A Survey Report on Scheduling Algorithms for UMTS

Archana Lakhera, Vineet Richariya

Abstract: High Speed Downlink Packet Access (HSDPA) is a feature which was introduced in year 2002 as a part of the Release 5 specifications of 3GPP WCDMA/ULTRA-FDD standards. Scheduling algorithms implemented in the base stations have direct influence on mobile network performance. Most of the new scheduling algorithms proposed by the research community have not been tested in a real world environment or an industry standard network simulator, therefore unable to gain more practical utility. This survey paper focuses on exploring the effective mobile communication specifically for third generations. This review paper also focuses on compare the current UMTS (Universal Mobile Telecommunication System) and HSDPA.

I. INTRODUCTION

The objective behind HSDPA implementation is to increase user peak data rates, quality of services, and to generally improve spectral efficiency for downlink asymmetrical and bursty packet data services. This is accomplished by introducing a fast and complex channel control mechanism based on a short and fixed packet transmission time interval (TTL), adaptation modulation and coding (AMC), & fast physical layer (L1) hybrid ARQ.

As part of the natural evolution of data communications and telecommunications, the development of cellular networks is having an exponential increase that started in 2002 with the launch of the Wideband Code Division Multiple Access (WCDMA) networks. The Third generation Partnership Project (3GPP) WCDMA networks are currently deployed in 120 countries around the world, with 379.3 million subscribers. Mobile communication forecasts suggest that the average revenue per user for voice traffic is set to decline in cellular networks, which leads operators to introduce new data services to sustain their business growth in the regions where the speech service is already deployed. This pushes the WCDMA networks to deliver an ever increasing share of voice and data traffic, driven by the rapid increase in the demand for data services, primarily IP.

3G systems are defined by a collection of international standards and technologies, defined in the ITU specification International Mobile Telecommunications-2000 (IMT-2000), with the goal of increasing efficiency and improving the performance of mobile wireless networks. IMT-2000 is a radio and network access specification, defining several recommended methods and technology platforms that meet the overall goals of the specification. It provides a framework for worldwide wireless access by connecting the various systems of terrestrial and/or satellite based networks and intends to take advantage of the potential synergy between digital mobile telecommunications technologies and systems for fixed and mobile wireless access systems.

HSDPA networks provide us with mobile broadband at speeds up to a theoretical maximum of approximately 10 Mb/s. However, due to network congestion it is often extremely difficult to achieve speeds anywhere near this maximum value. One of the challenges for these networks is to meet the stringent quality of service requirements of traffic such as voice over IP (VoIP) and video streaming, whilst trying to optimize network throughput. One of the network elements that have a direct influence on performance is the scheduling algorithm used in the base station (Node B). Current scheduling algorithms are very basic in design and there have been new, more sophisticated algorithms proposed by the academic community. Most of these new algorithms have not even been tested using live test-bed scenarios or even with industrial strength simulators; therefore it is very difficult to comment on their performance in a meaningful and critical way.

II. UMTS

The Universal Mobile Telecommunications System (also known as UMTS) is a third generation (or 3G) telecommunications technology for mobile electronics. The most common form of UMTS makes use of W-CDMA (Wideband Code Division Multiple Access, which is an air interface standard that is a compulsory feature of any mobile telecommunications device of the 3G network). However, the system makes use of TD-CDMA (Time Division CDMA) and TD-SCDMA (Time Division Synchronous CDMA). UMTS is a complete network system. As such, it also covers the radio access network, the core network, and the authentication of users using the USIM cards (or Subscriber Identity Module). UMTS requires the use of new base stations, as well as new frequency allocations. Despite these restrictions, however, UMTS is closely related to GSM (that is Global System for Mobile Communications, the most popular standard for mobile communication technology), and builds upon the concepts of GSM – most UMTS handsets support GSM in order to allow dual mode operation without any issues.

Manuscript received February 28, 2011. Archana Lakhera is with the Lakshmi Narain College Of Technology, Bhopal, INDI A (e-mail: simmy04lakhera@gmail.com).

Vineet Richariya, is with the Lakshmi Narain College Of Technology, Bhopal, INDI A (e-mail:vinneet_rich@yahoo.com.).
III. HSDPA

High Speed Downlink Packet Access (HSDPA) is an enhanced 3G (third generation) mobile telephony communications protocol in the High Speed Packet Access (HSPA) family, also dubbed 3.5G, 3G+ or turbo 3G which allows networks based on Universal Mobile Telecommunications System (UMTS) to have higher data transfer speeds and capacity. HSDPA will enable the user to achieve high data rates in the downlink while on the move. Current HSDPA deployments support down-links speeds of 1.8, 3.6, 7.2 and 14.0 Mbits/s downlink and 84 Mbits/s with Release 9 of the 3Gpp standards.

