Capacity Planning and Dimensioning of an Agricultural Call Center

Himadri Subrah Saha, Rakhi Roy *and* Mustafa Mahmud Hussain

Abstract—Call centers are an integral part of many businesses, and their economic role is significant and growing. This call center can take a major part in our agriculture and thus it can enhance the growth of our economy. Properly designing a new call center is one of the most important tasks. Any organization may face difficulties. When it comes to design for a special purpose the task should need to be done more accurately. This paper focuses the steps involved in assessing the technical design, staffing requirements of an agricultural call centre required to serve this type of agricultural call centre for incoming calls.

***Index Terms*—Call center, Erlang B, Erlang C, Forecasting.**

I. INTRODUCTION

There is no doubt that Information and Communication Technology (ICT) holds the promise of transforming the ways we live into new and more powerful ways. ICT has become a strategic resource, a commodity and foundation of every activity from technology, communication, health to entertainment. ICT now plays a major role in education, learning and research in general, agriculture, health, commerce and even in poverty alleviation by generating or creating new jobs and investment opportunities. Bangladesh as a country is besieged by poor infrastructural facilities especially in area of telecommunications. The impact of the information revolution is tremendous, the existing infrastructure, social-economic, cultural, and political situations pose major difficulties in introducing, implementing and diffusing the new technologies for internetworking. The technology and funds are not necessarily the major inhibiting factors, but the will and awareness until lately do not seem to be present in the country, although the poor telecommunication system has made the matter worse. The Bengali still find himself in a state of isolation and stagnation. With the new wave of awareness on the country, Bangladesh could seize the opportunities of the new information technology. This will amongst other advantages allow the region to fight disease, poverty and ignorance in all directions. Agriculture is the only sector Over the course of the last two decades, call centers and contact centers have become the most preferred way for most businesses to communicate with their customers. IT professionals trained in a variety of disciplines from abroad and locally are applying their innovative ideas to maximize the benefit obtained from the information Solution. More and more international companies are seeking solutions from Bangladeshi professionals to remain competitive in the global economy. A well developed infrastructure, availability of skilled labor, software technology companies at nominal cost, and significant government incentives provide a conducive environment for the development of the IT and BPO industry. Bangladesh offers a large supply of low-cost labor and state of the art technology infrastructure for establishing world-class call centers. Companies in Bangladesh are developing hardware and software at much lower cost than our competitors. Bangladeshi trained professional call center agents will be techno-literate individuals and undergo special language training courses to ensure that callers don't feel that they are talking to someone in another part of the world. Bangladesh has now many companies providing transcription services to clients locally as well as globally. Specialized training programs in this sector have provided the industry with a large pool of data entry operators providing low cost, quality services. The most important reason why Bangladesh is a potential market for outsourcing is a simple one. It costs less, far less, to do business in Bangladesh, than any-where else. To summarize, the main motivation factors include: 1. Government Support 2. Availability of Better Infrastructure & HR 3. Low Operating Cost [1].The objective of this agricultural call center will be to provide the farmers the appropriate information to increase the production of their crops, to give information about pesticides in their field, to give consultancy and information which fertilizer is suitable for his land and his crop needs which fertilizer right now, to provide information how to increase the fertility of the their land, circulating valuable information about poultry feeds and to provide information on cattle feeding,poultry,fish cultivation and many more agriculture related information.

II. AGRICULTURE CALL CENTER ARCHITECTURE

At its core, a call center constitutes a set of resources – typically people, computers and telecommunication equipment – which enable the delivery of services via the telephone. The working environment of a large call center can be envisioned as an endless room, with numerous

Himadri Subrah Saha is with the Department of Electronics and Communication, East West University, 43, Mohakhali, Dhaka, Bangladesh (e-mail: hssahaetc09@gmail.com).

Rakhi Roy is with the Department of Electrical and Electronics, American International University,Kamal Ataturk Avenue,Dhaka-1213,Bangladesh (e-mail: rakhiroy@aiub.edu).

