with Performance evaluation and design of Multiple Access Protocol for Mobile Communication Network. He handled many research projects during the last 5 years; Power control and recourse management for WCDMA System funded and sponsored by AICTE New Delhi, Code and Time complexity for WCDMA System, OCQPSK spreading techniques for third generation communication system, "IT mediated education and dissemination of health information via Training & e-Learning Platform" sponsored and funded by Oil Natural Gas Commission (ONGC), New Delhi, India (November 2006),"IT based Training and E-Learning Platform", sponsored and funded by UCOST, Department of Science and Technology,Govt. of Uttarakhand, India (December 2006) etc. He is the author of 30 Technical papers in International, National journals and conference proceedings and three books in the area of Computer Network and Security.

Prof. Durg Singh Chauhan

He did his B.Sc Engg.(1972) in electrical engineering at I.T. B.H.U., M.E. (1978) at R.E.C. Tiruchirapalli (Madras University) ,PH.D. (1986) at IIT/Delhi and his post doctoral work at Goddard space Flight Centre, Greenbelf Maryland. USA (1988-91). His brilliant career brought him to teaching profession at Banaras Hindu University where he was Lecturer, Reader and then has been Professor till today. He was director KNIT sultanpur in 1999-2000 and founder vice Chancellor of U.P.Tech. University (2000-2003-2006). Later on, he served as Vice-Chancellor of Lovely Profession University (2006-07) and Jaypee University of Information Technology (2007-2009) ,currently he has been serving as Vice-Chancellor of Uttarakhand Technical University for (2009-12) Tenure.
He was member, NBA-executive AICTE, (2001-04)-NABL-DST executive (2002-05) and member, National expert Committee for IIT-NIT research grants. Currently He is Member, University Grant Commission (2006-09). He was member, CAPART, National executive and chairman central zone, Lucknow from (2001-2004). He is presently nominated by UGC as chairman of Advisory committees of three medical universities. Dr Chauhan got best Engineer honour of institution of Engineer in 2001 at Lucknow.
He supervised 12 Ph.D., one D.Sc and currently guiding half dozen research scholars. He had authored two books and published and presented 85 research papers in international journals and international conferences and wrote more than 20 articles on various topics in national magazines. He delivered hundreds of lectures in USA and Canadian universities and visited half dozen countries in Europe and Asian continent. He is Fellow of institution of Engineers and Member IEEE. He brought all the universities he served at international scene by his specific contributions. Beside many other Contributions the social service was his mission throughout his life and engaged in tribal areas since two decades. He has been admired for his number of contributions in society. He headed more than 40 NBA visits, 20 deemed university teams of the UGC as chairman, member for half dozen vice chancellor search committees in UP, MP,TN and Rajasthan. Member, executive committee NERIST Arunachal Pradesh, and was member R.E.C. Kurukshetra, U.P. college, Varanasi (autonomous) in the beginning of his first tenure at U.P.Tech. University. Lucknow,India