- Primary goal of HSDPA is to enhance system throughput with minimum changes in network architecture,
- Need of higher bit rates for sophisticated UE applications.

IV. HSDPA Vs CURRENT UMTS SYSTEM

In WCDMA downlink various methods for data packet transmissions are already exits in Release 99. There are three different channels in Release 99/Release 4 WCDMA specifications that can be used for downlink packet data are:
- Dedicated Channel (DCH)
- Downlink-shared Channel (DSCH)
- Forward Access Channel (FACH)

The basic requirements for HSDPA are to carry high rate in the downlink. The HSDPA technology will:
- Reduce the round trip delay
- Increase the peak data rates up to 14 Mbps
- Compatibility of service within the IMT-2000 family of standards (GSM, ATM, IP).
- High quality of service.
- Worldwide or at least regional common frequency bands.
- Small terminals for worldwide use and global roaming capability.
- Applications and terminals. Support for multimedia services,
- Flexibility for evolution to the next generation of wireless networks.
- Increase the UTRAN network capacity

To achieve the above current UMTS architecture is maintained and some other features or functionalities are added on top of the existing architecture.

3.1 Physical Channel Changes

To support HSDPA, new physical channels have been added to the UMTS specification:

3.1.1 High Speed Physical Downlink Shared Channel (HS-PDSCH) is the transport mechanism for the new HSDPA logical channels. This channel will be both time and code shared between users attached to a Node-B & HS-PDSCH is the channel mapped to the HS-DSCH transport channel that carries actual user data.

3.1.2 High Speed Dedicated Physical Control Channel (HS-DPCCH) is an uplink channel that carries packet acknowledgment signaling for each transport block and a Channel Quality Indicator (CHI) used by the Node-B to perform AMC.

3.2 Logical Channel Additions:

3.2.1 High Speed Downlink Shared Channel (HS-DSCH) - provides the logical mechanism for data transfer. This is the transport channel carrying the user data with HSDPA operation.

3.2.2 High Speed Shared Control Channel (HS-SCCH) - provides timing and coding information to the User Equipment (UE). This allows the UE to listen the HS-DSCH at the correct time and using the correct codes to allow successful decoding of received data.

With HSDPA two fundamental features of WCDMA are disabled which is:
- Variable SF and
- Fast Power Control

These two features are replaced by:
- Adaptive Modulation Coding (AMC)
- Fast retransmission strategy (HARQ)
- Scheduling Algorithm

Thus the comparison for the UMTS Release-99 and UMTS Release-5 (HSDPA) can be made as:

<table>
<thead>
<tr>
<th>Table 4.1: Comparisons between Rel-99 and HSDPA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UMTS Release-99</strong></td>
</tr>
<tr>
<td>TTI=10, 20, 40, 80 ms</td>
</tr>
<tr>
<td>Variable SF=1 256</td>
</tr>
<tr>
<td>More transport block per TTI</td>
</tr>
<tr>
<td>Convolutional code or turbo codes</td>
</tr>
<tr>
<td>QPSK only</td>
</tr>
<tr>
<td>Congurable CRC</td>
</tr>
<tr>
<td>Scheduling in RNC</td>
</tr>
<tr>
<td>Retransmission in AM RLC</td>
</tr>
</tbody>
</table>

V. SCHEDULING ALGORITHMS

In general, there are various scheduling algorithms which have direct influence on mobile network performance. Some commonly used scheduling algorithms are:

4.1 Round-robin Method: This method is simplest one which served in a cyclic orderly fashion. Starvation is not possible with the RR scheduler. Here CQI information does not used and therefore may offer lower system throughput than MaxCIR and PF. And another disadvantage of RR scheduling algorithm is that there is no differentiation in the quality of services for different classes of users.

4.2 Maximum C/I (carrier-to-interface) ratio method: In this method, the system throughput is maximize by choosing the user who with the best channel quality condition in every TTI. But there is a problem that users with bad channel conditions cannot be scheduled ever than starvation.
4.3 Proportional fairness (PF): In this method starvation problem solve by fairness thinking. It tries to increase the degree of fairness among users by selecting those with the largest relative channel quality.