Mustafa Mahmud Hussain is with the Department of Electronics and Communication, East West University, 43, Mohakhali, Dhaka, Bangladesh (e-mail: mhussain@ewubd.edu).

open-space cubicles, in which people with earphones sit in front of computer terminals, providing teleservices to phantom customers. The large-scale emergence of call centers, noticeably during the last decade, has been enabled by technological advances in the area of Information and Communication Technology (ICT). First came PABX's (Private Automatic Branch Exchanges, or simply PABX), which are the telephone exchanges within companies. In Fig 1- Call/Contact Center a PABX connects via trunks (telephone lines).These, in turn, are stated by telephone agents, often called CSR's for Customer Service Representatives, for short. Intermediary between the PABX and the agents is the ACD (Automatic Call Distribution) switch, whose role is to distribute calls among idle qualified agents. A secondary responsibility of the ACD is the archival collection of operational data, which is of prime importance as far as call center research is concerned. [1] [2] [3][4]

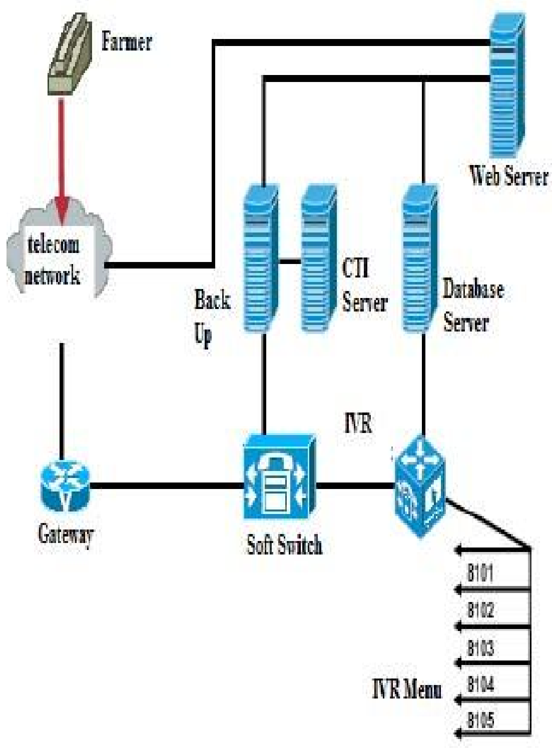

Fig. 1. System Architecture

III. PLANNING THE AGRICULTURE CALL CENTER

Level –I: The call coming to the call center is picked up by an operator (level –I functionary) who after a short welcome message takes down the basic information and the query of the caller. These details are fed into a computer located next to the operator by the operator himself. And the first level receiver of the call would also feeds into the computer the question being asked by the farmer. The first level operators preferably would be an agricultural graduate with rural background knowing local language. They should also posses' good communication skills.