4.4 Packet Scheduling: In HSDPA system, packet scheduler is one of central resources management (RRM) functions since it determines overall behavior and performance. In case of packet scheduling for each time interval (TTI), packet scheduler determines which user shared channel transmission should be assigns at a given time. User equipment should use high speed physical downlink shared channel (HS-PDSCH) to transmission the data. In HSDPA, the packet scheduler can exploit short term variations in the different user’s radio conditions by selecting good instantaneous channel condition for transmission. This concept is based on the fact that good channel conditions allow for higher modulation and coding increasing the system throughput.

4.5 Packet scheduling algorithm in QoS Provision in HSDPA: This method is introduced to satisfy the both QoS requirements and maximum the system throughput. This scheduling algorithm is effective when HSDPA resources limited. Meanwhile, this method not only guarantee the QoS requirements but also maximum the throughput performance with stable and efficiency.

4.6 Error-rate consideration scheduling algorithm: The error rate metric improves the effectiveness of sharing resources without affecting a good balance between the system performance and user fairness.

VI. DATA TRANSMISSIONS

With HSDPA, data transmission can be divided in time and codes (code multiplexing) to accommodate several users per transmission time interval (TTI). Code multiplexing makes it possible to use all available codes per TTI, even if the codes are not all supported by a given end-user’s device. For instance, three users with a five-code device can be served simultaneously during the same TTI. Code multiplexing also enables combined transmissions when several users’ RBS-buffered data does not fill up an entire TTI. It can even reduce delay for active end users in a cell by reducing waiting time while transmissions are being scheduled.

Delay-sensitive applications with short, bursty data packages, such as voice over IP (VoIP), will benefit from code multiplexing when HSDPA usage increases in a network.

VII. SIMULATION ENVIRONMENT

Simulation is becoming an increasingly popular method for network performance analysis. Software simulator is a valuable tool especially for recent networks with complex architectures and topologies. A typical simulator can provide the programmer with the necessary information of how to control and manage the performance of a computer network. Functions and protocols are described either by finite state machine, native programming code, or a combination of the two.

Network simulators have developed since they first appeared as performance, management and prediction tools. They are normally used as network management tools, for which packet level analysis is not commonly employed. The most known network simulator OPNET (OPNET stands for OPtimum NETwork performance) from OPNET Technologies Inc. is superior compared with other network simulation packages in terms of user interface, flexibility, scalability, and accuracy. OPNET’s IT Guru can be applied for the performance study of any network; it provides a comprehensive development environment for the specification simulation and performance analysis of computer networks.

7.1 The Simulation Methodology:
Model creation using OPNET IT GURU is straightforward. Each location can be modeled as a subnet that contains switches with some computers and other WLANs that represent the networks. The links being used inside each subnet of the access link type. According to the OPNET software performance, each node (computer or network device) in the simulation model has a set of attributes (parameters) which can be configured through the node attributes editor. They describe the behavior of the node throughout the simulation.

VIII. FUTURE DEVELOPMENTS

The first commercial HSDPA services and network implementations have proven to be attractive and robust, providing significant improvement over other technologies. But this is just the beginning—future enhancements will include code multiplexing, more HSDPA codes and dynamic code allocation, advanced receiver technologies, enhanced schedulers, and enhanced uplink (E-UL) and evolution of the standards.

IX. CONCLUSIONS

HSDPA is rapidly becoming a commercial reality in numerous networks around the world. Measurements made in live networks show impressive performance. The strengths of Ericsson’s WCDMA radio network design,

- Positively influence end-user perception of HSDPA performance; and
- minimize the need for operators to deploy additional cell carriers in order to support new HSDPA services.

Following a strong start, HSDPA will continue to evolve through numerous performance enhancements that will both make HSDPA services more appealing to end users and provide the system capacity that is needed to support rapid HSDPA service uptake.

REFERENCES


Archana Lakhera, MTec (Computer Science & Engineering) final year student of Lakhmi Narain College Of Technology, Bhopal. She did her B.E(Information Technology)from Madhav Institute Of Technology & Science,Gwalior,India in year 2007. Prof. Vineet Richariya,Head Of Department of Information Technology, Lakhmi Narain College Of Technology, Bhopal,India.He did his MTec(Computer Science & Engineering)from BITS Pilani in year 2001.He did his B.E (Computer Science & Engineering) from Jiwaji University,Gwalior,India in year 1990.