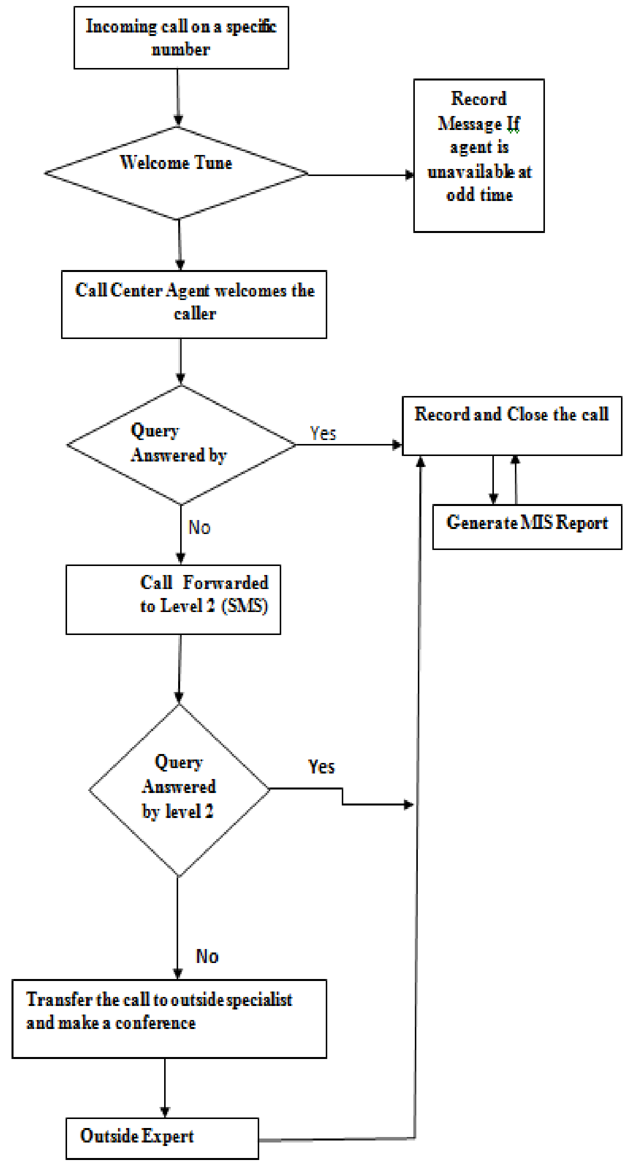

Fig. 2. Call Flow Schematic Diagram

Level-II: The level –II may consist of Subject Matter Specialists (SMS) who are having working experience in research institutes like SRDI, BARI, BRRI, BARC etc. In case the first level operator is not able to answer the question, the operator forwards (in call sharing mode) the call to the concerned Subject Matter Specialist. The data relating to the caller including the question asked is also be transferred to the Level-II functionary on his computer along with the call. Hence, when the specialist takes the forwarded call, his computer also shows the data and question asked so that there is no repetition. It is envisaged that in normal cases, the entire spill over questions from the first level get answered at this level. The replies would be sent to the farmers promptly by post/e-mail/fax/ telephone etc. within 72 hours of receipt of the question.

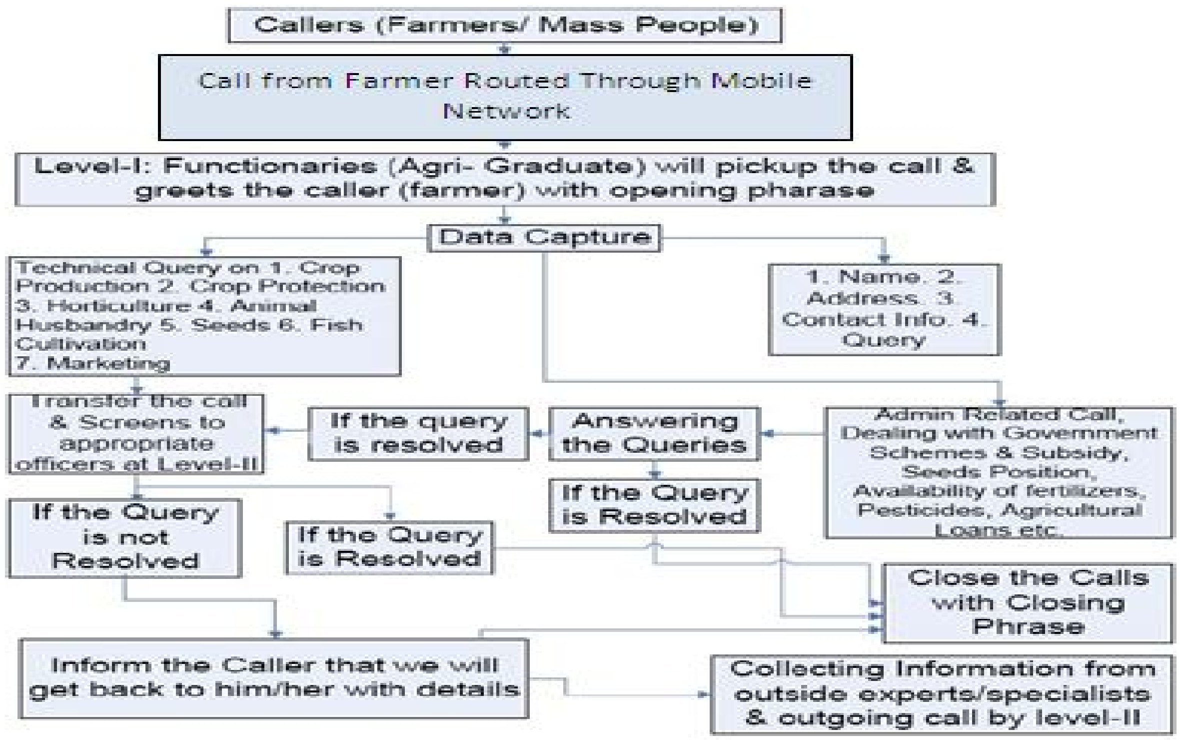

Fig. 3. Total Process Flow

While selecting the specialists, it would be important to first identify the subject matter they will be dealing with. These specialists should be such that they will answer most of the questions that are likely to be asked. There could be two options available on the selections of the specialists.

There are two distinct areas of design required in such an application. The questions which must be answered are:

1. How many call centre agents do I need?
2. How many trunks do I need?

As call holding times depend upon average queuing times (which depend upon the number of agents deployed), the two questions must be addressed in the order shown. Calculating the number of agents required is a continuous process which will require regular reassessment as the circumstances of a call center change. Assessments may be made for each working hour of a day, and should take such factors as marketing campaigns and daily call peaks into account.
We suggest performing a calculation for each working hour. In order to estimate the number of agents required in a particular hour, the following information relating to that hour is required as a minimum:

1. Number of calls received
2. Average duration of these calls
3. Average delay that you accept that incoming callers may experience.

Traffic Analysis A network cannot be properly designed without understanding the traffic patterns which that network will carry. In order to carry out a complete network design, a matrix of traffic figures between every combination of site on that network should be gathered. For each call center, a traffic figure should be obtained for inbound and outbound calls. When sizing a call center or other telephony facility it is desirable to install sufficient facilities to handle the expected traffic load. A good design will not over-size the facility and leave resources unused or under-size it causing blockage and long queue times. Sizing requires looking at several standard parameters. The values of these parameters are plugged into traffic formulas that will perform a statistical analysis of the traffic and predict the numbers of ports, agents, etc. that will be required for the contact center under normal conditions. Various formulas have been developed for analyzing traffic and determining values such as number of ports required, agents, etc. These traffic models have been developed for various situations. Erlang B, Erlang C, Poisson, and Engset, are used for different situations and sets of business rules. The model used depends on the call center traffic arrival pattern and how the calls are treated. Erlang B: Used for calculations where the arrival of the call traffic is random, number of sources is infinite and callers that are blocked do not call back (are cleared) calculations. Erlang B for systems where blocked calls are sent to another facility or receive a busy, and Erlang C for systems where blocked calls are queued.

Erlang B formula can be written as,

$$B(c,a) = \frac{\frac{a^c}{c!}}{\sum_{k=0}^{c} \frac{a^k}{k!}} \quad (1)$$

Where B(c, a) = Proportion of offered load that is rerouted based on the Erlang B model given "c" servers and "a" offered load.

Erlang C: Used for calculations where the arrival of the call traffic is random, number of sources is finite and Callers are put in a queue (delayed) until an agent is available.

$$C(c,a) = \frac{\frac{a^c}{c!(1-\frac{a}{c})}}{\sum_{k=0}^{c-1} \frac{a^k}{k!} + \frac{a^c}{c!(1-\frac{a}{c})}} \quad (0 \le a \le c) \quad (2)$$

C(c, a) = Proportion of offered load that is delayed based on the Erlang C model given "c" servers and "a" offered load.

Poisson: Used for calculations where the arrival of the call traffic is random and callers that are blocked call again. Poisson tables are also referred to as Retrial tables. Developed by AT&T engineer Edward Molina in the 1905. In the 1920s AT&T put these calculations to use when they found the predicted service levels from Molina's calculations matched well with their production systems and the actual numbers seen. When the calculations and implementations were published, it was pointed out that a French mathematician, S.D. Poisson, had derived the same formulas in the 1820s. Molina gave credit to Poisson and the calculations bear his name. Poisson calculations assume a blocked call is re-tried.

$$P(c,a) = 1 - \sum_{k=0}^{c-1} \frac{a^k}{k!}(e^{-a}) \quad (3)$$

P(c,a) = Proportion of offered load that is blocked based on the Poisson model given "c" servers and "a" offered load.

Engset: Used for calculations where the arrival of the call traffic is smooth, number of sources is finite and all callers are answered immediately. (no blocking or delay) In 1918 T. Engset discovered an anomaly in the Erlang B tables. In the Erlang B it is assumed that there are an infinite number of sources for calls. In situations where you had a limited number of sources generating calls to a call center (such as calls coming from a limited number of employees) Erlang B can result in too high a number of servers required.

Engset calculations produce a more accurate result for traffic generated by a finite source.

$$E(c,s,a) = \frac{\binom{s-1}{c} \cdot \hat{a}^c}{\sum_{k=0}^{c-1} \binom{s-1}{c} \hat{a}^k} \quad (4)$$

Where $\hat{a} = \frac{a}{s - a[1 - E(c,s,a)]}$

and E(c,s, a) - The probability of blocking given "c" servers, "a" offered load, and "s" sources.

We have used standard telephony traffic formulas to calculate the needs for trunks, agents, and IVR ports. Traffic calculations are the result of the statistical analysis of a call arriving at any one time. These calculations are based on the Busy Hour Call Attempts (BHCA) and the Service Level Goal (SLG). Number of calls received and Average duration of these calls describes the incoming traffic levels and must be established from call statistics or from estimates based on your understand of call center business. Aver-age delay that a caller accepts that incoming callers may experience is your performance criterion. Another per-formance criterion which can be used defines call handling in terms of the percentage of calls answered within a target queuing time (e.g. 85% of calls answered within 20 seconds of ringing). Wrap up time (or wrap time) is the time an agent remains unavailable to answer a call after a call has been completed. It is usually the time taken to carry out administrative tasks relating to a call such as entering an order on a terminal. For the purposes of Erlang C, wrap up time should be included in average call duration. Having established these three minimum parameters for an hour, an estimate of the number of agents required can be made using the Erlang C Traffic Model. Whereas the number of agents required can (and should) be dynamic, changing from hour to hour, the number of lines required to connect a call center with a central office exchange is fixed (at least in traditional circuit switched technology) and must cater for the maximum anticipated traffic levels which will be encountered. Engineering the number of lines required is known as dimensioning a trunk group. The Erlang B traffic model can be used to estimate the number of lines required. This traffic model requires the following inputs:

- Busy Hour Traffic
- Blocking

Busy Hour Traffic Represents the quantity of traffic expressed in a unit called Erlang. For the purposes of these calculations, 1 Erlang can be considered equivalent to 1 hour of calls.

The busiest hour must always be used for busy hour traffic calculations. But, wrap up time is not included. In working out the number of lines required, the busy hour traffic must be based on the duration of the calls and the queuing times as these account for trunk occupancy; wrap up time does not occupy a trunk. The busy hour traffic is calculated as follows: BHT= [{Average call duration (s) + Average delay (s)} *Calls per hour] / 3600 The resulting figure shows the total trunk occupancy in hours, including the average delay period during which calls are being queued in an ACD and occupying trunks. It is important to note that the busy hour traffic figure should represent the busiest traffic load a call centre will ever be offered. The trunk group being designed must be large enough to cater not just for today's peak, but for every peak. Therefore, extreme caution should be exercised when calculating BHT. Blocking The blocking figure describes the calls which cannot be completed because insufficient lines have been pro-vided. A figure of 0.01 means that 1% of calls would be blocked; this is a normal figure to use in traffic engineering. For some applications, 0.03 (3%) blocking is used. Having established these two parameters, an estimate of the number of lines required can be made using the Erlang B Traffic Model. The Erlang B and C traffic models make certain assumptions about the nature of the call arrivals. Amongst them is the assumption that call arrivals are random (Poisson arrivals). Although this is quite reasonable in most applications, it can cause inaccurate results when there is a sudden peak of calls. This type of peak can be produced by a radio or television advertisement being shown (which can often be the reason for a call centre's existence in the first place!) Where drastic call peaks are expected, over-engineering of trunks and call center agents should always be carried out - always be on the safe side! The Erlang C traffic model does not take abandoned calls into account, but if your call center is engineered correctly, this should not be a factor. It may cause a problem when attempting to use Erlang C to analyses an existing call centre with poor performance. [3] [4] [5] [6] [7]

IV. RESULTS AND ANALYSIS

Having established these three minimum parameters Number of calls received, Average duration of these calls, Average delay that you accept that incoming callers may experience for an hour, an estimate of the number of agents required can be made using the Erlang C Traffic Model.

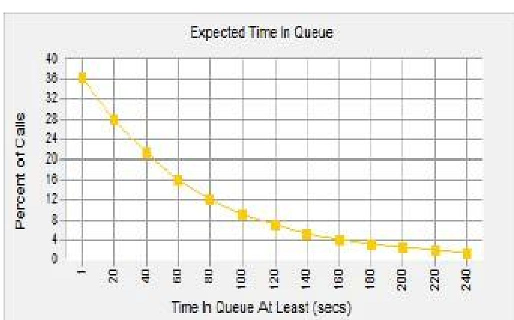

Fig. 4. Expected time in queue

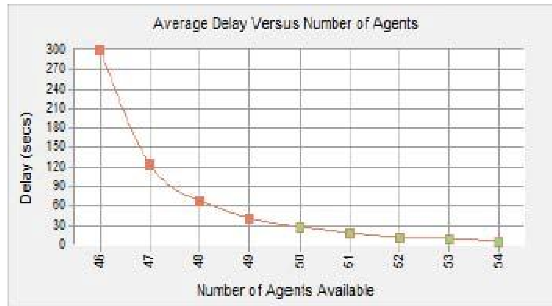

Fig. 5. Average delay vs. number of agents

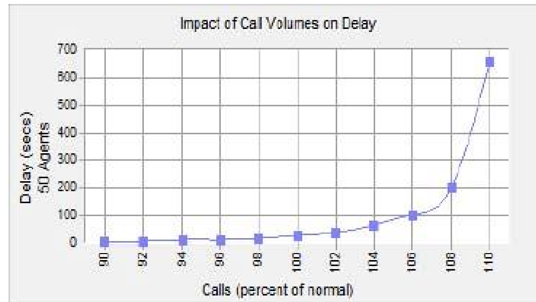

Fig. 6. Impact of call volumes on delay

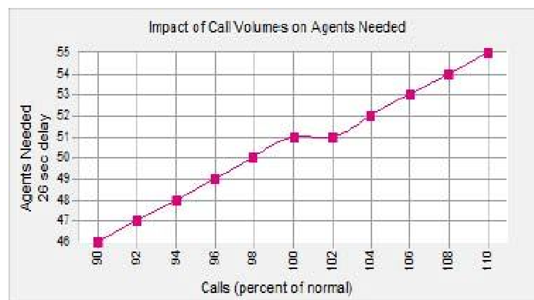

Fig. 7. Impact of call volumes on agent needed

In our analysis and simulation, we have taken

- Calls received in the hour 200
- Average call duration 240 seconds (210seconds duration + 30 seconds wrap up time).
- Average delay to all calls 10 seconds
- 92% Calls answered in within 40 sec
- Using Erlang C Traffic Model We have calculated Number of agents required is 18
- Using Erlang B Traffic Model We have calculated Number of trunks required is 25

V. CONCLUSION

A Call Center cannot be properly designed without understanding the traffic patterns which that network will carry. In order to carry out a complete network de-sign, a matrix of traffic figures between every combination of site on that network should be gathered. For each site, a traffic figure should be obtained for calls to every other site, and this information can be used to calculate between which sites network links should be installed. Calculating the number of agents required is a continuous process which will require regular reassessment as the circumstances of a call center change.

REFERENCES

[1] Brandt, M. Brandt, G. Spahl, and D. Weber, 1997," Modeling and optimization of call distribution systems". *In V. Ramaswami and P.E. Wirth, editors, Proceedings of the 15th International Teletra_Conference*, pages 133-144. Elsevier Science.

[2] L. Bennington, J. Commane, and P. Conn, 2000,"Customer satisfaction and call centers: an Australian study," *Inter-national Journal of Service Industry Management*, vol 11,pp. 162-173,.

[3] S. Bhulai and G.M. Koole, 2000,"A queuing model for call blending in call centers. *In Proceedings of the 39th IEEE CDC*, pp 1421-1426. IEEE Control Society,

[4] L. Peterson, B. Davie, *"Computer Networks"*, 2003.A Systems Approach, 3rd ed.,

[5] Morgan Kaufmann, A. Tanenbaum, *"Computer Networks"*, 4th ed., Prentice Hall

[6] W. Stallings, *Data and Computer Communications*, 7th ed., Prentice Hall, 2003.

[7] J. Kurose, K. Ross, Computer Networks: A Top-Down Approach Featuring the Internet, Addison Wesley, 2001.

Himadri Subrah Saha has completed his graduation in Electronics and Telecommunication from KIIT University,Bhubaneswar,Orissa,India..Right now he is continuing his M Sc. In Telecommunication in East West University,Dhaka,Bangladesh.
He was Assistant Project Manager in an IT Company named Intelligent Image Management Limited,Dhaka,Bangladesh and served there around 2 years.
He is with the Department of Electronics and Communication in East West University,Dhaka,Bangladesh and working as a Graduate Teaching Assistant. His research interests are MIMO (Multiple-Input Multiple-Output),OFDM (Orthogonal Frequency Division Multiplexing),Fading Channels,Cognetive Radio,VoIP and IP Telephoney etc.

Rakhi Roy has completed his graduation in Electrical and Electronics from American International University-Bangladesh.Right now she is continuing her M Sc. In Telecommunication in American International University-Bangladesh.
She is with the Department of Electrical and Electronics in American International University-Bangladesh and working as a Lecturer.Her research interests are MIMO (Multiple-Input Multiple-Output),OFDM (Orthogonal Frequency Division Multiplexing),Fading Channels,Cognetive Radio,VoIP and IP Telephoney ,Renewable Energy, Power Efficiency etc.

Mustafa Mahmud Hussain has completed his graduation in Electrical and Electronics from Ahasanullah University of Science and Technology. He has completed his MSc Telecommunications (Mobile and Personal Communications) from King's College London, University of London, UK.
Right now he is with the Department of Electronics and Communication Engineering in East West University, Bangaldesh as an Assistant Professor.
He was Lecturer (EEE) in American International University Bangladesh (www.aiub.edu), Banani, Dhaka, Bangladesh from December'03 to Mar'04.
He is working in East West University from the year 2004 and taking classes both in post graduate and graduate level.
He is one of the prominent telecommunication consultants in the country. He is also a regular IT content and article writer in the daily newspapers in Bangladesh.
His research interests are MIMO (Multiple-Input Multiple-Output),OFDM (Orthogonal Frequency Division Multiplexing),Fading Channels,Cognetive Radio,VoIP and IP Telephoney,STBC (Space Time Block Code),DIDO (Distributed Input Distributed Output).